Monthly water situation report

England

Summary – September 2017

September rainfall was well above the monthly long term average at 133%. Monthly rainfall totals were normal or higher for the time of year across all hydrological areas. Soil moisture deficit decreased during September across much of England and at the end of the month, soils were wetter than average across most areas. Monthly mean river flows increased compared to August at just over half of indicator sites and were classed as normal or higher for the time of year at all but 5 sites. Groundwater levels continued to recede at all but 6 indicator sites during September but end of month levels were normal or higher for the time of year at just over half of the indicator sites. Reservoir stocks decreased at nearly two-thirds of reported reservoirs or reservoir groups, but stocks remain normal or higher for the time of year at just over three-quarters of sites. Overall reservoir storage for England remained unchanged at the end of September at 79% of total capacity.

Rainfall

September monthly rainfall totals were highest across parts of north-west and south-west England at 150 to 230mm and lowest across parts of Kent, Essex, Suffolk and south London at 40 to 50mm. Rainfall totals were above the September long term average (LTA) across more than four-fifths of hydrological areas, with parts of Devon, Cornwall and North Yorkshire receiving approximately 175 to 200% of the LTA. Hydrological areas receiving below the LTA were concentrated in south-east England with the Isle of Thanet in Kent receiving 70% of the LTA (Figure 1.1).

Rainfall totals for September were classed as normal to notably high for the time of year across all of the hydrological areas. Cumulative rainfall totals for the past 3 and 6 months show a similar picture across England. However, the rainfall deficit is still evident in the 12 month cumulative rainfall totals, with much of south-west, south-east and central England being below normal or notably low for the time of year (Figure 1.2).

At a regional scale, September rainfall totals were above average across all regions, ranging from 110% of the LTA in south-east England to 147% in both north-east and north-west England. September rainfall was classed as normal for the time of year across east and south-east England, notably high in north-west England and above normal elsewhere. The monthly rainfall total for England was 133% of the 1961-90 LTA for September (136% of the 1981-2010 LTA) (Figure 1.3).

Soil moisture deficit

In response to the above average September rainfall, soil moisture deficits (SMDs) generally decreased across England during September. With the exception of parts of Essex and Suffolk, soils were wetter at the end of September than at the end of August across the whole of England, with SMDs ranging from approximately 1mm in parts of north-west and south-west England to just over 140mm across parts of Norfolk and Cambridgeshire.

At the end of the month, soils were wetter than the September LTA across much of England, particularly along the south coast and across parts of south-west, central and north-east England. Soils were drier than average across much of east England and the area around the lower River Severn and Severn Estuary (Figure 2.1).

At a regional scale, soils were wetter at the end of September compared to the end of August across all regions, with end of month SMDs ranging from 11mm in north-west England to 87mm in east England. SMDs were approximately average for the time of year in east and central England but smaller than average (wetter soils) elsewhere (Figure 2.2).

River flows

September monthly mean river flows increased compared to August at just over half of the indicator sites across England. Flows were classed as normal or higher for the time of year at all but 4 indicator sites; flows in the rivers Kennet, Great Stour and Eastern Rother in south-east England and the River Avon in south-west England were

below normal for the time of year. Flows at all indicator sites in north-west England were above normal or notably high the time of year (Figure 3.1).

At the regional index sites, monthly mean river flows were below normal for the time of year on the Great Stour in south-east England but normal or above normal elsewhere (Figure 3.2).

Groundwater levels

Groundwater levels continued to recede during September at the majority of sites; increases were recorded at 4 sites in sandstone aquifers in central and north-west England and 2 chalk aquifer sites, Wetwang in the Hull and East Riding chalk and Woodyates in the Upper Dorset Stour chalk. End of month groundwater levels were below normal or lower for the time of year at just under half of the indicator sites, with Ashley Green (Chilterns East chalk aquifer) remaining exceptionally low for the fourth consecutive month.

End of month groundwater levels at the major aquifer index sites ranged from notably low for the time of year at Little Bucket (East Kent Stour chalk aquifer), Stonor Park (South West Chilterns chalk aquifer) and Redlands (Cam and Ely Ouse chalk aquifer) to above normal for the time of year at Dalton Holme (Hull and East Riding chalk aquifer) (Figures 4.1 and 4.2).

Reservoir storage

Reservoir stocks decreased at nearly two-thirds of the reported reservoirs or reservoir groups during September. The largest decreases (9%) occurred in the Lower Lee and Lower Thames reservoir groups. In contrast, stocks increased in the Elan Valley and Teesdale reservoir groups by 10 and 13% respectively. End of month stocks were classed as normal or higher for the time of year at just over three-quarters of all reported reservoirs and reservoir groups. The remaining sites were classed as below normal for the time of year, whilst Bewl Reservoir remained classed as notably low for the sixth consecutive month (Figure 5.1).

Compared with the end of August, regional reservoir stocks increased by between 1 and 4% in north-east, north-west and central England, decreased by 8% in south-east England and decreased only slightly elsewhere. End of September stocks ranged from 67% of total capacity in south-west England to 86% in east England. Overall storage for England remained unchanged at 79% of total capacity (Figure 5.2).

Forward look

October is likely to see a mix of settled conditions and wet and windy weather, with the heaviest rainfall in the north and west of the country. For the 3-month period October to December above-average rainfall is more considered probable than below-average rainfall[1].

Projections for river flows at key sites[2]

Just over half of the modelled sites have a greater than expected chance of cumulative river flows being normal or higher the end of March 2018. By the end of September 2018, two-fifths of the modelled sites have a greater than expected chance of being normal or higher for the time of year.

For scenario based projections of cumulative river flows at key sites by March 2018 see Figure 6.1
For scenario based projections of cumulative river flows at key sites by September 2018 see Figure 6.2
For probabilistic ensemble projections of cumulative river flows at key sites by March 2018 see Figure 6.3
For probabilistic ensemble projections of cumulative river flows at key sites by September 2018 see Figure 6.4

Projections for groundwater levels in key aquifers[2]

Just over half of the modelled sites have a greater than expected chance of groundwater levels being normal or higher for the time of year at the end of March 2018. By September 2018, nearly three-fifths of the modelled sites have a greater than expected chance of groundwater levels being normal or higher for the time of year.

For scenario based projections of groundwater levels in key aquifers in March 2018 see Figure 6.5
For scenario based projections of groundwater levels in key aquifers in September 2018 see Figure 6.6
For probabilistic ensemble projections of groundwater levels in key aquifers in March 2018 see Figure 6.7
For probabilistic ensemble projections of groundwater levels in key aquifers in September 2018 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

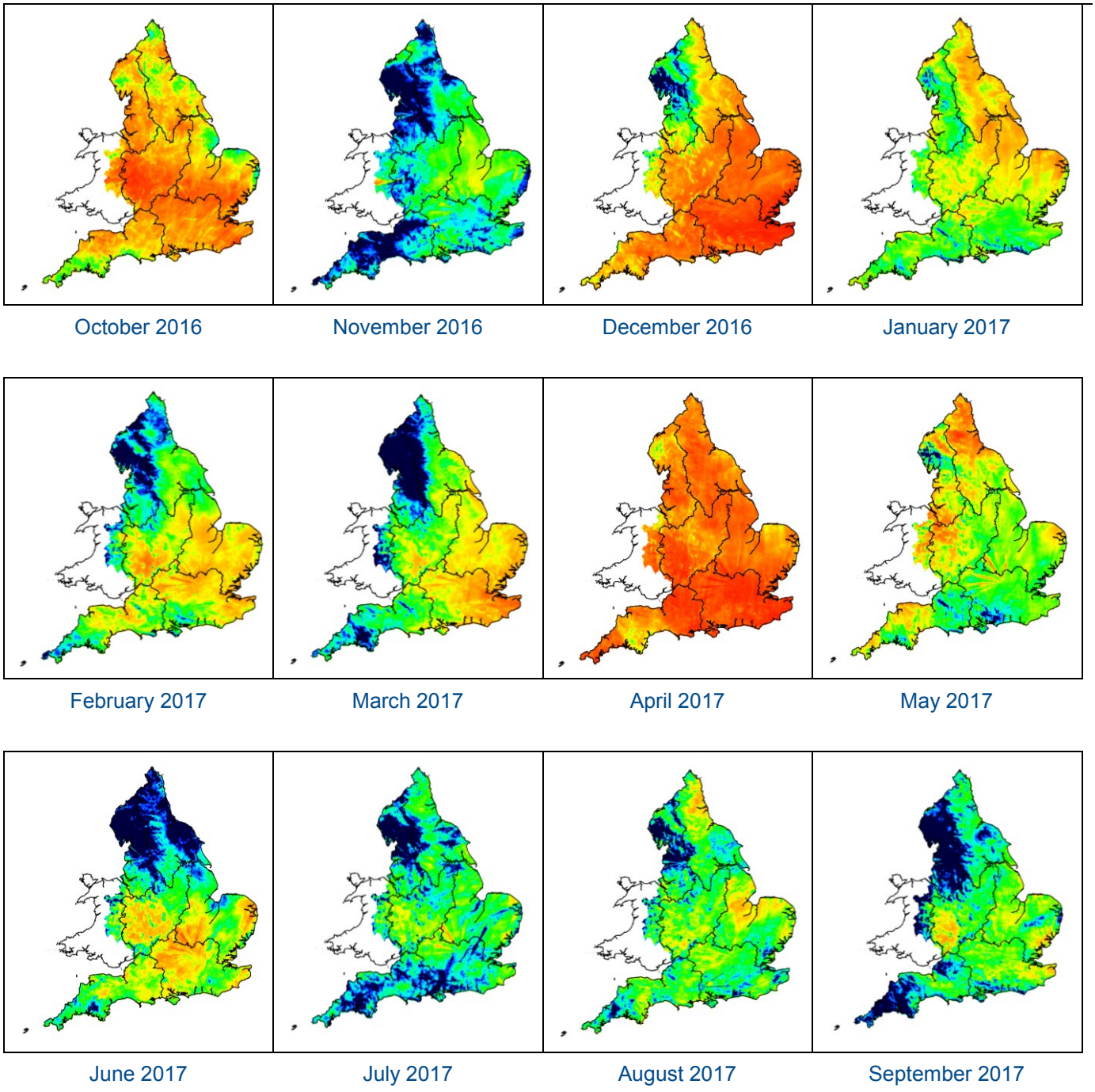


Figure 1.1: Monthly rainfall across England and Wales for the past 12 months. UKPP radar data (Source: Met Office © Crown Copyright, 2017). Note: Radar beam blockages in some regions may give anomalous totals in some areas. Crown copyright. All rights reserved. Environment Agency, 100026380, 2017.

