Monthly water situation report

England

Summary – December 2017

December rainfall totals were above average across England at 115% of the monthly long term average. Monthly rainfall totals were normal or higher for the time of year across the majority of hydrological areas. Soil moisture deficits decreased across England in response to the month's rainfall but soils remain slightly drier than average in parts of east and south-east England. Monthly mean river flows increased compared to November at almost all indicator sites and were normal for the time of year at three-quarters of sites. Groundwater levels increased at nearly four-fifths of indicator sites during December, although end of the month levels remained below normal or lower for the time of year at half of the sites. Reservoir stocks increased at four-fifths of reported reservoirs and reservoir groups, with notable increases of more than 20% occurring at 5 reservoirs. At the end of December, stocks were normal or higher for the time of year at just over two-thirds of sites, whilst overall storage for England increased to 86% of total capacity.

Rainfall

December rainfall totals were above the long term average (LTA) across four-fifths of hydrological areas. The highest rainfall totals were generally in south-west and north-west England, with the Avon, Dart and Erme (Devon) hydrological area receiving 202mm of rainfall (122% of the LTA) and the Upper Dee (north Wales) and River Esk (Cumbria) hydrological areas receiving 196mm (96% of the LTA) and 195mm (123% of the LTA), respectively. In parts of Norfolk, Suffolk and Essex, rainfall totals were almost 200% of the December LTA (Figure 1.1).

Rainfall totals were normal or higher for the time of year across the majority of hydrological areas, particularly those in parts of central, east and south-east England where totals were above normal or notably high. Rainfall totals were below normal in 10 hydrological areas in north-east England, ranging from 60 to 80% of the LTA. The 3 and 12 month cumulative rainfall totals highlight a rainfall deficit across parts of south-east, south-west and central England where rainfall totals were either below normal or notably low for the time of year (Figure 1.2).

At a regional scale, December rainfall totals were above average across all geographic regions apart from north-east England and ranged from 75% of the December LTA in north-east England (below normal for the time of year) to 153% in east England (above normal for the time of year). December rainfall totals for central and south-east England were also above normal for the time of year and all other regions were normal (Figure 1.3).

Soil moisture deficit

The rainfall during December has continued to reduce soil moisture deficits across much of England. At the end of December, soil moisture deficits were at, or close to, zero across much of England, although deficits of between 40 and 70mm persist in parts of east and south-east England. In these areas, soils remain slightly drier than average for the time of year (Figure 2.1). At a regional scale, end of month SMDs ranged from less than 1mm in north-west and south-west England to 19mm in east England (Figure 2.2).

River flows

Monthly mean river flows for December increased at almost all indicator sites compared to November and were classed as normal for the time of year at three-quarters of sites. Flows on the River Yare in Norfolk were notably high for the time of year. River flows for the remaining indicator sites, predominantly in south and south-east England were below normal for the time of year, with the groundwater-fed River Ver being notably low (Figure 3.1).

At the regional index sites, monthly mean river flows were below normal for the time of year for the River Thames at Kingston and the Great Stour at Horton in south-east England, but normal elsewhere (Figure 3.2).

Groundwater levels

Groundwater levels increased at nearly four-fifths of indicator sites during December, in response to the above average rainfall. However, end of month levels remained below normal or lower for the time of year at half the sites, most of which are located in chalk aquifers in the south and south-east of England. The end of December level at

Ashley Green (Chilterns East chalk aquifer) remained the lowest on record (which dates from 1987) for the time of year for the fifth consecutive month, whilst Little Bucket (East Kent Stour chalk) remained dry for the third consecutive month (Figure 4.1).

End of month groundwater levels at four of the major aquifer index sites were lower than normal for the time of year; Stonor Park (South West Chilterns chalk aquifer) and Redlands Hall (Cam and Ely Ouse chalk aquifer) were below normal, Chilgrove (Chichester chalk aquifer) was notably low and Little Bucket was exceptionally low. Levels at the remaining four index sites were normal for the time of year (Figure 4.2).

Reservoir storage

Reservoir stocks increased at four-fifths of reported reservoirs and reservoir groups during December. Notable increases in stocks occurred at Clatworthy (21%), Chew Valley and Blithfield (22%), Blagdon (29%) and Bough Beech (33%) reservoirs. Stocks remained unchanged or decreased by up to 4% in the remaining fifth of reservoirs and reservoir groups. End of month stocks were classed as normal or higher for the time of year at just over two-thirds of reservoirs and reservoir groups. Four sites were classed as notably low (Carsington and Ogston, Wimbleball and Bewl reservoirs and the Lower Thames reservoir group) (Figure 5.1).

Compared with the end of November, regional reservoir stocks increased across all regions, with the largest increases occurring in south-east (16%) and south-west (10%) England. End of December stocks ranged from 74% of total capacity in south-east England to 93% in north-east England. Overall storage for England increased to 86% of total capacity (Figure 5.2).

Forward look

January's weather is expected to be unsettled with showers, longer spells of heavy rain and occasional snowfall affecting all areas at times. For the 3-month period January-February-March, there is an increased likelihood of above average precipitation across the UK as a whole[1].

Projections for river flows at key sites[2]

Three-fifths of the modelled sites have a greater than expected chance of cumulative river flows being normal or higher for the time of year at the end of March 2018. At the end of September 2018, just under a third of the modelled sites have a greater than expected chance of cumulative flows being normal or higher.

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]

Approximately three-fifths 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 March 2018. At the end of September 2018, just over half of the modelled sites have a greater than expected chance of levels being below normal or lower.

