Monthly water situation report

England

Summary – September 2018

The September rainfall total for England was below average with 61 mm, representing 86% of the 1961-1990 long-term average (88% of the 1981-2010 long-term average) making it the fifth consecutive month of below average rainfall totals for England. Despite this, September rainfall totals were classed as normal for the time of year across most of England. Soils got wetter during September across most of England but remain drier than average for the time of year across most of the country, with the driest soils in the east and south-east of England. Monthly mean river flows decreased at three-fifths of indicator sites, compared to August and groundwater levels continued to decrease at all but two indicator sites during September. Reservoir stocks decreased at two-thirds of reservoirs and reservoir groups across England. At just under two-thirds of reservoirs or reservoir groups, stocks were classed as below normal, or lower, for the time of year.

Rainfall

September rainfall totals were generally highest in parts of northern and central England and lowest across parts of southern and eastern England. The highest rainfall total was in the Upper Dee catchment, with 198 mm representing 138% of the long-term average (LTA). The lowest rainfall total was in the Lower Welland and Nene catchments, where 22 mm represented 49% of the LTA (Figure 1.1 and Figure 1.2).

Across most of England, September rainfall totals were classed as normal for the time of year. In just under a third of catchments rainfall totals were classed as below normal, mainly in south-east and east England. The six-month cumulative rainfall totals were classed as exceptionally low in five catchments with either below normal or notably low cumulative totals recorded in most other catchments (Figure 1.2).

The September rainfall total for England was 61 mm, representing 86% of the 1961-1990 LTA (88% of the 1981-2010 LTA). The monthly rainfall total for England was below average for the fifth consecutive month. At a regional scale, the rainfall total for east England was classed as below normal (60% of LTA). In all other regions the rainfall totals were classed as normal for the time of year (Figure 1.3).

Soil moisture deficit

Soils got wetter during September across most of England. Despite this, soil moisture deficits (SMDs) remained below average for the time of year across most of the country. The driest soils were in the east and south-east of England and the wettest soils were in the north-west. (Figure 2.1)

At a regional scale, soil moisture deficits across England reduced during September. Despite a record high July soil-moisture deficit in north-west England, this had recovered to close to average SMD by the end of September (Figure 2.2).

River flows

Monthly mean river flows decreased at three-fifths of indicator sites in September, compared to August. Flows were classed as below normal at a quarter of indicator sites and notably low at a tenth of sites. The lower flows were generally in southern and eastern England. At all other indicator sites monthly mean flows were in the normal range for the time of year (Figure 3.1).

The regional index sites reflected a similar pattern. Monthly mean flows increased, and were classed as normal for the time of year, on the River Lune (north-west), South-Tyne (north-east), River Exe (south-west) and River Dove (central England). Flows reduced on the Bedford Ouse (east England) and Great Stour (south-east England). A below normal monthly mean flow was recorded at Kingston on the River Thames, representing 67% of the long-term average flow for September (Figure 3.2).

Groundwater levels

Groundwater levels continued to decrease at all but two indicator sites during September. End of month groundwater levels were classed as normal for the time of year at just under two-thirds of sites and below normal

at almost a quarter of sites. The groundwater level in the Fylde and Preston sandstone aquifer at Crow Lady Farm was classed as below normal at the end of August and was at a notably low level for the time of year by the end of September.

Four indicator sites in the chalk aquifers of south-east and south-west England were recording below normal groundwater levels at the end of September (Figure 4.1). These include the Stonor Park borehole (South West Chilterns) and Chilgrove borehole (Chichester Chalk aquifer) (Figure 4.2).

Reservoir storage

Reservoir stocks decreased at two-thirds of the reservoirs and reservoir groups across England during September. Reductions of 10% of total storage capacity, or greater, were seen at eight reservoirs and reservoir groups including Grafham Water, Hanningfield, Ardingly and the Lower Thames Group (in east and south-east England). End of month reservoir stocks at Hanningfield were 44% of capacity and classed as exceptionally low for the time of year (Figure 5.1). Reservoir stocks in Stithians, Colliford, Roadford and Wimbleball reservoirs (in south-west England) were classed as below normal by the end of September and fell by between 10-14% of total capacity.

Reservoir stocks in the NCZ Regional Group of reservoirs increased by 12% of total capacity and there was an 11% increase in Lake Vyrnwy. At just under two-thirds of reservoirs or reservoir groups, stocks were classed as below normal or lower, for the time of year, with the remaining third of reservoirs and reservoir groups classed as normal.

Regional reservoir stocks increased in north-east, north-west and central England, but continued to decrease in east, south-east and south-west England. Total reservoir storage for England was at 64% of capacity at the end of September (Figure 5.2).

Forward look

The first half of October is expected to be mainly unsettled in the north and west, with heavy rain at times and more settled in the south and east. The middle and latter part of the month is likely to be unsettled across all areas with a brief period of settled weather returning at the end of the month. For the 3-month period October-November-December, above average precipitation is more likely than below average precipitation[1].

Projections for river flows at key sites[2]

All of the modelled sites have a greater than expected chance of cumulative river flows being below normal or lower for the time of year by the end of both March and September 2019.

For scenario based projections of cumulative river flows at key sites by March 2019 see Figure 6.1
For scenario based projections of cumulative river flows at key sites by September 2019 see Figure 6.2
For probabilistic ensemble projections of cumulative river flows at key sites by March 2019 see Figure 6.3
For probabilistic ensemble projections of cumulative river flows at key sites by September 2019 see Figure 6.4

Projections for groundwater levels in key aquifers[2]

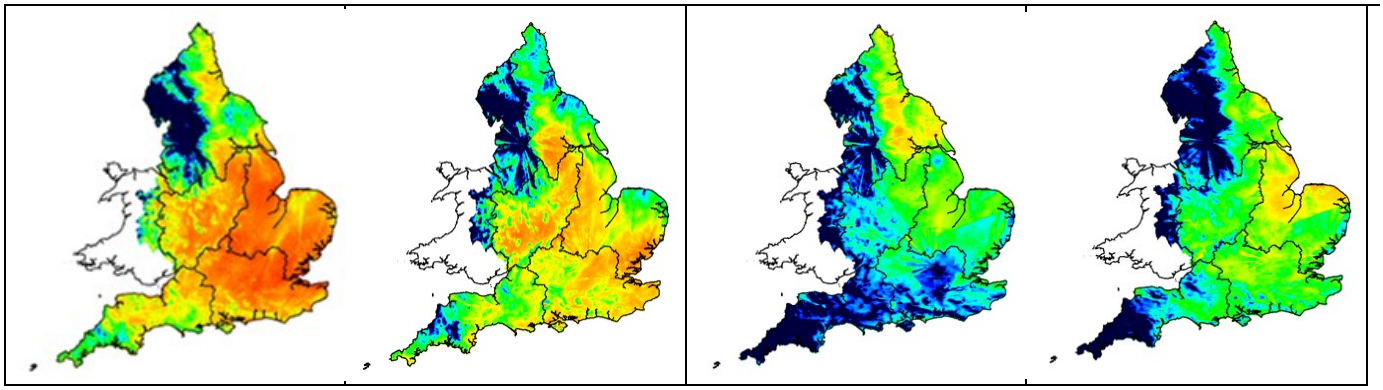
Nearly two-thirds of the modelled sites have a greater than expected chance of groundwater levels being below normal or lower for the time of year at the end of both March and September 2019.

For scenario based projections of groundwater levels in key aquifers in March 2019 see Figure 6.5
For scenario based projections of groundwater levels in key aquifers in September 2019 see Figure 6.6
For probabilistic ensemble projections of groundwater levels in key aquifers in March 2019 see Figure 6.7
For probabilistic ensemble projections of groundwater levels in key aquifers in September 2019 see Figure 6.8

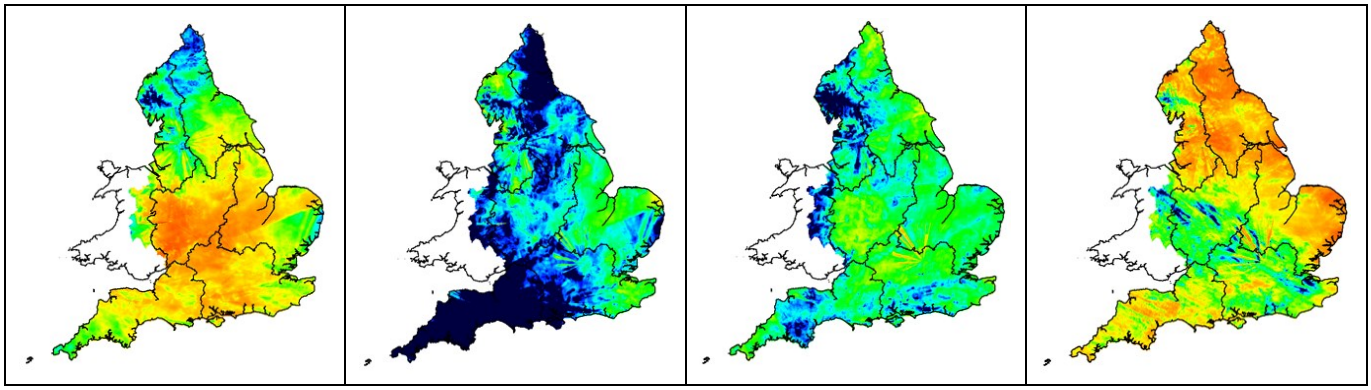
Authors: National Water Resources Hydrology Team

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).

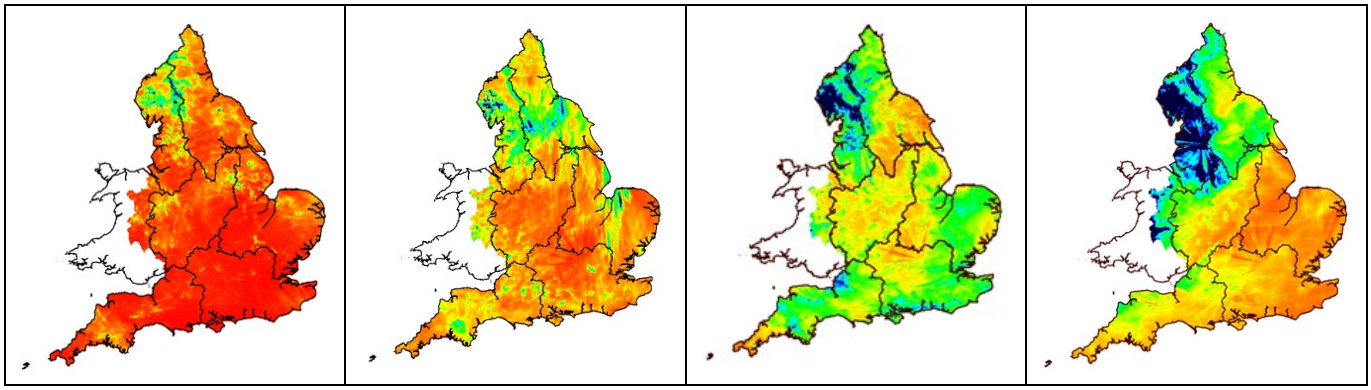
Rainfall



October 2017 | November 2017 | December 2017 | January 2018

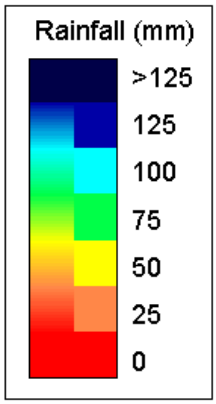


February 2018 | March 2018 | April 2018 | May 2018



June 2018 | July 2018 | August 2018 | September 2018

Figure 1.1: Monthly rainfall across England and Wales for the past 12 months. UKPP radar data (Source: Met Office © Crown Copyright, 2018). Note: Radar beam blockages in some regions may give anomalous totals in some areas. Crown copyright. All rights reserved. Environment Agency, 100026380, 2018.