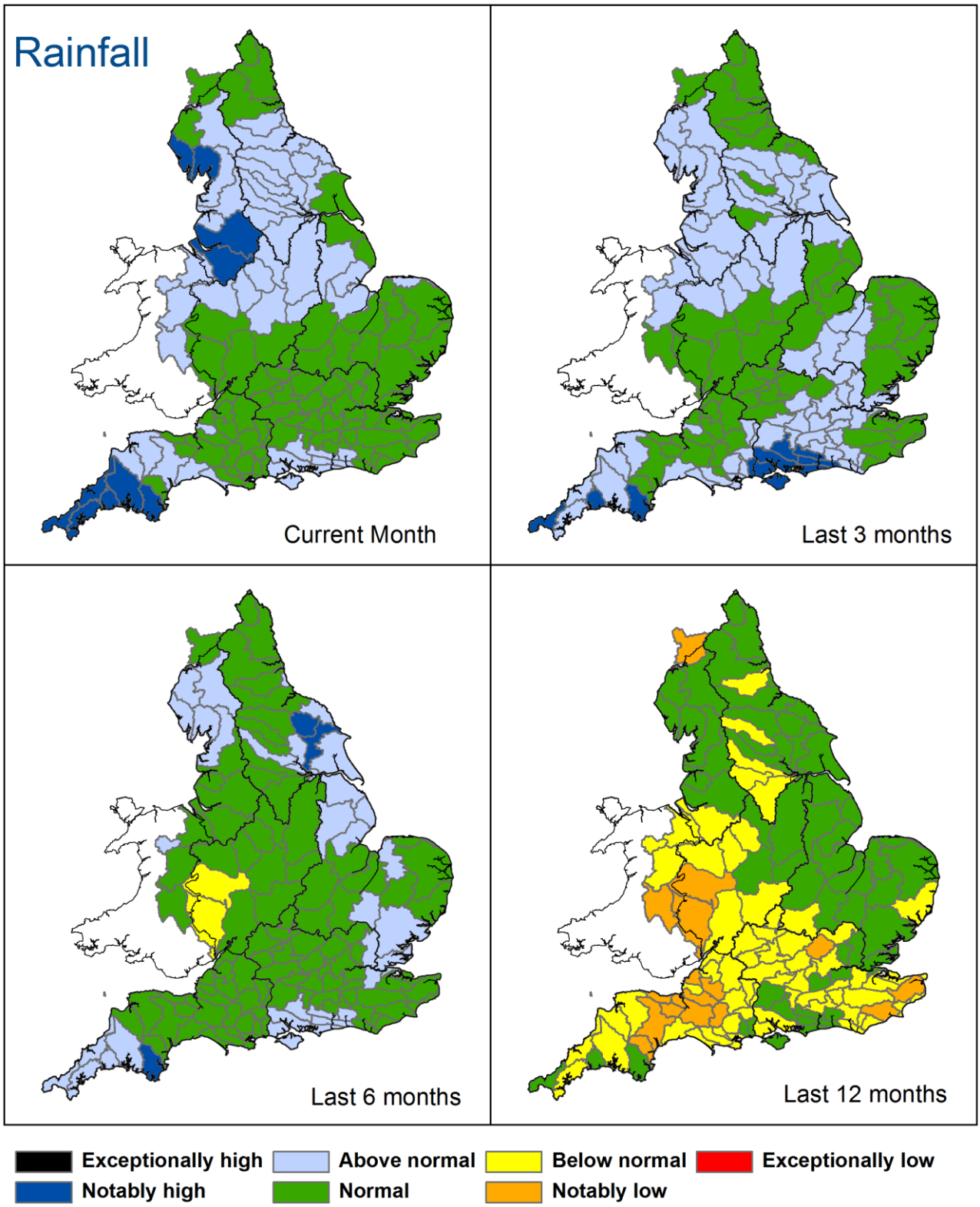


Figure 1.2: Total rainfall for hydrological areas across England for the current month (up to 30 September), the last 3 months, the last 6 months, and the last 12 months, classed relative to an analysis of respective historic totals. Final NCIC (National Climate Information Centre) data based on the Met Office 5km gridded rainfall dataset derived from rain gauges *(Source: Met Office © Crown Copyright, 2017).* 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, 2017.

Rainfall charts

Above average rainfall

Below average rainfall

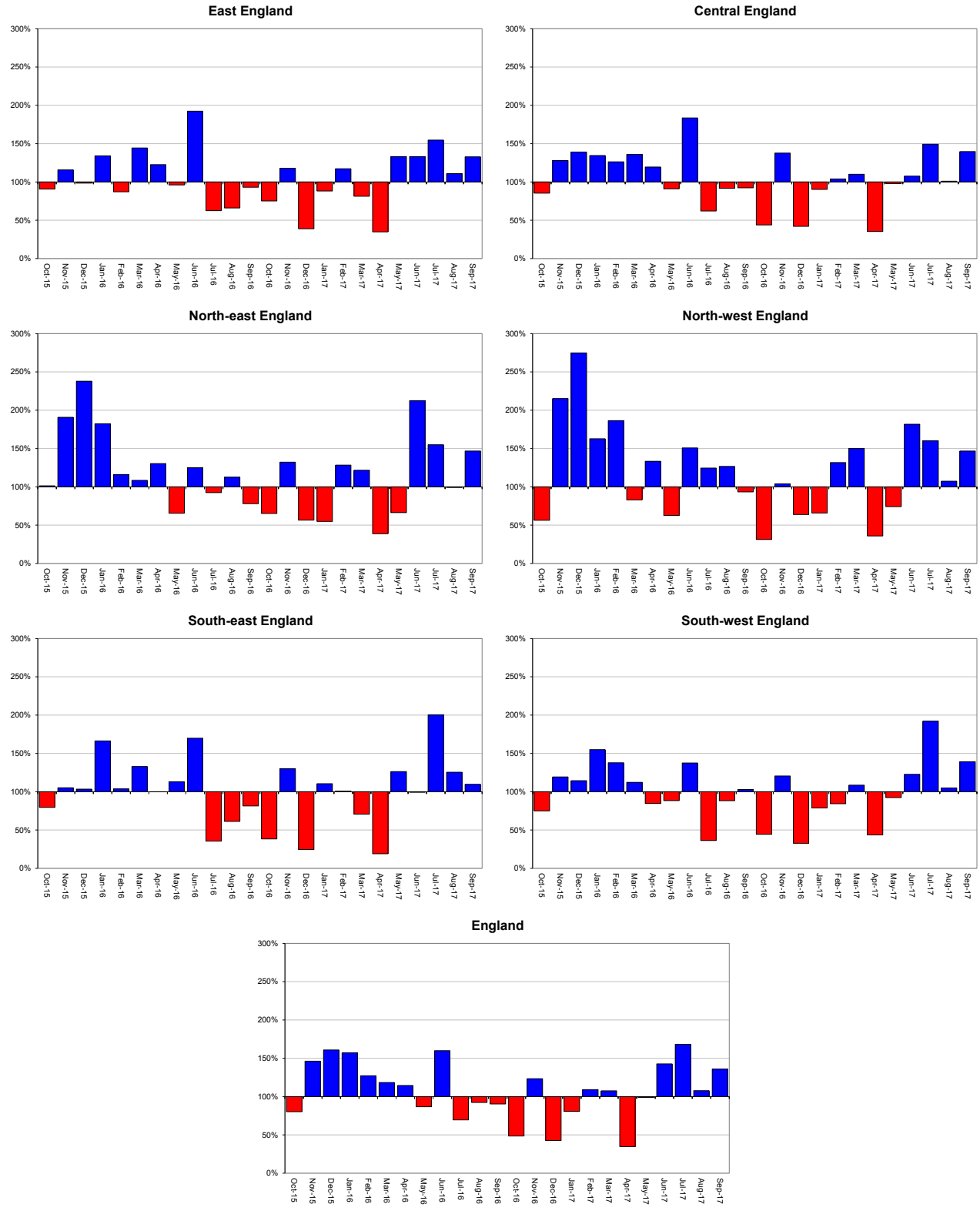


Figure 1.3: Monthly rainfall totals for the past 24 months as a percentage of the 1961 – 1990 long term average for each region and for England. NCIC (National Climate Information Centre) data. (Source: Met Office © Crown Copyright, 2017).