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

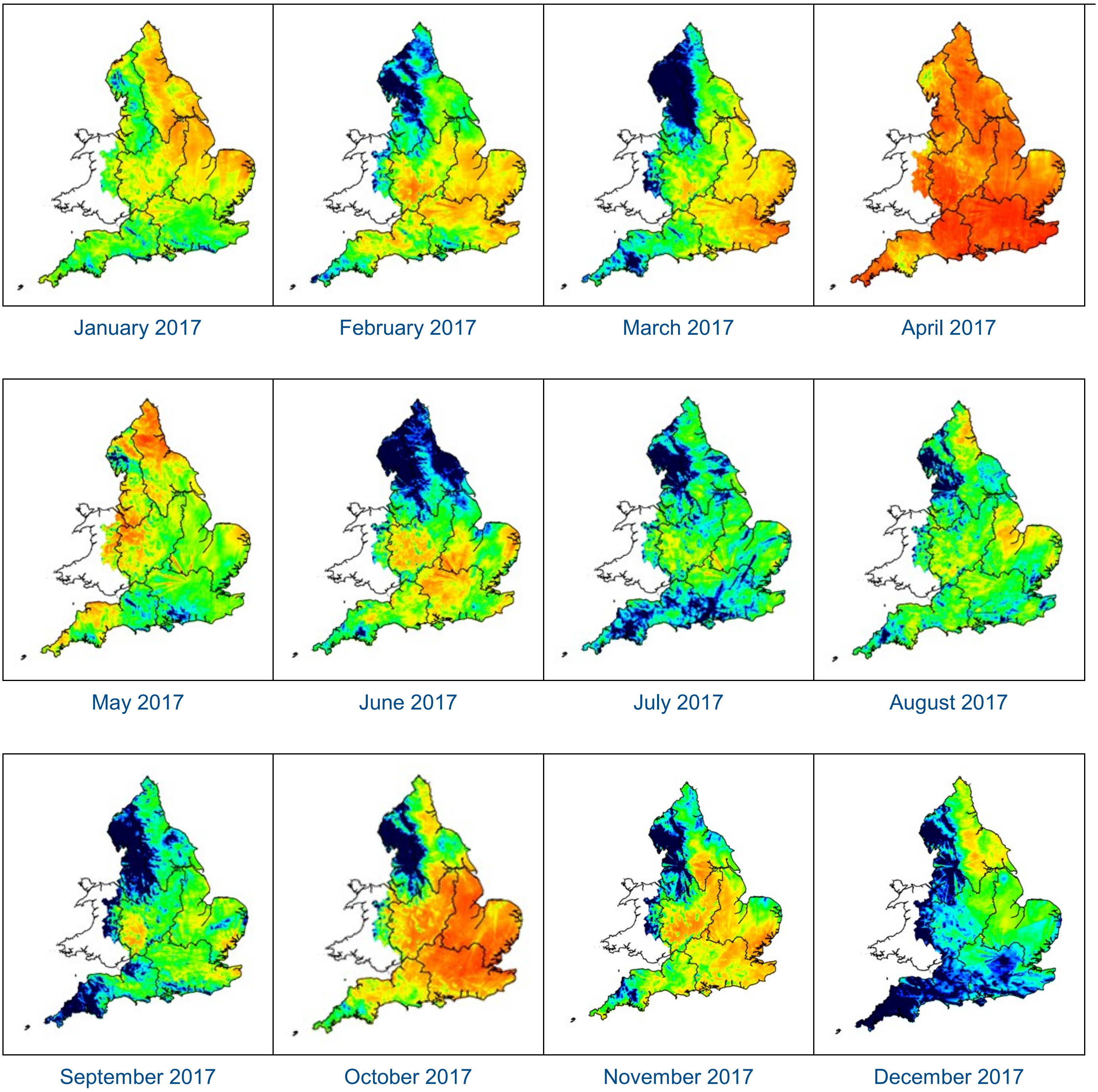
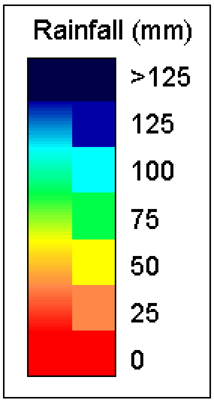


Figure 1.1: Monthly rainfall across England and Wales for the past 12 months. UKPP radar data (Source: Met Office © Crown Copyright, 2018). Note: Radar beam blockages in some regions may give anomalous totals in some areas. Crown copyright. All rights reserved. Environment Agency, 100026380, 2018.



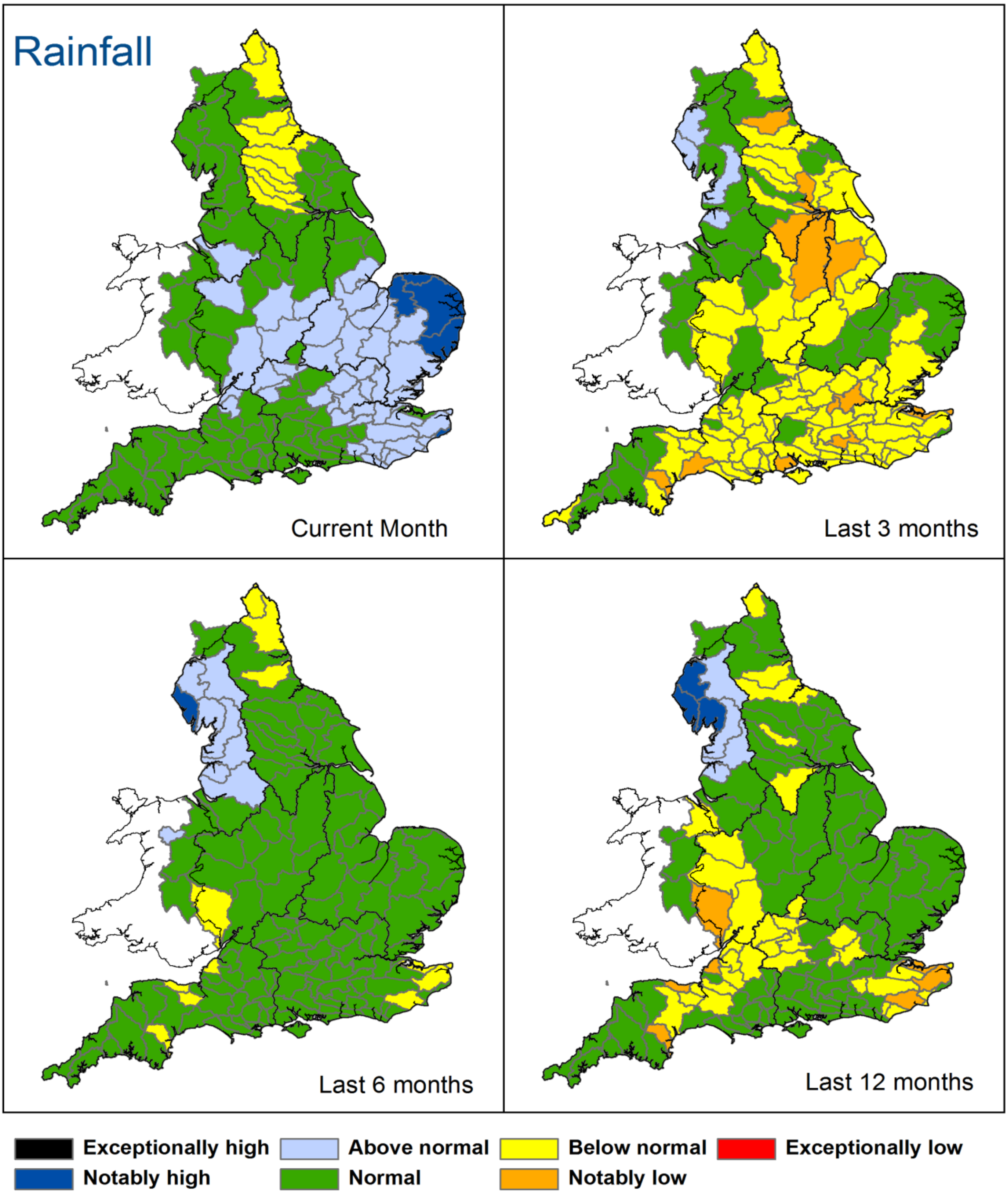


Figure 1.2: Total rainfall for hydrological areas across England for the current month (up to 31 December), the last 3 months, the last 6 months, and the last 12 months, classed relative to an analysis of respective historic totals. Final NCIC (National Climate Information Centre) data based on the Met 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