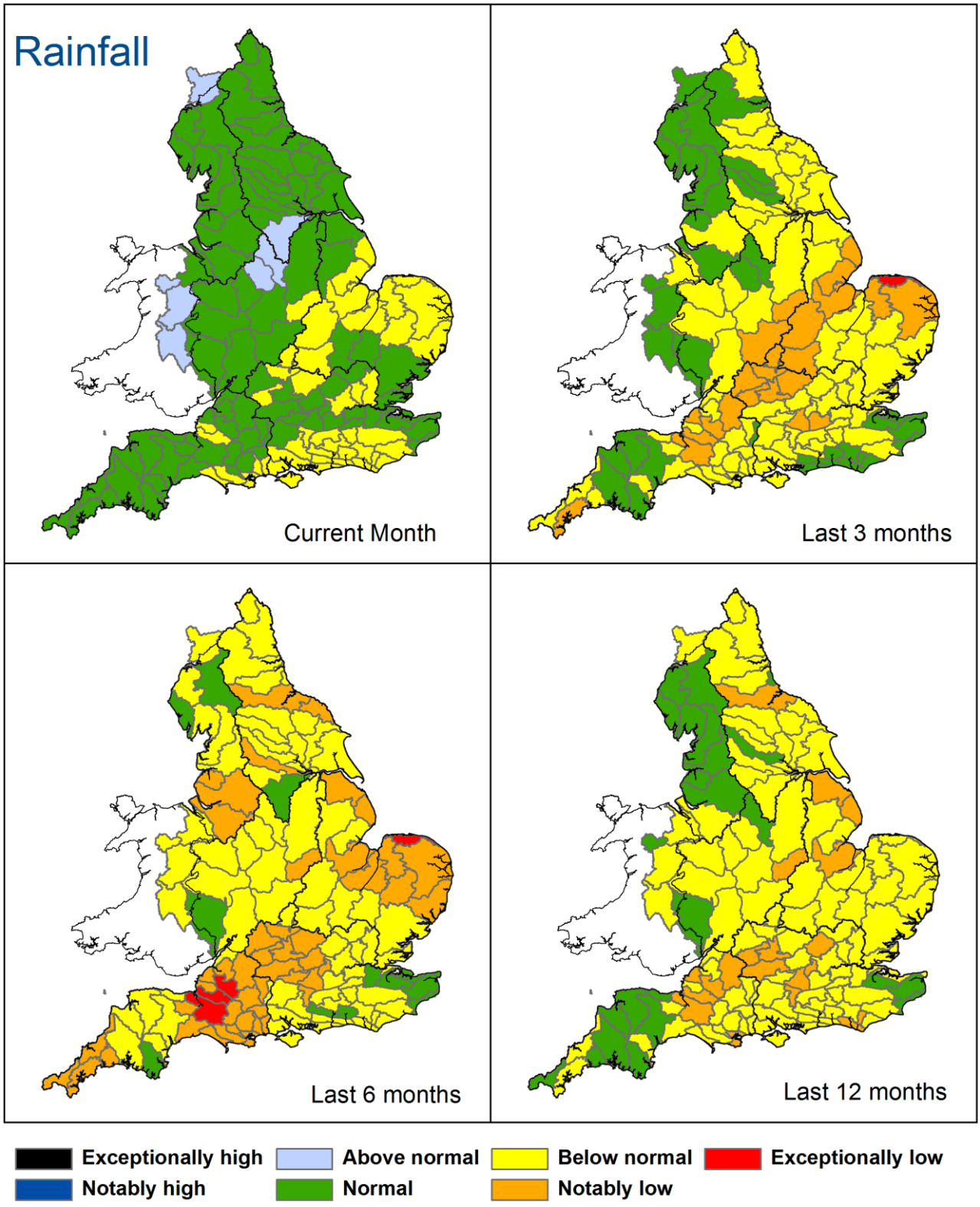


Figure 1.2: Total rainfall for hydrological areas across England for the current month (up to 30 September), the last 3 months, the last 6 months, and the last 12 months, classed relative to an analysis of respective historic totals. Final NCIC (National Climate Information Centre) data based on the Met Office 5km gridded rainfall dataset derived from rain gauges *(Source: Met Office © Crown Copyright, 2018).* 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, 2018.

Rainfall charts

Above average rainfall

Below average rainfall

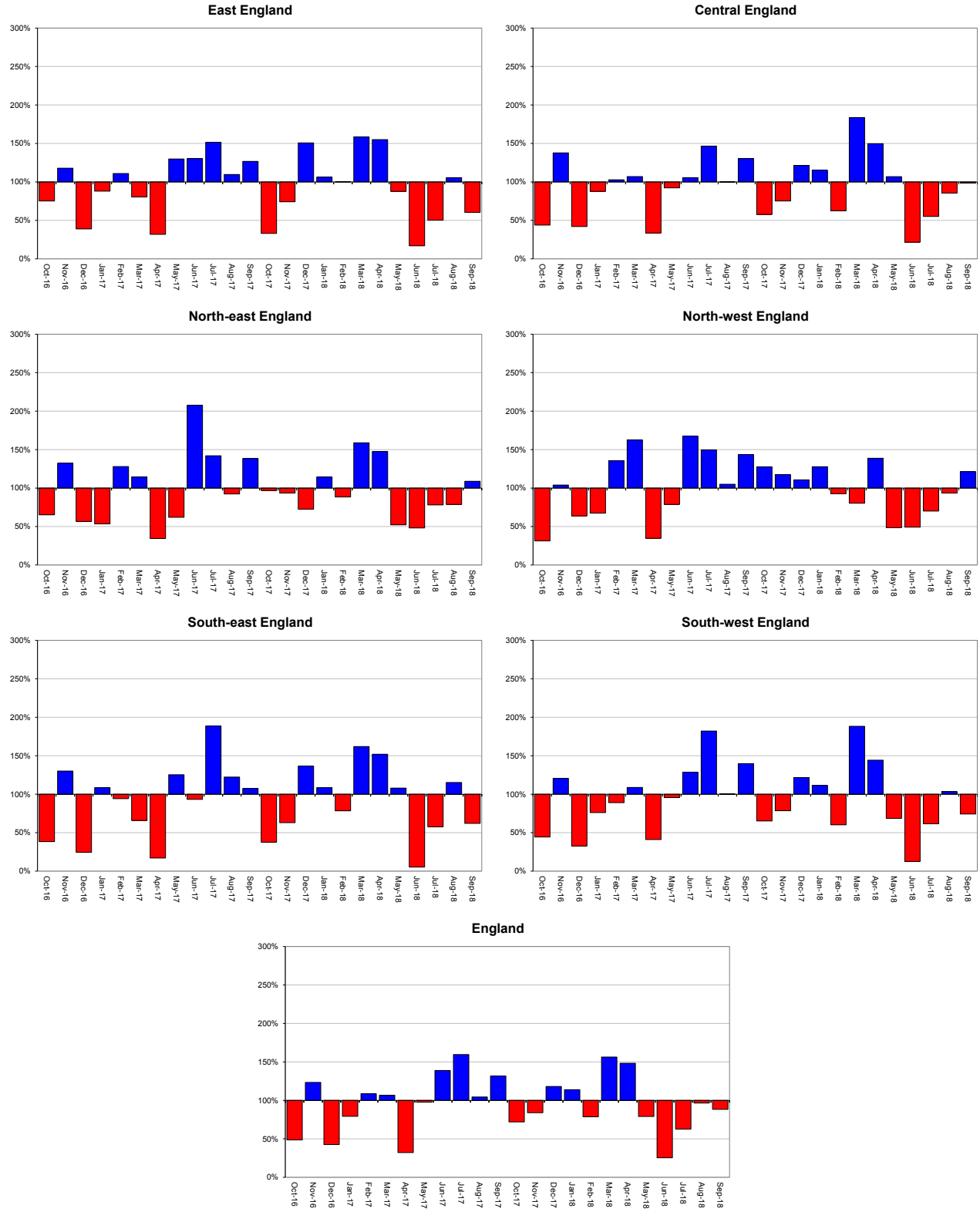


Figure 1.3: Monthly rainfall totals for the past 24 months as a percentage of the 1961 – 1990 long term average for each region and for England. NCIC (National Climate Information Centre) data. (Source: Met Office © Crown Copyright, 2018).

