Monthly water situation report

England

Summary – June 2014

June rainfall was below average across England at 78% of the long term average. Rainfall totals were lower than *normal* for the time of year in the northwest, east and far southeast of England but elsewhere they were *normal*. Consequently, soil moisture deficits (SMDs) increased across the whole country. Monthly mean river flows for June were *normal* or higher for the time of year at all but two indicator sites across England. Groundwater levels decreased at most of our indicator sites during June, but remain *normal* or higher for the time of year at all sites. Overall reservoir stocks decreased during June, with storage in England as a whole at 90% of total capacity at the end of the month.

Rainfall

During June, the highest rainfall totals (more than 80 mm) fell across parts of Devon and Cornwall, whilst the lowest rainfall totals (less than 20 mm) fell across parts of Kent and Sussex (Figure 1.1).

June rainfall totals were classed as *normal* for the time of year at just over three quarters of hydrological areas across England; rainfall totals across the Brue and Parrett catchments in southwest England were *above normal*. In the remaining hydrological areas across the northwest, east and far southeast, rainfall totals ranged from *below normal* to *exceptionally low*. Cumulative rainfall totals for the three months ending in June were higher than *normal* for much of England, although parts of the northwest and the far southeast of England were *below normal* for the time of year. The influence of the exceptional rainfall in January and February remains evident in the cumulative six month rainfall totals, with the majority of hydrological areas having *exceptionally high* or *notably high* rainfall totals (Figure 1.2).

Rainfall totals for June were below average in all but one region of England. Monthly totals as a percentage of the June long term average (LTA) ranged from 56% in the northwest to 102% in the southwest. Overall, England received 78% of the June LTA rainfall (Figure 1.3). It has been the wettest six month period on record (ending in June) in southeast and southwest England and across England as a whole, and the second wettest six month period (ending in June) in central England.

Soil moisture deficit

In response to the below average rainfall during June, soil moisture deficits (SMDs) increased across England and by the end of the month ranged from just under 40 mm in parts of Devon, Cornwall, Derbyshire and Yorkshire to just over 110 mm along the north Kent coast. SMDs were in the range 41 – 70 mm across most of southern, central and northern England, whereas deficits in the east and far southeast of England were in the range 71 – 112 mm (Figure 2.1).

End of June SMDs were 6 – 25 mm smaller than the LTA in the MORECS grid squares covering a swathe of England from the southwest to the northeast. In contrast, SMDs in the northwest, east and far southeast of England were 6 – 50 mm larger than the LTA (Figure 2.1).

At the end of May, SMDs ranged from 6 mm in the southwest to 22 mm in the east. By the end of June, SMDs ranged from 50 mm in the northeast to 81 mm in the east, with the largest increase of 63 mm occurring in the southeast (Figure 2.2).

River flows

In response to the below average rainfall, monthly mean river flows decreased compared to May at all but one of our indicator sites. Flows on the River Avon in central England increased slightly compared to May. June river flows were *normal* or *above normal* for the time of year at just over four-fifths of our indicator sites, with flows at a further four sites in central and southern England being *notably high*. The groundwater-fed River Darent in southeast England remains exceptionally high for the time of year. Flows on the Derwent in northwest England and the Eastern Rother in the southeast fell to *below normal* for the time of year (Figure 3.1).

River flows at three index sites in southwest, southeast and eastern England were *above normal* for the time of year; flows at the remaining index sites were *normal* (Figure 3.2).

Groundwater levels

Groundwater levels continued their seasonal decline at the majority of indicator sites during June. Levels increased slightly at Swan House (Wear Magnesian Limestone aquifer) and Wetwang (Hull and East Riding Chalk aquifer) in the northeast and Four Crosses (Staffordshire Trent Valley Sandstone aquifer) in central England. At the end of June, groundwater levels were *normal* or higher for the time of year at all our indicator sites. Levels at Swan House in the northeast, Stonor Park (South West Chilterns Chalk aquifer) in the southeast and Skirwith and Priors Heyes (Carlisle Basin & Eden Valley and West Cheshire Sandstone aquifers respectively) in the northwest were *exceptionally high* for the time of year; levels at the latter two sites were the highest on record for the end of June (groundwater levels at Priors Heyes remain *exceptionally high* compared with past levels as the aquifer is recovering from the effects of historic abstraction) (Figure 4.1).

Groundwater levels at the major aquifer index sites were *normal* or *above normal* for the time of year at six sites with the remaining two being *exceptionally high* (Figure 4.2).

Reservoir storage

Reservoir stocks decreased during June at all but three of the updated reservoirs or reservoir groups (located in southeast England). The largest decrease of 16% occurred in the NCZ Regional Group in northwest England, with decreases of 10% occurring in the Pennines Group and Vrynwy reservoir, which also supply the northwest. The Derwent Valley reservoir which supplies parts of central England also decreased by 10%. In spite of these decreases, end of June reservoir stocks remained classed as *normal* or higher for the time of year at all reservoirs and reservoir groups. Five of the seven reported reservoirs in southwest England were *notably high* for the time of year (Figure 5.1).

Overall reservoir stocks decreased across all regions of England, with the largest decrease of 13% occurring in the northwest. Elsewhere the decreases ranged from less than 1% in the southeast to 6% in the northeast. At the end of June, overall reservoir stocks were lowest in the northwest at 75% of total capacity and highest in the southeast at 98%. Overall reservoir storage for England decreased by 5% during June to 90% of total capacity (Figure 5.2).

Forward look

Mid to late July is likely to see typical weather patterns for this time of year, with unsettled conditions in the northwest and spells of warmer and drier weather across the south and southeast. Temperatures are expected to be average for the time of year under unsettled conditions, but higher elsewhere during periods of fine weather. Longer term, for the period July-August-September, above average temperatures are more likely than below average temperatures and there is no strong signal in the precipitation forecast for this period[1].

Scenario based projections for river flows at key sites [2]

September 2014: With average (100% of the LTA) rainfall between July and the end of September 2014, cumulative river flows are likely to be *normal* at nearly four fifths of our modelled sites, and higher at all of the others. With 120% of the LTA rainfall, river flows are likely to be *above normal* or higher at more than half of the modelled sites. With 80% of the LTA rainfall river flows are likely to be *below normal* at nearly a third of the modelled sites (see Figure 6.1).
March 2015: With average rainfall between July 2014 and the end of March 2015, cumulative river flows are likely to be *normal* at all except two of the modelled sites. With above average rainfall (120% of the LTA), cumulative flows are likely to be *above normal* or higher at all except one of our modelled sites. With below average rainfall (80% of the LTA), river flows are likely to be *below normal* or lower at all except two of the modelled sites (see Figure 6.2).

Probabilistic ensemble projections for river flows at key sites [2]

September 2014: More than half of our modelled sites have a greater than expected chance of *normal* cumulative flows from July to September 2014. Two thirds of our modelled sites have a greater than expected chance of *above normal* or higher cumulative flows. Three sites have a greater than expected chance of *below normal* or lower cumulative flows from June to September 2014 (see Figure 6.3).
March 2015: Half of the modelled sites have a greater than expected chance of *above normal* or higher cumulative flows from June 2014 to March 2015. More than half of the modelled sites have a greater than

[1] Source: Met Office
[2] Information produced by the Water Situation Forward Look group led by Environment Agency in partnership with the Centre for Ecology and Hydrology, British Geological Survey, Met Office.

expected chance of *normal* flows, whilst over a quarter of the modelled sites have a greater than expected chance of *below normal* cumulative flows between June 2014 and March 2015 (see Figure 6.4).

Scenario based projections for groundwater levels in key aquifers [3]

September 2014: With average rainfall (100% of the LTA) from July to September 2014, groundwater levels are likely to be *normal* or higher for the time of year at all except one modelled site, and *above normal* or higher at nearly half of the modelled sites. With above average rainfall (120% of the LTA) all of the modelled sites are likely to be *normal* or higher. With 80% of the LTA rainfall, all except one modelled site are likely to have *normal* or higher groundwater levels for the time of year (see Figure 6.5).

March 2015: With average rainfall (100% of the LTA) from July 2014 to March 2015, groundwater levels are likely to be *normal* or higher for the time of year at all but one modelled site. With above average rainfall (120% of the LTA), levels are likely to be *notably high* or higher for the time of year at four fifths of the modelled sites. With below average rainfall (80% of the LTA), groundwater levels are likely to be *below normal* or lower at a third of our modelled sites (see Figure 6.6).

Probabilistic ensemble projections for groundwater levels in key aquifers [3]

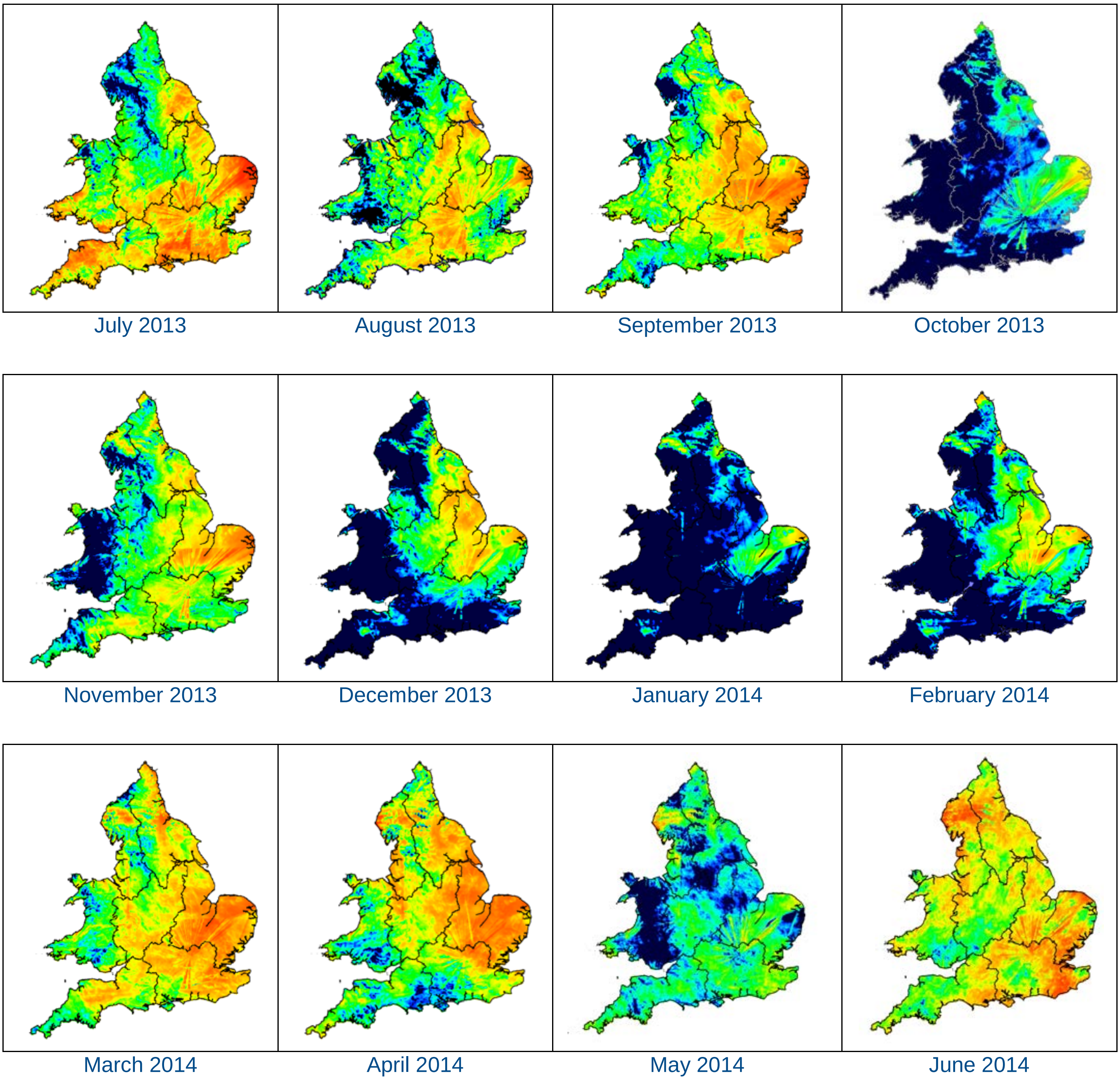
September 2014: More than two thirds of modelled sites have a greater than expected chance of *above normal* or higher groundwater levels for the time of year. A third of the sites have a greater than expected chance of *normal* levels (see Figure 6.7).

