Monthly water situation report

England

Summary – June 2016

June has been another month of above average rainfall in England, with totals significantly higher than the long term average - particularly in the east. As a result of the rainfall, soil moisture deficits decreased across most of England through June and river flows increased at two thirds of the indicator sites, with most sites now classed as normal or higher for the time of year. Groundwater levels decreased at the majority of indicator sites but remain normal or higher at all but one of the sites. Reservoir stocks decreased at the majority of reported sites in June but remain mostly normal or higher for the time of year.

Rainfall

Rainfall totals for June ranged from less than 60mm in Wearside, other parts of County Durham and west Somerset to more than 140mm over much of Cumbria. Monthly rainfall totals were above the June long term average (LTA) in all but two of the hydrological areas across England, with the East Suffolk and North Essex hydrological areas receiving more than 240% of the June LTA rainfall (Figure 1.1)

For all hydrological areas in England rainfall totals for June were normal or higher for the time of year. Parts of east and south-east England had exceptionally high June rainfall including Essex and East Suffolk, where it was the third wettest June on record (since 1910). Over the three month period to the end of June, rainfall totals were above normal to exceptionally high for much of central, east and south-east England (Figure 1.2)

At the regional scale June rainfall totals ranged from 135% of the LTA in north-east England to 200% in east England. Rainfall totals across England as a whole were above average for the eighth consecutive month at 170% of the June LTA (Figure 1.3)

Soil moisture deficit

Soil Moisture Deficits (SMDs) decreased across almost all of England during June, with the largest decreases occurring in south-east and central England. At the end of June values were less than 10mm across a third of England and between 11mm and 70mm in most others areas (Figure 2.1).

End of month SMDs were smaller than the long term average (LTA) for the end of June in most of England, although parts of north-east and north-west England were larger than LTA. SMDs were smaller than the end of May in many parts of England (Figure 2.1).

At a regional scale SMDs decreased during the month in all areas apart from north-east England compared to the previous month. Values at the end of June ranged from 17mm in south-east to 44mm in north-east England (Figure 2.2).

River flows

Monthly mean river flows for June increased at almost two-thirds of indicator sites across England compared with May. Almost all sites were classed as normal or higher for the time of year. Just over a third of the sites were normal for the time of year and just over half were above normal or higher for the time of year (Figure 3.1).

Monthly mean flows at Denver (Ely Ouse) and Springfield (River Chelmer) were 310% and 216% of the long term average (LTA) for June respectively and correspond to the highest June mean flows on record (1972 and 1966 respectively). Monthly mean flows for the River Darent at Hawley and the combined site of Teston and Farleigh on the River Medway also recorded monthly mean flows of over 200% of LTA (Figure 3.1).

Monthly mean river flows were classed as notably high for the time of year at 3 of the regional index sites in east and south-east England. The River Dove at Marston-On-Dove was above normal for the time of year. The River Lune at Caton and the River Exe at Thorverton were normal for the time of year, but the South Tyne at Haydon Bridge was below normal for the time of year (Figure 3.2)

Groundwater levels

Groundwater levels decreased at three-quarters of indicator sites during June. At the end of the month, groundwater levels were normal for the time of year at more than half of the indicator sites and were above normal or higher at all but one of the remaining sites. Groundwater levels rose very slightly at Crossley Hill (Nottinghamshire and Doncaster Permo-Triassic sandstone), but levels at this site remain below normal for the time of year (Figure 4.1).

End of month groundwater levels at the major aquifer index sites were normal or higher for the time of year. Redlands (Cambridge and Ely Ouse chalk), Jackaments Bottom (Burford Jurassic limestone) and Stonor Park (south-west Chilterns chalk) remain normal for the time of year. Heathlanes (Shropshire sandstone), Dalton Holme (Hull & East Riding chalk), Chilgrove (Chichester chalk) and Little Bucket (East Kent Stour chalk) remain above normal and Skirwith (Carlisle Basin and Eden Valley sandstone) was exceptionally high for the time of year (Figure 4.2).

Reservoir storage

Reservoir stocks decreased at over two-thirds of reported reservoirs and reservoir groups during June and either stayed the same or increased slightly at the remaining reservoirs or reservoir groups. The largest increase in storage was at Hanningfield Reservoir (7%) and the largest decreases were in south-west England, with Chew Valley Lake and Wimbleball decreasing by 9%.

More than half of reservoirs or reservoir groups are above 90% of full capacity, with Abberton, Clywedog and Ardingly Reservoirs being full.

End of month stocks were classed as normal or higher for the time of year at the majority of reservoirs and reservoir groups. A number of reservoirs and reservoir groups supplying parts of central England and south-west England were classed as below normal for the time of year (Figure 5.1).

At the regional scale, reservoir stocks at the end of June increased in east England compared to May, but decreased or remained the same elsewhere. The largest decrease of 6% was in north-west England. Month end regional stocks for the end of June ranged from 76% of total capacity in north-west England to 97% in south-east England. Reservoir storage at the end of June for England overall decreased slightly compared to May, with stocks being 89% of total capacity (Figure 5.2)

Forward look

Changeable weather conditions are expected to continue through July with scattered showers and longer spells of rain interspersed with drier conditions. July is likely to be wettest in the north-west, and drier in the south. Longer term, for the period July-August-September, chances of above and below average rainfall are fairly balanced[1].

Projections for river flows at key sites[2]

By the end of September 2016 three quarters of modelled sites have a greater than expected chance of above normal or higher cumulative flows. By the end of March 2017 more than half of the sites have a greater than expected chance of normal cumulative flows.

For scenario based projections of cumulative river flows at key sites by September 2016 see Figure 6.1
For scenario based projections of cumulative river flows at key sites by March 2017 see Figure 6.2
For probabilistic ensemble projections of cumulative river flows at key sites by September 2016 see Figure 6.3
For probabilistic ensemble projections of cumulative river flows at key sites by March 2017 see Figure 6.4

Projections for groundwater levels in key aquifers[2]

At the end of September 2016 all projection sites have a greater than expected chance of normal or higher groundwater levels for the time of year. At the end of March 2017 most sites have a greater than expected chance of normal or higher groundwater levels for the time of year. Interestingly 3 sites have a greater than expected chance of below normal or lower groundwater levels at the end of March 2017.

[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 (www.hydoutuk.net).

For scenario based projections of groundwater levels in key aquifers in September 2016 see Figure 6.5
For scenario based projections of groundwater levels in key aquifers in March 2017 see Figure 6.6
For probabilistic ensemble projections of groundwater levels in key aquifers in September 2016 see Figure 6.7
For probabilistic ensemble projections of groundwater levels in key aquifers in March 2017 see Figure 6.8

Authors: E&B Hydrology Team

Rainfall

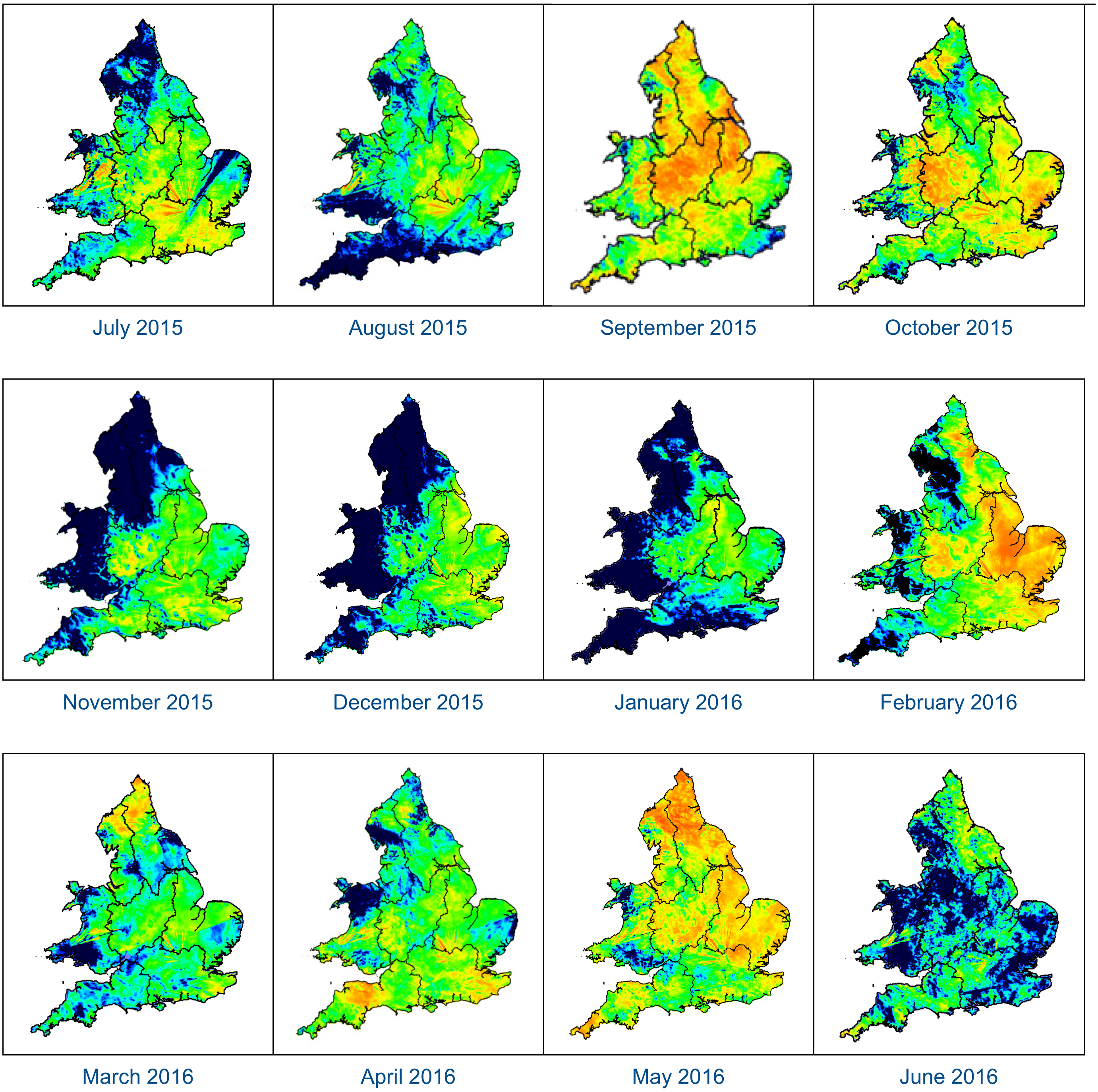
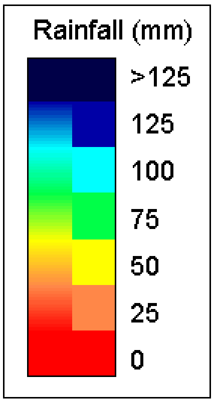


Figure 1.1: Monthly rainfall across England and Wales for the past 12 months. UKPP radar data (Source: Met Office © Crown Copyright, 2016). Note: Radar beam blockages in some regions may give anomalous totals in some areas.