Soil moisture deficit

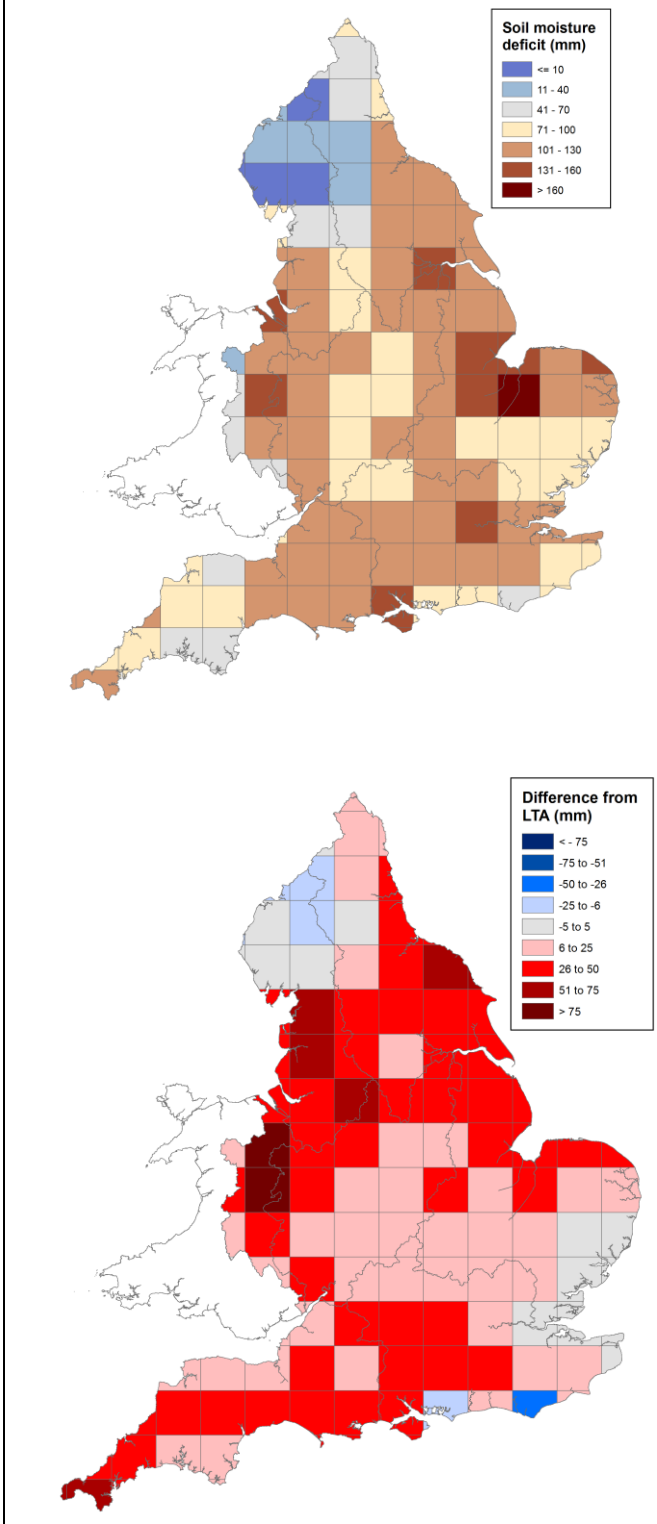
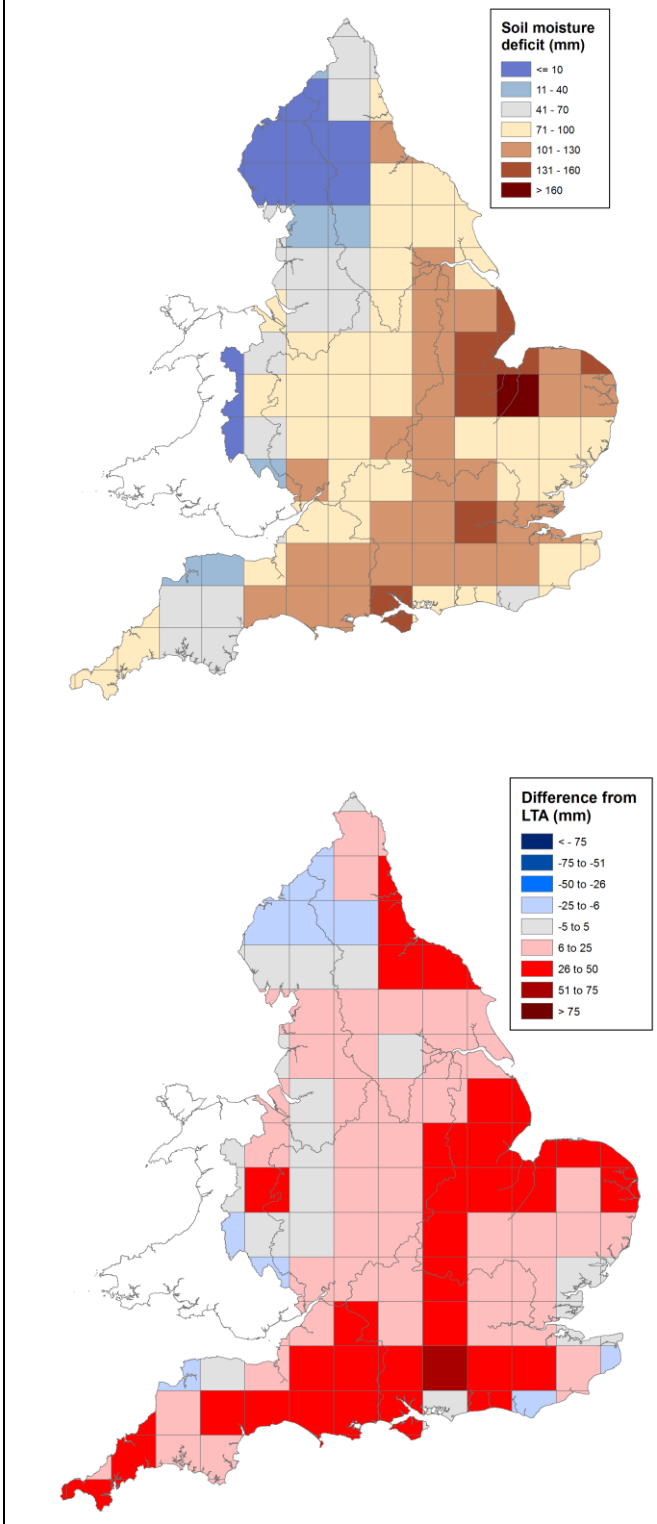
End of August 2018[1]	End of September 2018[2]
	

Figure 2.1: Soil moisture deficits for weeks ending 28 August 2018 [1] (left panel) and 25 September 2018 [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, 2018). Crown copyright. All rights reserved. Environment Agency, 100026380, 2018

Soil moisture deficit charts

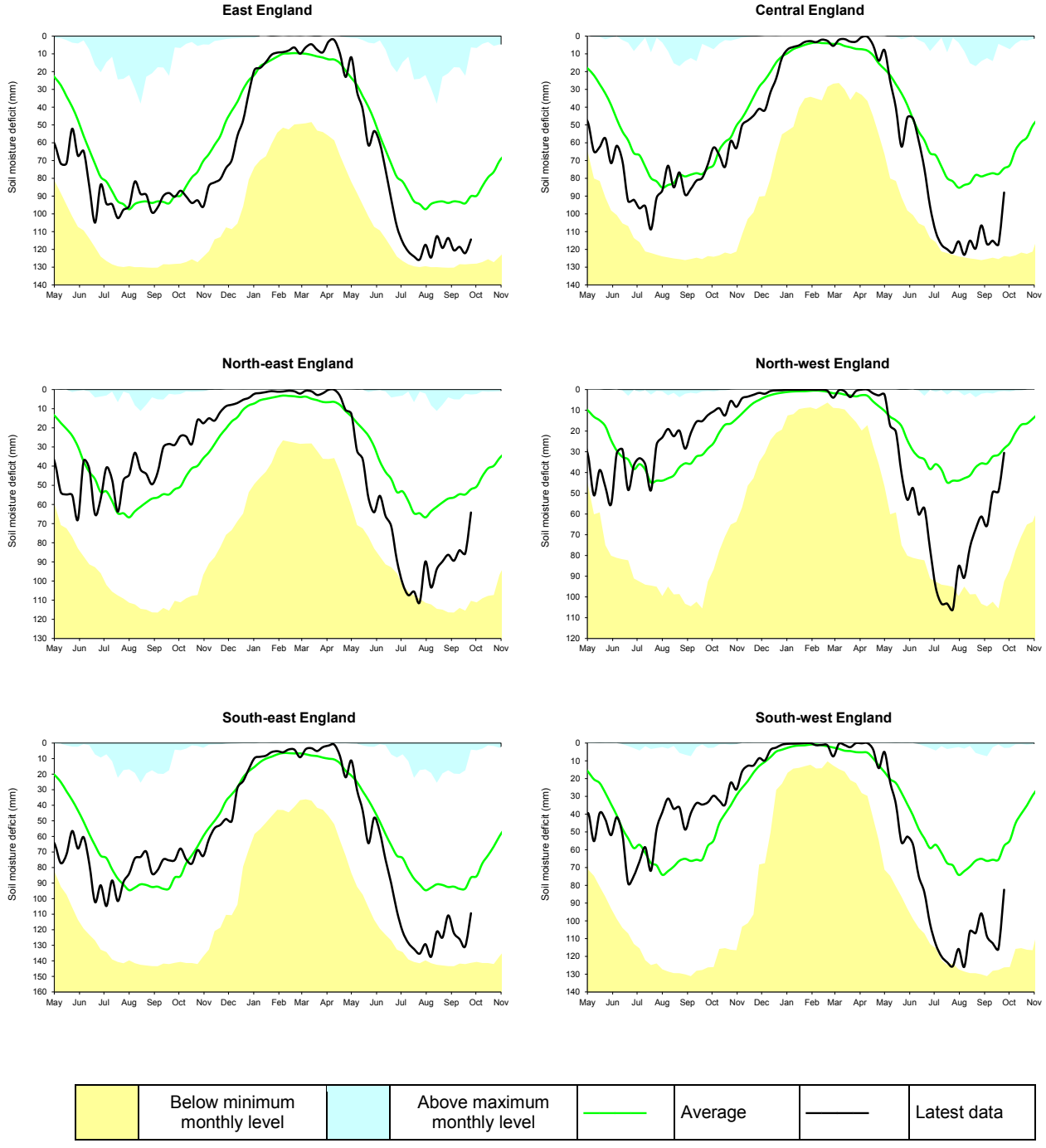
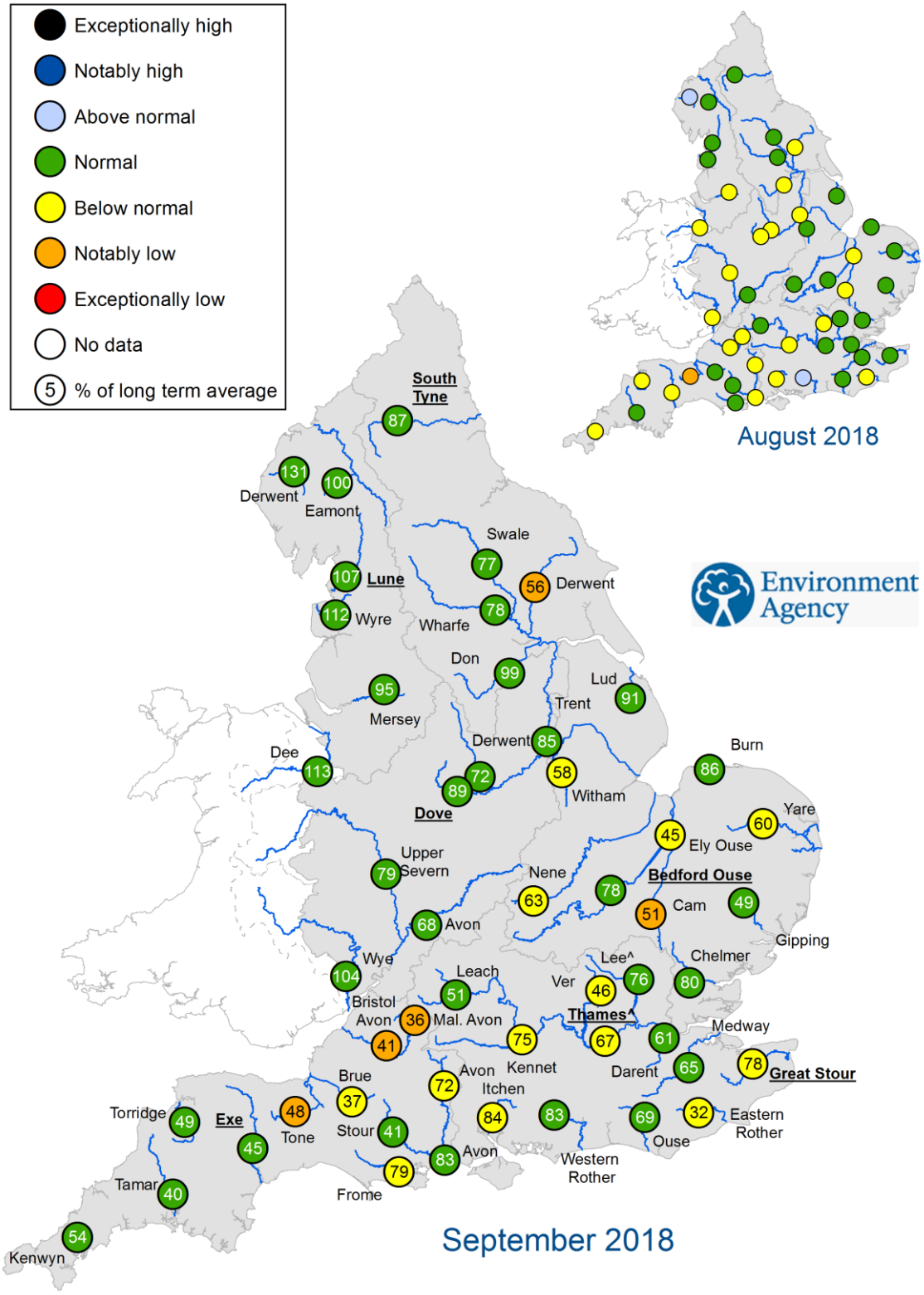