March 2015: Over two thirds of the modelled sites have a greater than expected chance of levels being *above normal* or higher for the time of year. More than a third of the modelled sites have a greater than expected chance of *normal* groundwater levels by the end of March 2015 (see Figure 6.8).

Authors: E & B Hydrology Team

[3] Information produced by the Water Situation Forward Look group lead by Environment Agency in partnership with the Centre for Ecology and Hydrology, British Geological Survey, Met Office.

Rainfall



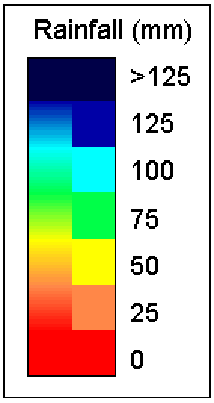


Figure 1.1: Monthly rainfall across England and Wales for the past 12 months. UKPP radar data (Source: Met Office © Crown Copyright, 2014). Note: Radar beam blockages in some regions may give anomalous totals in some areas. Crown copyright. All rights reserved. Environment Agency, 100026380, 2014.

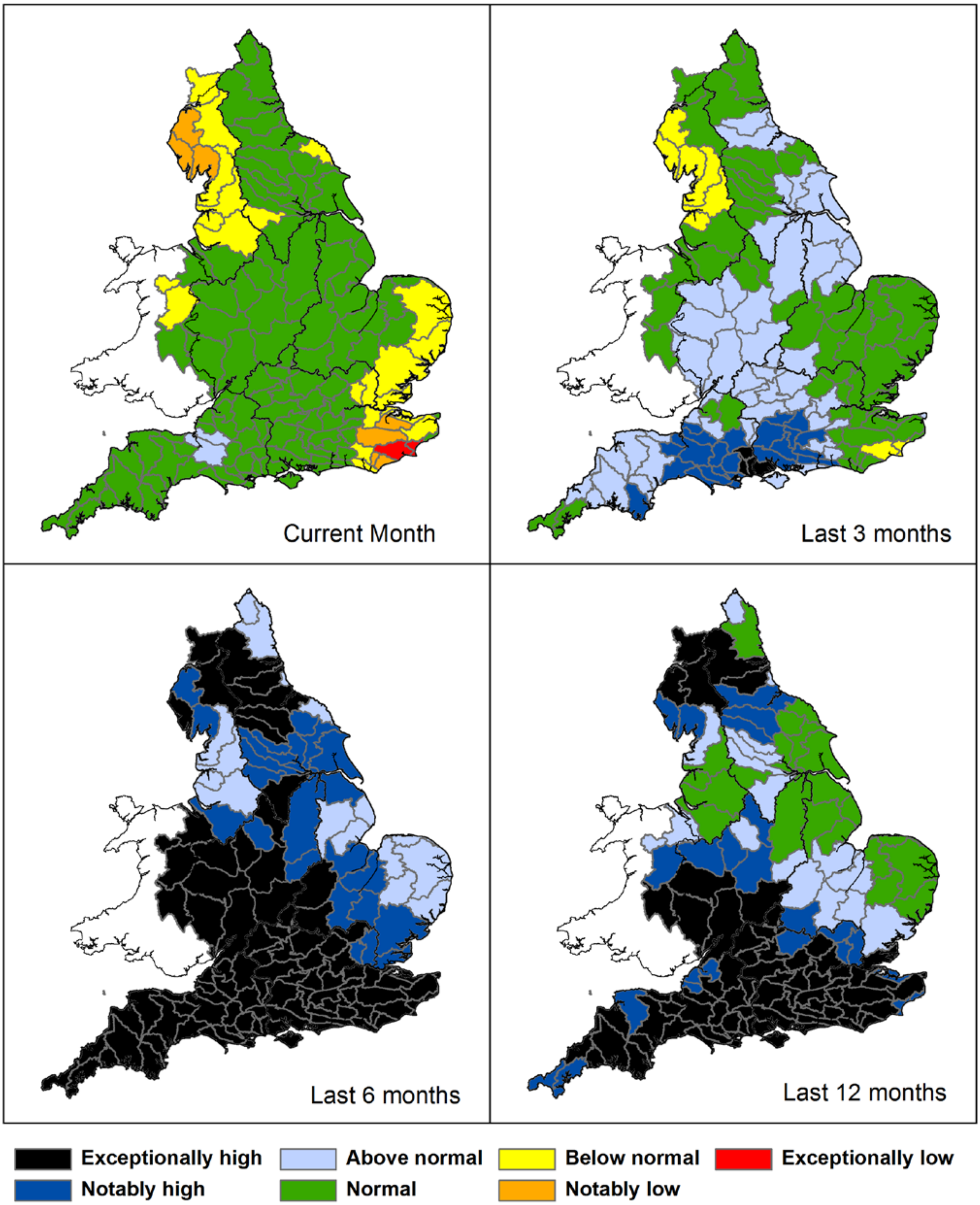


Figure 1.2: Total rainfall for hydrological areas across England for the current month (up to 30th June), the last three months, the last six months, and the last 12 months, classed relative to an analysis of respective historic totals. Final and provisional NCIC (National Climate Information Centre) data based on the Met Office 5km gridded rainfall dataset derived from rain gauges *(Source: Met Office © Crown Copyright, 2014).* Crown copyright. All rights reserved. Environment Agency, 100026380, 2014.

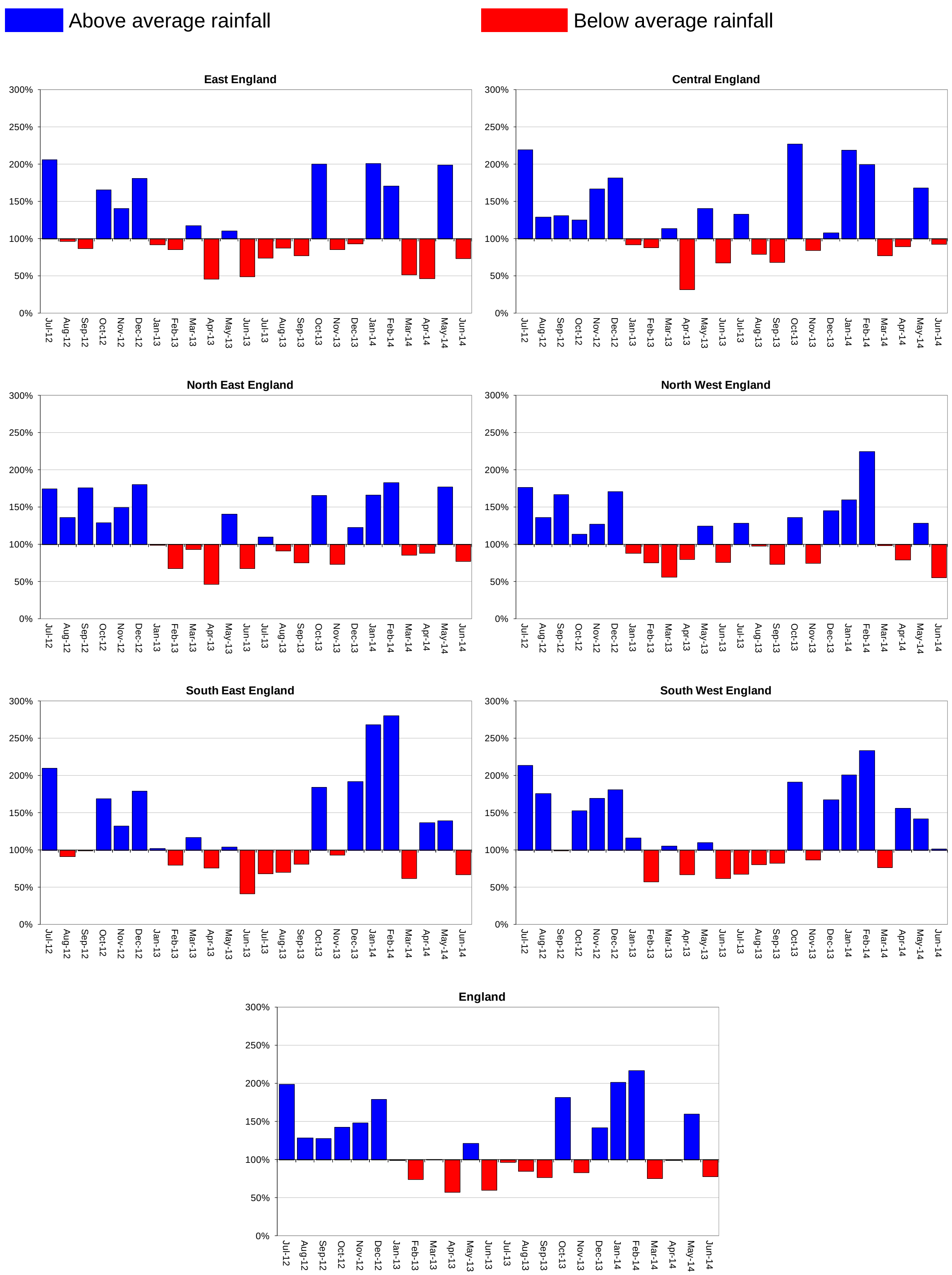


Figure 1.3: Monthly rainfall totals for the past 24 months as a percentage of the 1961 – 1990 long term average for each region and for England. NCIC (National Climate Information Centre) data. (Source: Met Office © Crown Copyright, 2014).