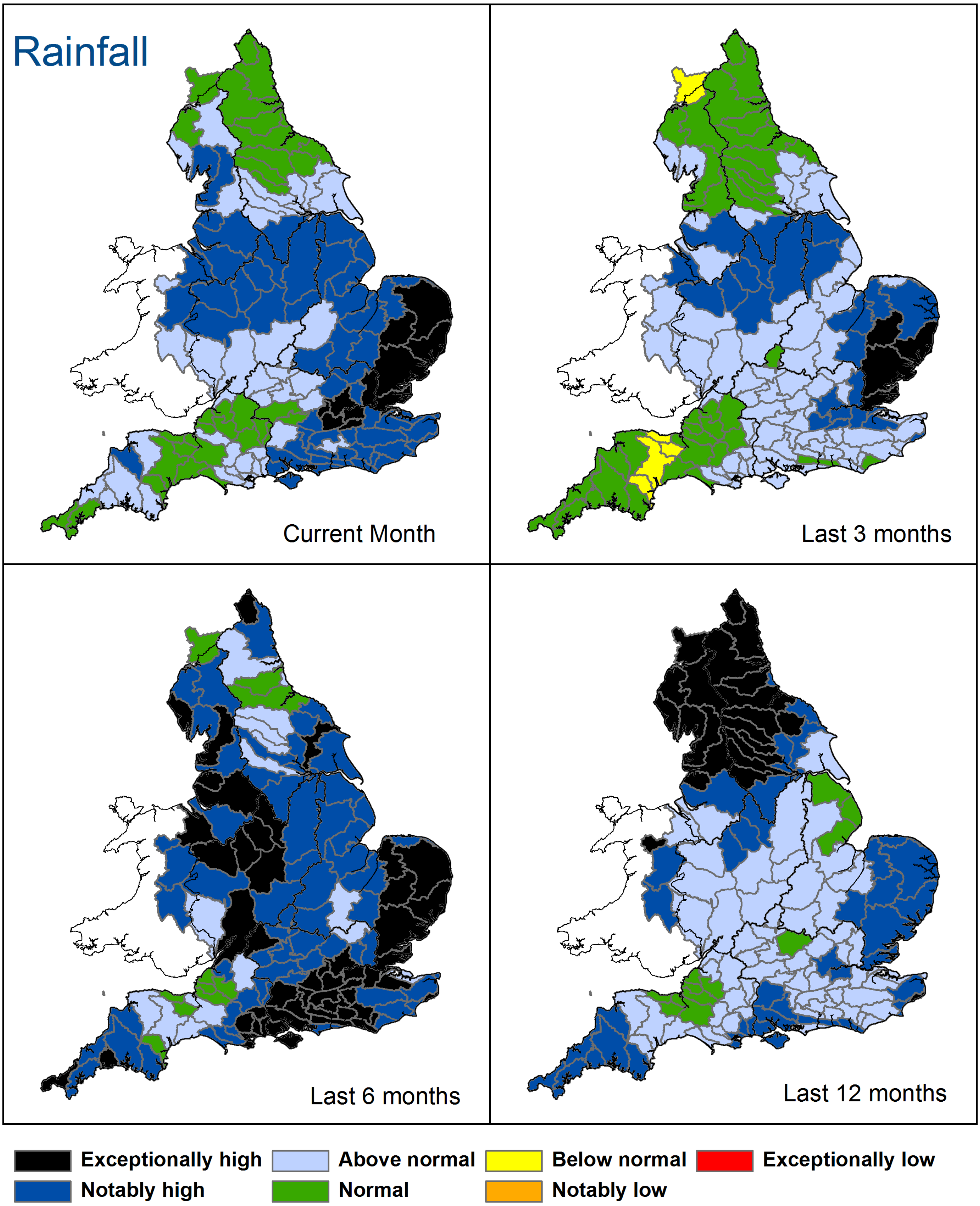


Figure 1.2: Total rainfall for hydrological areas across England for the current month (up to 30 June), the last 3 months, the last 6 months, and the last 12 months, classed relative to an analysis of respective historic totals. Final NCIC (National Climate Information Centre) data based on the Met Office 5km gridded rainfall dataset derived from rain gauges *(Source: Met Office © Crown Copyright, 2016).* Provisional data based on Environment Agency 1km gridded rainfall dataset derived from Environment Agency intensity rain gauges. Crown copyright. All rights reserved. Environment Agency, 100026380, 2016.

Rainfall charts

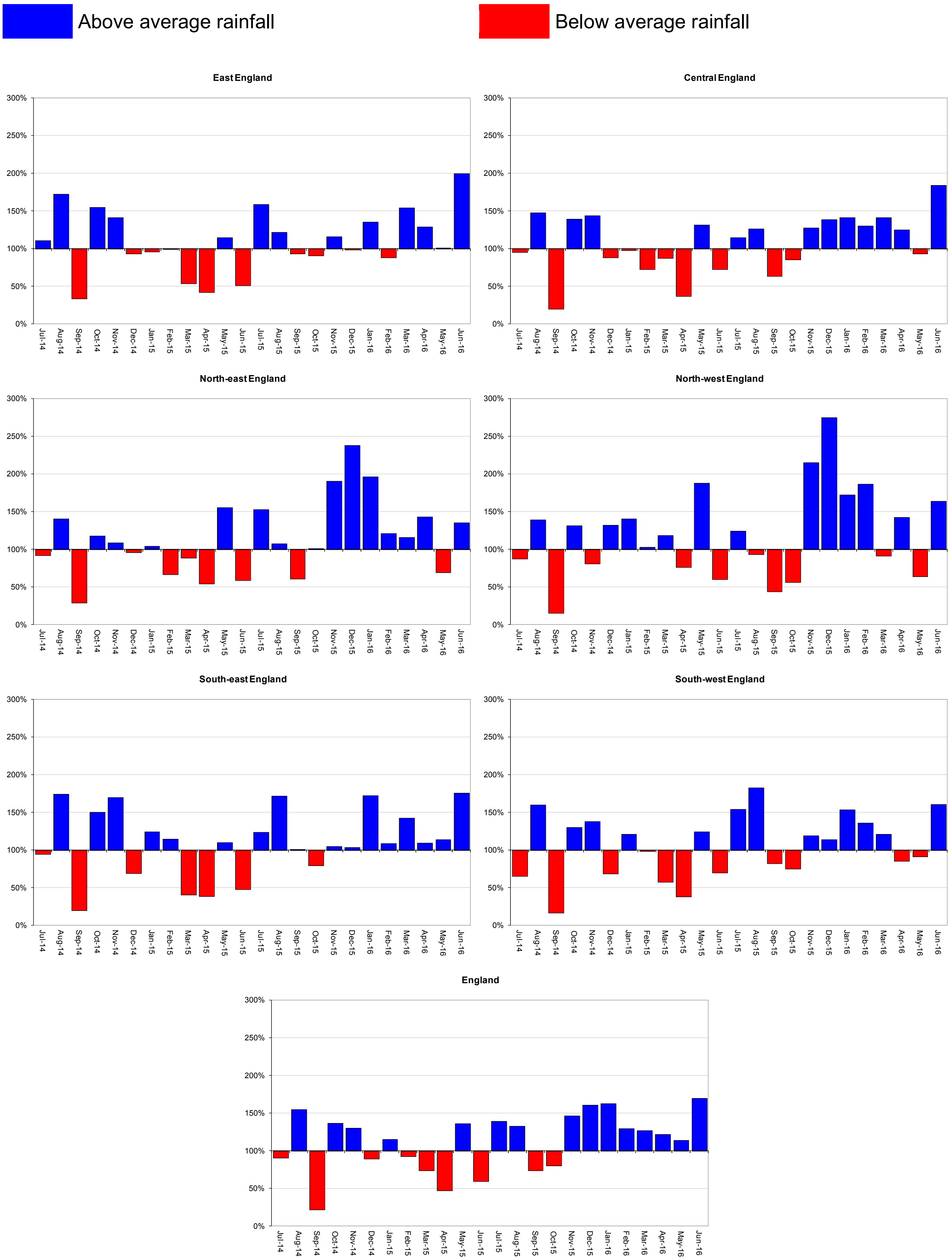


Figure 1.3: Monthly rainfall totals for the past 24 months as a percentage of the 1961 – 1990 long term average for each region and for England. NCIC (National Climate Information Centre) data. (Source: Met Office © Crown Copyright, 2016).

Soil moisture deficit

End of May 2016[1]	End of June 2016[2]