Figure 2.2: Latest soil moisture deficits for all geographic regions compared to maximum, minimum and 1961-90 long term average. Weekly MORECS data for real land use. (Source: Met Office © Crown Copyright, 2018).

River flows



^ "Naturalised" flows are provided for the River Thames at Kingston and the River Lee at Feildes Weir

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 August and September 2018, expressed as a percentage of the respective long term average and classed relative to an analysis of historic August and September monthly means (Source: Environment Agency). Crown copyright. All rights reserved. Environment Agency, 100026380, 2018.

River flow charts

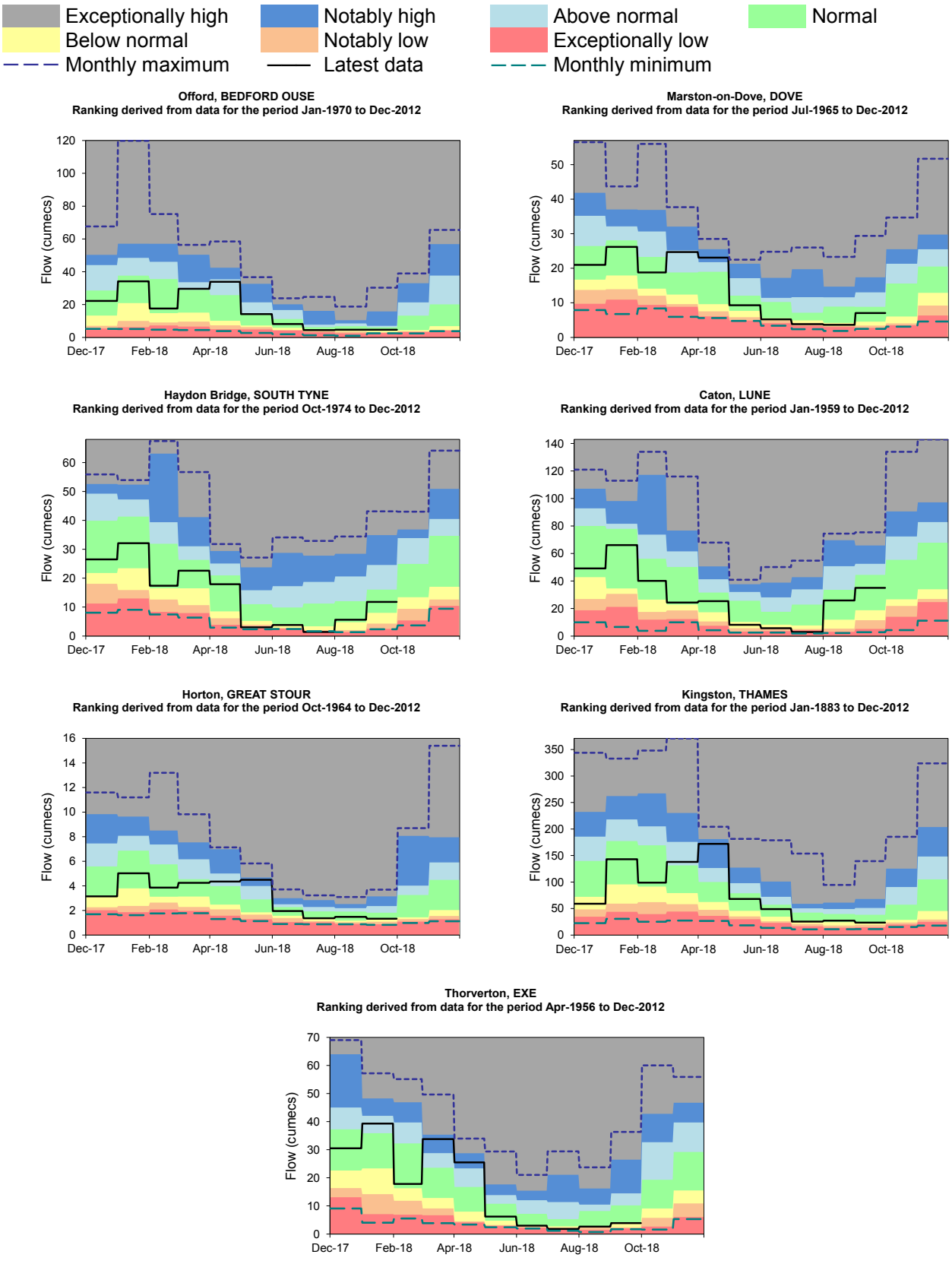
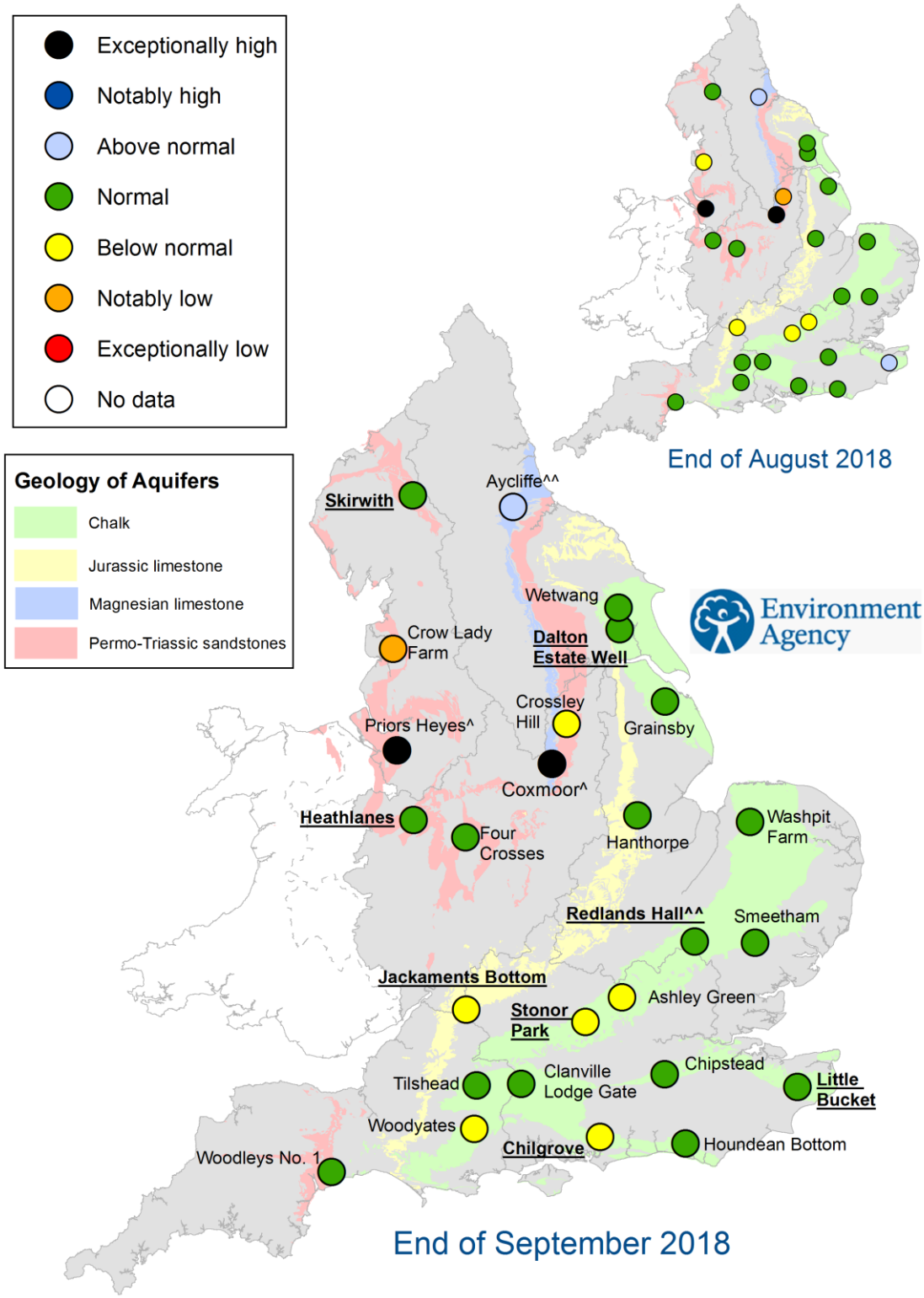


Figure 3.2: Index river flow sites for each geographic region. Monthly mean flow compared to an analysis of historic monthly mean flows, long term maximum and minimum flows. (Source: Environment Agency).

Groundwater levels



^ The levels at Priors Heyes and Coxmoor remain high compared to historic levels because the aquifers are 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
Underlined 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 August and September 2018, classed relative to an analysis of respective historic August and September levels (Source: Environment Agency). Geological map reproduced with kind permission from UK Groundwater Forum, BGS © NERC. Crown copyright. All rights reserved. Environment Agency, 100026380, 2018.