Soil moisture deficit

End of May 2014 [1]	End of June 2014 [2]

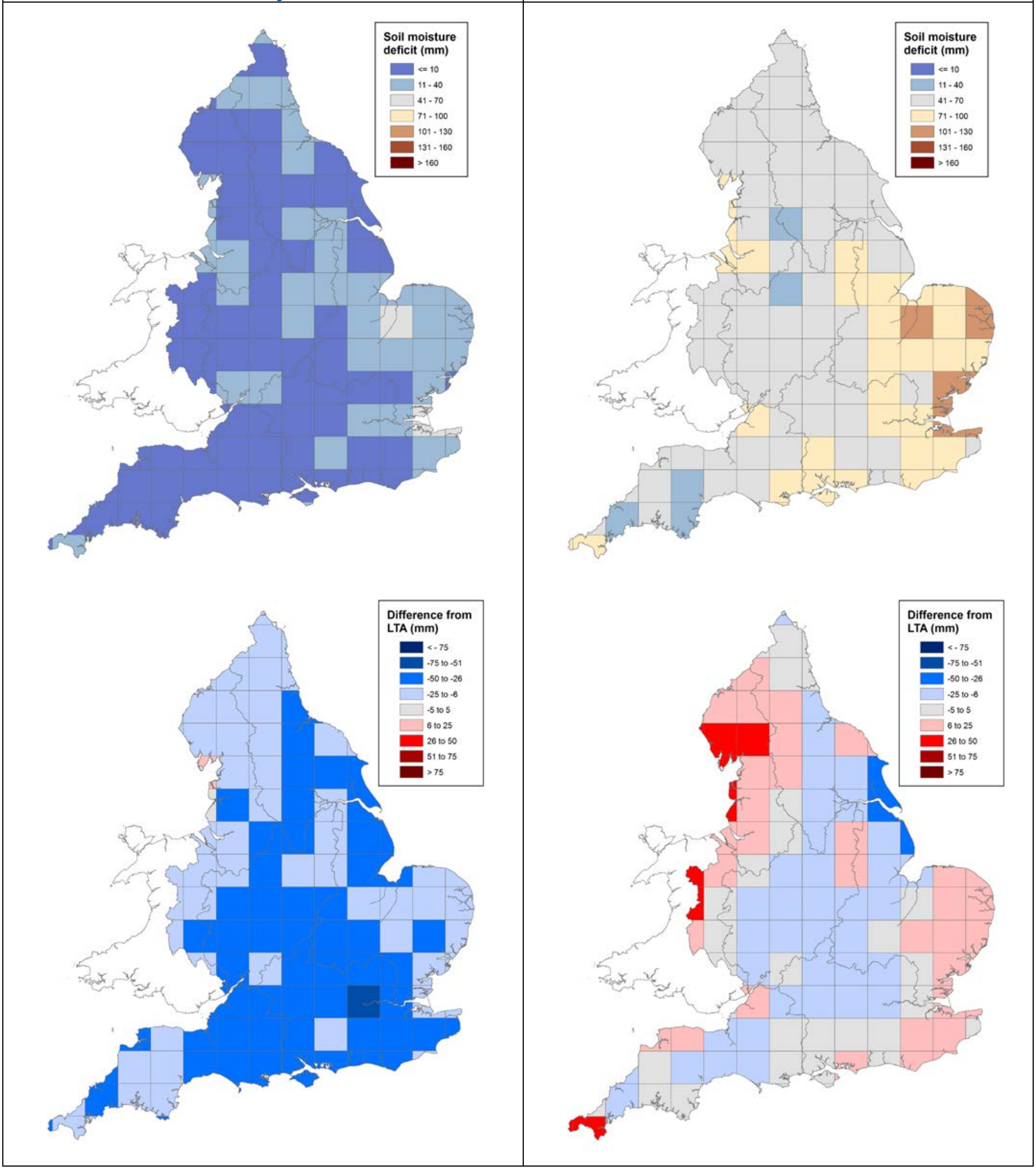


Figure 2.1: Soil moisture deficits for weeks ending 27 May 2014 [1] (left panel) and 01 July 2014 [2] (right panel). Top row shows actual soil moisture deficits (mm) and bottom row shows the difference (mm) of the actual from the 1961-90 long term average soil moisture deficits. MORECS data for real land use (Source: Met Office © Crown Copyright, 2014). Crown copyright. All rights reserved. Environment Agency, 100026380, 2014

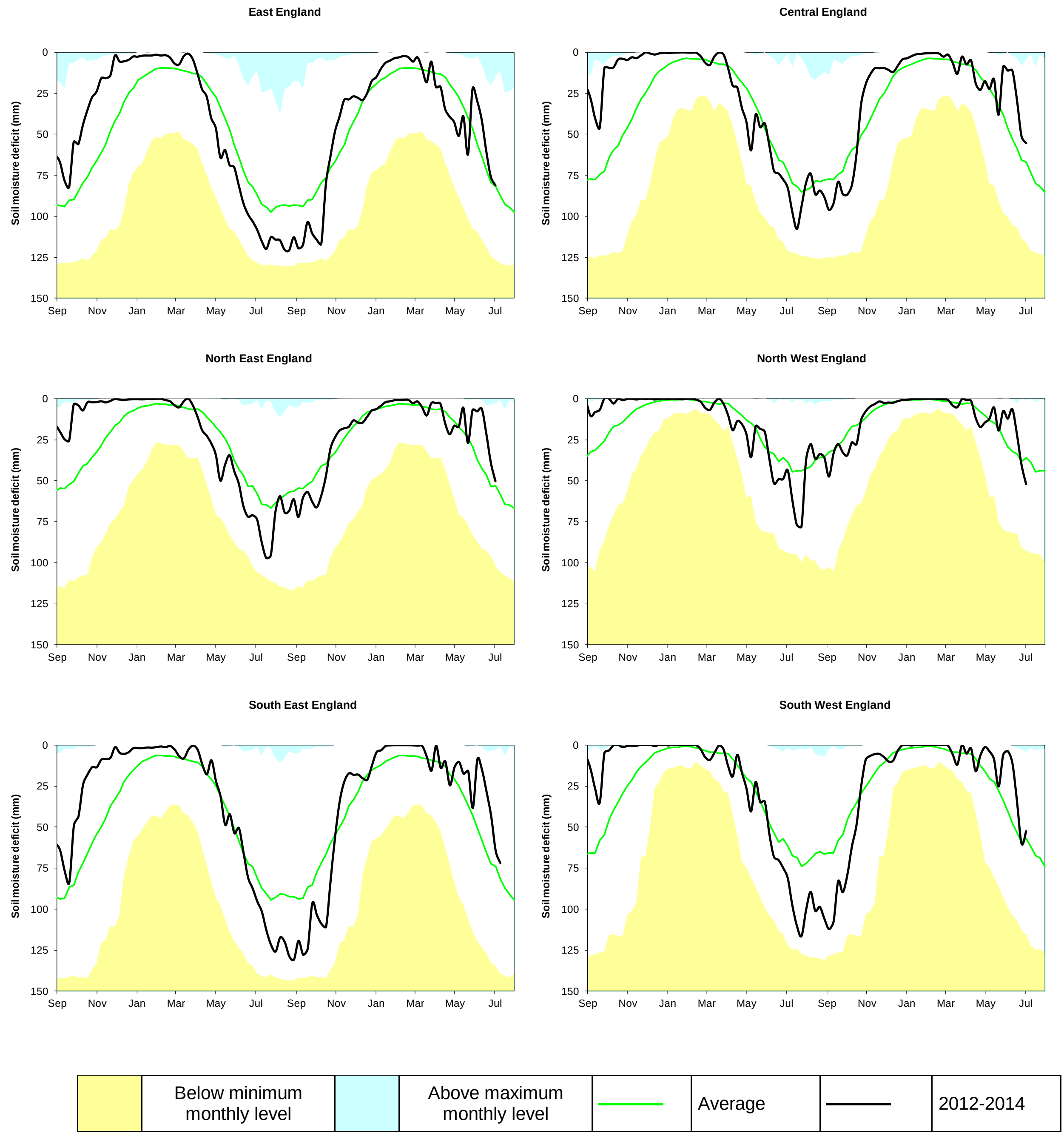
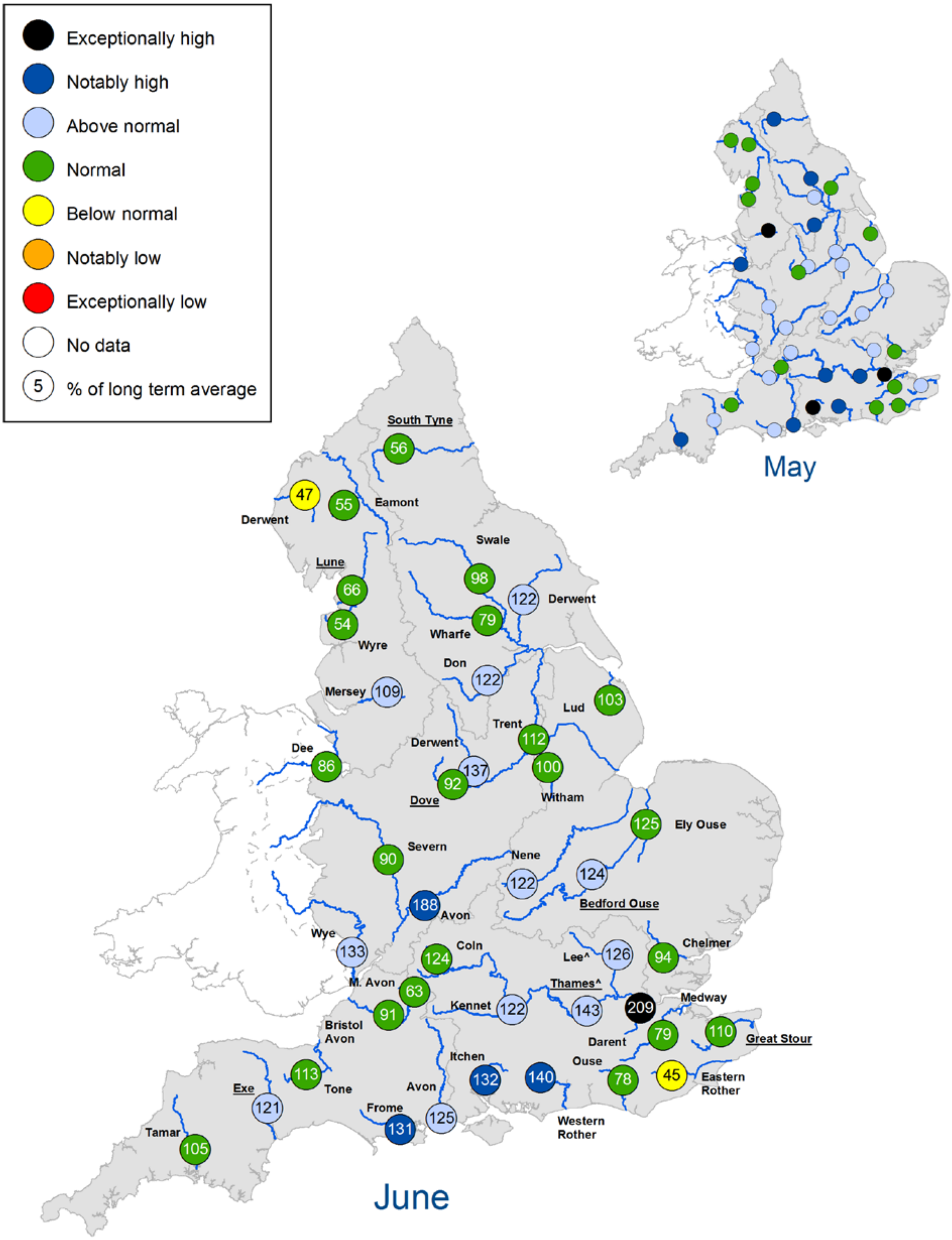


Figure 2.2: Latest soil moisture deficits for all regions compared to maximum, minimum and 1961-90 long term average. Weekly MORECS data for real land use. (Source: Met Office © Crown Copyright, 2014).

River flows



^ “Naturalised” flows are provided for the ‘Thames at Kingston’ and the ‘Lee at Feildes Weir’

+/- Monthly mean flow is the highest/lowest on record for the current month (note that record length varies between sites)

Underlined sites are regional index sites and are shown on the hydrographs in Figure 3.2

Figure 3.1: Monthly mean river flow for indicator sites for May 2014 and June 2014, expressed as a percentage of the respective long term average and classed relative to an analysis of historic May and June monthly means (Source: Environment Agency).