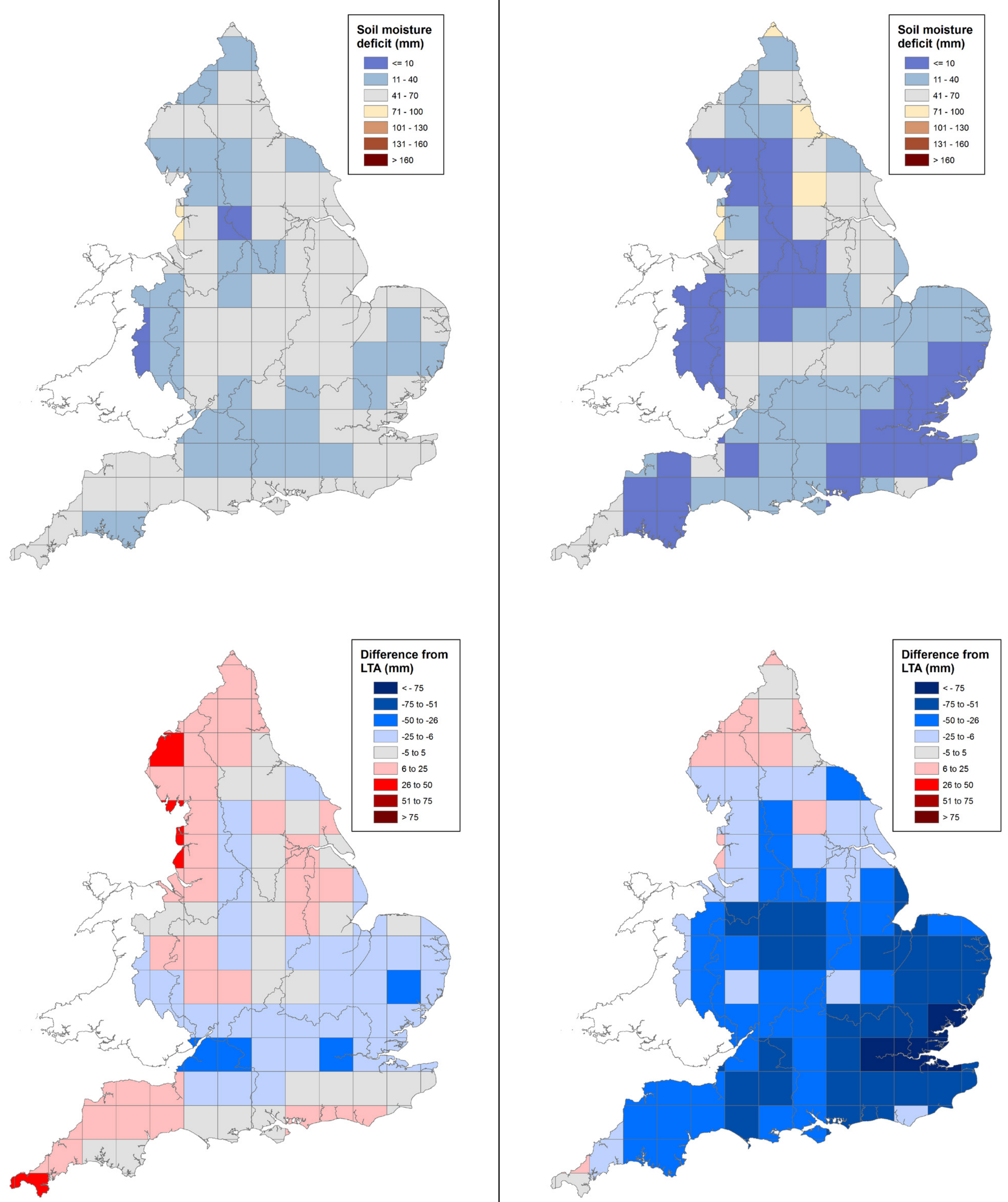


Figure 2.1: Soil moisture deficits for weeks ending 31 May 2016 [1] (left panel) and 01 July 2016 [2] (right panel). Top row shows actual soil moisture deficits (mm) and bottom row shows the difference (mm) of the actual from the 1961-90 long term average soil moisture deficits. MORECS data for real land use (Source: Met Office © Crown Copyright, 2016). Crown copyright. All rights reserved. Environment Agency, 100026380, 2016

Soil moisture deficit charts

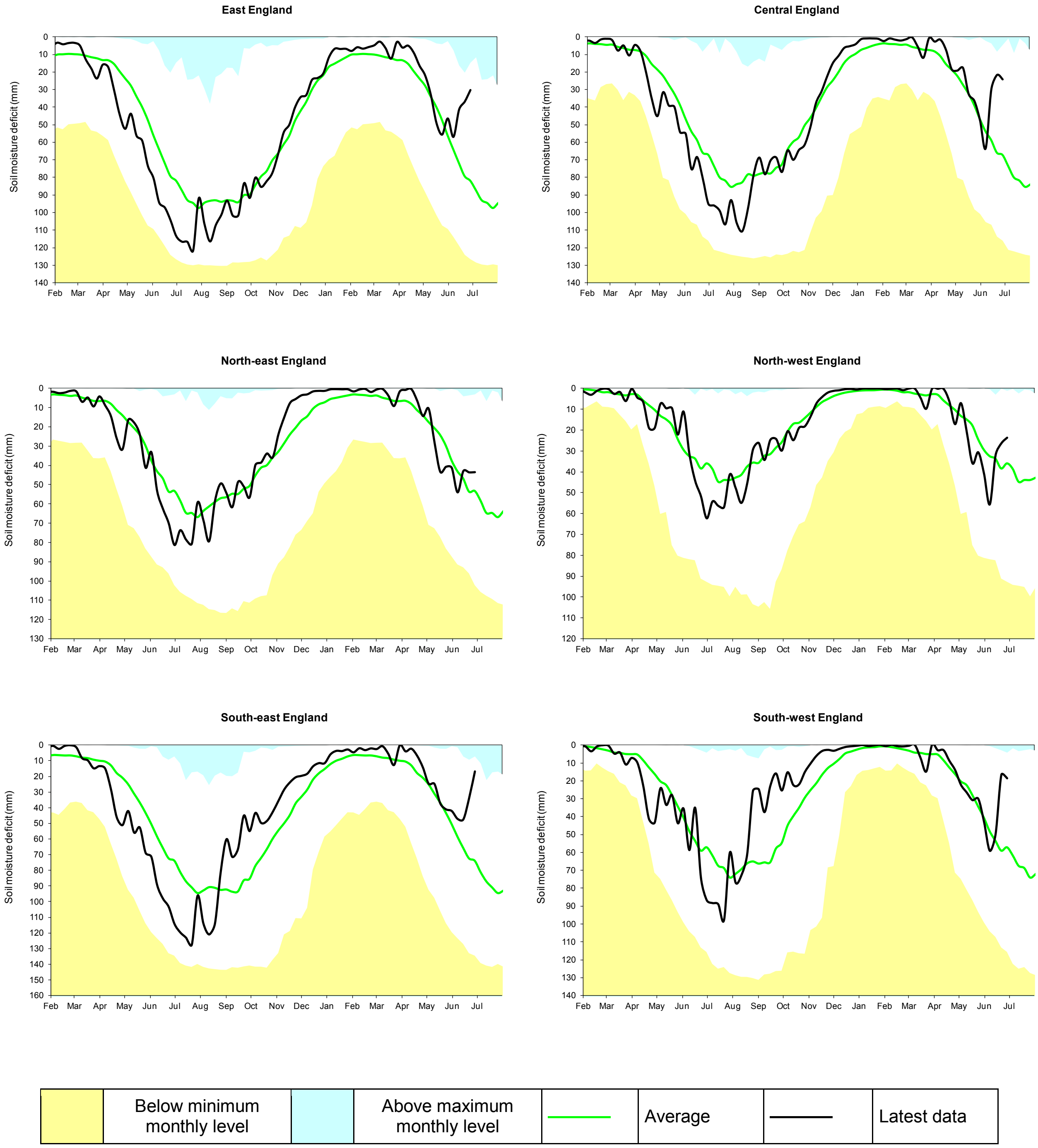
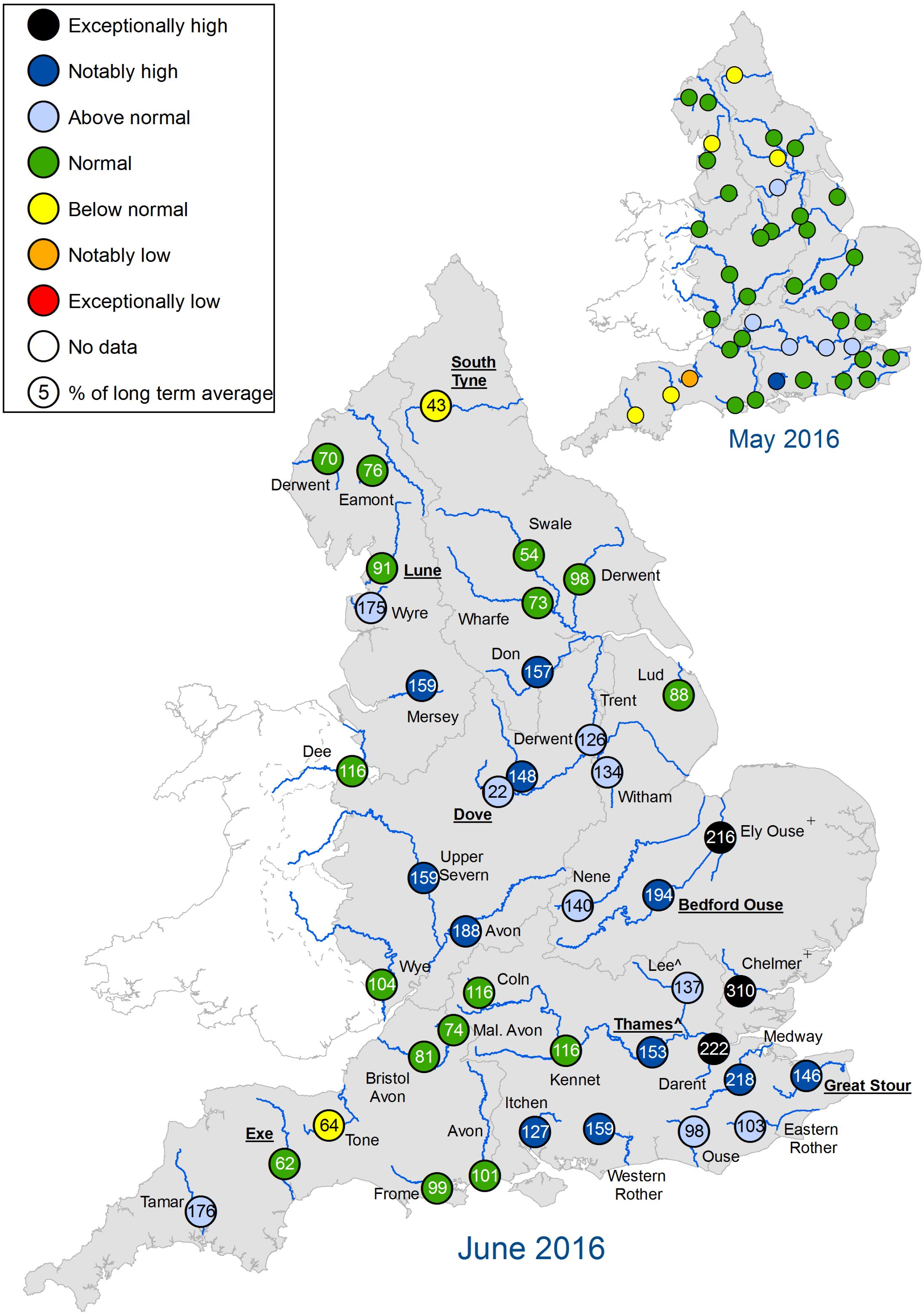


Figure 2.2: Latest soil moisture deficits for all geographic regions compared to maximum, minimum and 1961-90 long term average. Weekly MORECS data for real land use. (Source: Met Office © Crown Copyright, 2016).

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 2016 and June 2016, 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).