Groundwater level charts

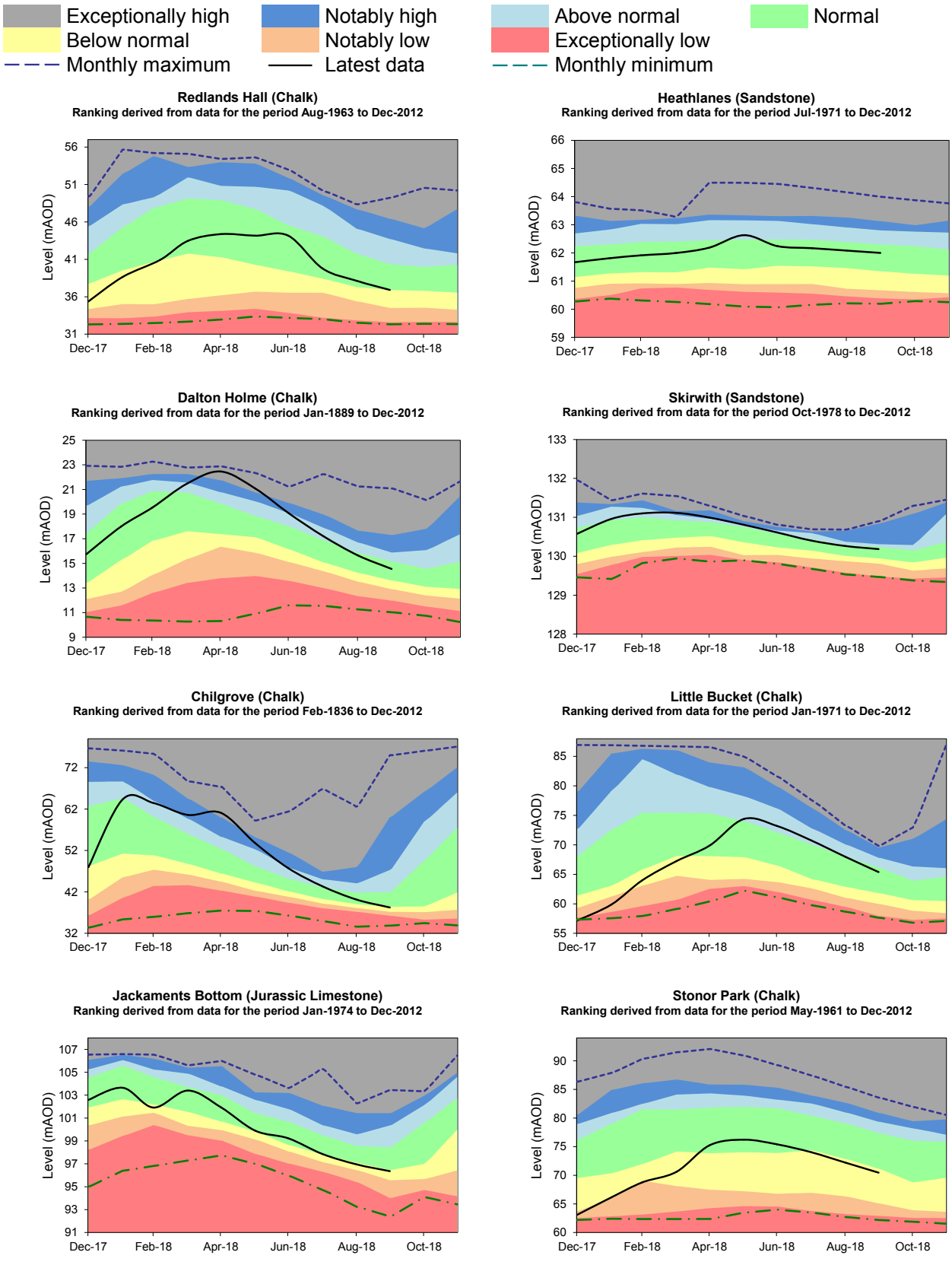
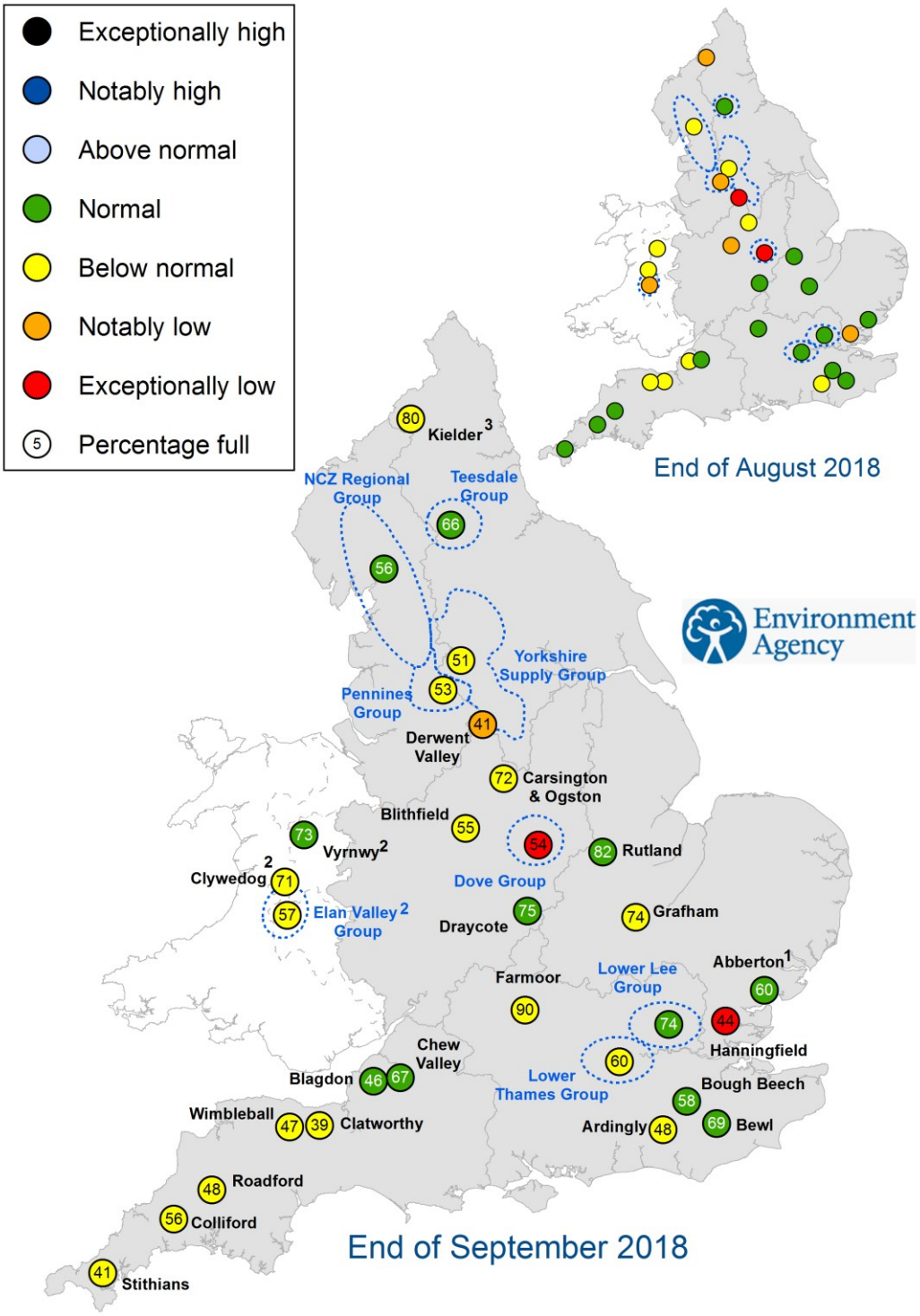


Figure 4.2: Index groundwater level sites for major aquifers. End of month groundwater levels months compared to an analysis of historic end of month levels and long term maximum and minimum levels. (Source: Environment Agency, 2018).

Reservoir storage



1. Current levels at Abberton Reservoir in east England are relative to increased capacity
2. Vyrnwy, Clywedog and Elan Valley reservoirs are located in Wales but provide a water resource to Central and north-west England
3. Current levels at Kielder are lower than historical levels due to the implementation of a new flood alleviation control curve

Figure 5.1: Reservoir stocks at key individual and groups of reservoirs at the end of August and September 2018 as a percentage of total capacity and classed relative to an analysis of historic August and September 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, 2018.

Reservoir storage charts

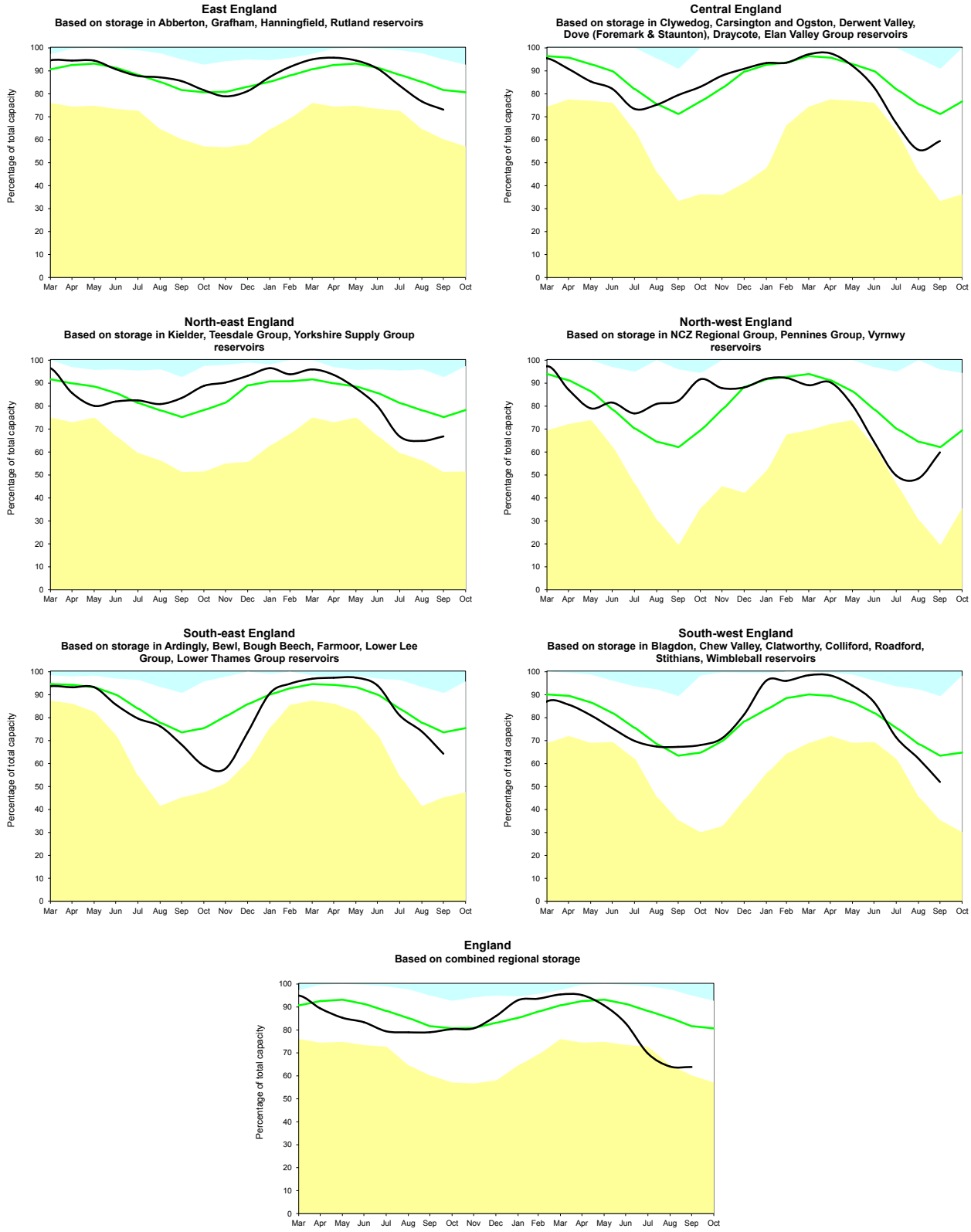


Figure 5.2: Regional reservoir stocks. End of month reservoir stocks compared to long term maximum, minimum and average stocks (Source: Water Companies). Note: Historic records of individual reservoirs/reservoir groups making up the regional values vary in length.