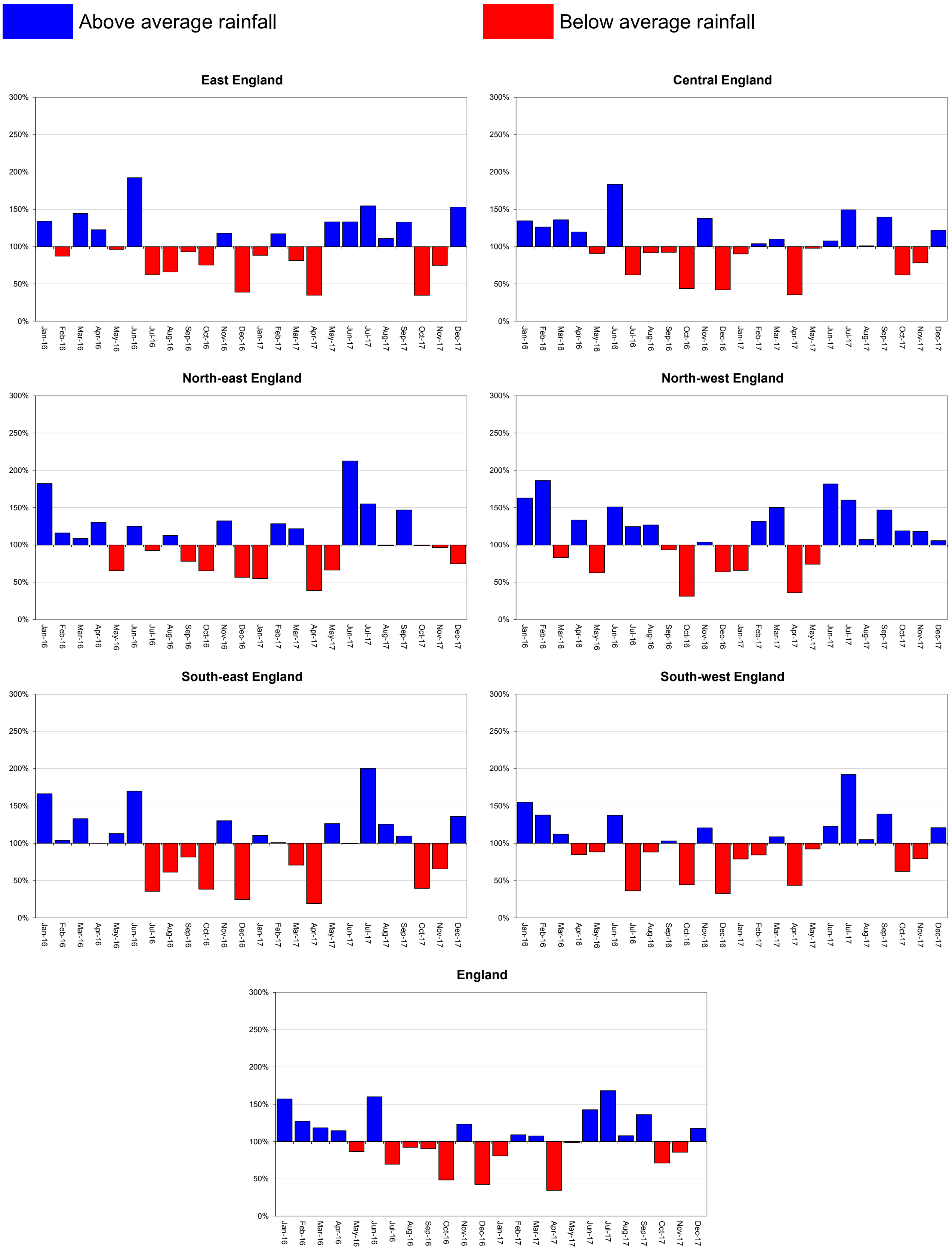


Figure 1.3: Monthly rainfall totals for the past 24 months as a percentage of the 1961 – 1990 long term average for each region and for England. NCIC (National Climate Information Centre) data. (Source: Met Office © Crown Copyright, 2018).

Soil moisture deficit

End of November 2017[1]	End of December 2017[2]