River flow charts

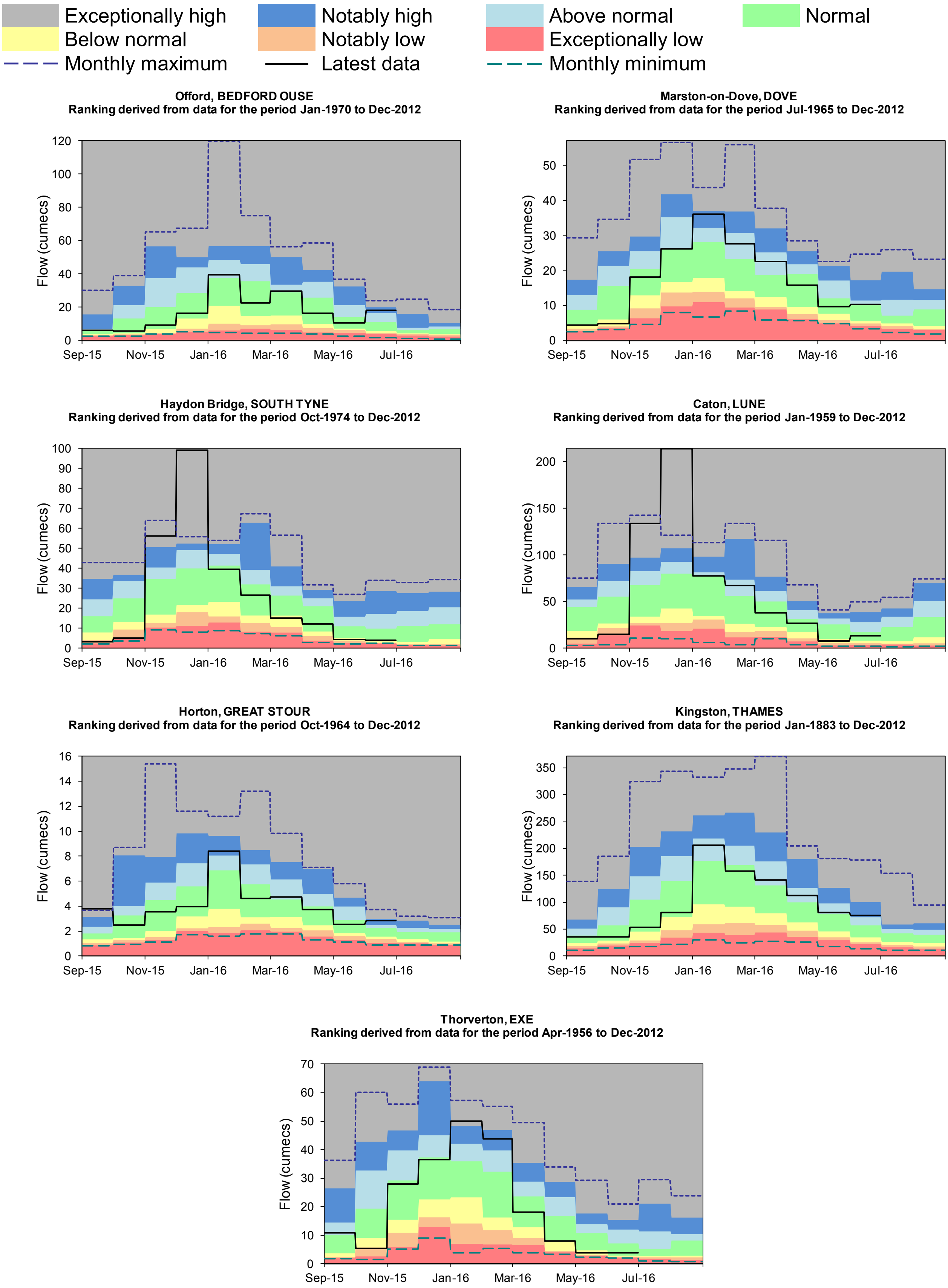
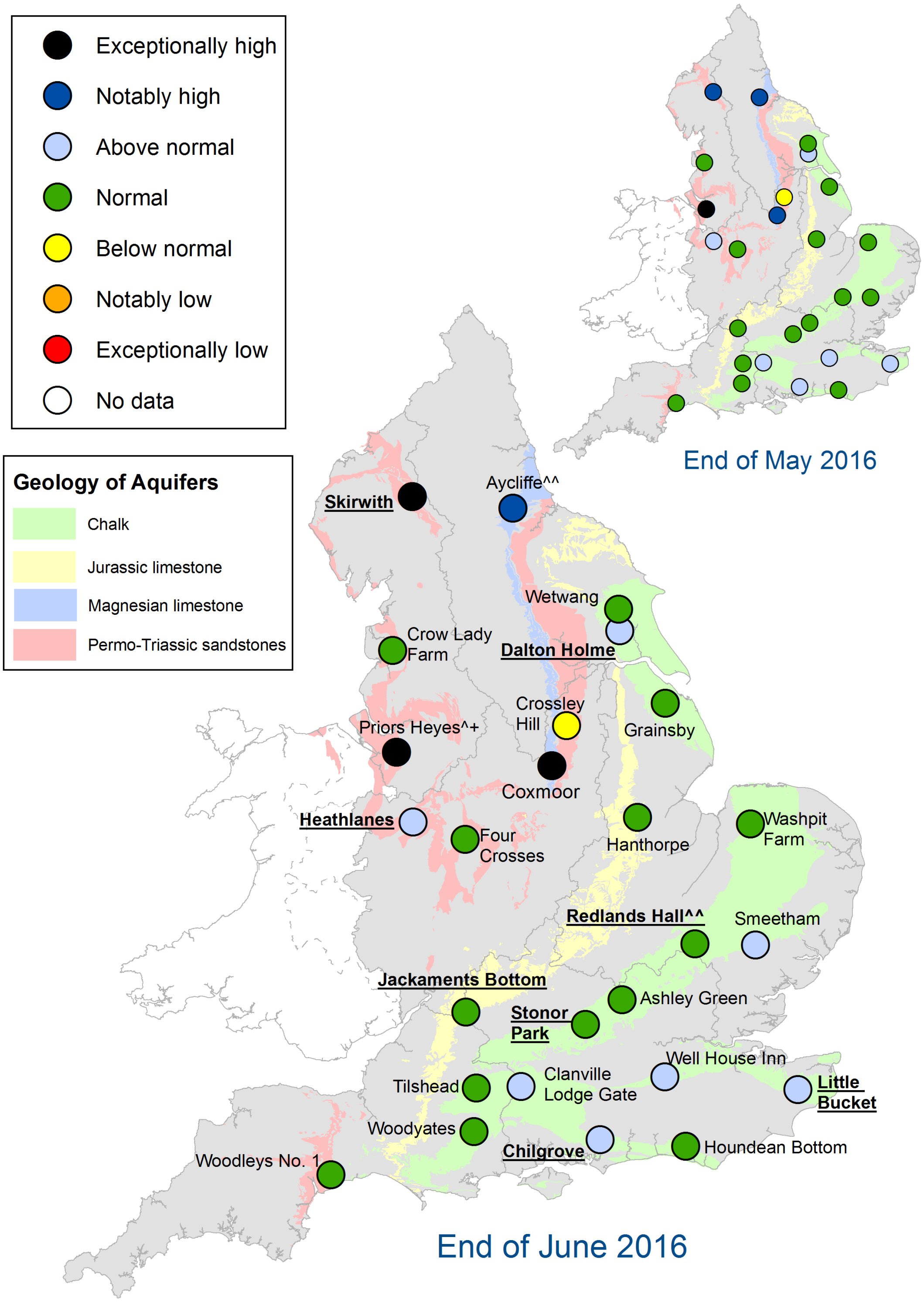


Figure 3.2: Index river flow sites for each geographic region. Monthly mean flow compared to an analysis of historic monthly mean flows, long term maximum and minimum flows. (Source: Environment Agency).

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 2016 and June 2016, 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, 2016.