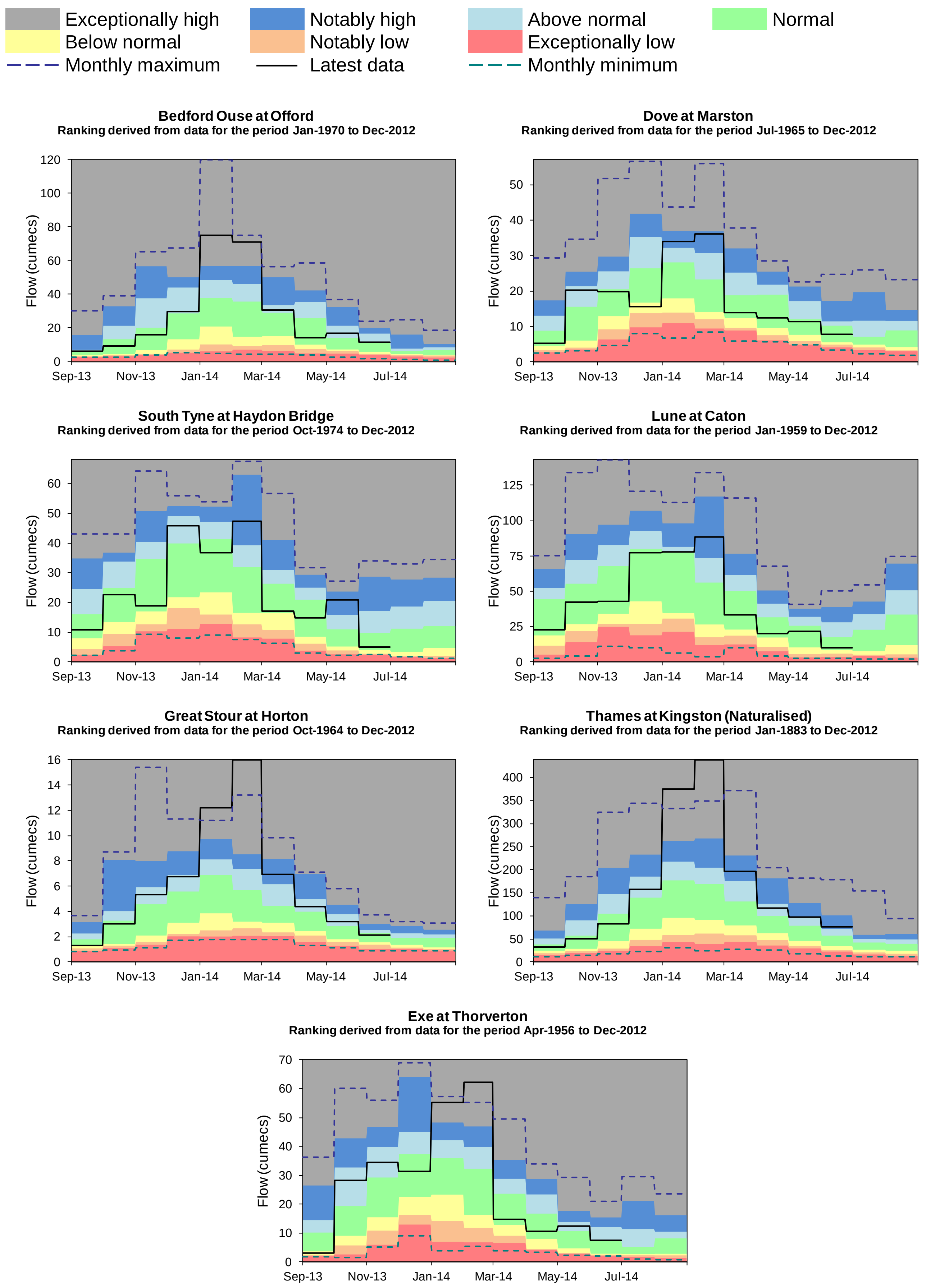
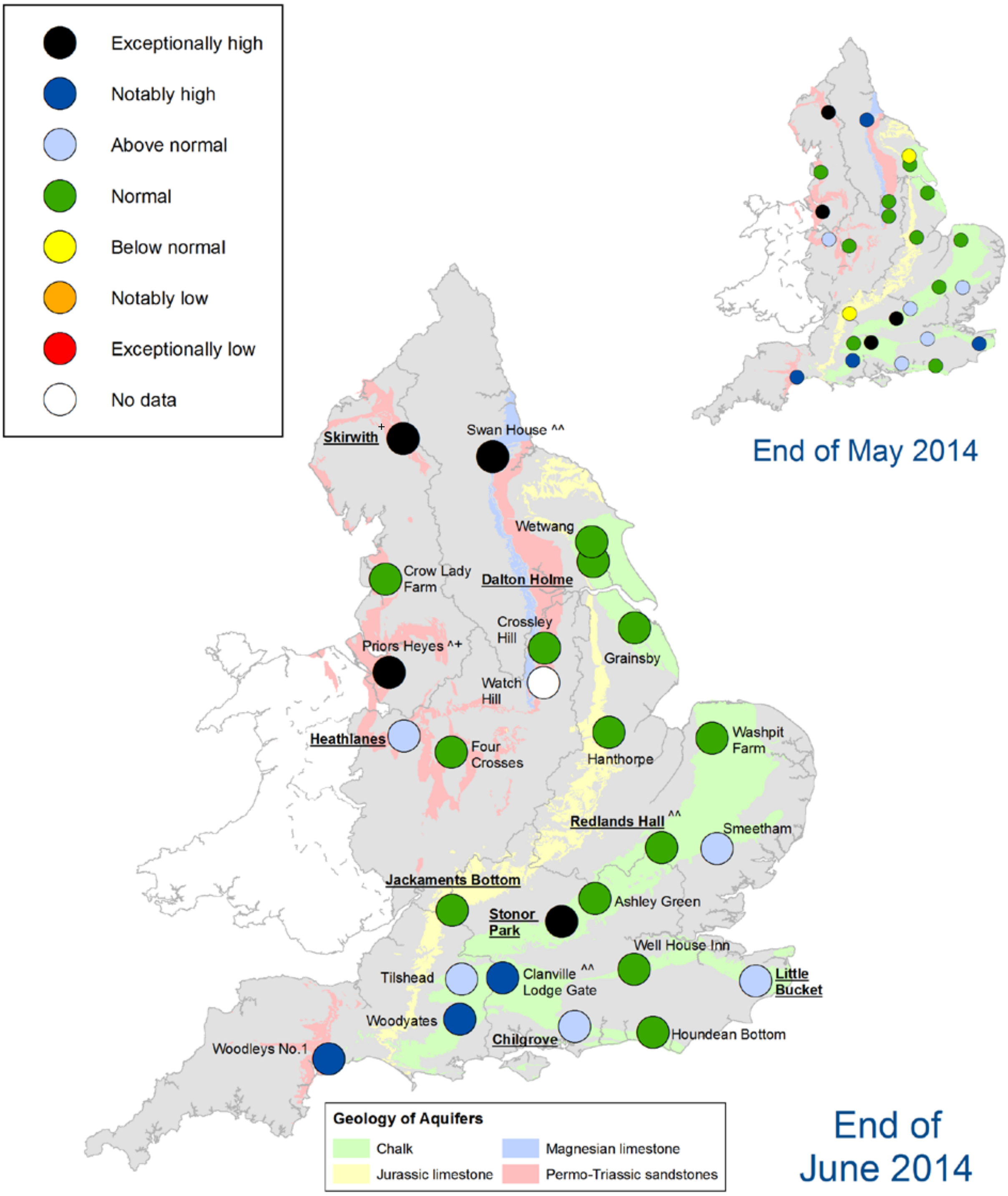


Figure 3.2: Index river flow sites for each region. Monthly mean flow compared to an analysis of historic monthly mean flows, long term maximum and minimum flows. (Source: Environment Agency).

Groundwater levels



^ The level at Priors Heyes remains high compared to historic levels because the aquifer is recovering from the effects of historic abstraction.
^^ Sites are manually dipped at different times during the month. They may not be fully representative of levels at the month end
+/- End of month groundwater level is the highest/lowest on record for the current month (note that record length varies between sites).
Highlighted sites are major aquifer index sites and are shown in the groundwater level charts in Figure 4.2

Figure 4.1: Groundwater levels for indicator sites at the end of May 2014 and June 2014, classed relative to an analysis of respective historic May and June levels (Source: Environment Agency). Geological map reproduced with kind permission from UK Groundwater Forum, BGS © NERC. Crown copyright. All rights reserved. Environment Agency, 100026380, 2014.