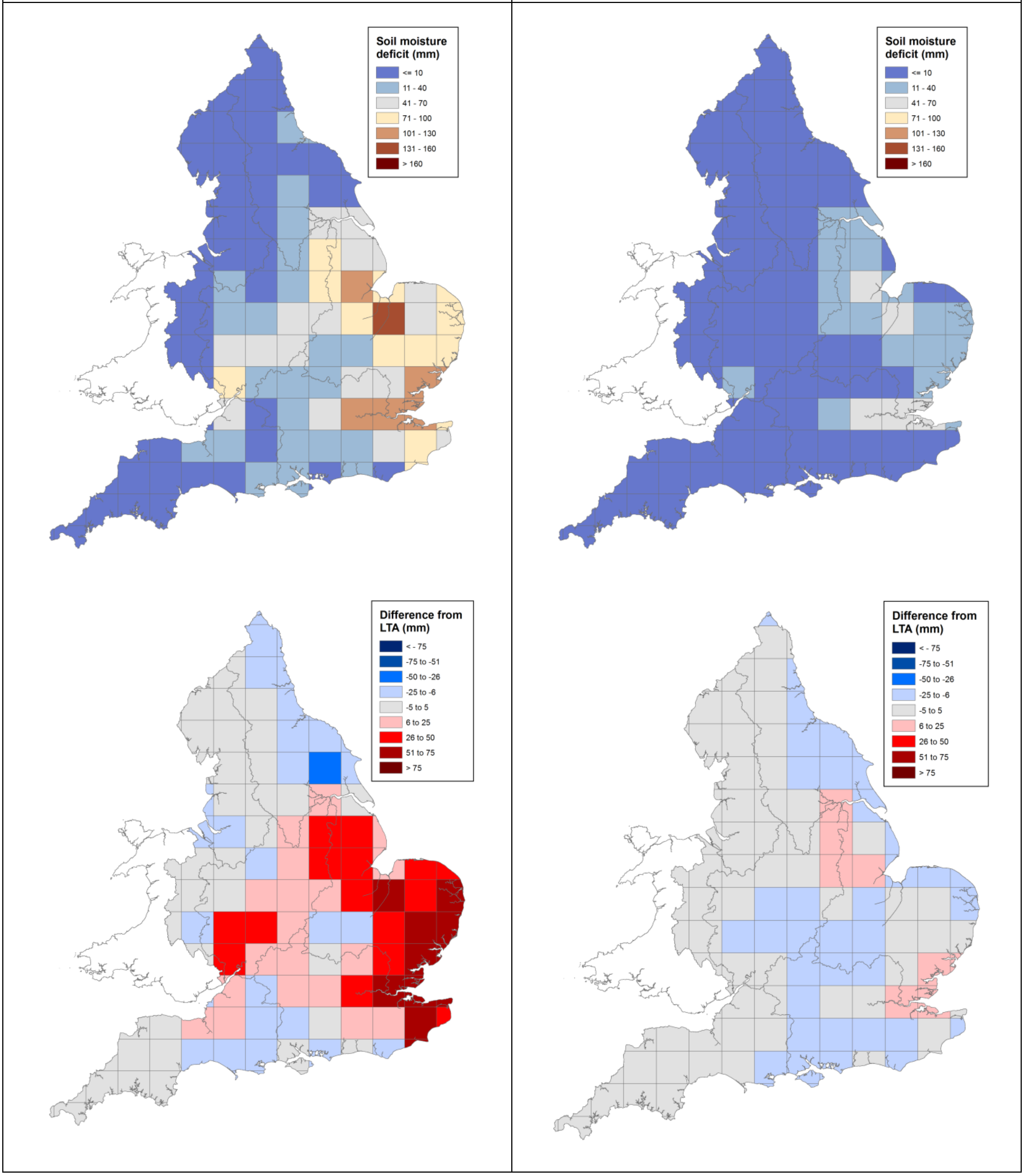
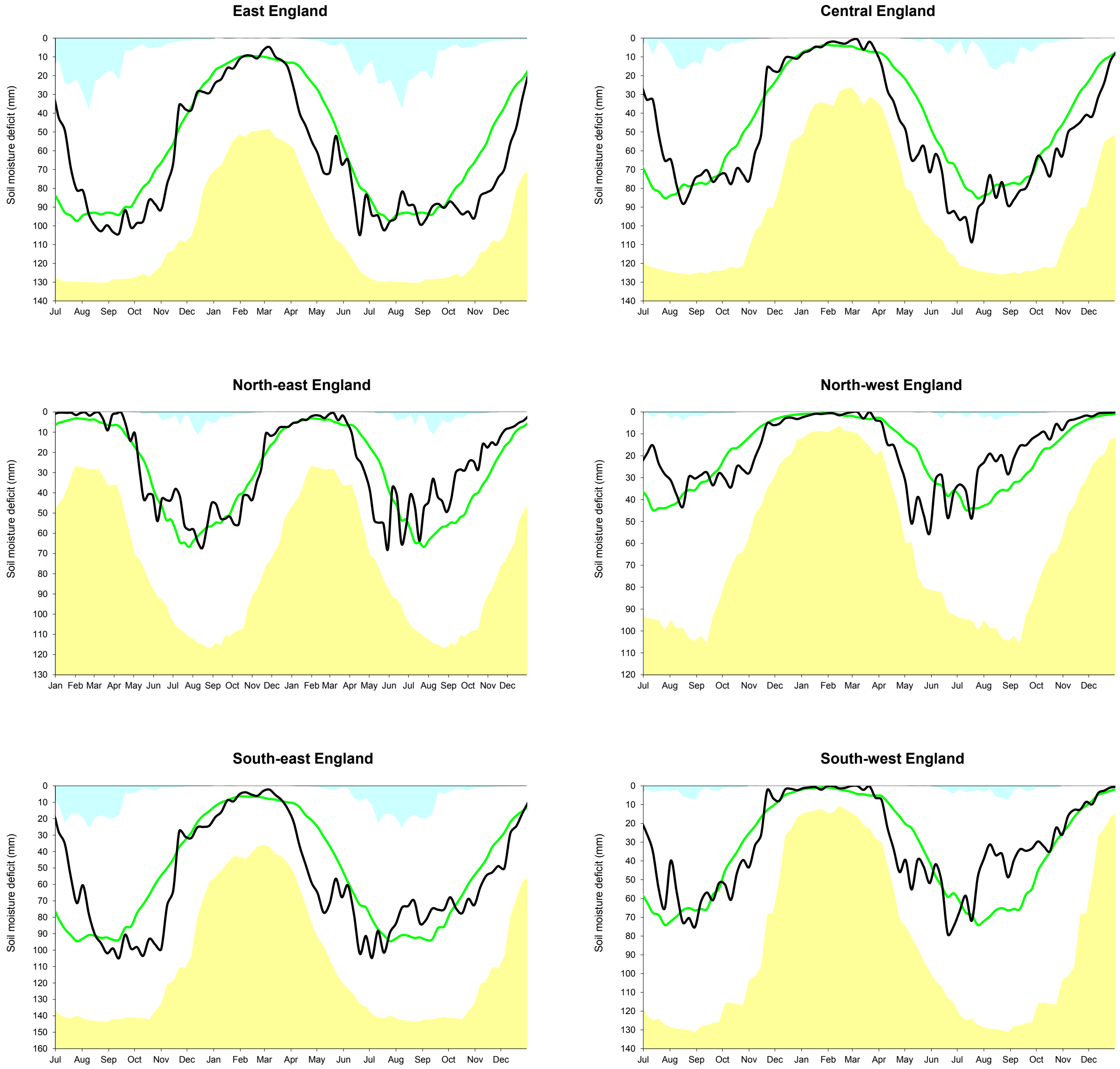


Figure 2.1: Soil moisture deficits for weeks ending 28 November 2017 [1] (left panel) and 2 January 2018 [2] (right panel). Top row shows actual soil moisture deficits (mm) and bottom row shows the difference (mm) of the actual from the 1961-90 long term average soil moisture deficits. MORECS data for real land use (Source: Met Office © Crown Copyright, 2018). Crown copyright. All rights reserved. Environment Agency, 100026380, 2018.