Forward look – river flow

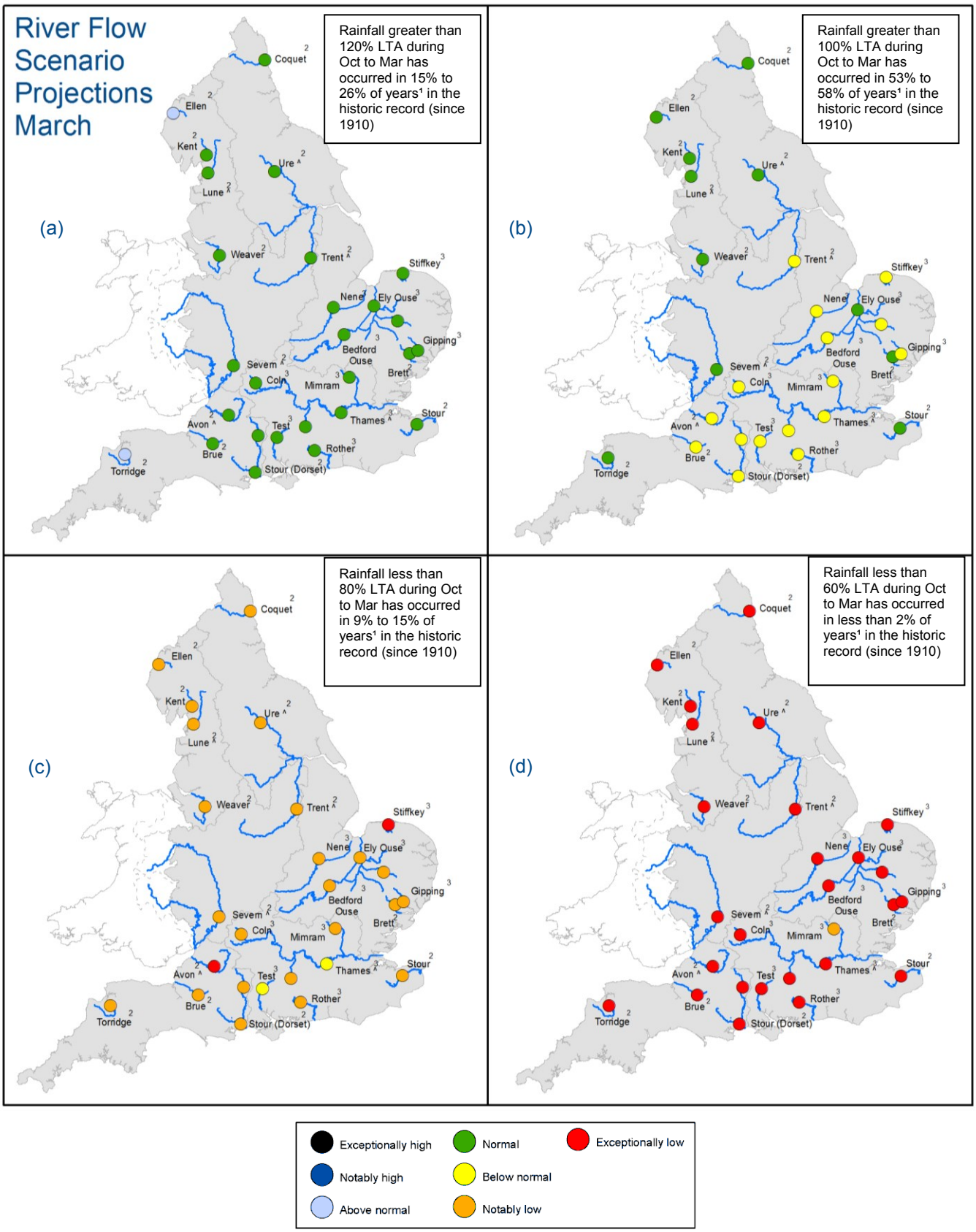
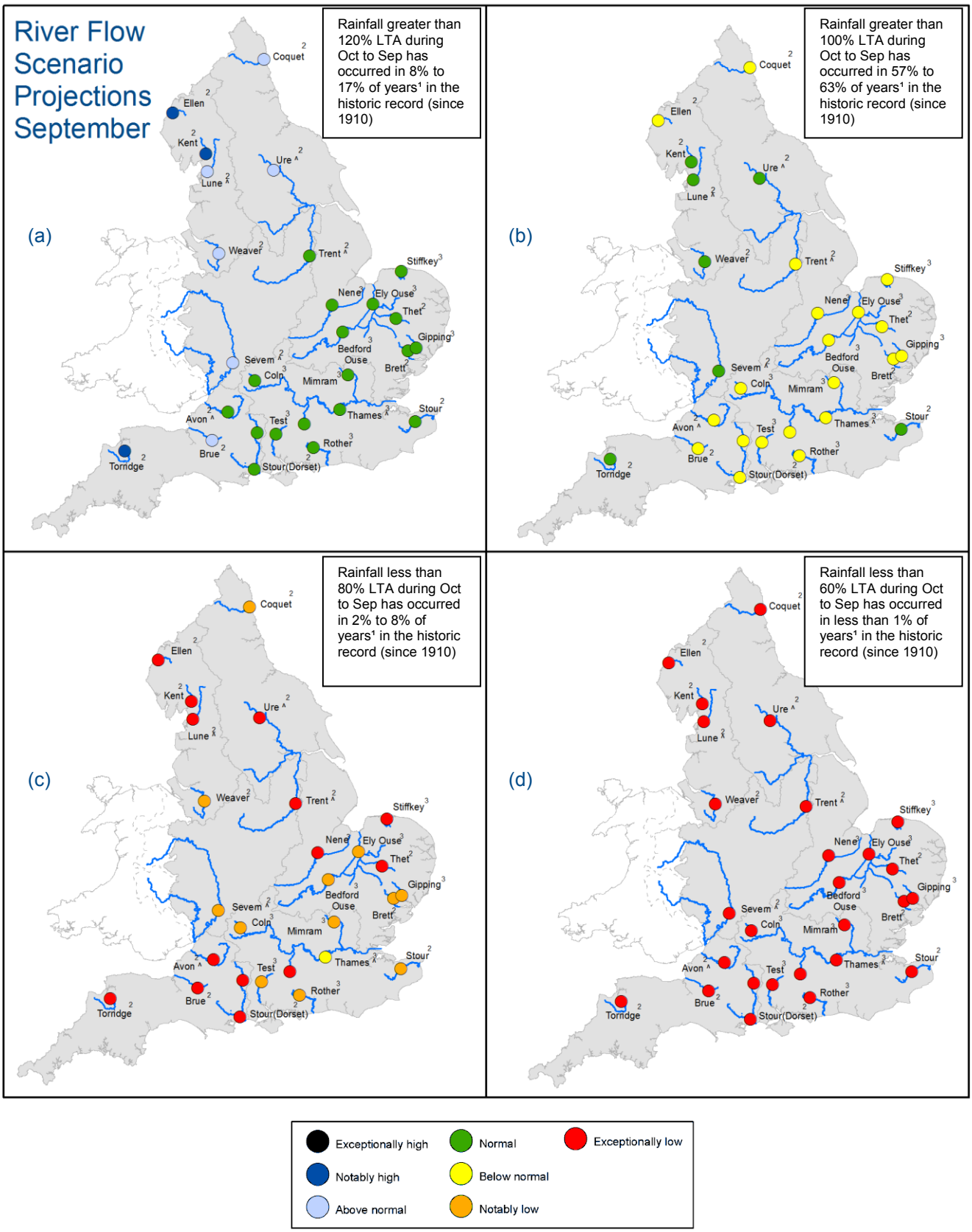


Figure 6.1: Projected river flows at key indicator sites up until the end of March 2019. Projections based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between October 2018 and March 2019 (Source: Centre for Ecology and Hydrology, Environment Agency).