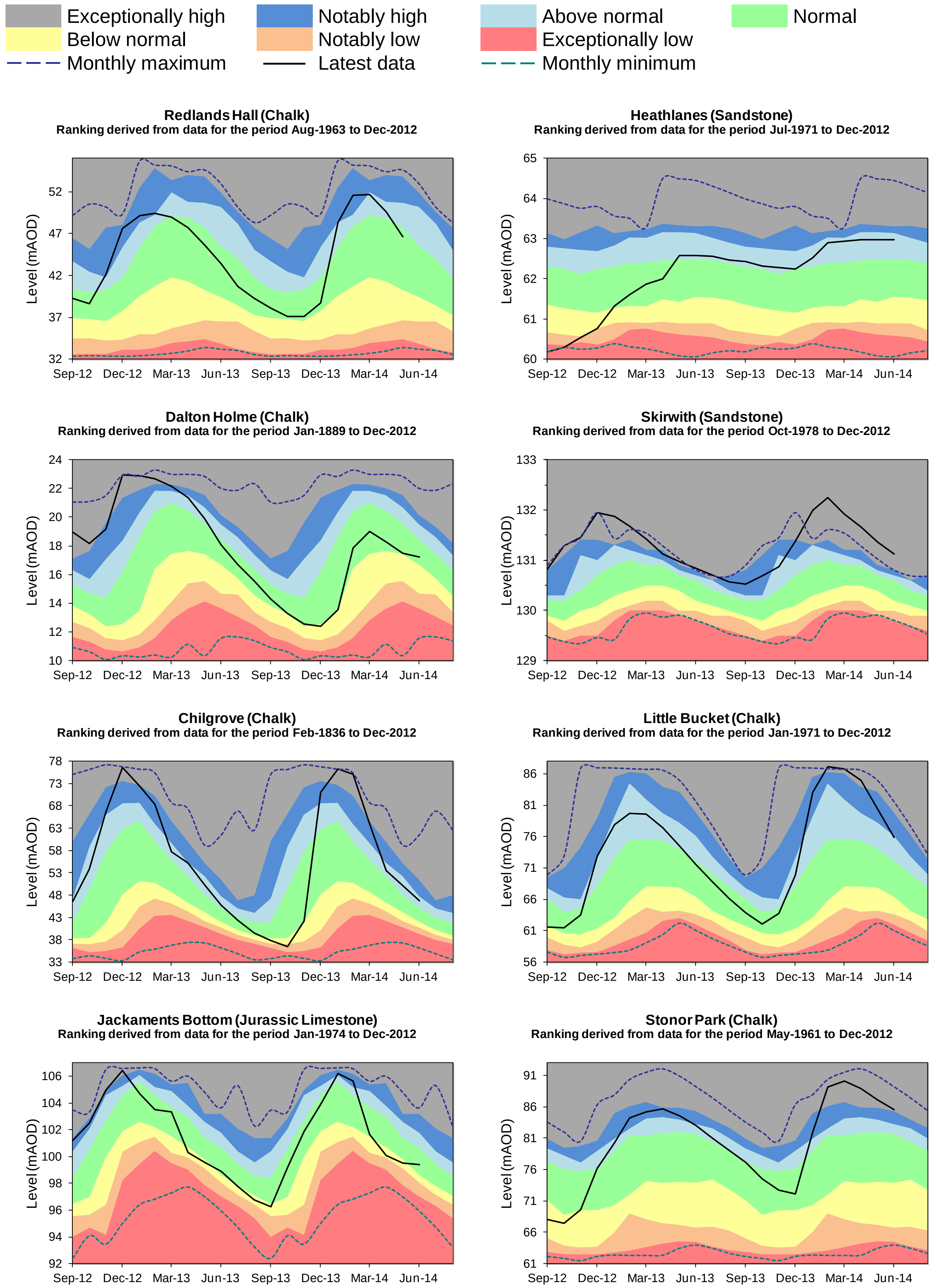
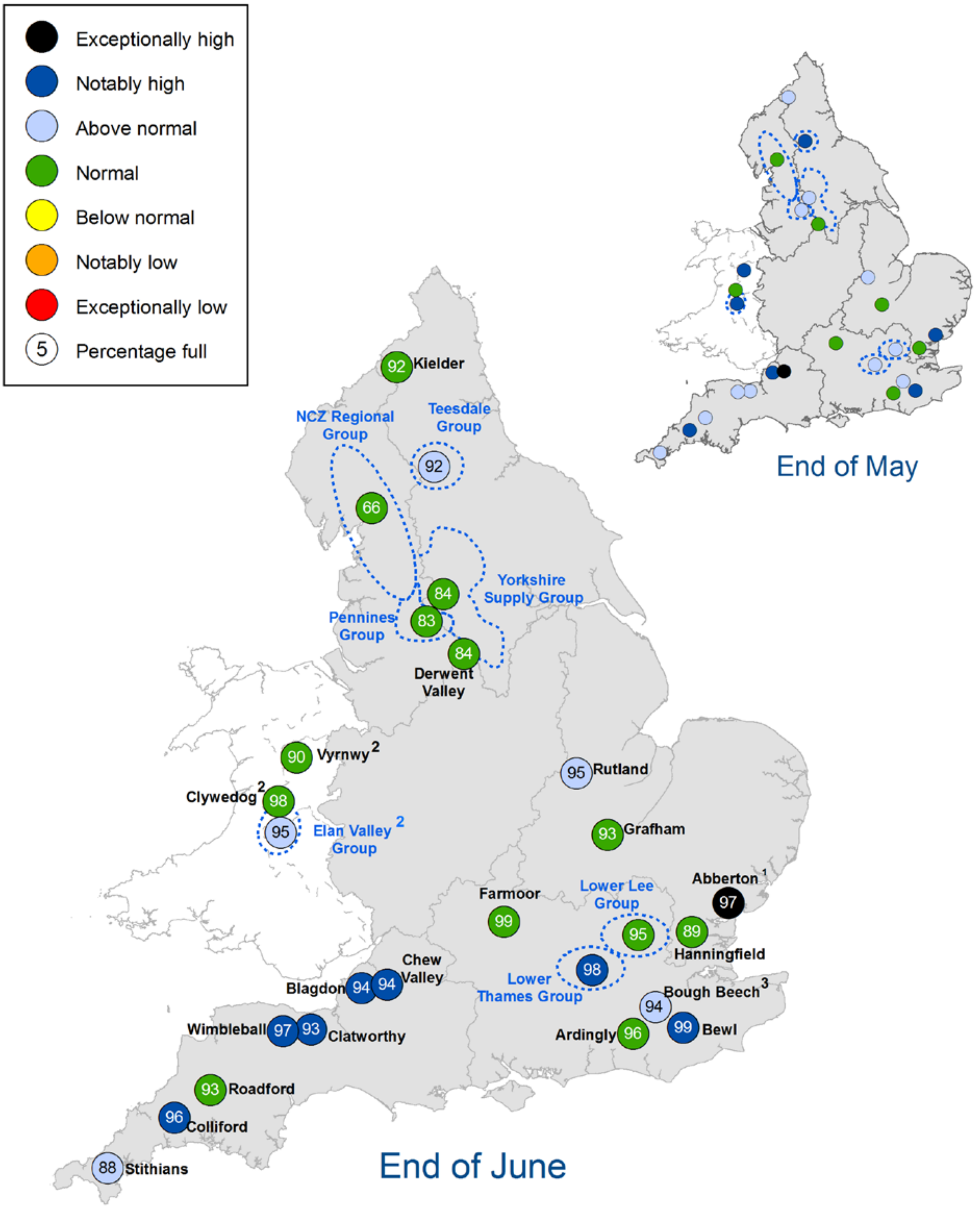


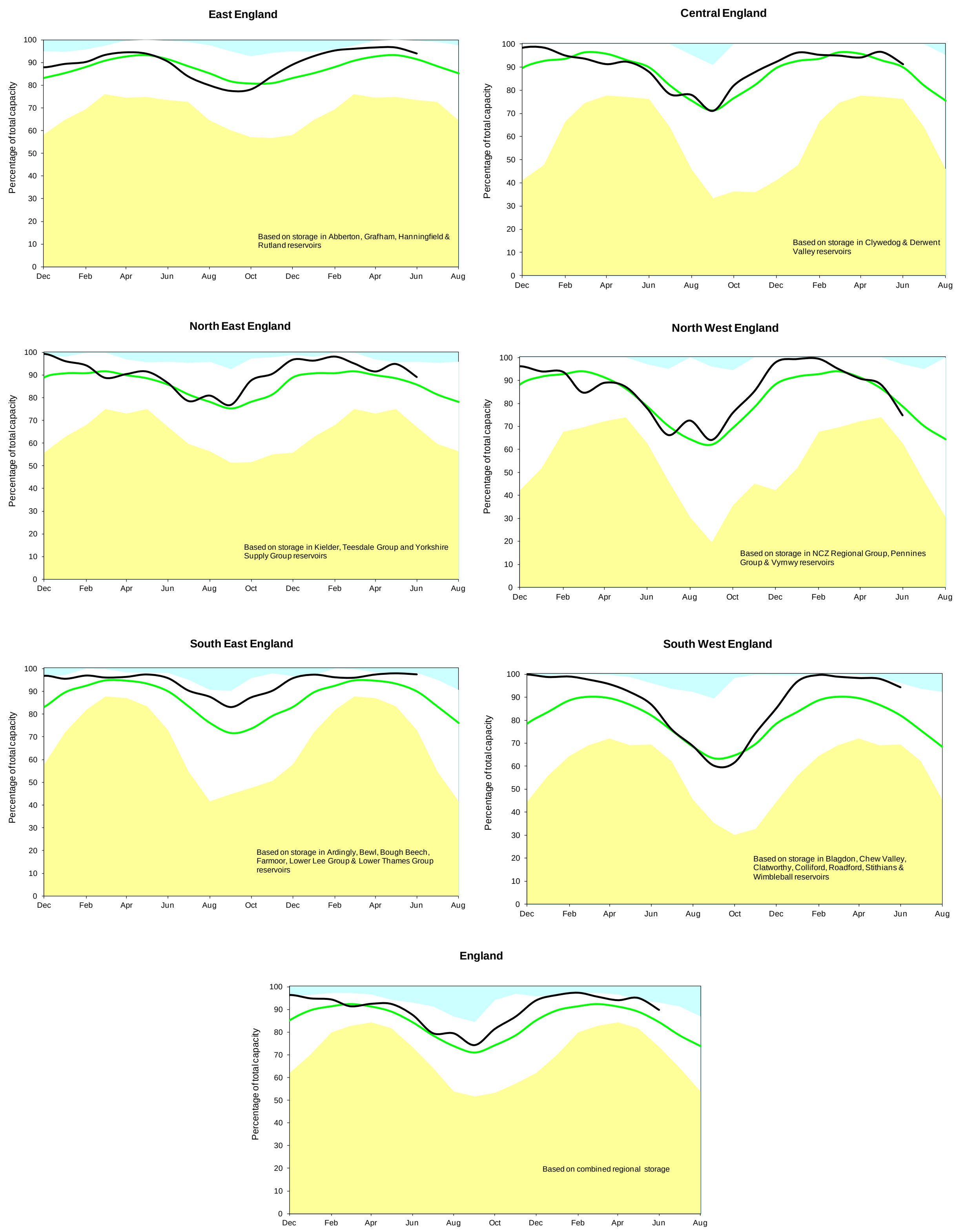
Figure 4.2: Index groundwater level sites for major aquifers. End of month groundwater levels months compared to an analysis of historic end of month levels and long term maximum and minimum levels. (Source: Environment Agency, 2014).

Reservoir storage



1. Water levels are affected by engineering work at Abberton Reservoir in Essex to increase capacity
2. Vyrnwy, Clywedog and Elan Valley reservoirs are located in Wales but provide a water resource to central and northwest England
3. Latest available update for Bough Beech is 02 June 2014

Figure 5.1: Reservoir stocks at key individual and groups of reservoirs at the end of May 2014 and June 2014 as a percentage of total capacity and classed relative to an analysis of historic May and June values respectively (Source: Water Companies). Note: Classes shown may not necessarily relate to control curves or triggers for drought actions. As well as for public water supply, some reservoirs are drawn down to provide flood storage, river compensation flows or for reservoir safety inspections. In some cases current reservoir operating rules may differ from historic ones. Crown copyright. All rights reserved. Environment Agency, 100026380, 2014.



	Below minimum monthly level		Above maximum monthly level		Average		2012-2014

Figure 5.2: Regional reservoir stocks. End of month reservoir stocks compared to long term maximum, minimum and average stocks (Source: Water Companies). Note: Historic records of individual reservoirs/reservoir groups making up the regional values vary in length.