Soil moisture deficit

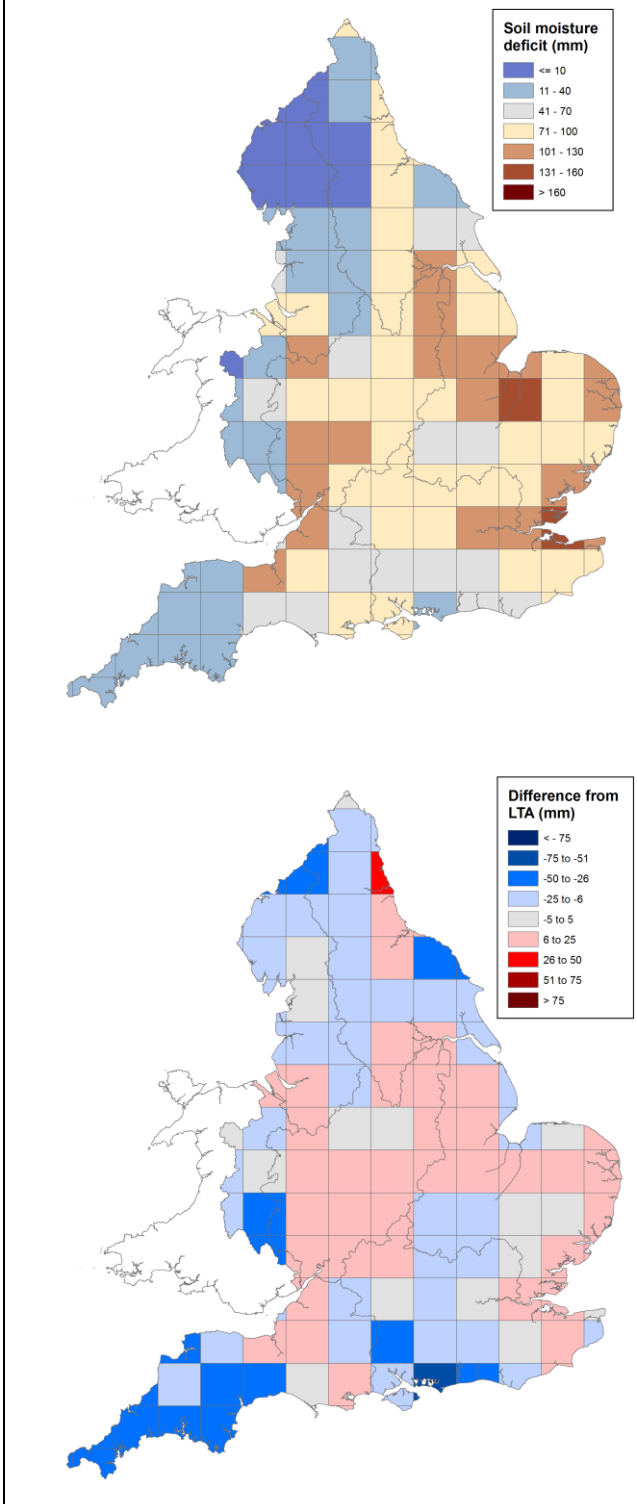
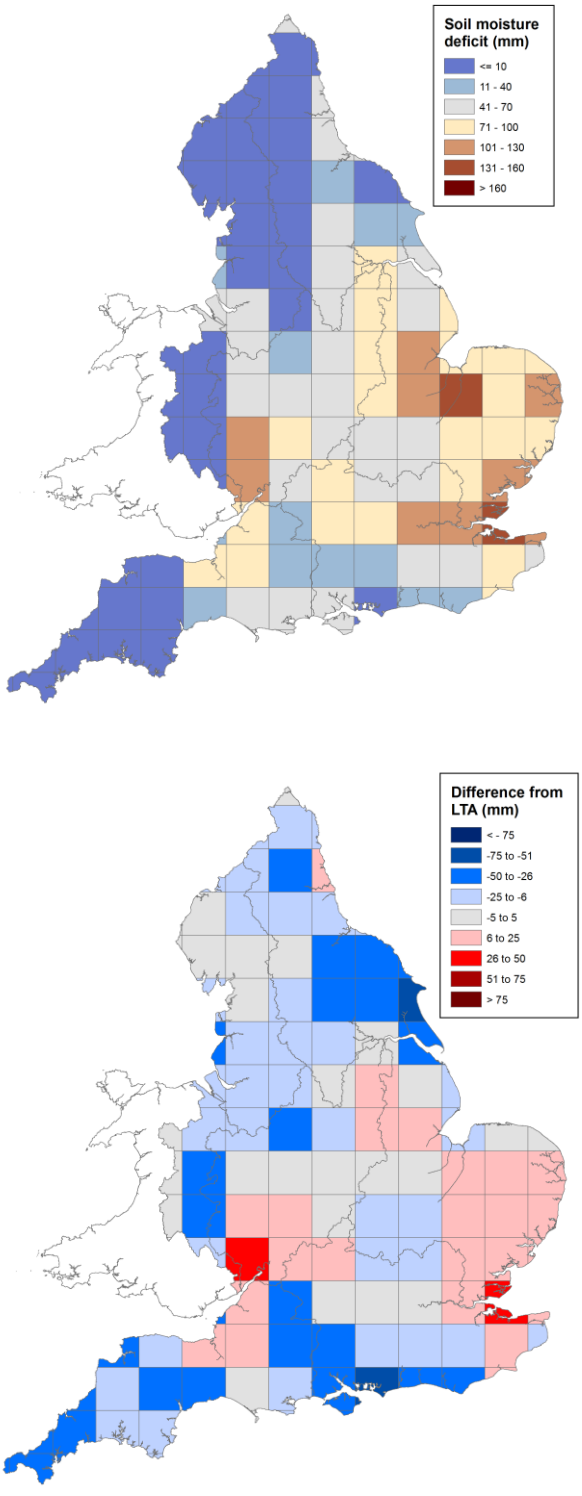
End of August 2017[1]	End of September 2017[2]
	

Figure 2.1: Soil moisture deficits for weeks ending 29 August 2017 [1] (left panel) and 3 October 2017 [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, 2017). Crown copyright. All rights reserved. Environment Agency, 100026380, 2017

Soil moisture deficit charts

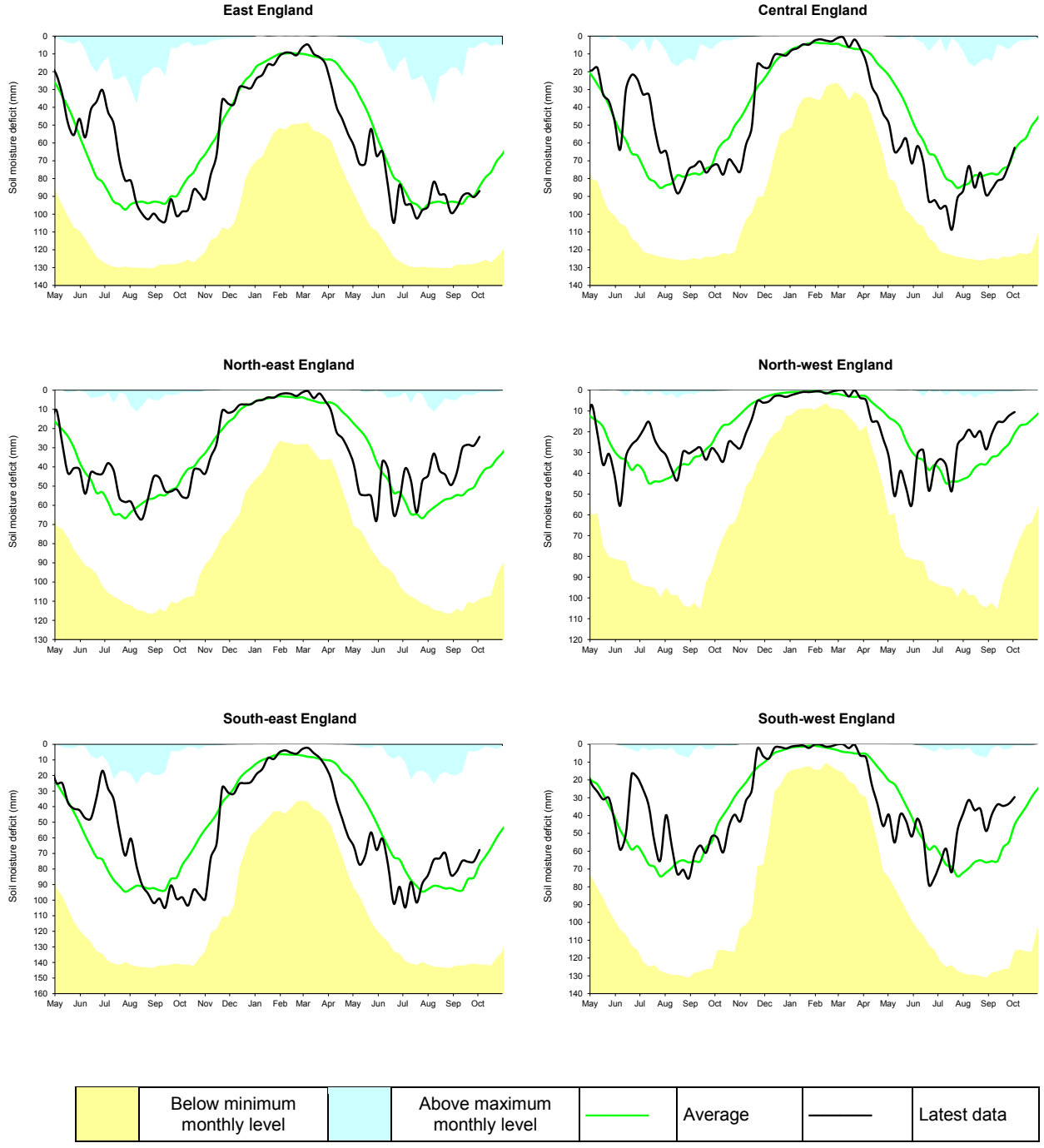
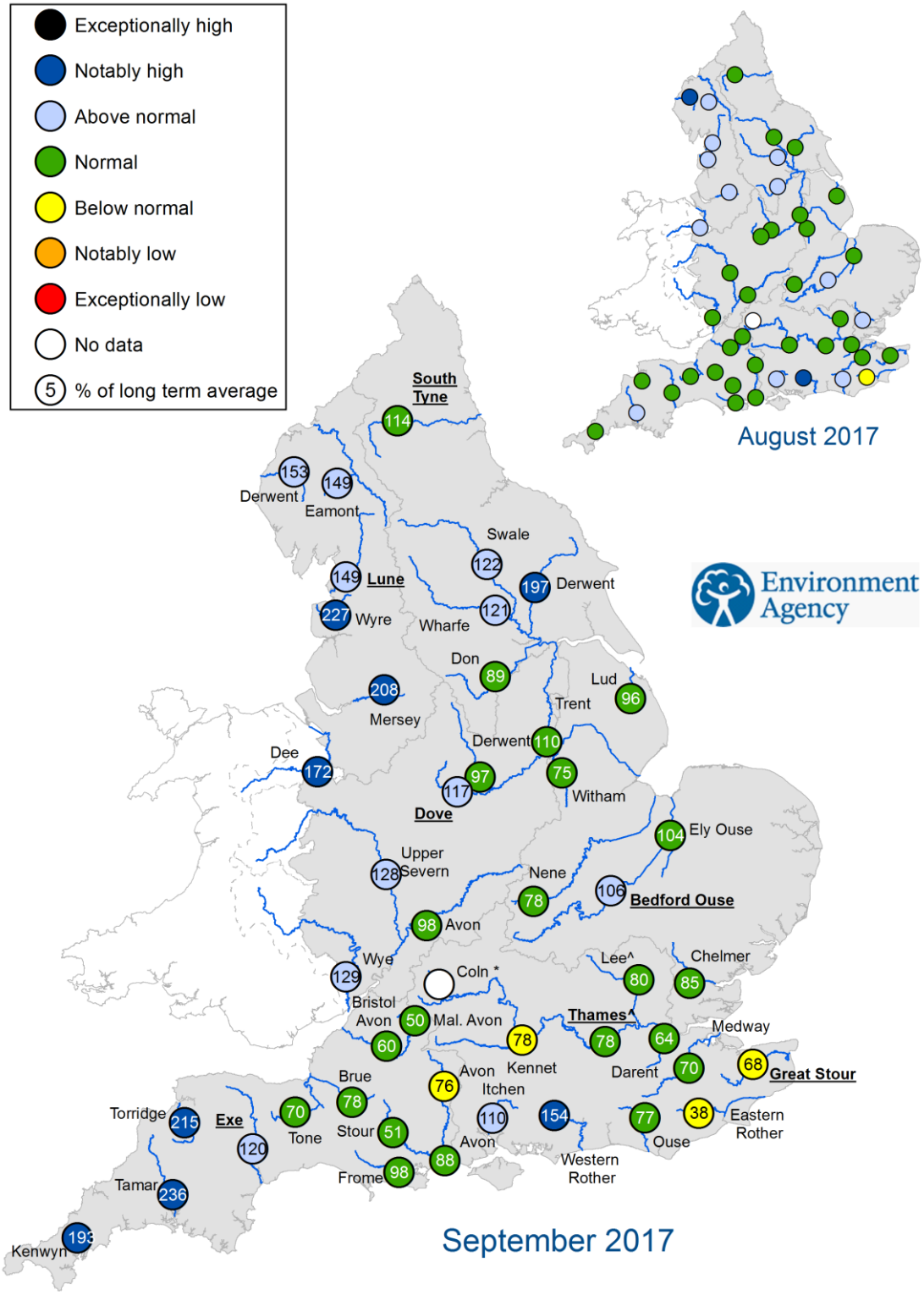


Figure 2.2: Latest soil moisture deficits for all geographic regions compared to maximum, minimum and 1961-90 long term average. Weekly MORECS data for real land use. (Source: Met Office © Crown Copyright, 2017).