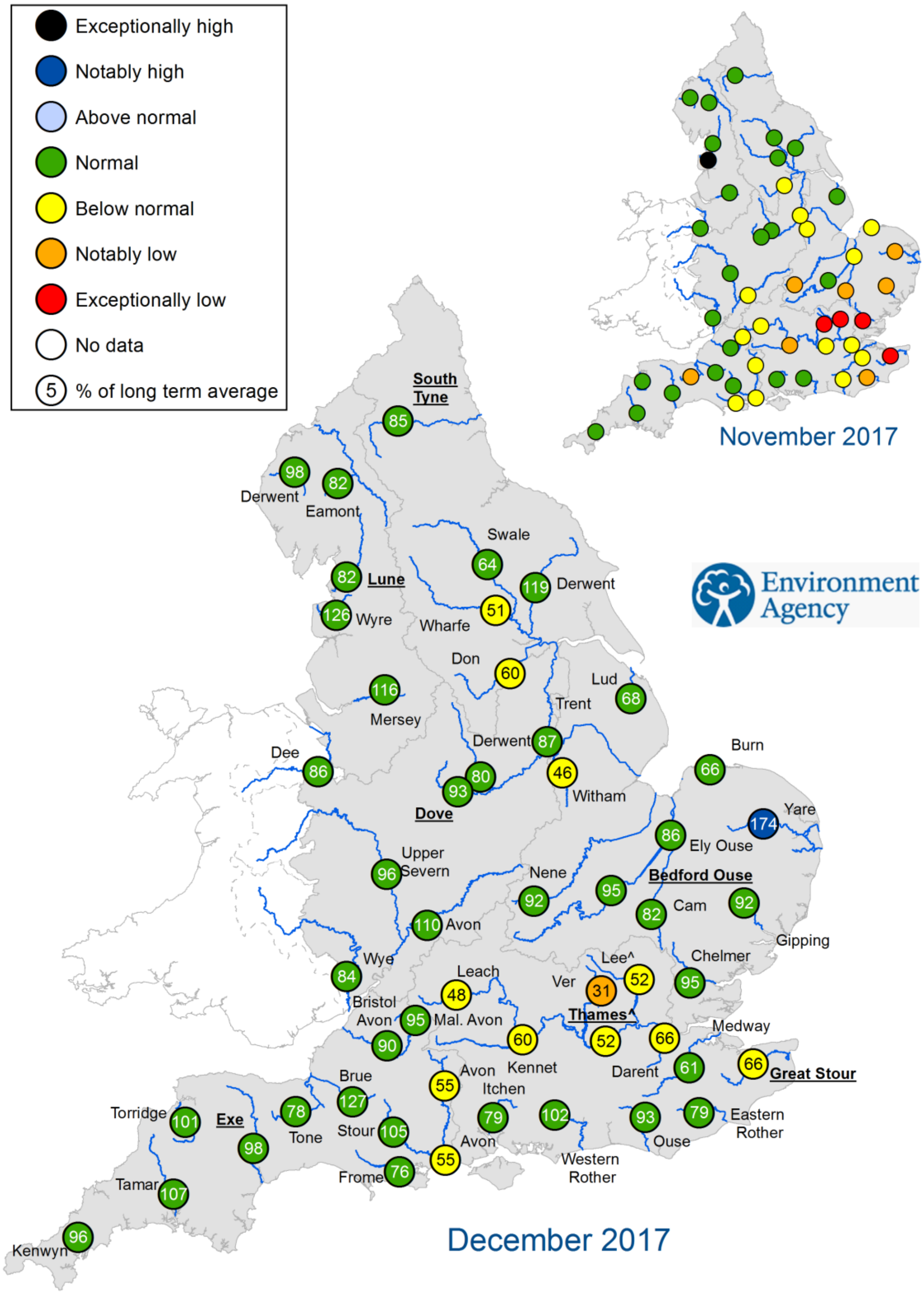
Soil moisture deficit charts



	Below minimum monthly level		Above maximum monthly level		Average	Latest data

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 November 2017 and December 2017, expressed as a percentage of the respective long term average and classed relative to an analysis of historic November and December monthly means (Source: Environment Agency).