Forward look – river flow

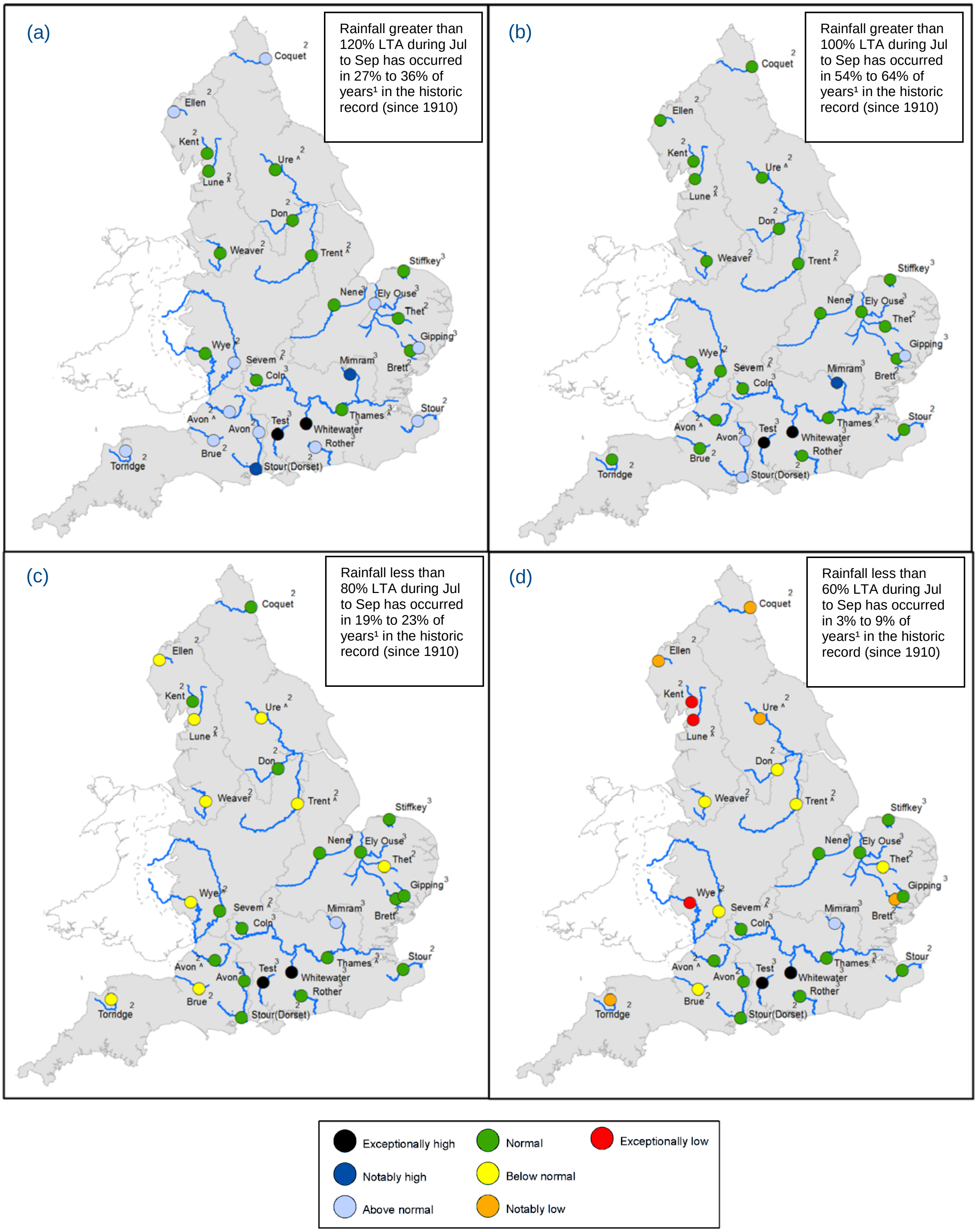


Figure 6.1: Projected river flows at key indicator sites up until the end of September 2014. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between July 2014 and September 2014 (Source: Centre for Ecology and Hydrology, Environment Agency)

1 This range of probabilities is a regional analysis
2 Projections for these sites are produced by CEH,
3 Projections for these sites are produced by the Environment Agency
^ “Naturalised” flows are projected for these sites

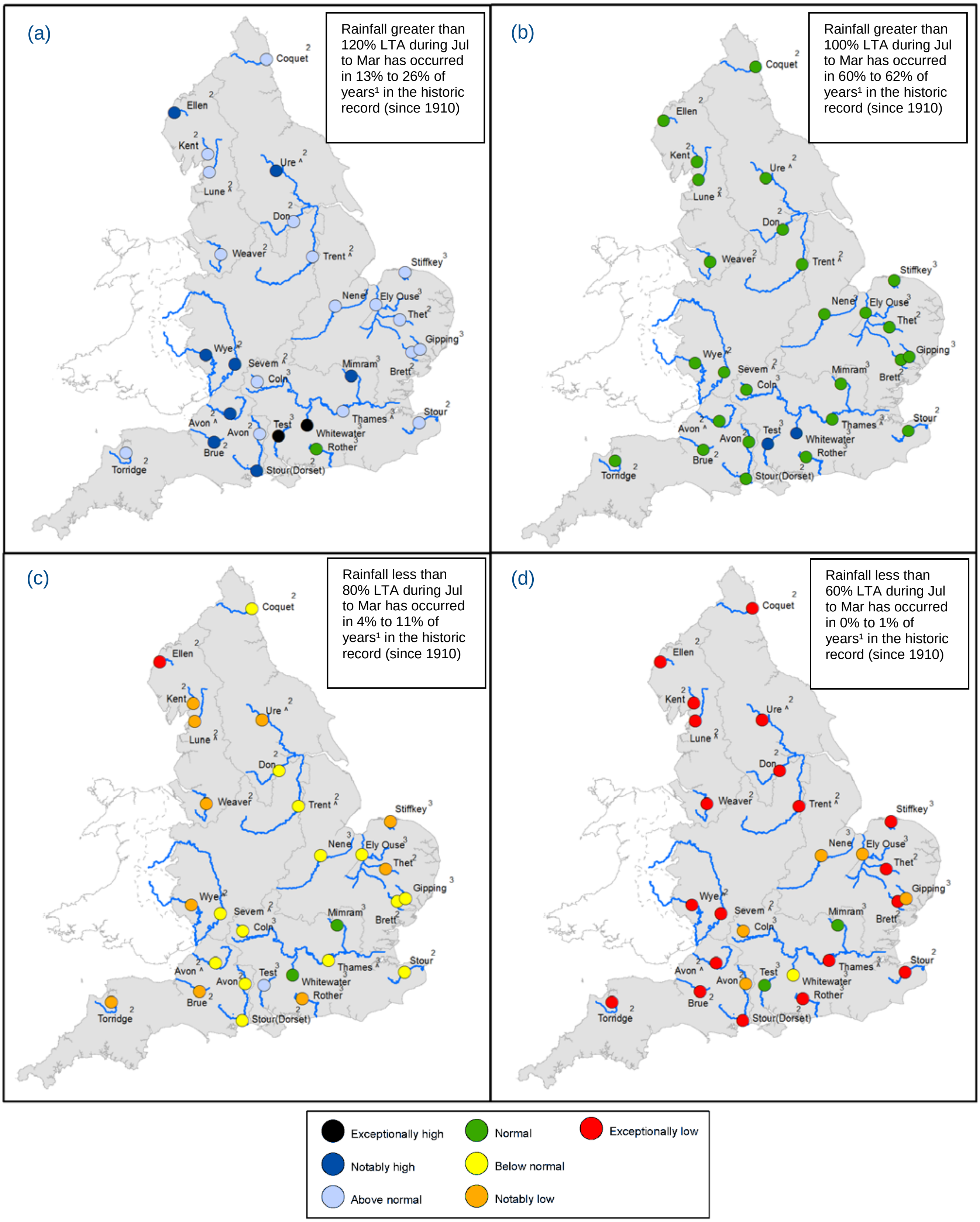


Figure 6.2: Projected river flows at key indicator sites up until the end of March 2015. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between July 2014 and March 2015 (Source: Centre for Ecology and Hydrology, Environment Agency)

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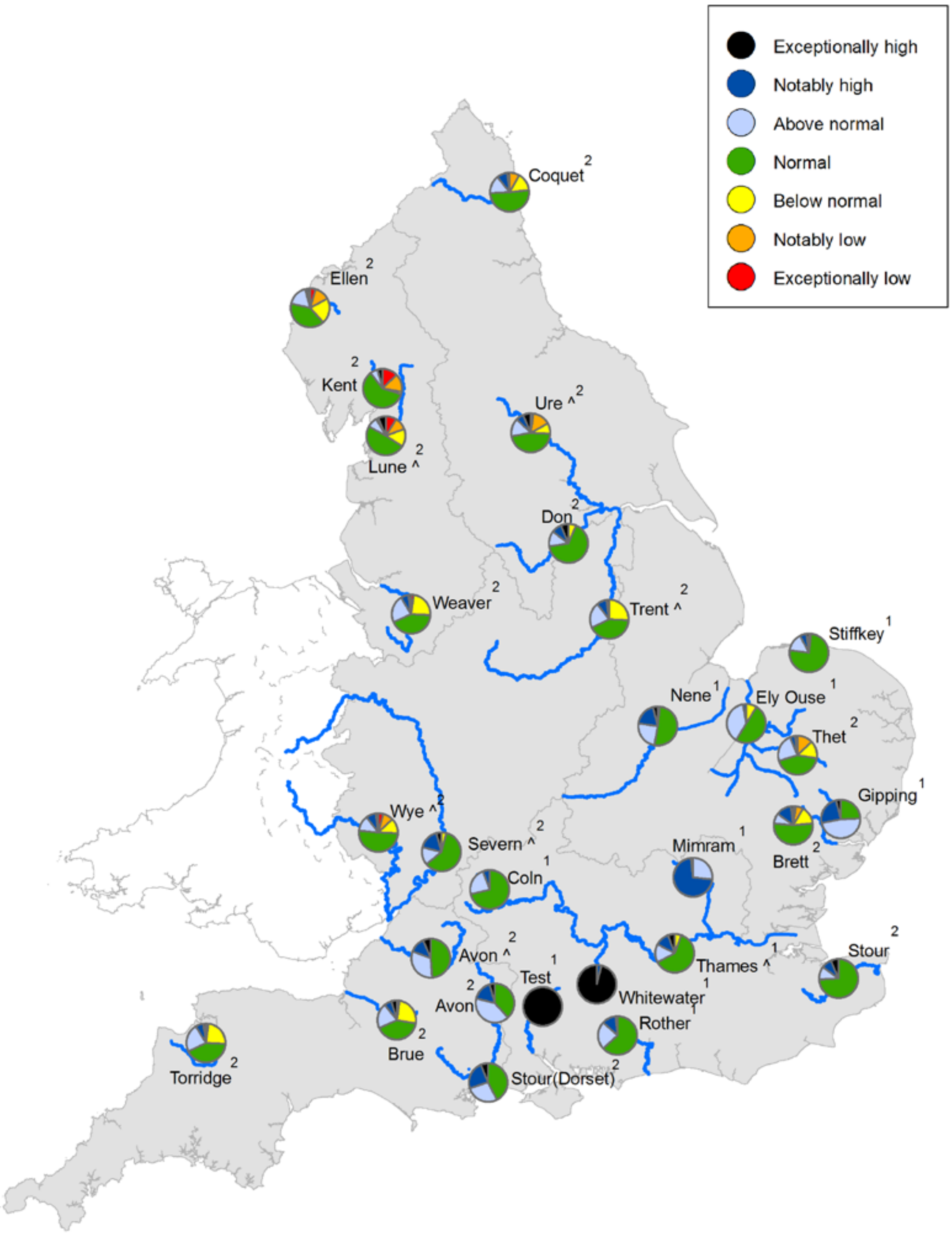

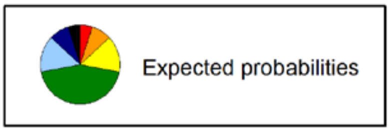

Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are those which would typically occur 44% of the time within the historic record.

Figure 6.3: Probabilistic ensemble projections of cumulative river flows at key indicator sites up until the end of September 2014. Pie charts indicate probability, based on climatology, of the surface water flow at each site being e.g. exceptionally low for the time of year. (Source: Centre for Ecology and Hydrology, Environment Agency).