Groundwater level charts

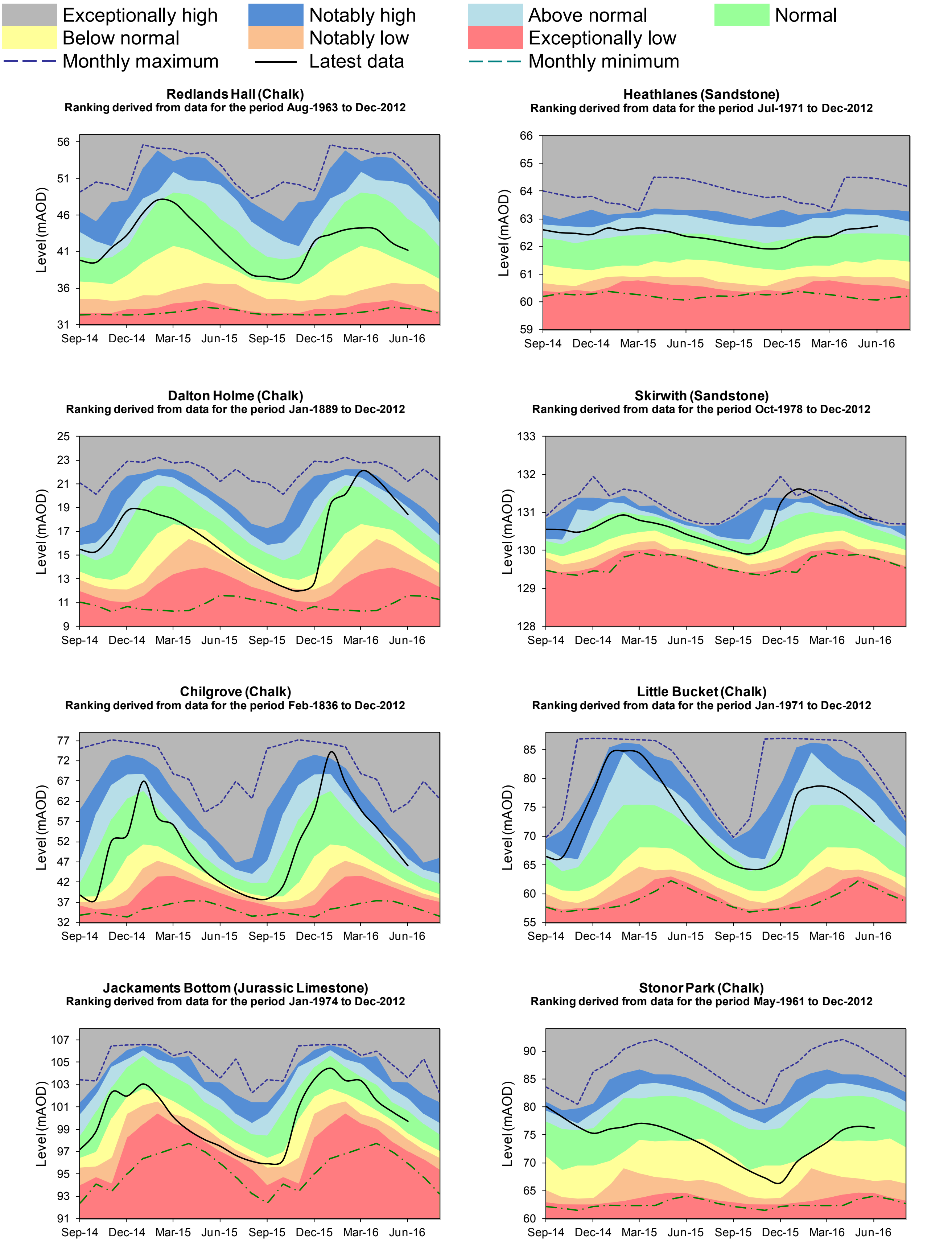
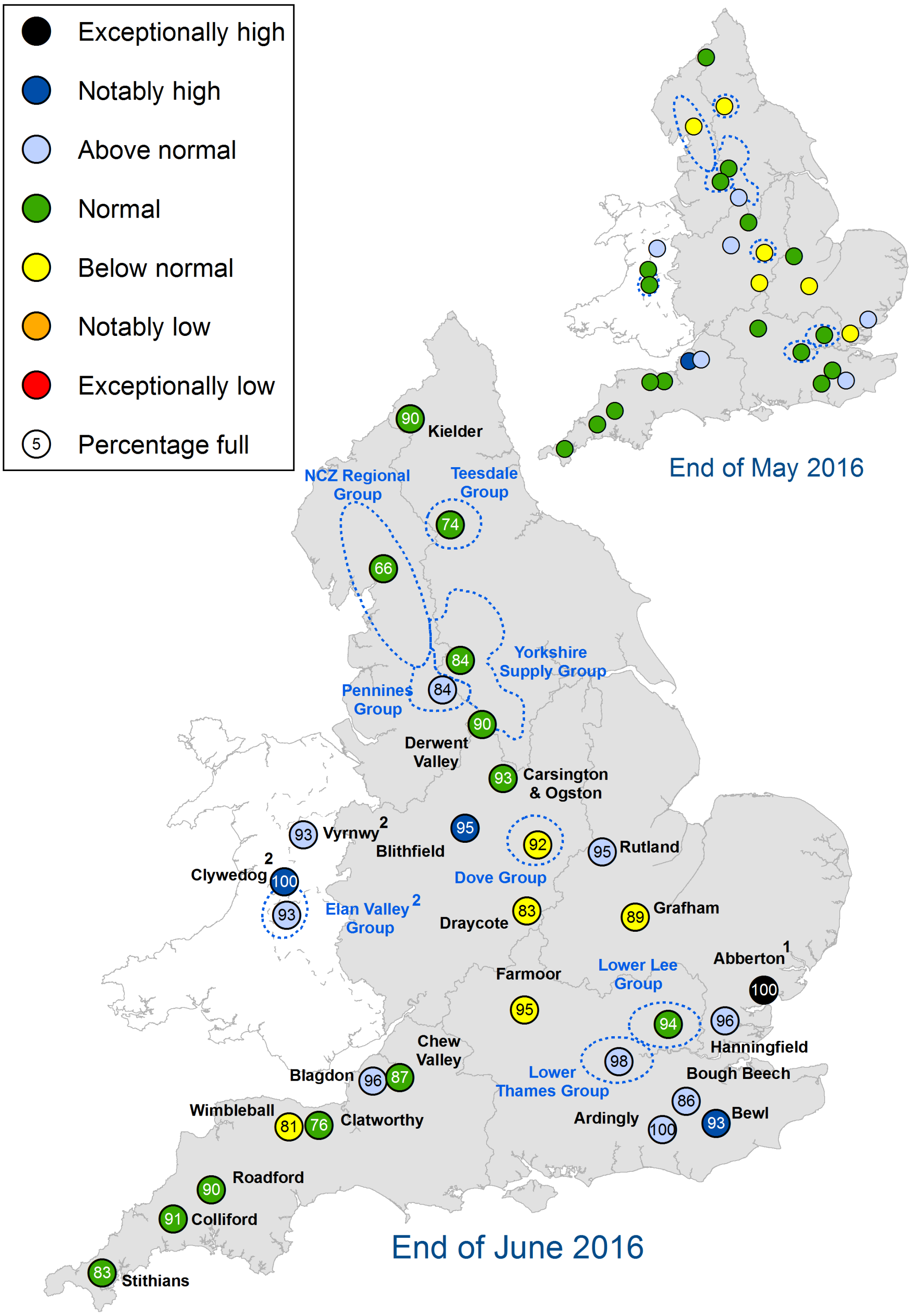


Figure 4.2: Index groundwater level sites for major aquifers. End of month groundwater levels months compared to an analysis of historic end of month levels and long term maximum and minimum levels. (Source: Environment Agency, 2016).

Reservoir storage

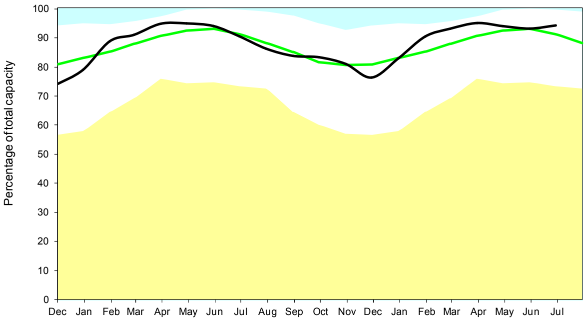


1. Engineering work at Abberton Reservoir in east England to increase capacity has been completed
2. Vyrnwy, Clywedog and Elan Valley reservoirs are located in Wales but provide a water resource to Central and north-west England

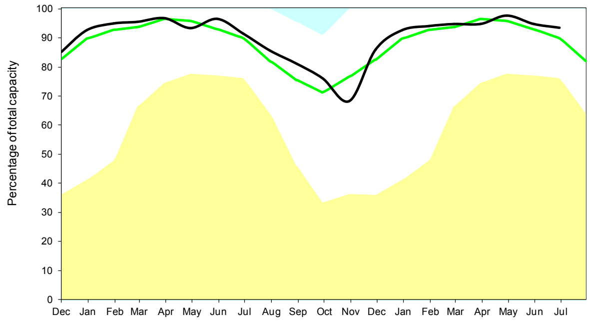
Figure 5.1: Reservoir stocks at key individual and groups of reservoirs at the end of May 2016 and June 2016 as a percentage of total capacity and classed relative to an analysis of historic May and June values respectively (Source: Water Companies). Note: Classes shown may not necessarily relate to 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.

Reservoir storage charts

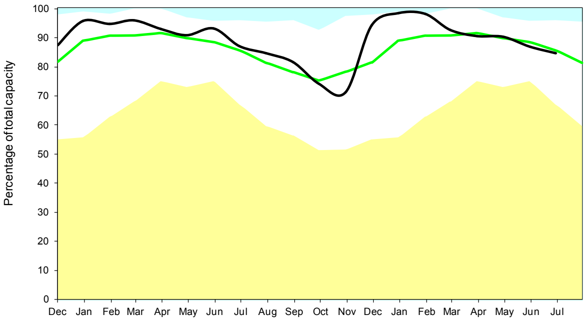
East England
Based on storage in Abberton, Grafham, Hanningfield, Rutland reservoirs



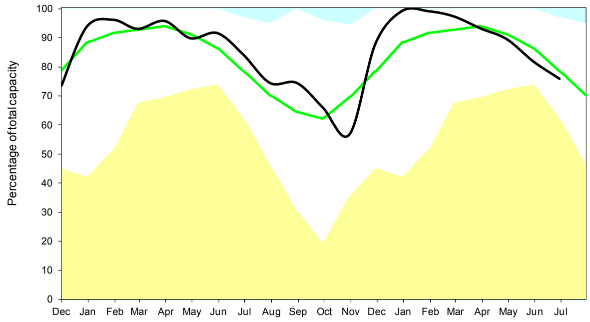
Central England
Based on storage in Clywedog, Carsington and Ogston, Derwent Valley, Dove (Foremark & Staunton), Draycote, Elan Valley Group reservoirs



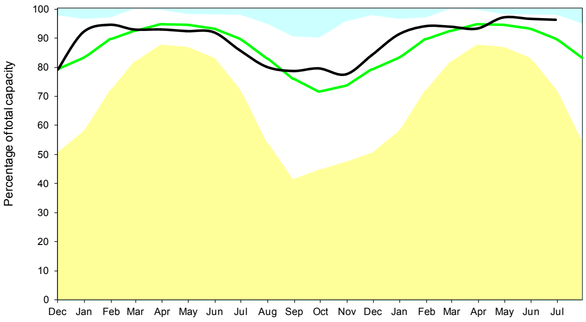
North-east England
Based on storage in Kielder, Teesdale Group, Yorkshire Supply Group reservoirs



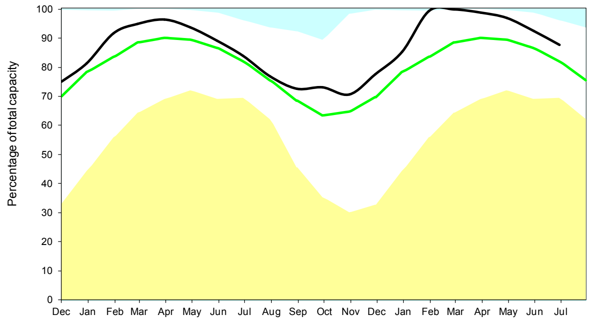
North-west England
Based on storage in NCZ Regional Group, Pennines Group, Vyrnwy reservoirs



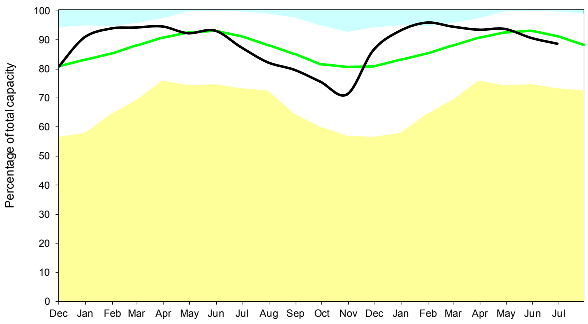
South-east England
Based on storage in Ardingly, Bewl, Bough Beech, Farmoor, Lower Lee Group, Lower Thames Group reservoirs



South-west England
Based on storage in Blagdon, Chew Valley, Clatworthy, Colliford, Roadford, Stithians, Wimbleball reservoirs