River flow charts

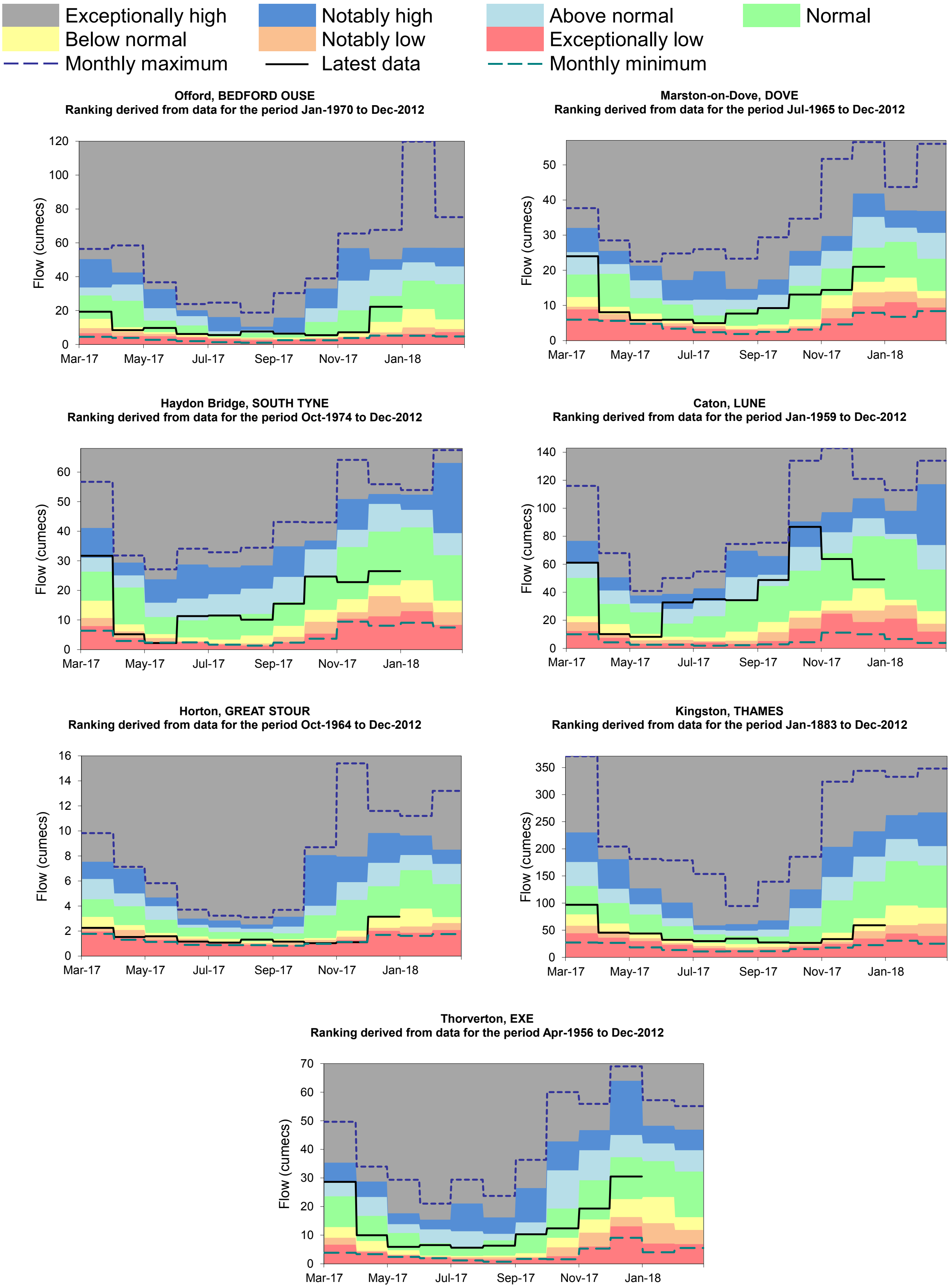
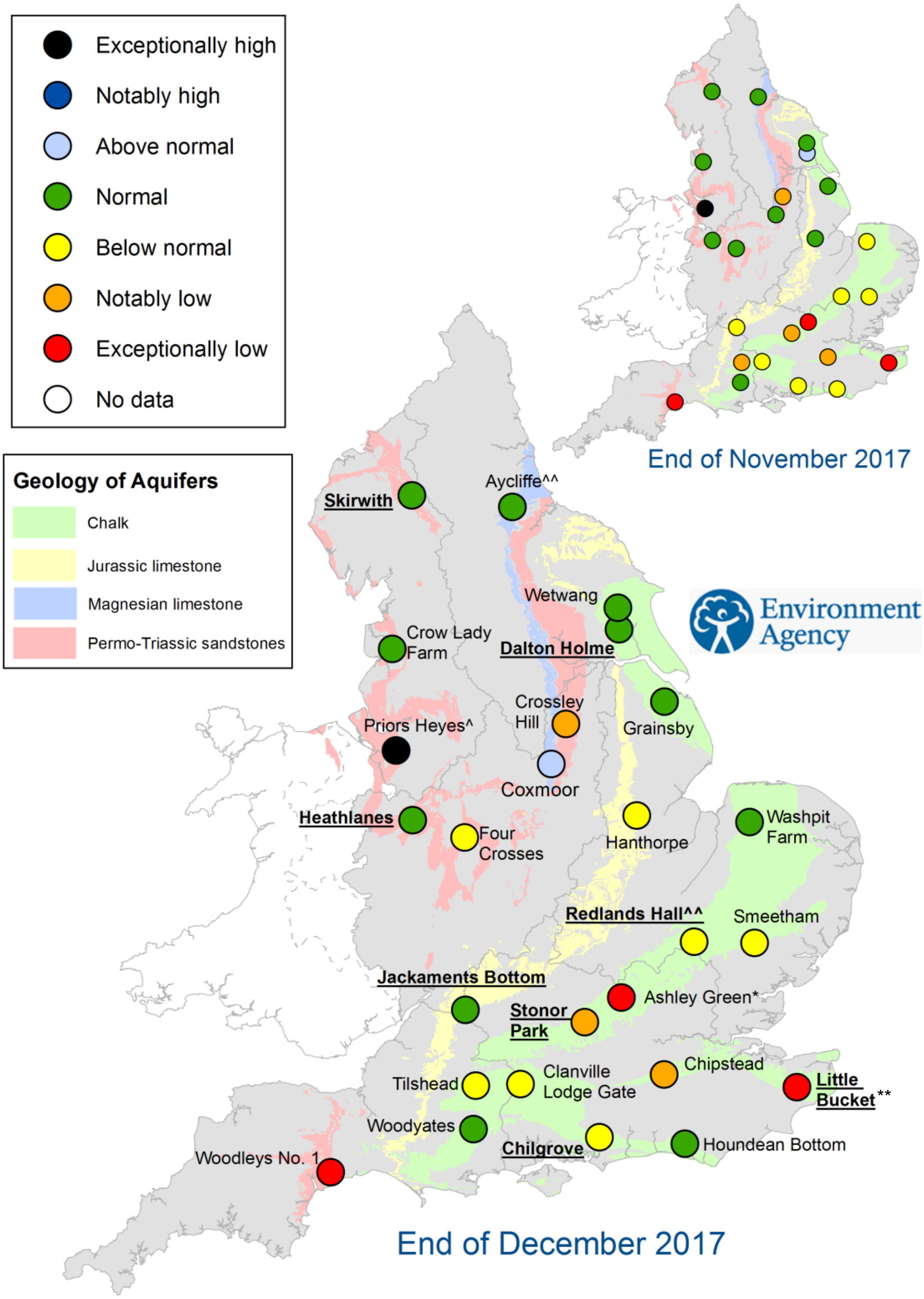


Figure 3.2: Index river flow sites for each geographic region. Monthly mean flow compared to an analysis of historic monthly mean flows, long term maximum and minimum flows. (Source: Environment Agency).