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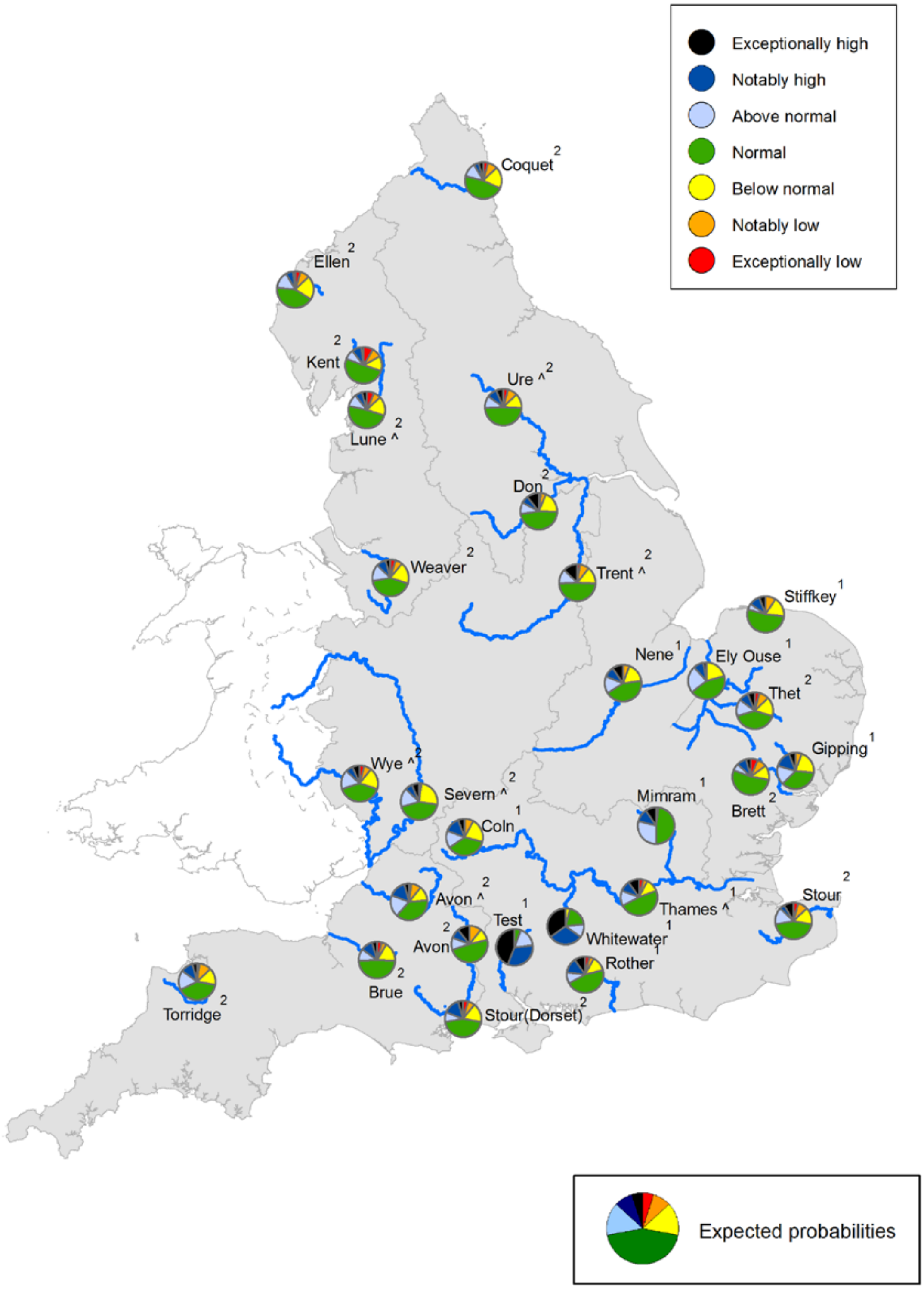
[2] Projections for these sites are produced by CEH
^ "Naturalised" flows are projected for these sites



Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are those which would typically occur 44% of the time within the historic record.

Figure 6.4: Probabilistic ensemble projections of cumulative river flows at key indicator sites up until the end of March 2015. Pie charts indicate probability, based on climatology, of the surface water flow at each site being e.g. exceptionally low for the time of year. (Source: Centre for Ecology and Hydrology, Environment Agency).

[1] Projections for these sites are produced by the Environment Agency
[2] Projections for these sites are produced by CEH
^ "Naturalised" flows are projected for these sites

Forward look - groundwater

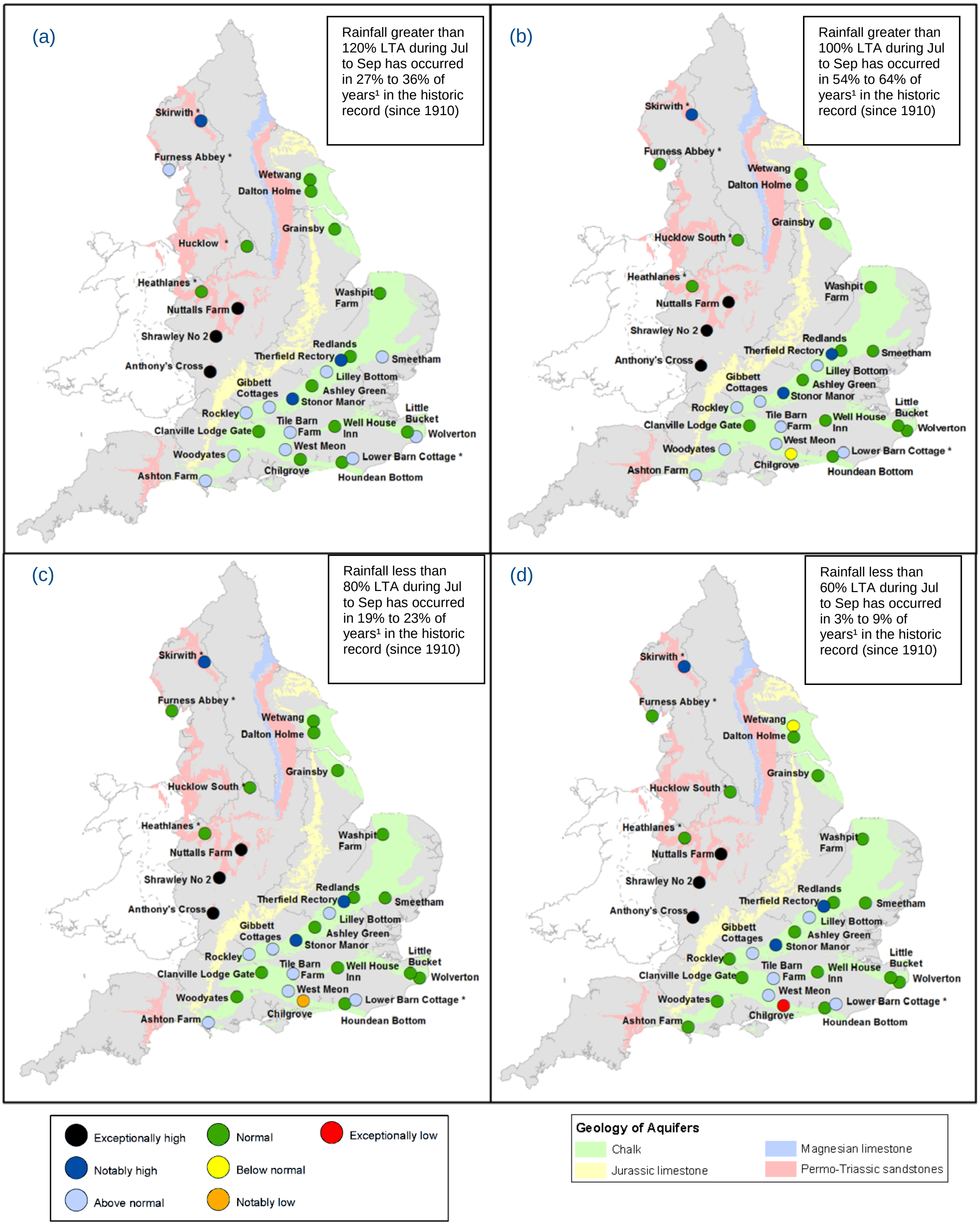


Figure 6.5: Projected groundwater levels at key indicator sites at the end of September 2014. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between July 2014 and September 2014 (Source: Environment Agency) Geological map reproduced with kind permission from UK Groundwater Forum BGS © NERC. Crown copyright all rights reserved. Environment Agency 100026380, 2014.

1 This range of probabilities is a regional analysis
* Projections for these sites are produced by BGS

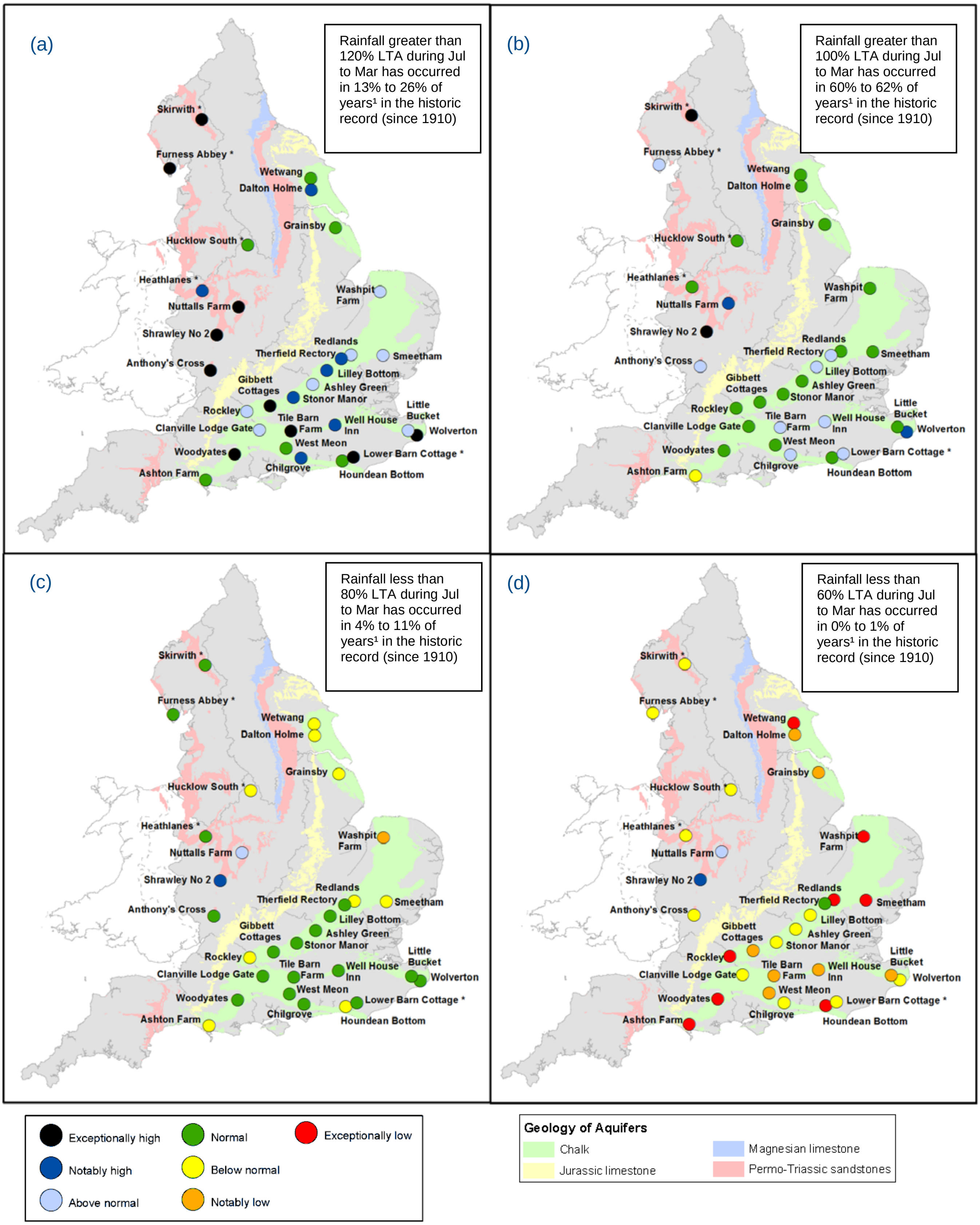


Figure 6.6: Projected groundwater levels at key indicator sites at the end of March 2015 Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between July 2014 and March 2015 (Source: Environment Agency) Geological map reproduced with kind permission from UK Groundwater Forum BGS © NERC Crown copyright. All rights reserved. Environment Agency 100026380 2014.