River flows



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

* Data for the River Coln at Bibury is currently under investigation

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 2017 and September 2017, 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, 2017.

River flow charts

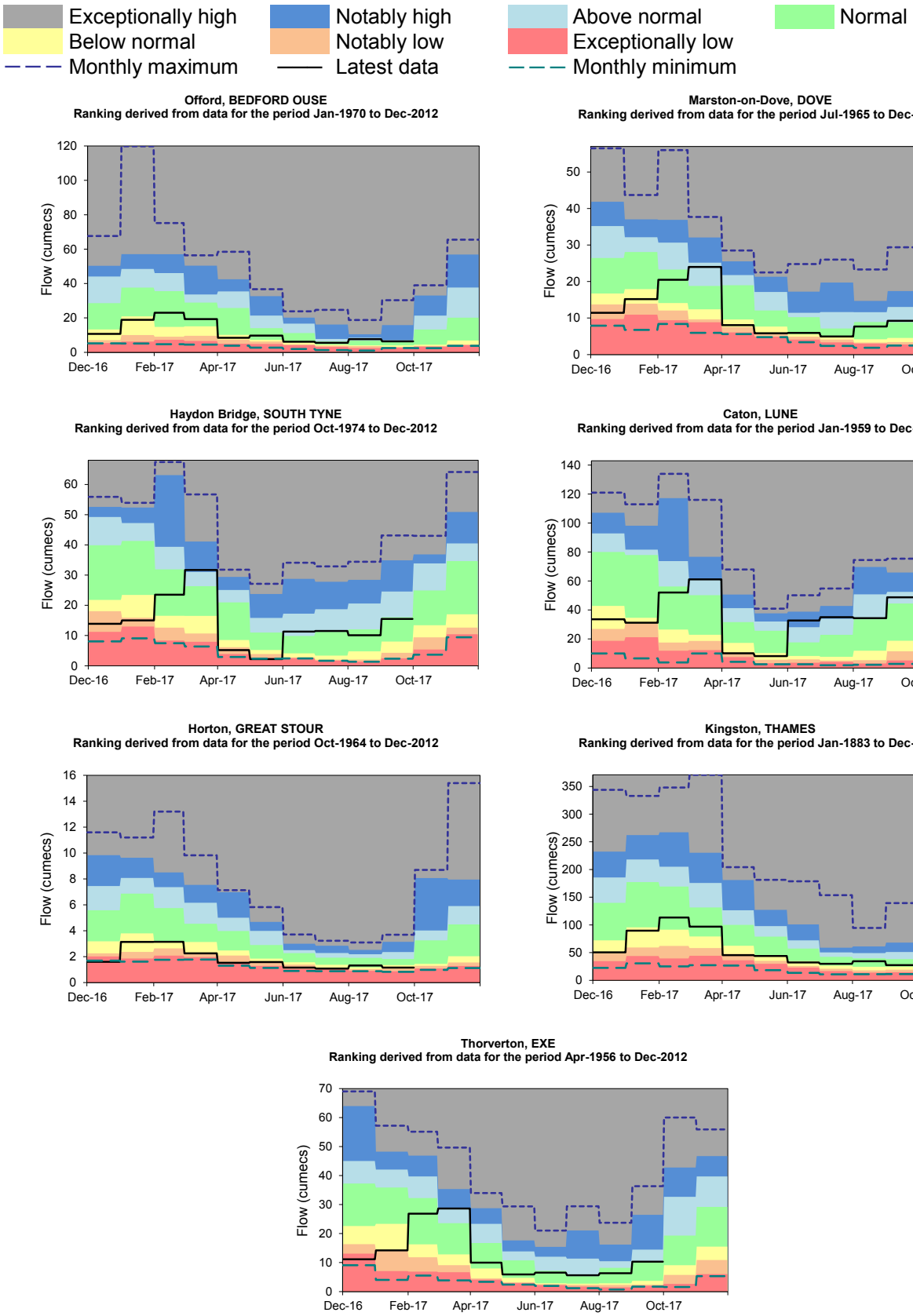
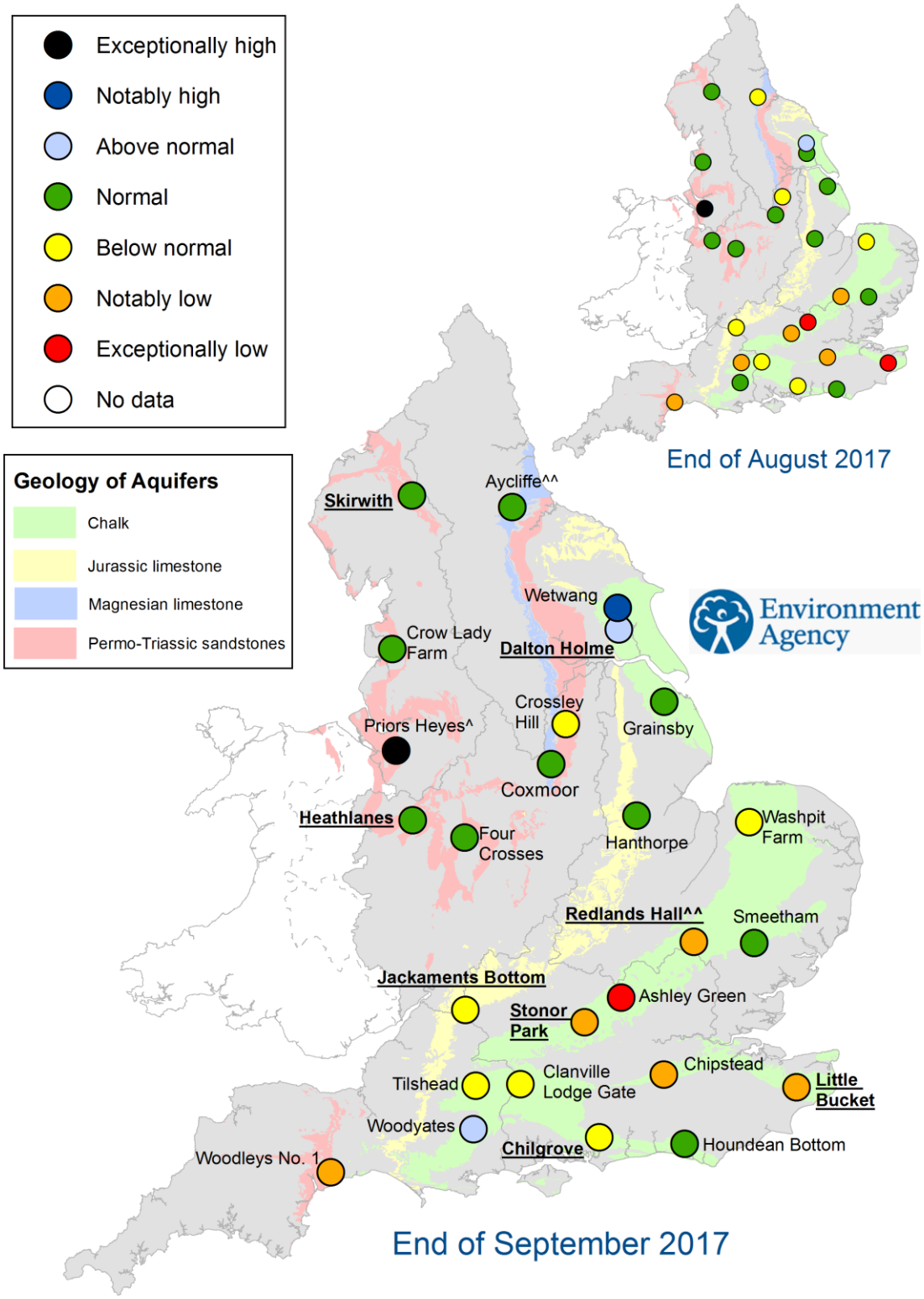


Figure 3.2: Index river flow sites for each geographic region. Monthly mean flow compared to an analysis of historic monthly mean flows, long term maximum and minimum flows. (Source: Environment Agency).

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
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 2017 and September 2017, 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, 2017.