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 lowest on record for the current month (note that record length varies between sites)
** Borehole is currently dry
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 November 2017 and December 2017, classed relative to an analysis of respective historic November and December 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

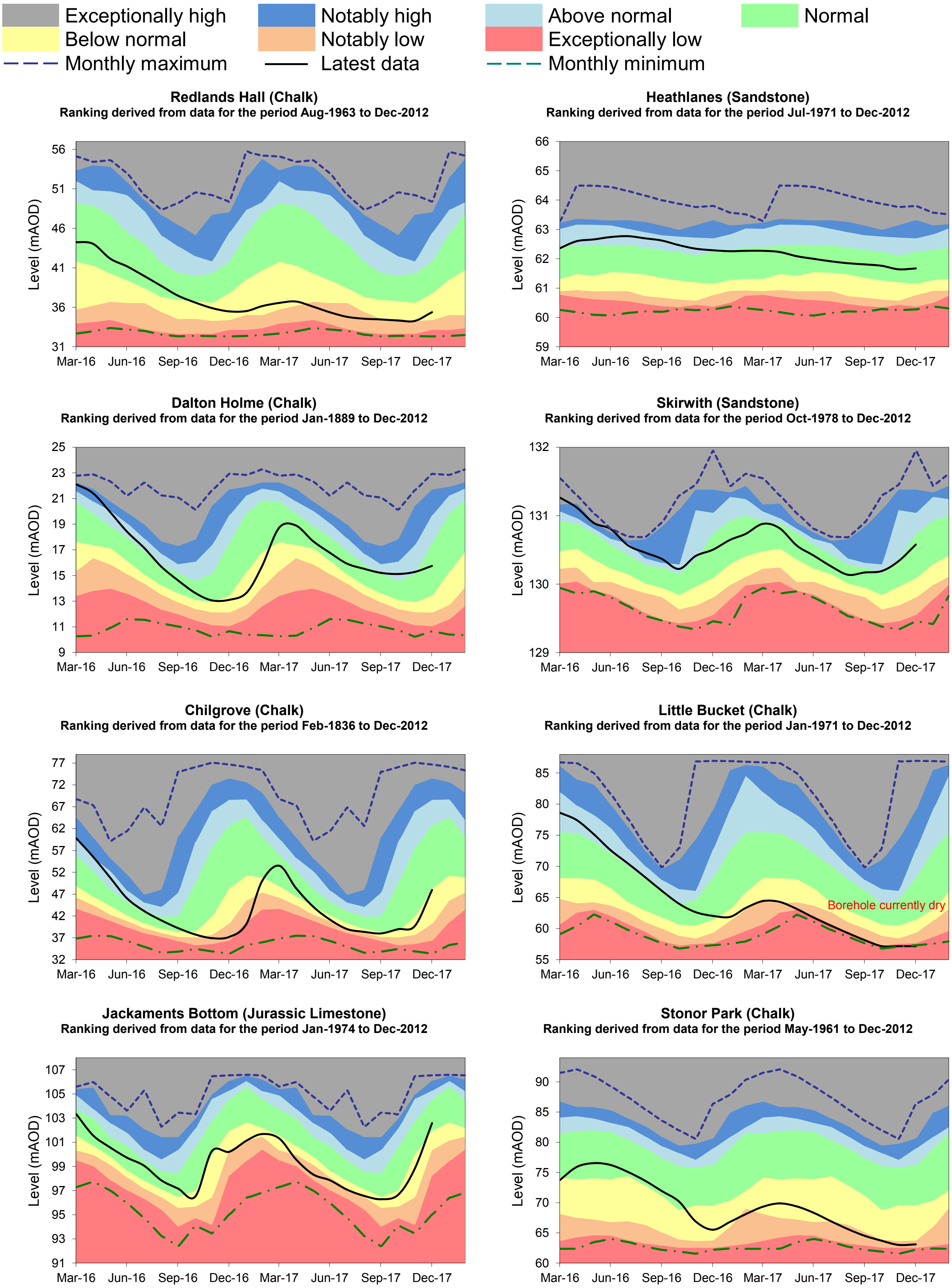
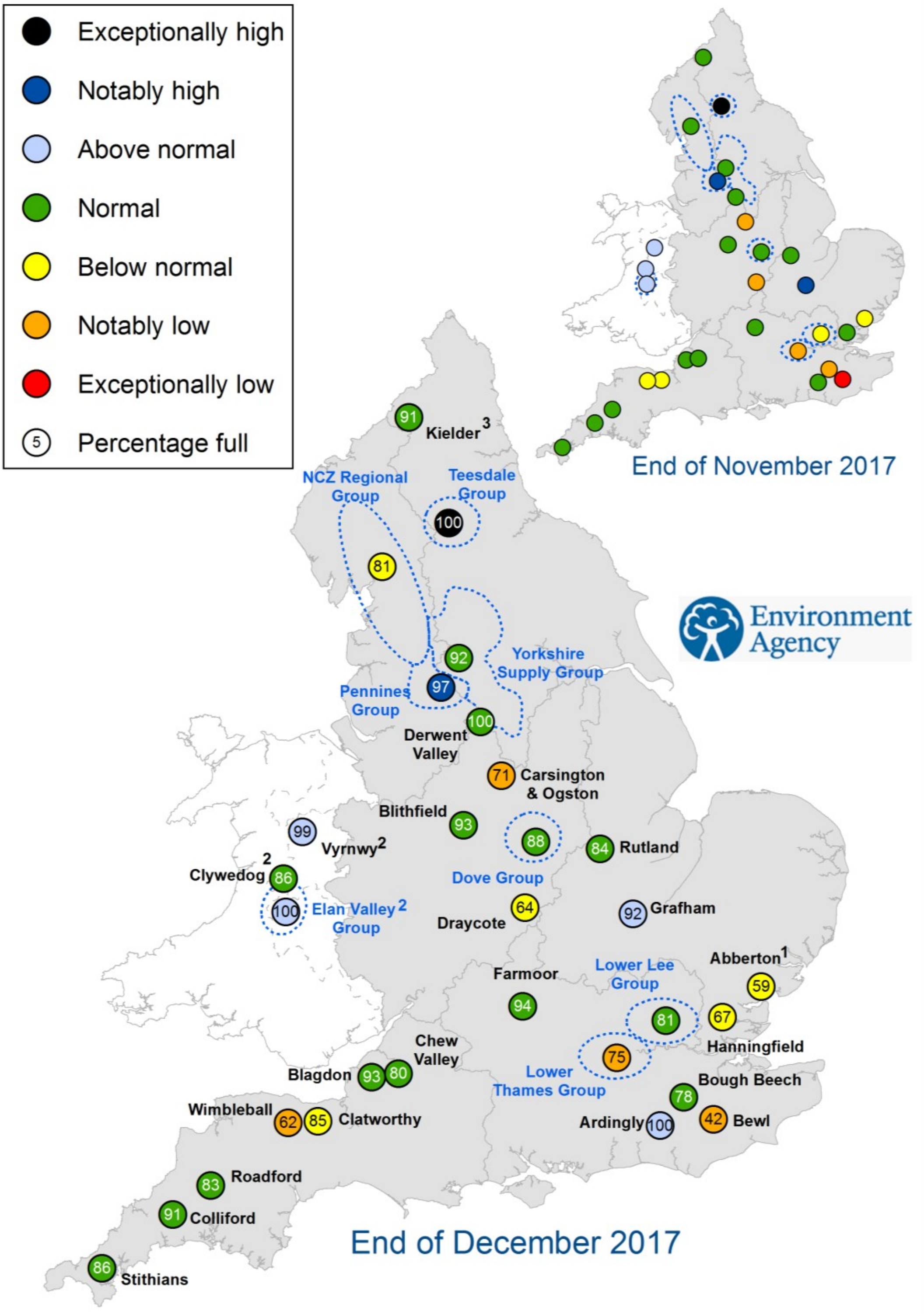


Figure 4.2: Index groundwater level sites for major aquifers. End of month groundwater levels months compared to an analysis of historic end of month levels and long term maximum and minimum levels. (Source: Environment Agency, 2018).