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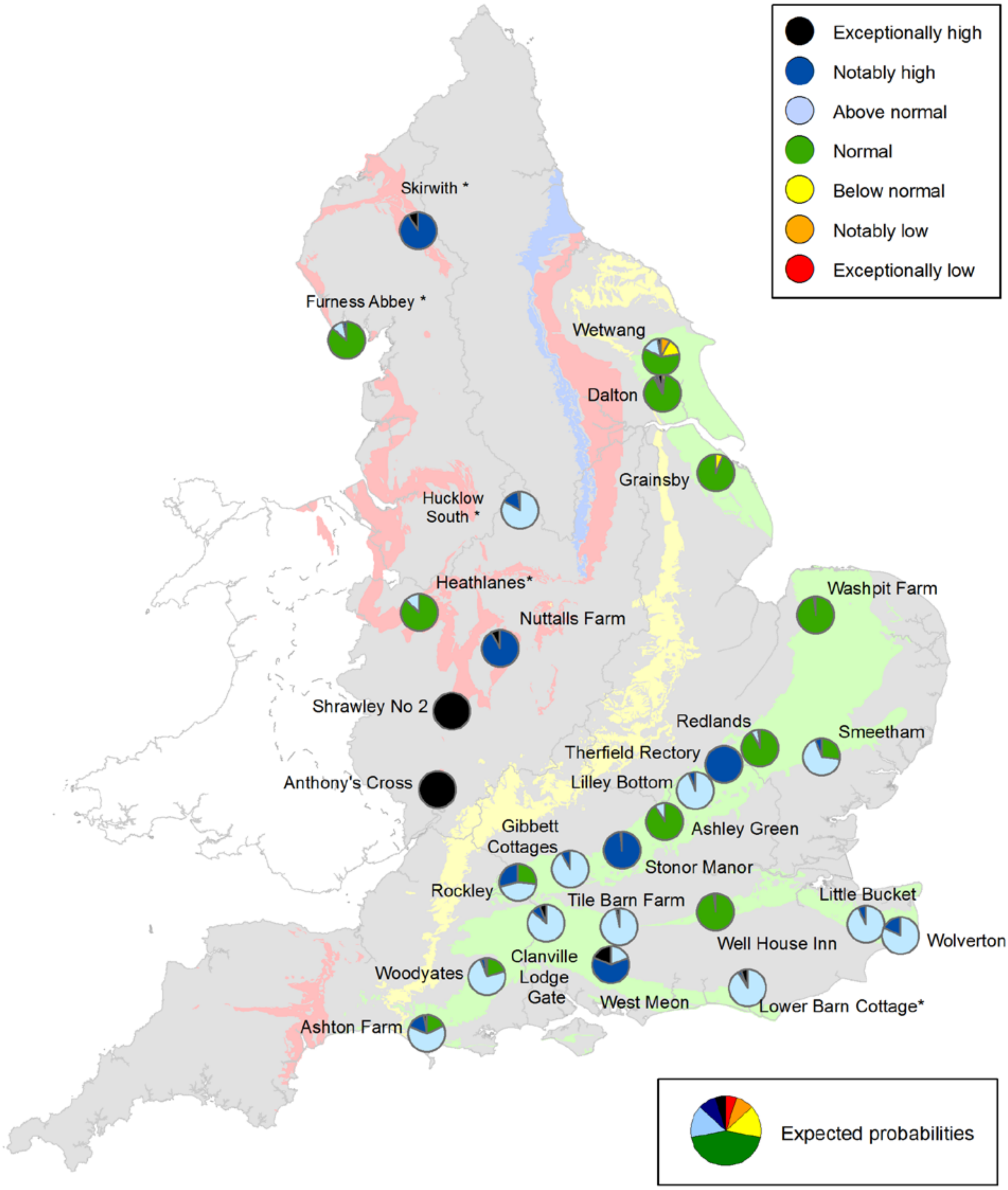
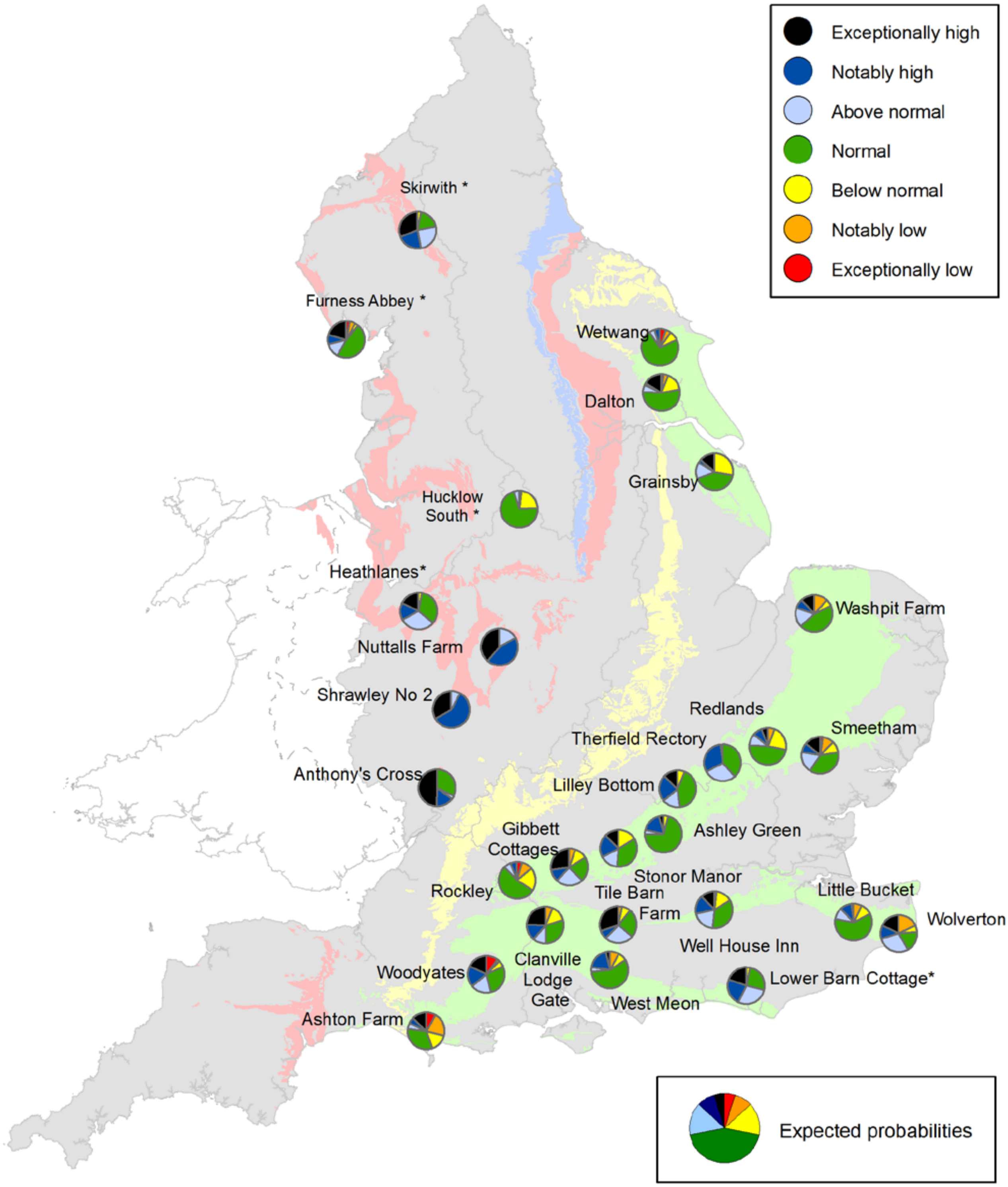


Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are those which would typically occur 44% of the time within the historic record.

Figure 6.7: Probabilistic ensemble projections of groundwater levels at key indicator sites at the end of September 2014. Pie charts indicate probability, based on climatology, of the groundwater level at each site being e.g. exceptionally low for the time of year. (Source: Environment Agency) Geological map reproduced with kind permission from UK Groundwater Forum, BGS © NERC. Crown copyright. All rights reserved. Environment Agency, 100026380, 2014.

* Projections for these sites are produced by BGS



Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are those which would typically occur 44% of the time within the historic record.

Figure 6.8: Probabilistic ensemble projections of groundwater levels at key indicator sites at the end of March 2015. Pie charts indicate probability, based on climatology, of the groundwater level at each site being e.g. exceptionally low for the time of year. (Source: Environment Agency) Geological map reproduced with kind permission from UK Groundwater Forum, BGS © NERC. Crown copyright. All rights reserved. Environment Agency, 100026380, 2014.

* Projections for these sites are produced by BGS

Figure 7.1: Geographic regions

Glossary

Term	Definition
Aquifer	A geological formation able to store and transmit water.
Areal average rainfall	The estimated average depth of rainfall over a defined area. Expressed in depth of water (mm).
Artesian	The condition where the groundwater level is above ground surface but is prevented from rising to this level by an overlying continuous low permeability layer, such as clay.
Artesian borehole	Borehole where the level of groundwater is above the top of the borehole and groundwater flows out of the borehole when unsealed.
Cumecs	Cubic metres per second (m^3s^{-1})
Effective rainfall	The rainfall available to percolate into the soil or produce river flow. Expressed in depth of water (mm).
Flood Alert/Flood Warning	Three levels of warnings may be issued by the Environment Agency. Flood Alerts indicate flooding is possible. Flood Warnings indicate flooding is expected. Severe Flood Warnings indicate severe flooding.
Groundwater	The water found in an aquifer.
Long term average (LTA)	The arithmetic mean calculated from the historic record, usually based on the period 1961-1990. However, the period used may vary by parameter being reported on (see figure captions for details).
mAOD	Metres Above Ordnance Datum (mean sea level at Newlyn Cornwall).
MORECS	Met Office Rainfall and Evaporation Calculation System. Met Office service providing real time calculation of evapotranspiration, soil moisture deficit and effective rainfall on a 40 x 40 km grid.
Naturalised flow	River flow with the impacts of artificial influences removed. Artificial influences may include abstractions, discharges, transfers, augmentation and impoundments.
NCIC	National Climate Information Centre. NCIC area monthly rainfall totals are derived using the Met Office 5 km gridded dataset, which uses rain gauge observations.
Recharge	The process of increasing the water stored in the saturated zone of an aquifer. Expressed in depth of water (mm).
Reservoir gross capacity	The total capacity of a reservoir.
Reservoir live capacity	The capacity of the reservoir that is normally usable for storage to meet established reservoir operating requirements. This excludes any capacity not available for use (e.g. storage held back for emergency services, operating agreements or physical restrictions). May also be referred to as 'net' or 'deployable' capacity.
Soil moisture deficit (SMD)	The difference between the amount of water actually in the soil and the amount of water the soil can hold. Expressed in depth of water (mm).

Categories

Exceptionally high	Value likely to fall within this band 5% of the time
Notably high	Value likely to fall within this band 8% of the time
Above normal	Value likely to fall within this band 15% of the time
Normal	Value likely to fall within this band 44% of the time
Below normal	Value likely to fall within this band 15% of the time
Notably low	Value likely to fall within this band 8% of the time
Exceptionally low	Value likely to fall within this band 5% of the time