Groundwater level charts

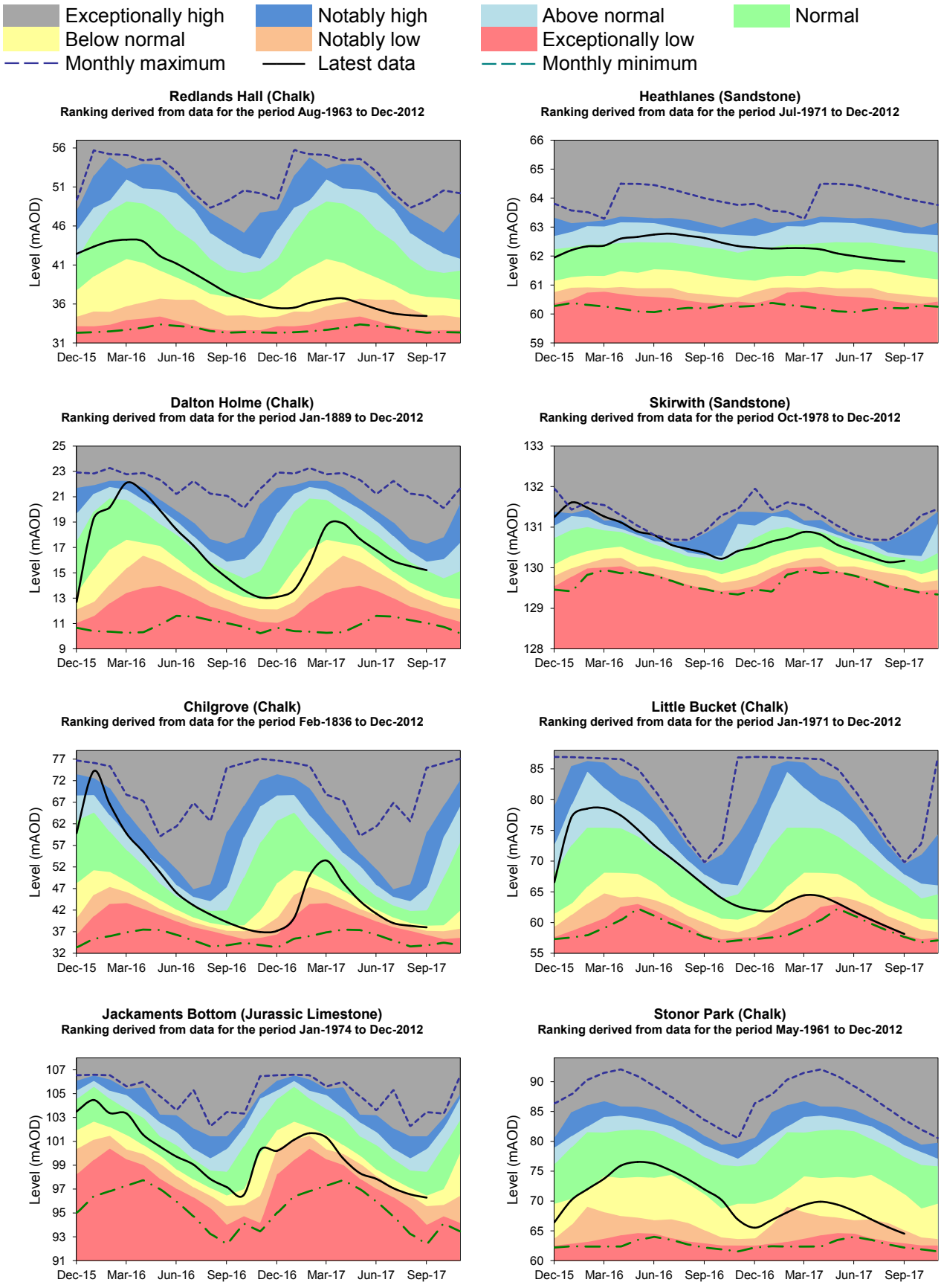
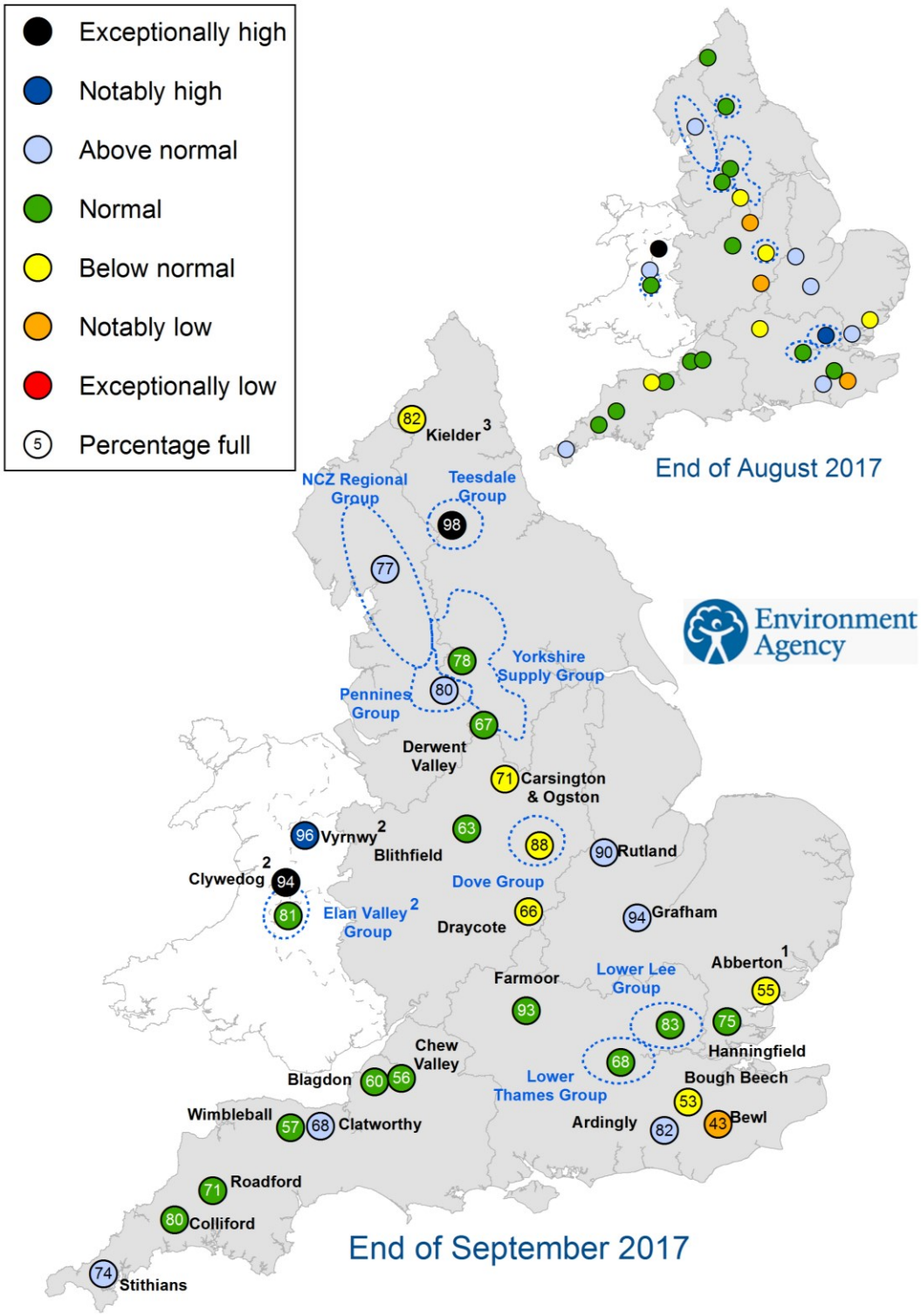


Figure 4.2: Index groundwater level sites for major aquifers. End of month groundwater levels months compared to an analysis of historic end of month levels and long term maximum and minimum levels. (Source: Environment Agency, 2017).

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
3. Current levels at Kielder will be deliberately lower than historical levels during a trial 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 2017 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, 2017.

Reservoir storage charts

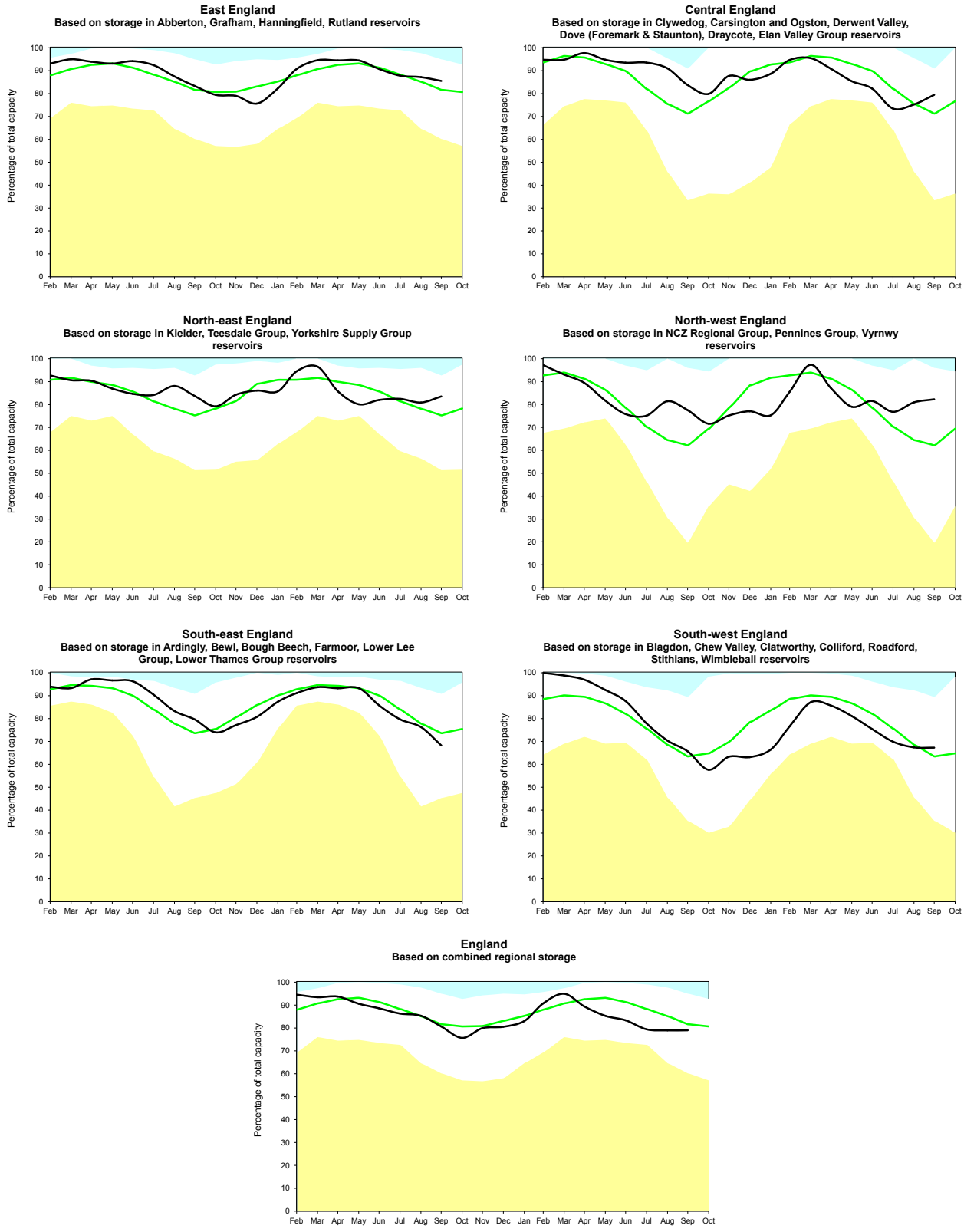


Figure 5.2: Regional reservoir stocks. End of month reservoir stocks compared to long term maximum, minimum and average stocks (Source: Water Companies). Note: Historic records of individual reservoirs/reservoir groups making up the regional values vary in length.