[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*



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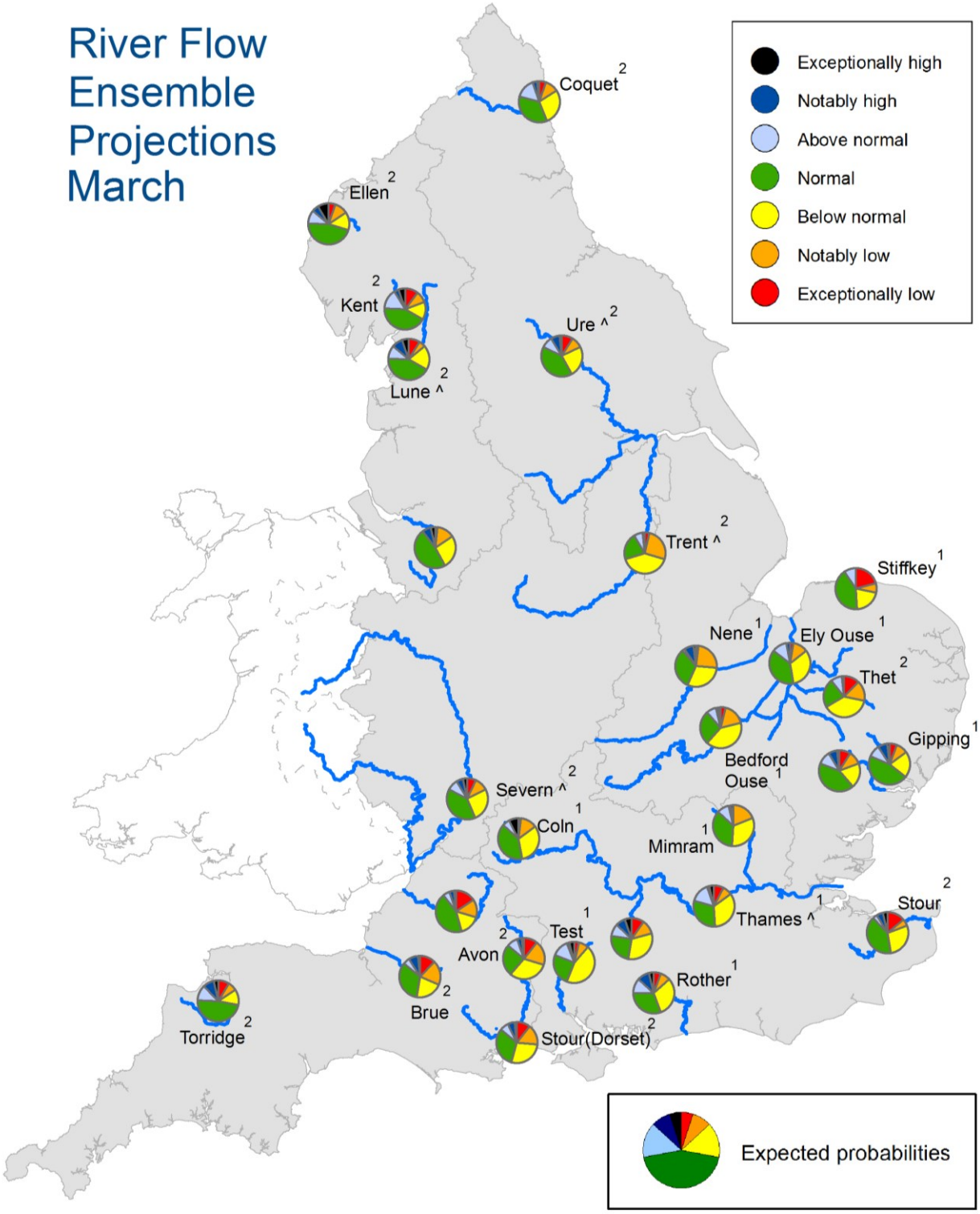

Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are 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 March 2019. 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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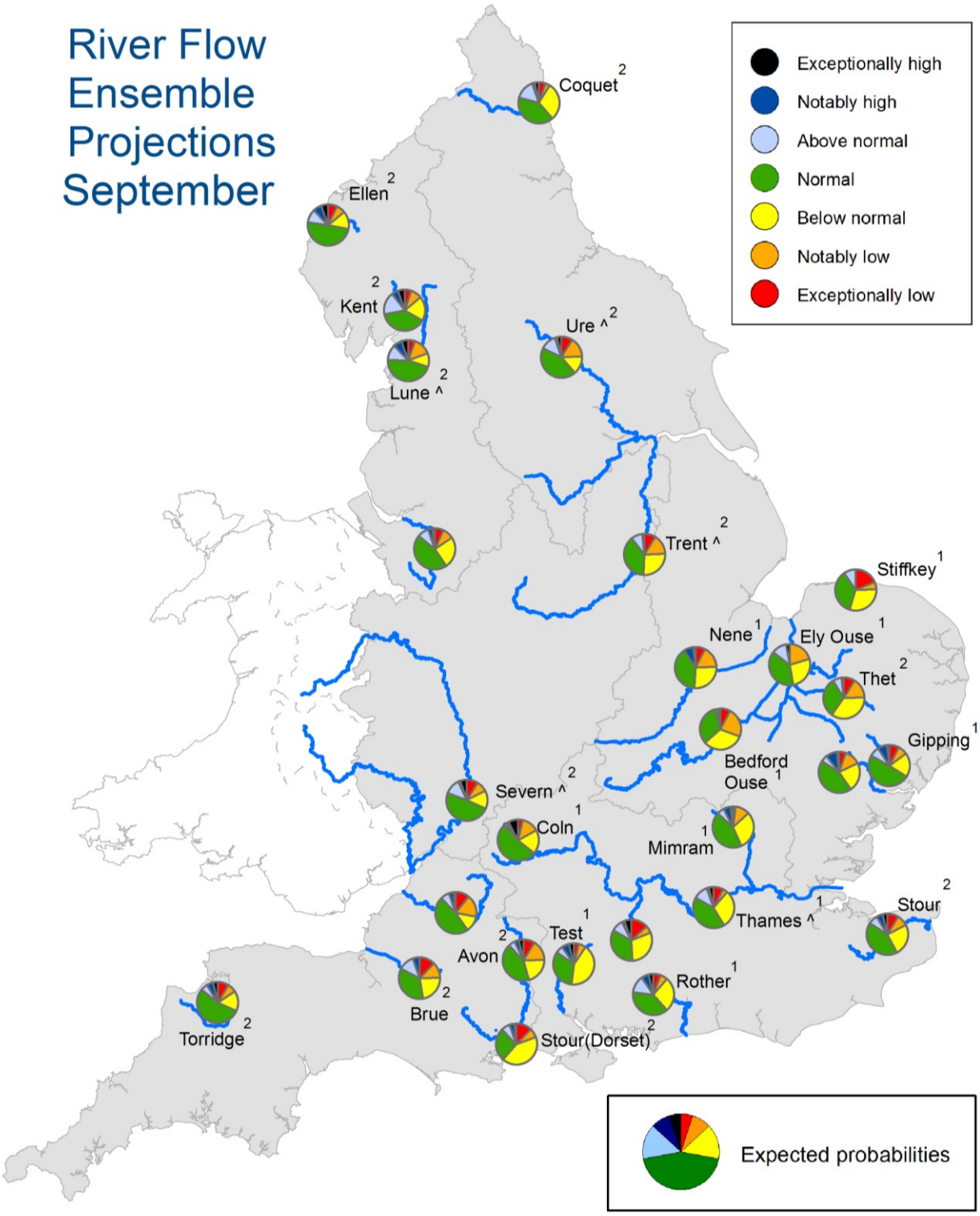

Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are 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 September 2018. 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

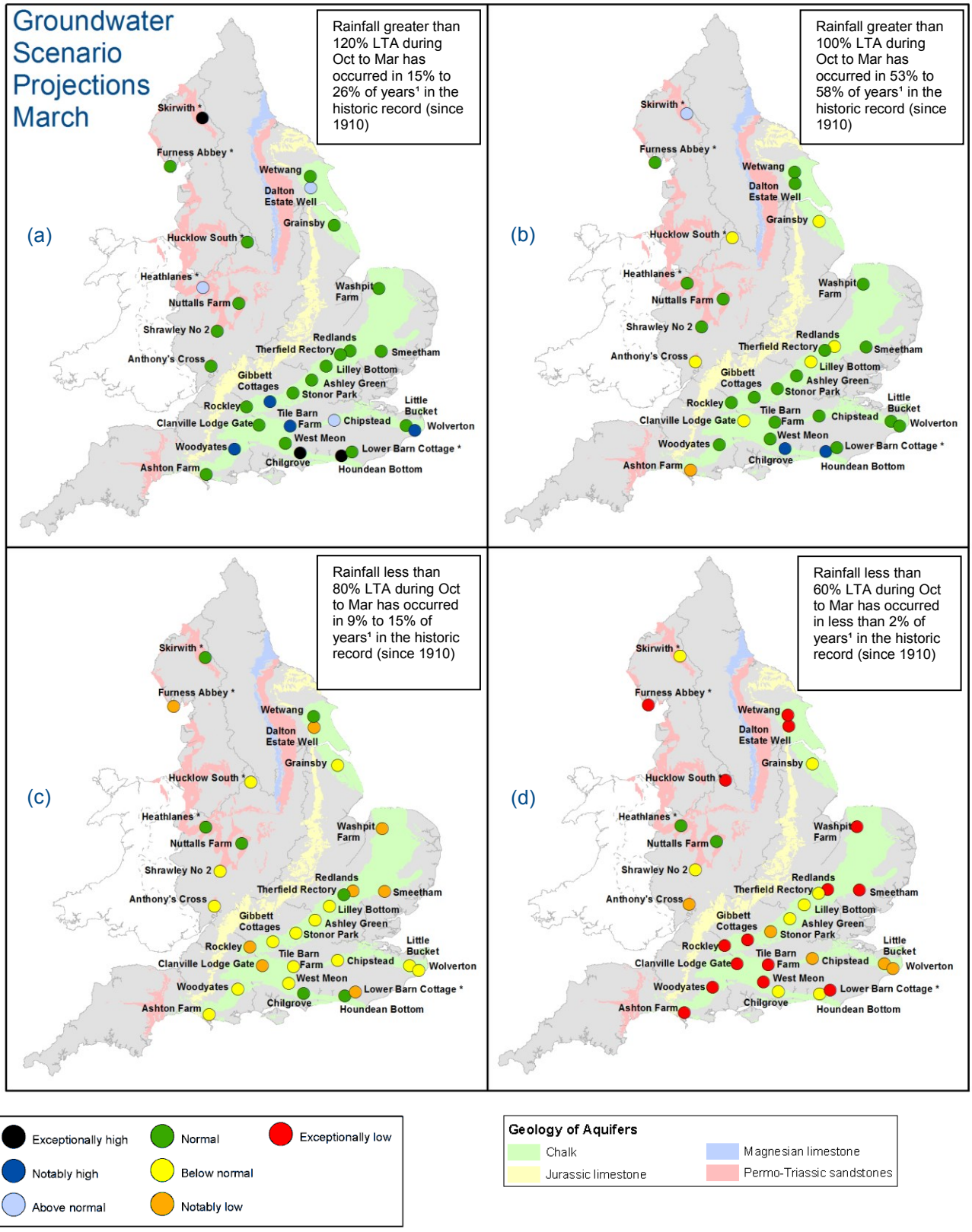

Figure 6.5: Projected groundwater levels at key indicator sites at the end of March 2019. Projections based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between October 2018 and March 2019 (Source: Environment Agency). Geological map reproduced with kind permission from UK Groundwater Forum BGS © NERC. Crown copyright all rights reserved. Environment Agency 100026380, 2018.