England
Based on combined regional storage



	Below minimum monthly level		Above maximum monthly level		Average		Latest data

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

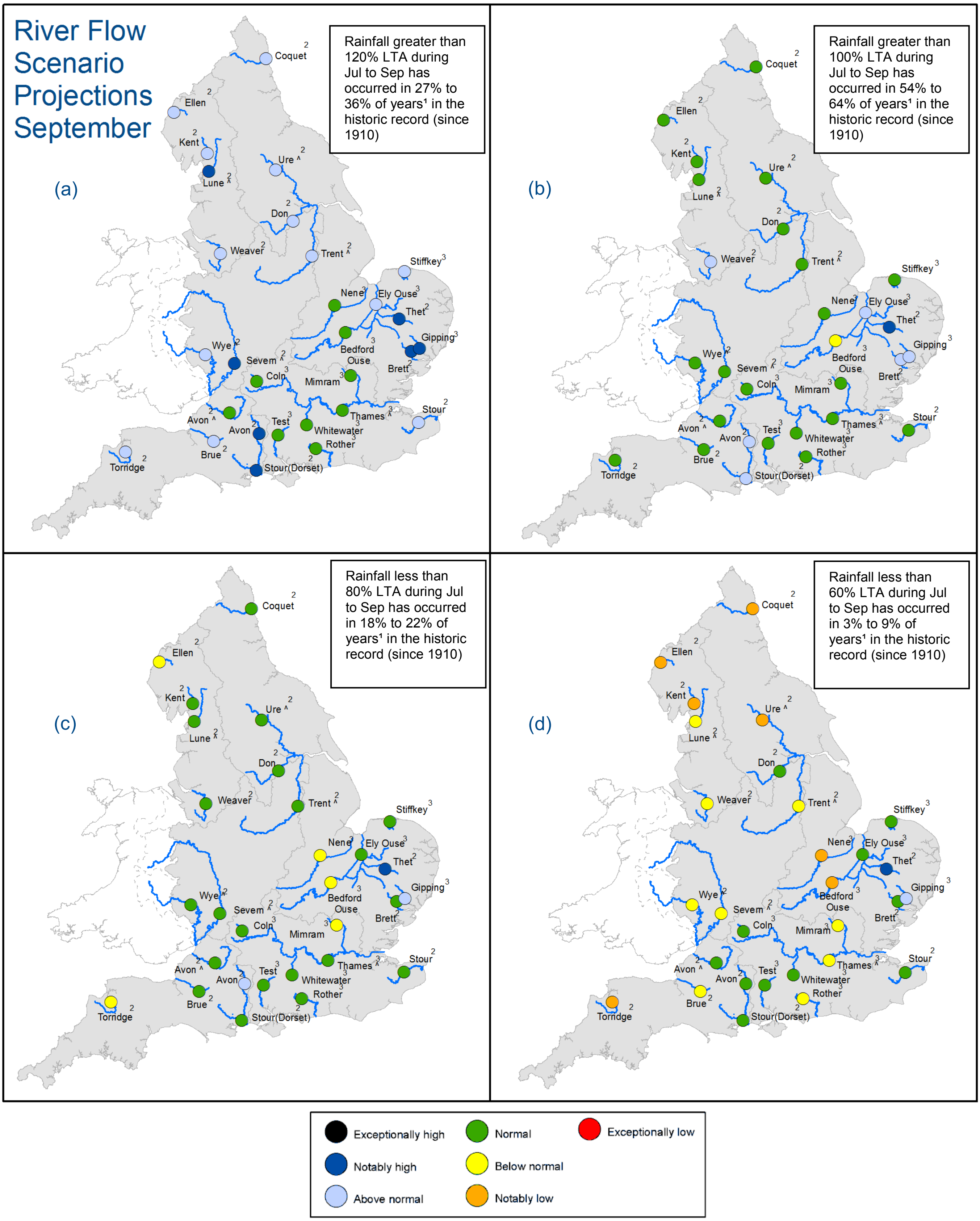


Figure 6.1: Projected river flows at key indicator sites up until the end of September 2016. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between July and September 2016 (Source: Centre for Ecology and Hydrology, Environment Agency)

[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*

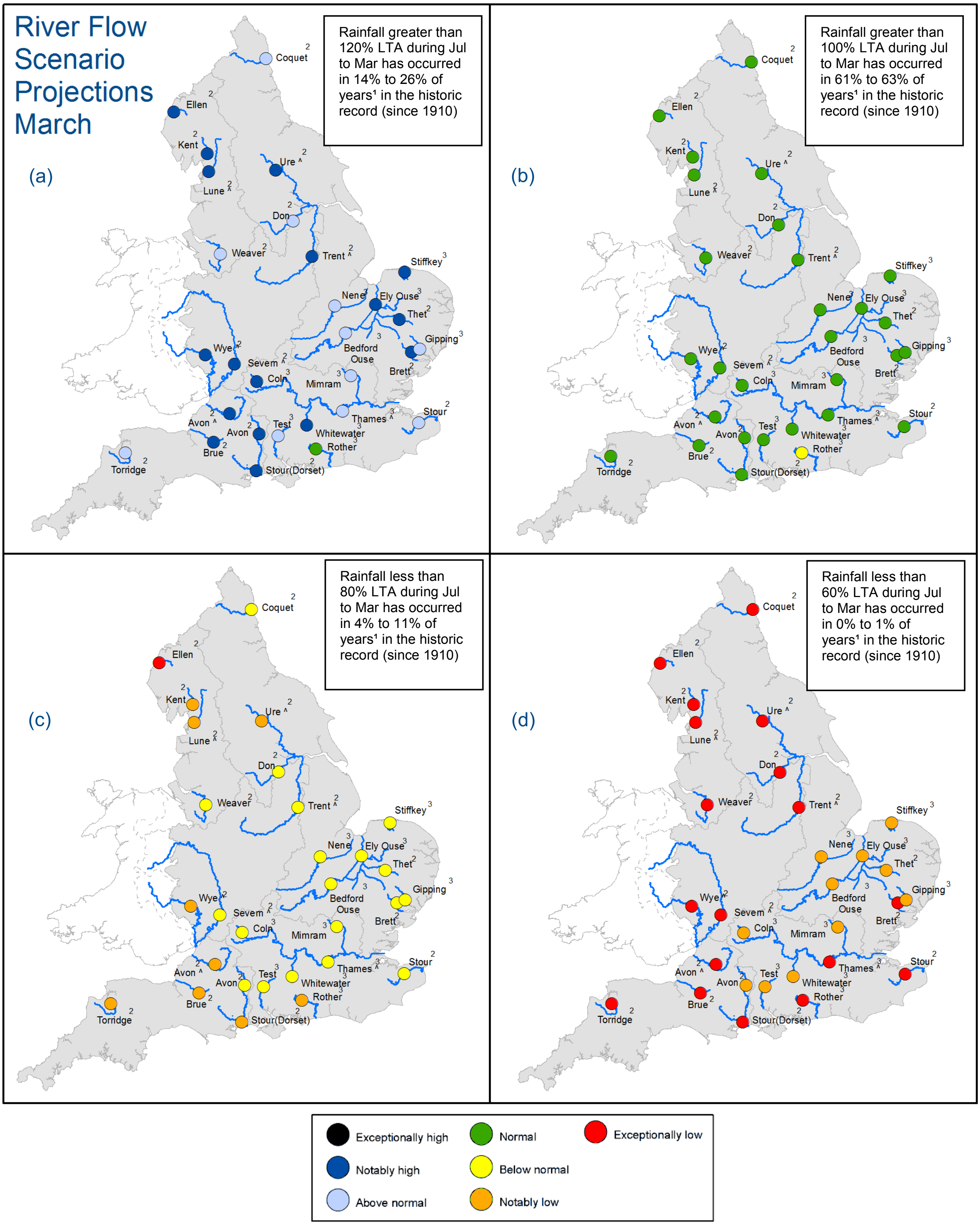


Figure 6.2: Projected river flows at key indicator sites up until the end of March 2017. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between July 2016 and March 2017 (Source: Centre for Ecology and Hydrology, Environment Agency)

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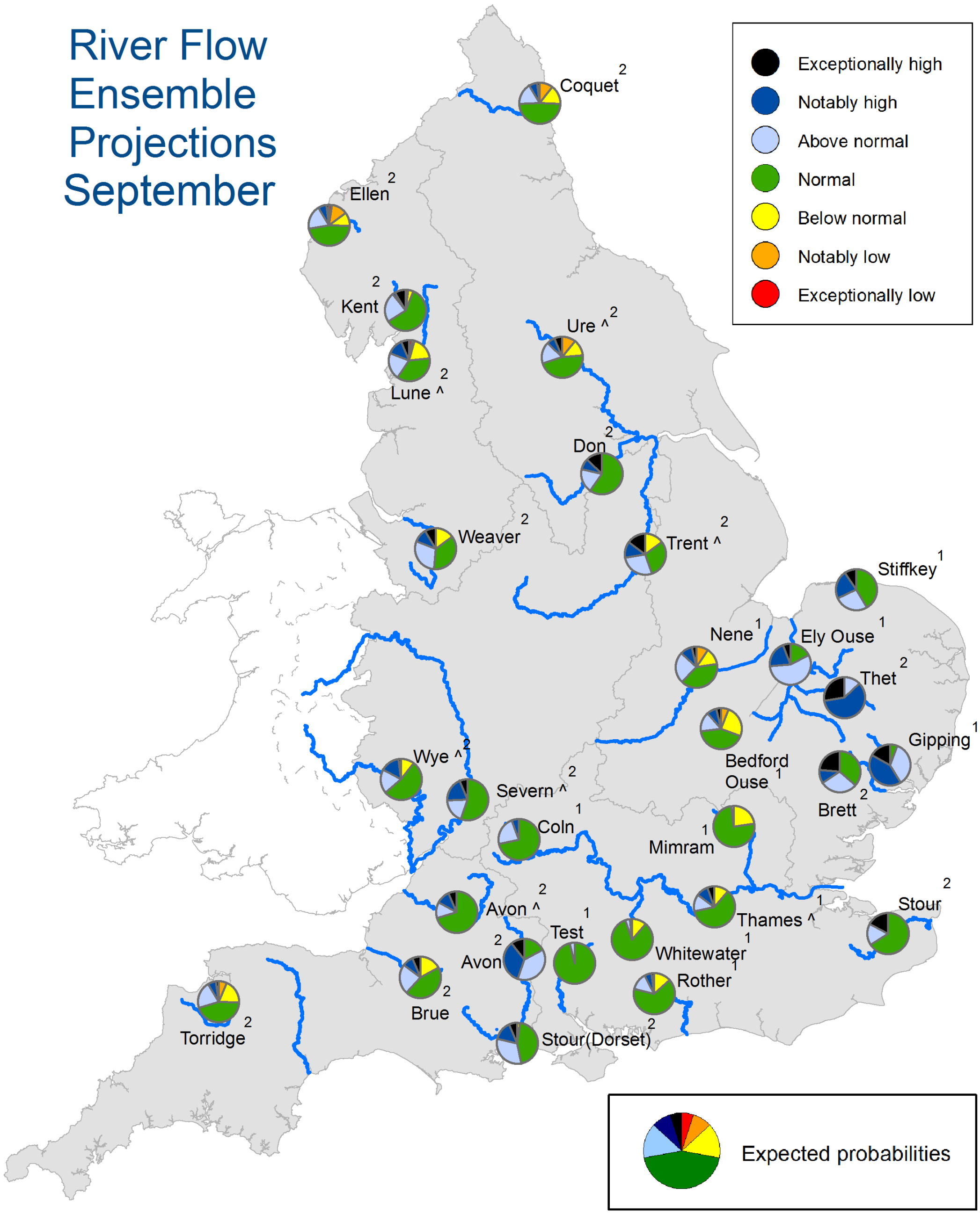

Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are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

Figure 6.3: Probabilistic ensemble projections of river flows at key indicator sites up until the end of September 2016. 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
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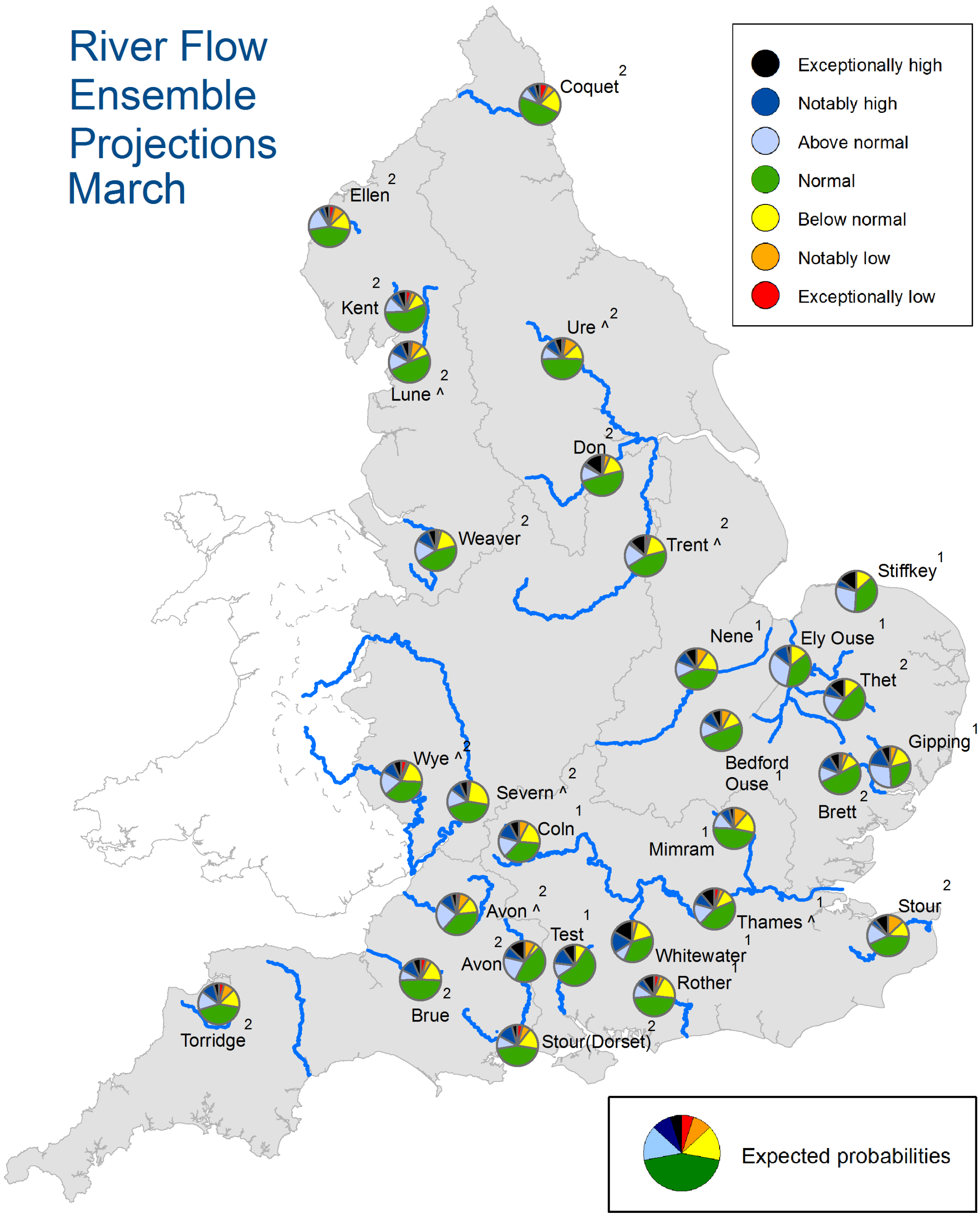
^"Naturalised" flows are projected for these sites



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 river flows at key indicator sites up until the end of March 2017. 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

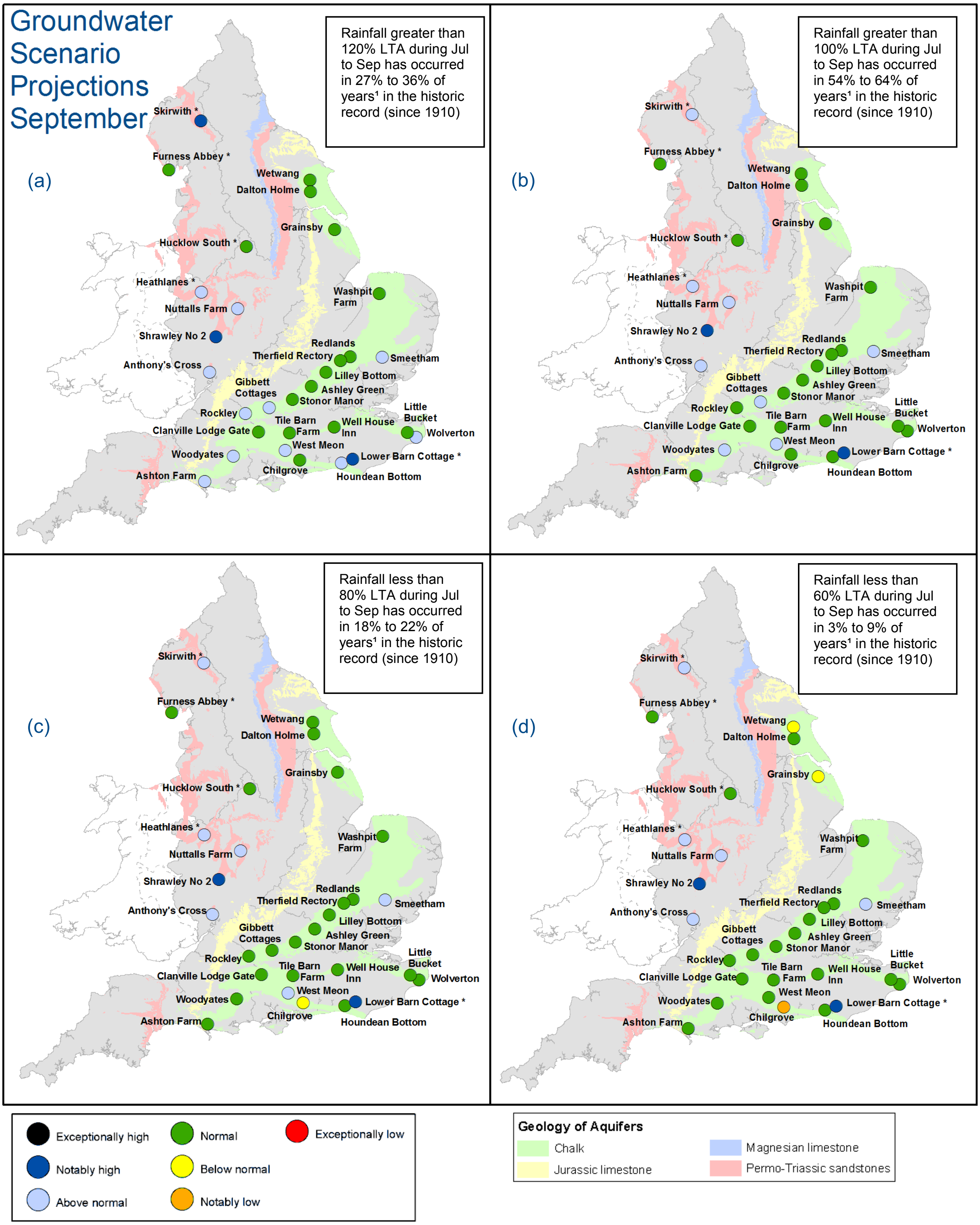


Figure 6.5: Projected groundwater levels at key indicator sites at the end of September 2016. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between July and September 2016 (Source: Environment Agency) Geological map reproduced with kind permission from UK Groundwater Forum BGS © NERC. Crown copyright all rights reserved. Environment Agency 100026380, 2016.