Forward look – river flow

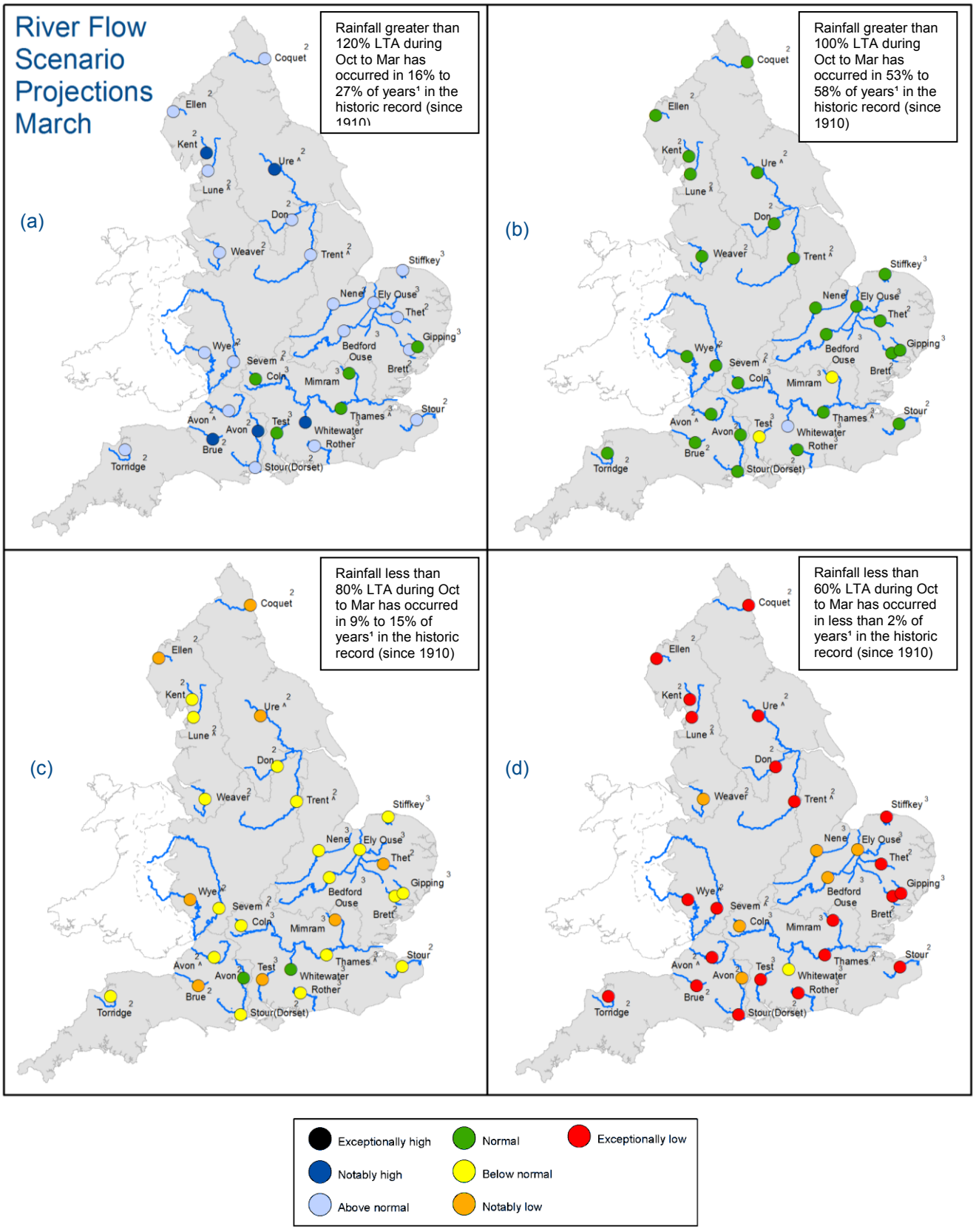
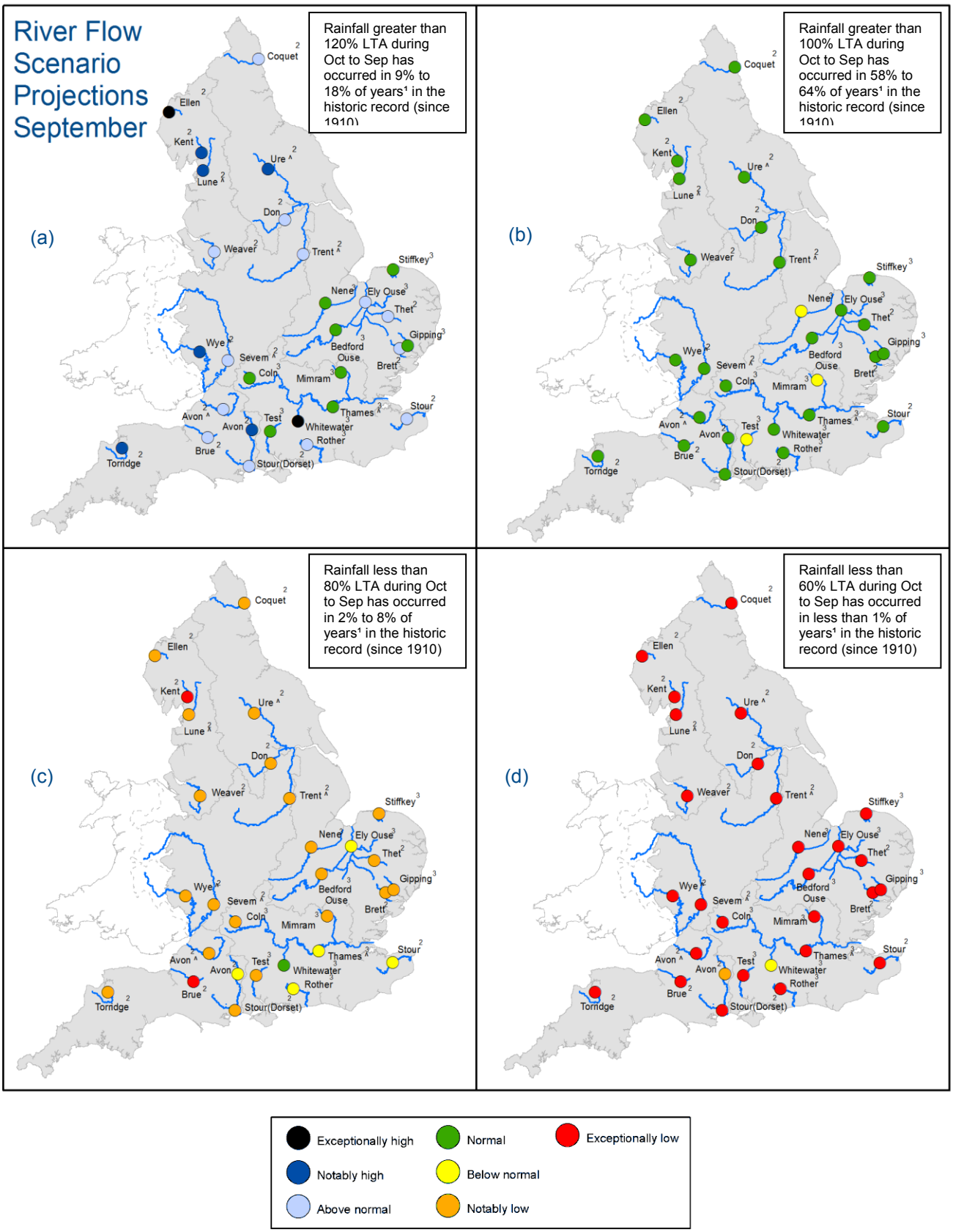


Figure 6.1: Projected river flows at key indicator sites up until the end of March 2018. Projections based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between October 2017 and March 2018 (Source: Centre for Ecology and Hydrology, Environment Agency).

[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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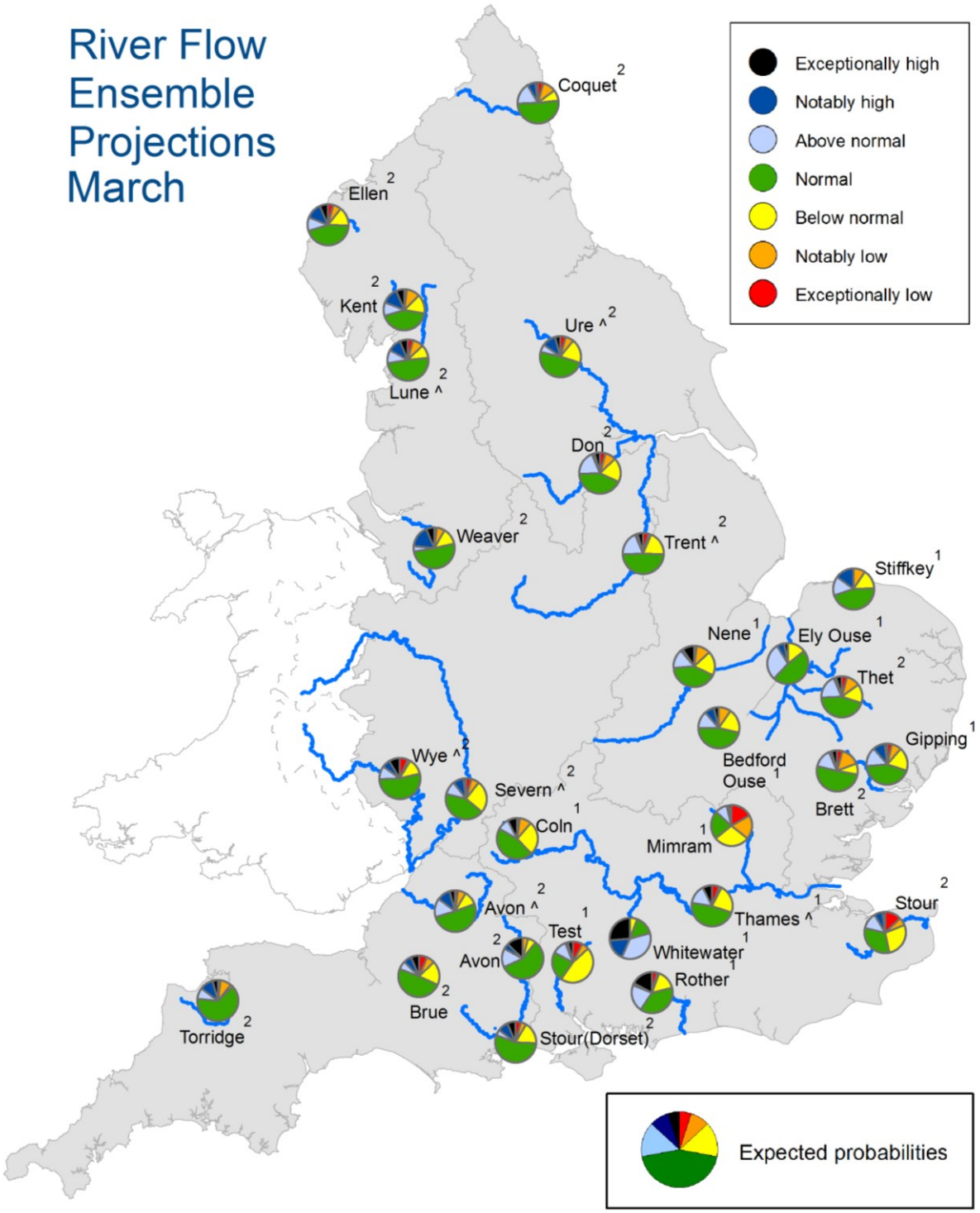

Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are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

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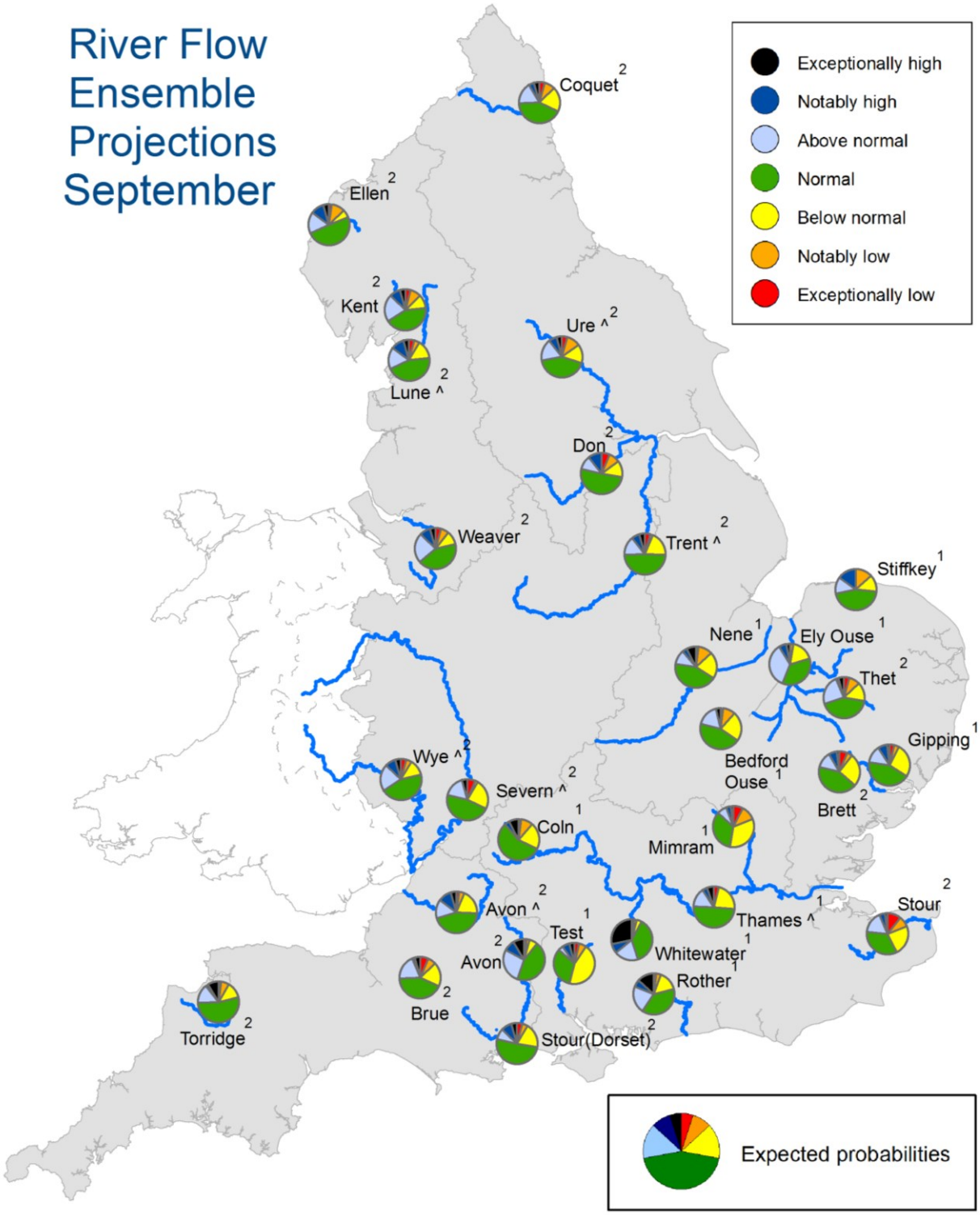

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Figure 6.4: Probabilistic ensemble projections of river flows at key indicator sites up until the end of September 2018. Pie charts indicate probability, based on climatology, of the surface water flow at each site being e.g. exceptionally low for 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

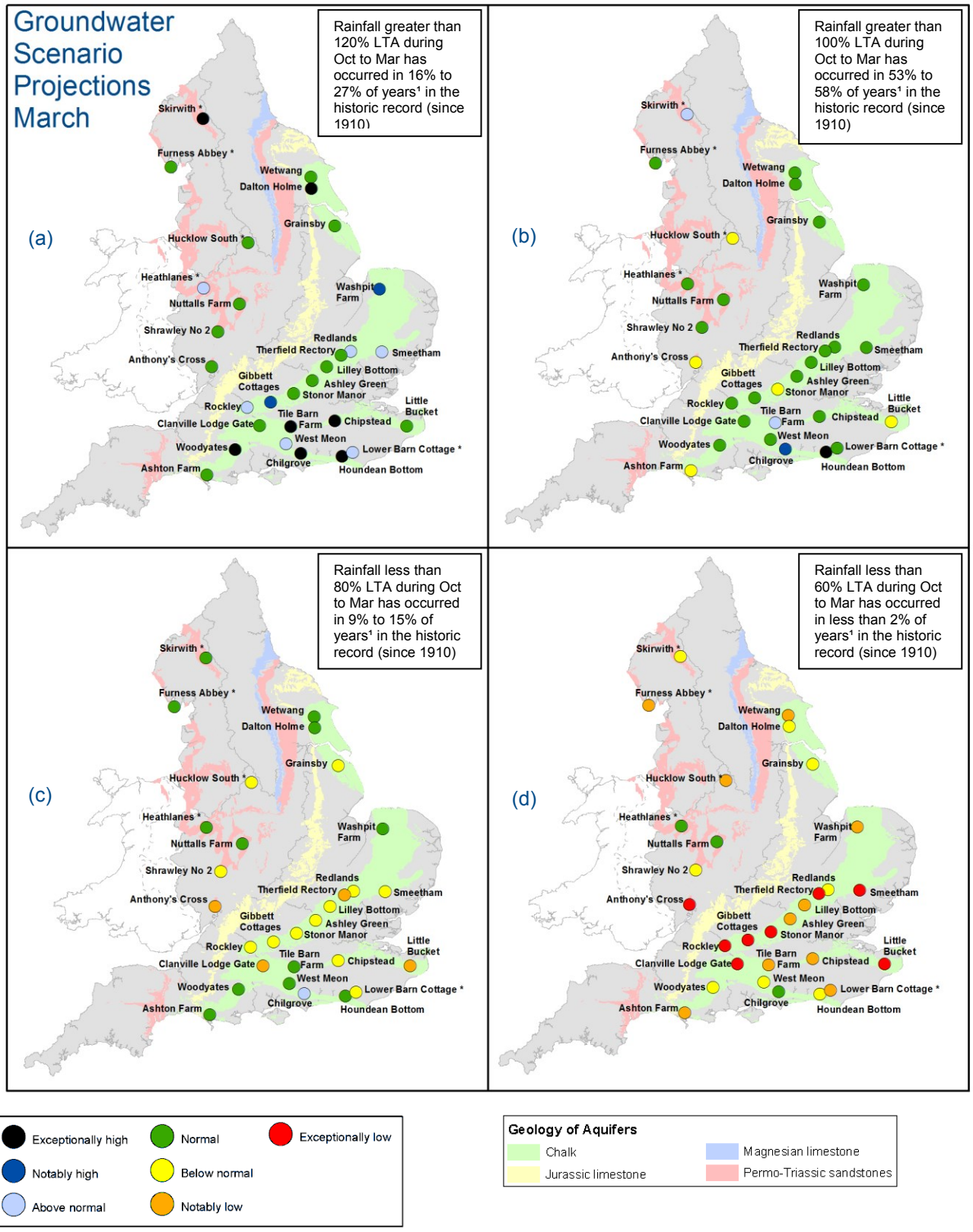

Figure 6.5: Projected groundwater levels at key indicator sites at the end of March 2018. Projections based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between October 2017 and March 2018 (Source: Environment Agency). Geological map reproduced with kind permission from UK Groundwater Forum BGS © NERC. Crown copyright all rights reserved. Environment Agency 100026380, 2017.