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

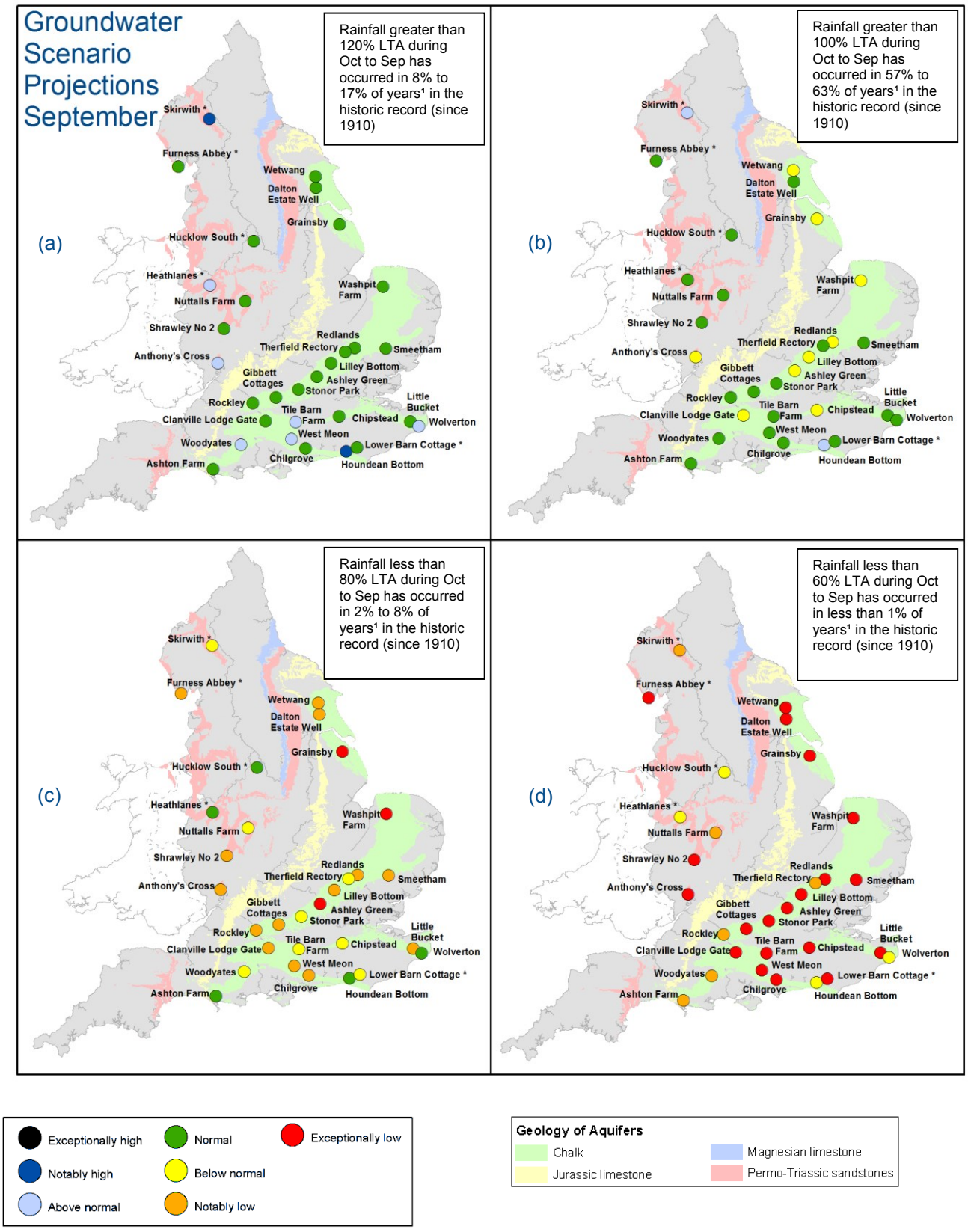

Figure 6.6: Projected groundwater levels at key indicator sites at the end of September 2019. Projections based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between October 2018 and September 2019 (Source: Environment Agency). Geological map reproduced with kind permission from UK Groundwater Forum BGS © NERC Crown copyright. All rights reserved. Environment Agency 100026380 2018.

* Projections for these sites are produced by BGS
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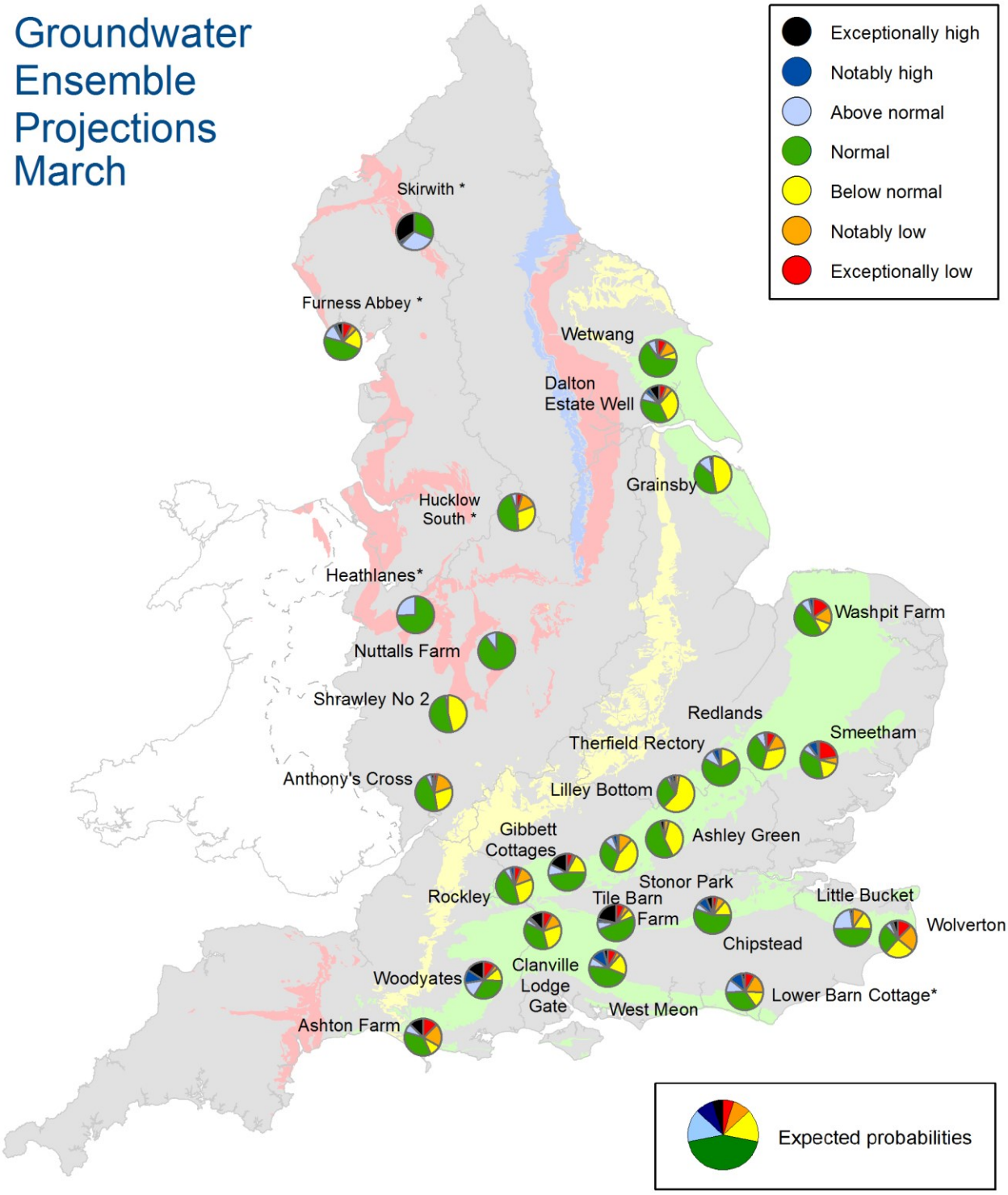
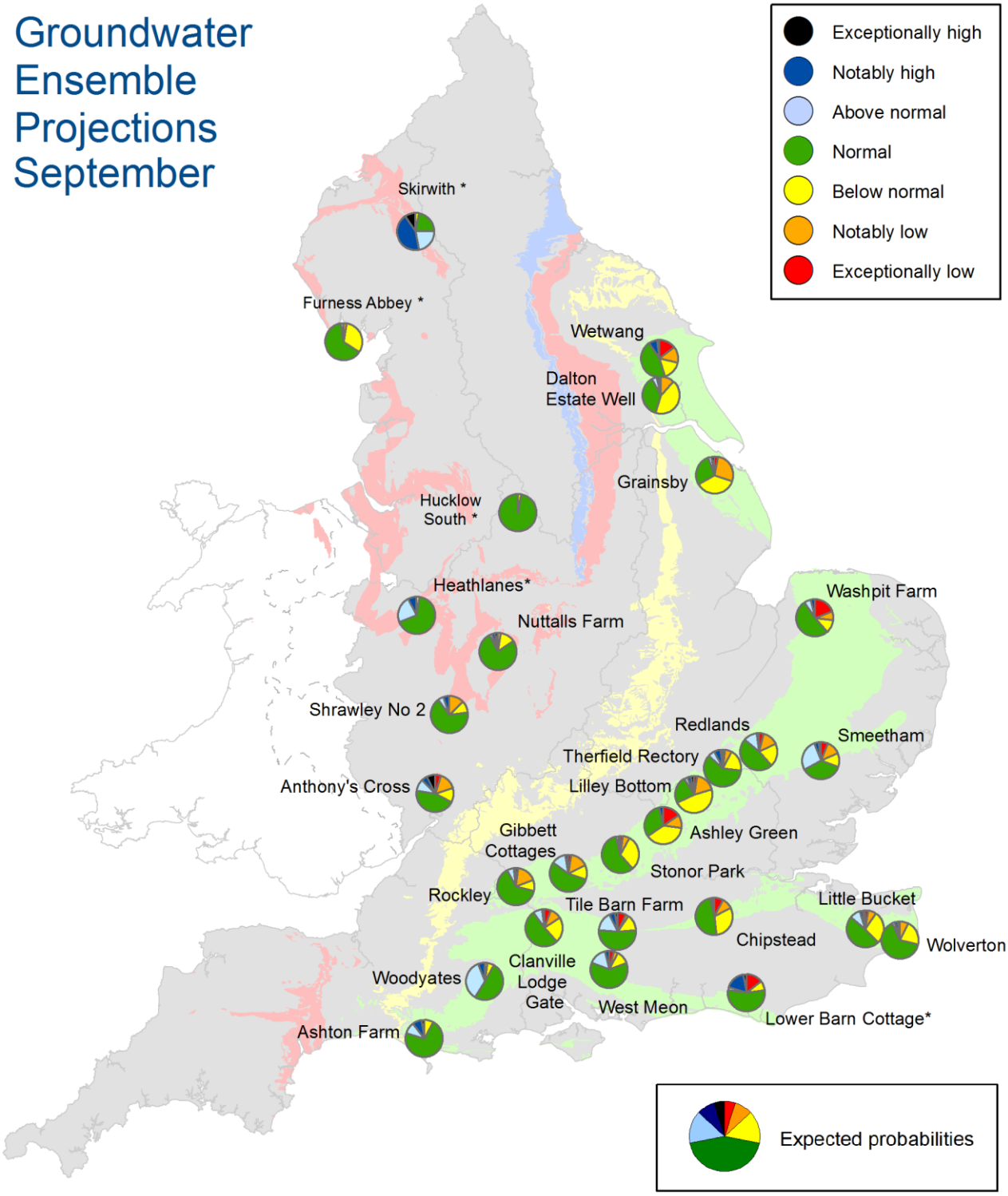


Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are 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 March 2019. 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.

** 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 September 2019. 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, 2018.

* 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. For rainfall and soil moisture deficit, the period refers to 1961-1990, unless otherwise stated. For other parameters, the period may vary according to data availability
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