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

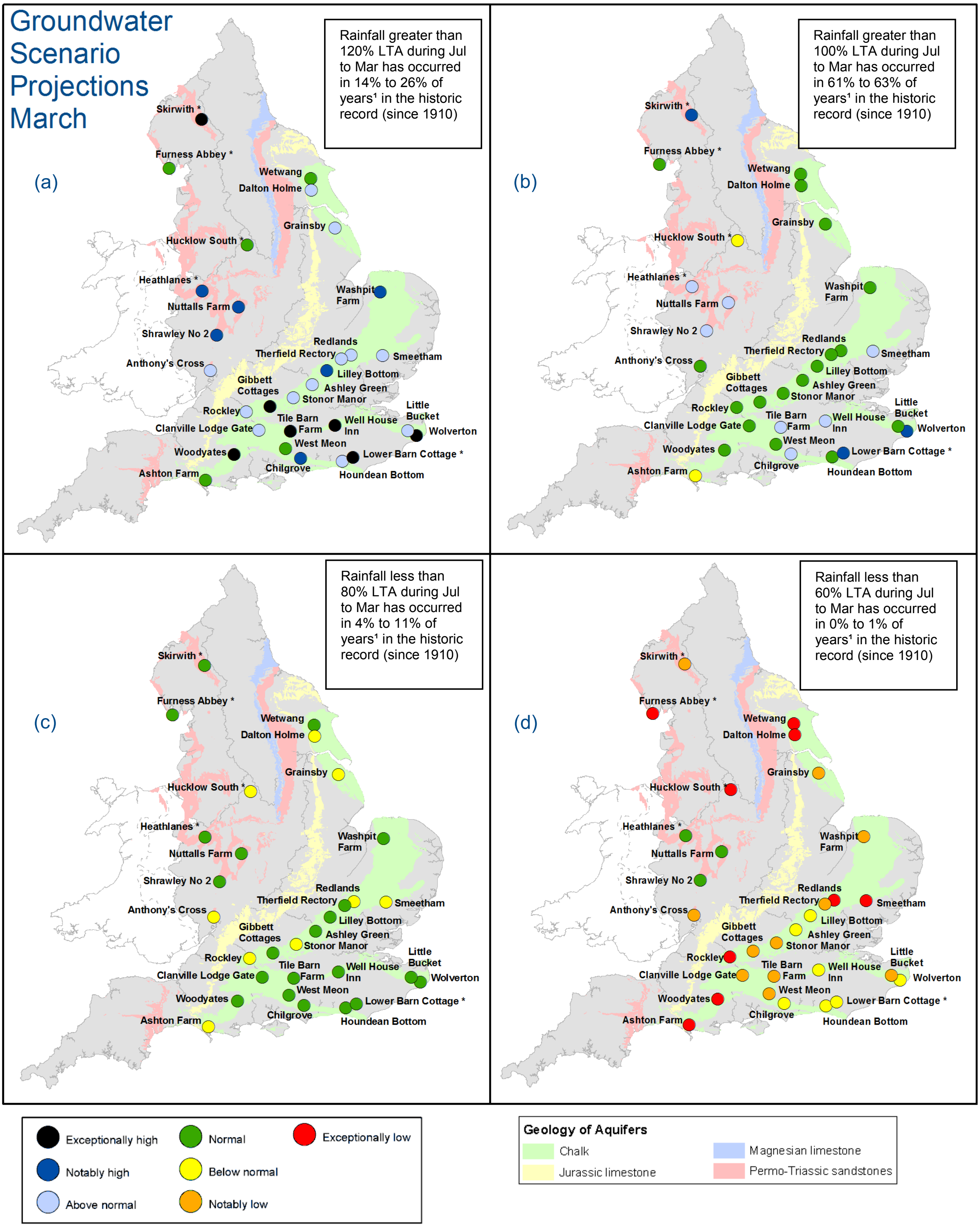
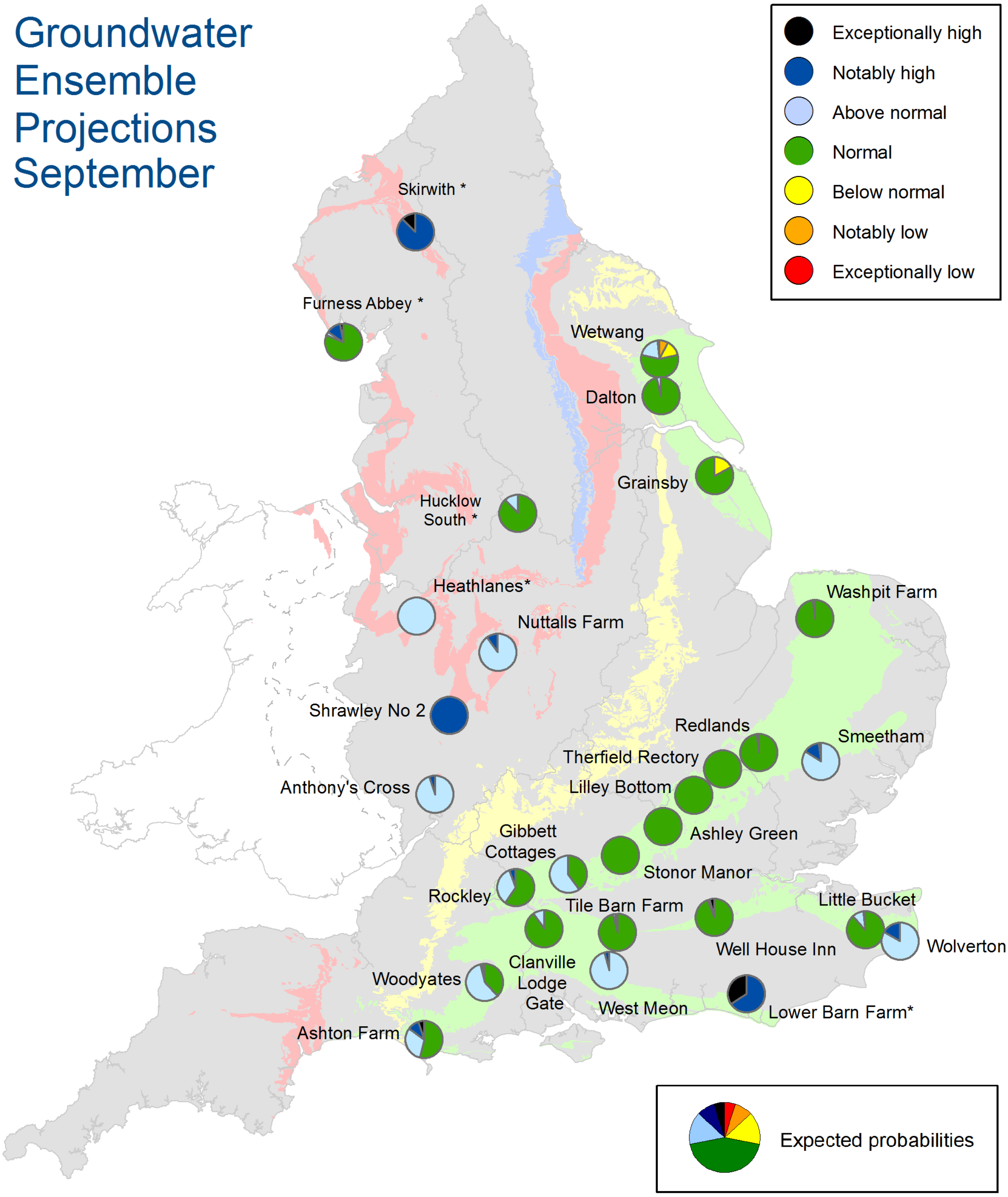


Figure 6.6: Projected groundwater levels at key indicator sites at the end of March 2017. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between July 2016 and March 2017 (Source: Environment Agency) Geological map reproduced with kind permission from UK Groundwater Forum BGS © NERC Crown copyright. All rights reserved. Environment Agency 100026380 2016.

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

Groundwater Ensemble Projections September

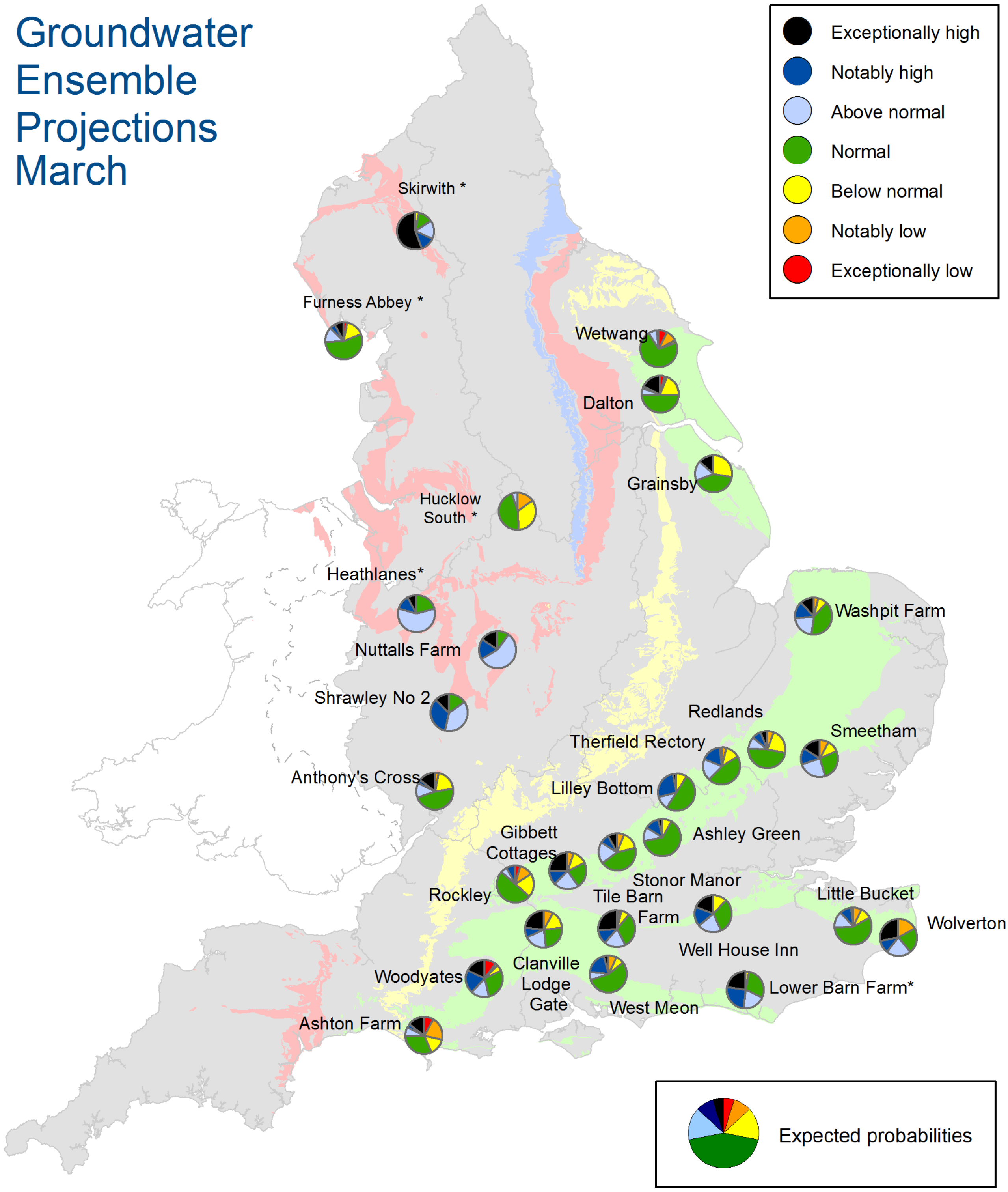


Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are 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. 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, 2016.

** Projections for these sites are produced by BGS*

Groundwater Ensemble Projections March



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 2017. 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, 2016.

* 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