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

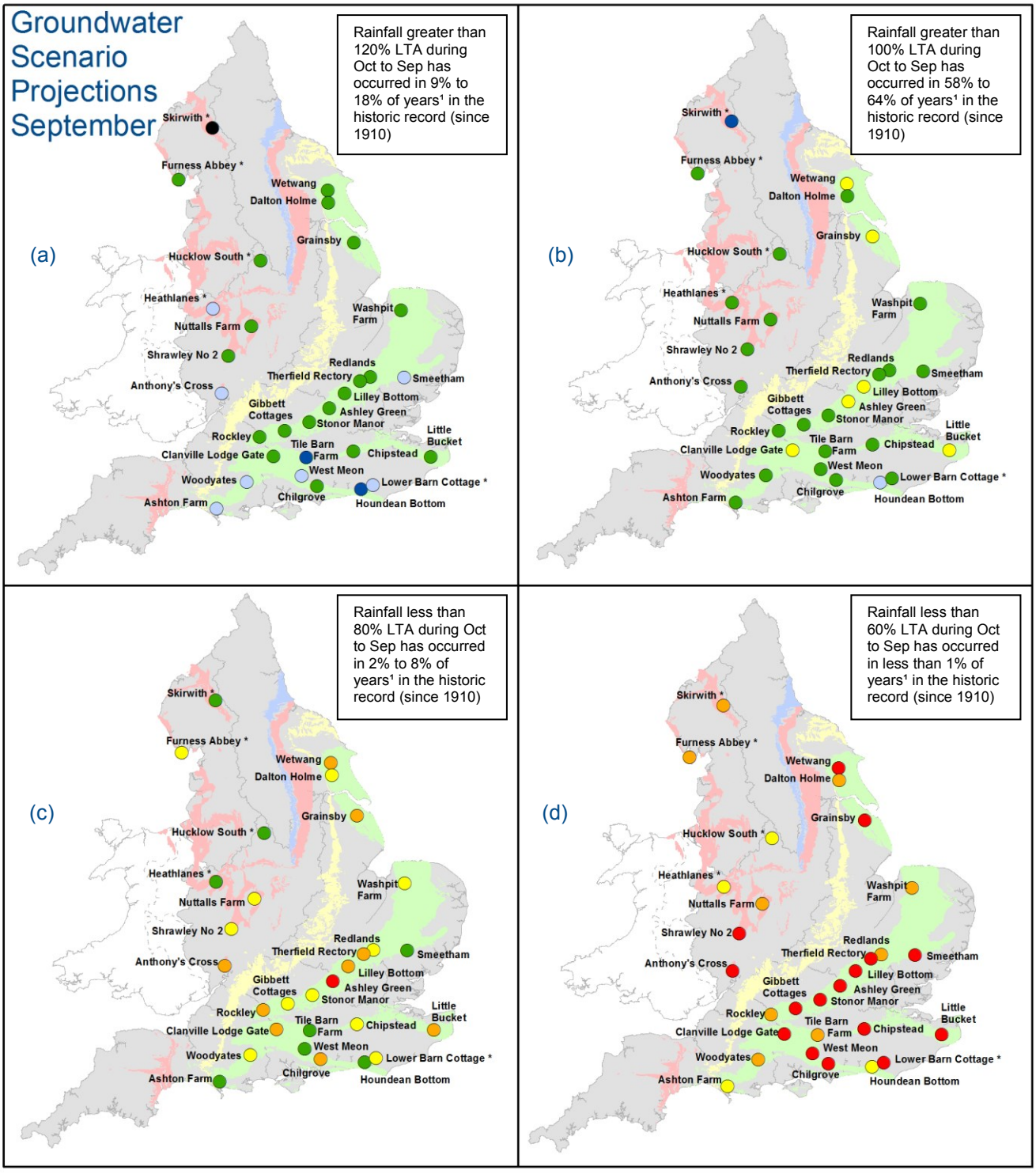

Figure 6.6: Projected groundwater levels at key indicator sites at the end of September 2018. Projections based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between October 2017 and September 2018 (Source: Environment Agency). Geological map reproduced with kind permission from UK Groundwater Forum BGS © NERC Crown copyright. All rights reserved. Environment Agency 100026380 2017.

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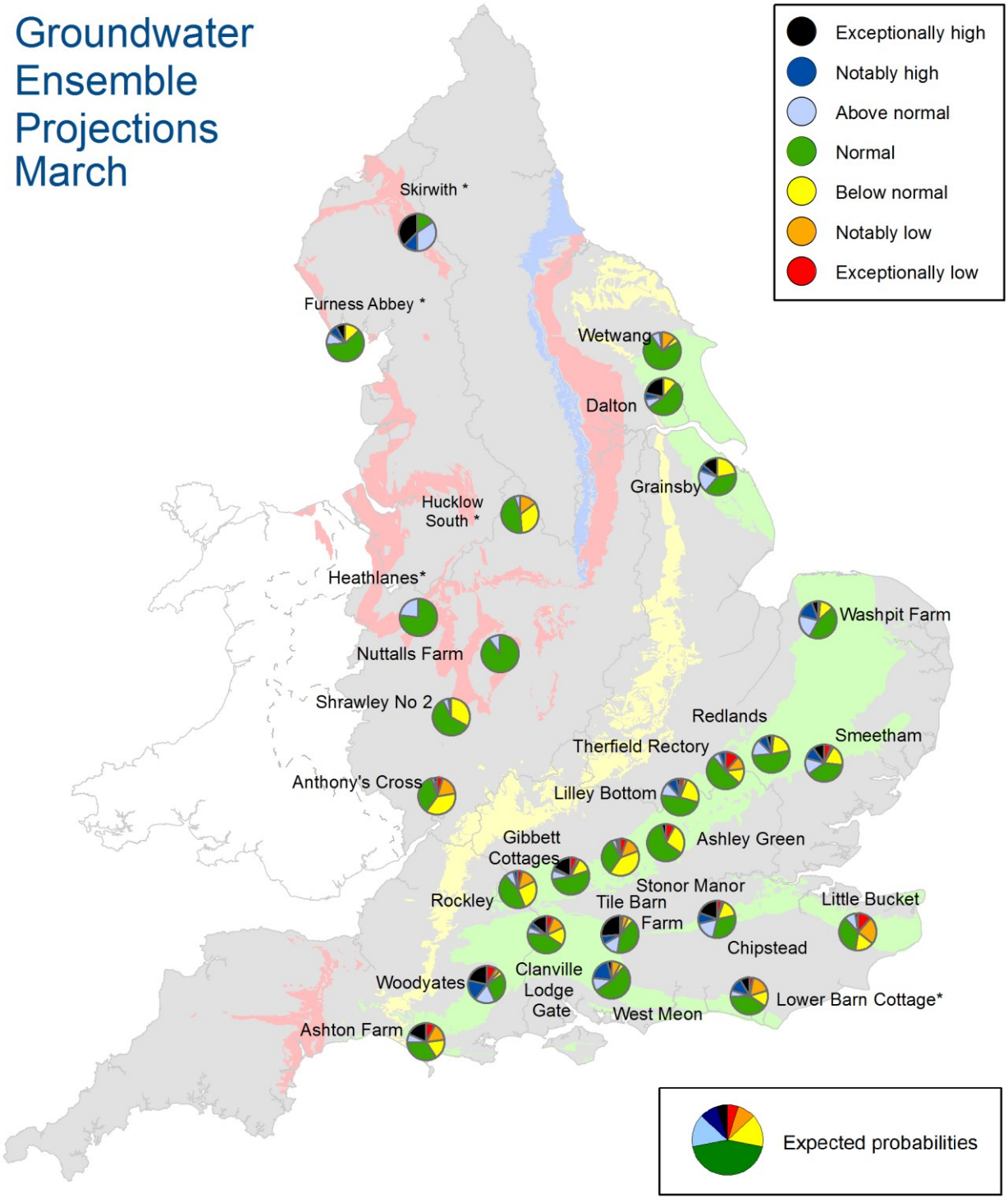
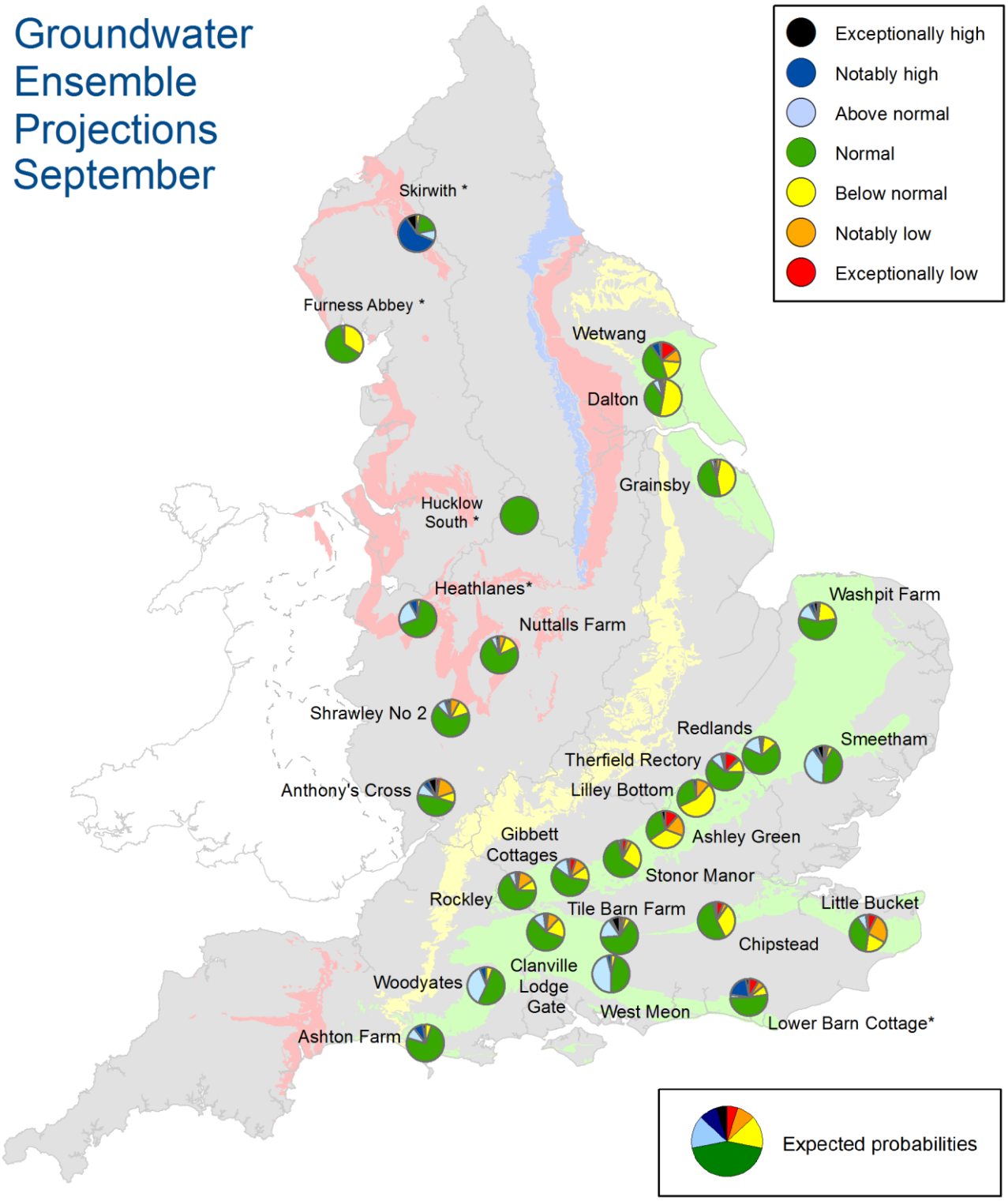


Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are 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 2018. 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, 2017.

** 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 2018. 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, 2017.

* 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