Reservoir storage

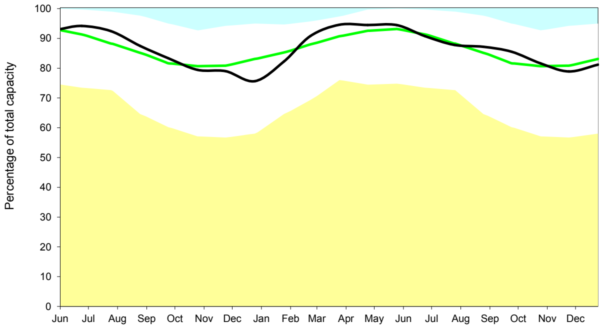


1. Current levels at Abberton Reservoir in east England are relative to increased capacity
2. Vyrnwy, Clywedog and Elan Valley reservoirs are located in Wales but provide a water resource to Central and north-west England
3. Current levels at Kielder are lower than historical levels due to the implementation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

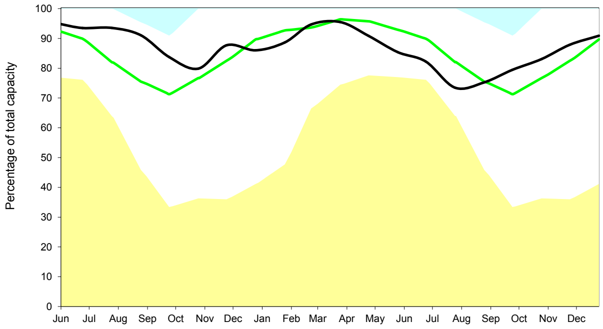
Figure 5.1: Reservoir stocks at key individual and groups of reservoirs at the end of November 2017 and December 2017 as a percentage of total capacity and classed relative to an analysis of historic November and December values respectively (Source: Water Companies). Note: Classes shown may not necessarily 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

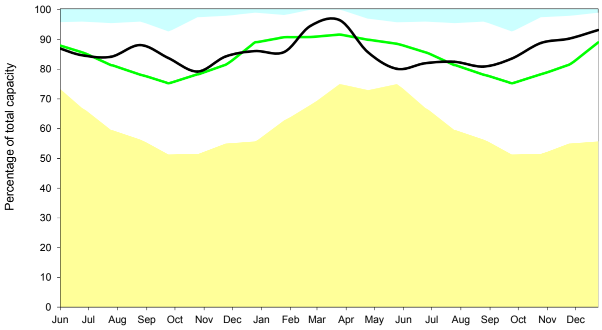
East England
Based on storage in Abberton, Grafham, Hanningfield, Rutland reservoirs



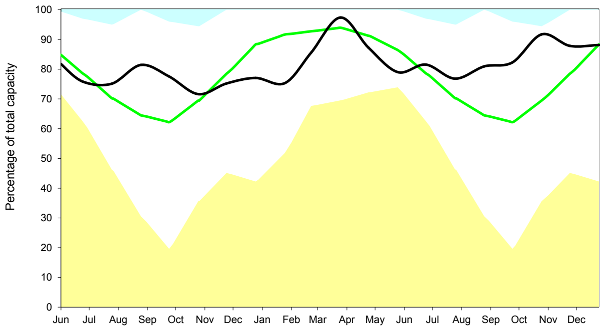
Central England
Based on storage in Clywedog, Carsington and Ogston, Derwent Valley, Dove (Foremark & Staunton), Draycote, Elan Valley Group reservoirs



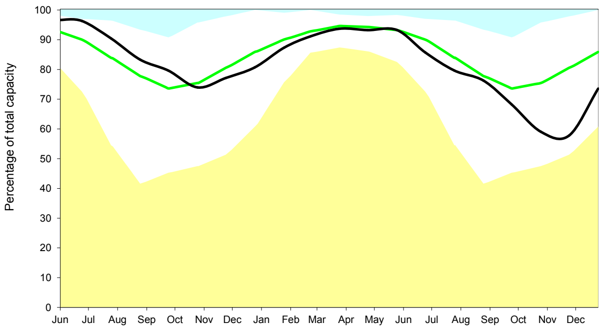
North-east England
Based on storage in Kielder, Teesdale Group, Yorkshire Supply Group reservoirs



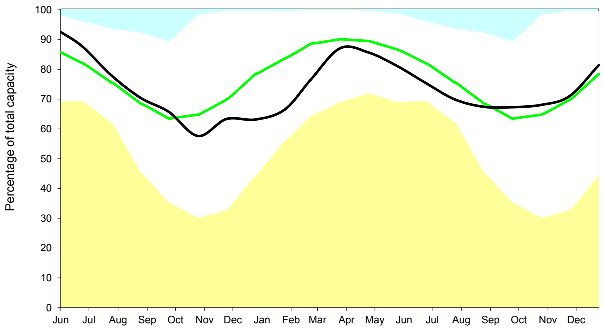
North-west England
Based on storage in NCZ Regional Group, Pennines Group, Vyrnwy reservoirs



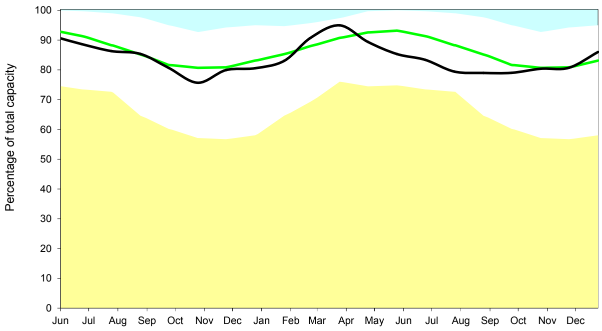
South-east England
Based on storage in Ardingly, Bewl, Bough Beech, Farmoor, Lower Lee Group, Lower Thames Group reservoirs



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



England
Based on combined regional storage



(yellow)	Below minimum monthly level	(light blue)	Above maximum monthly level	(green line)	Average	(black line)	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

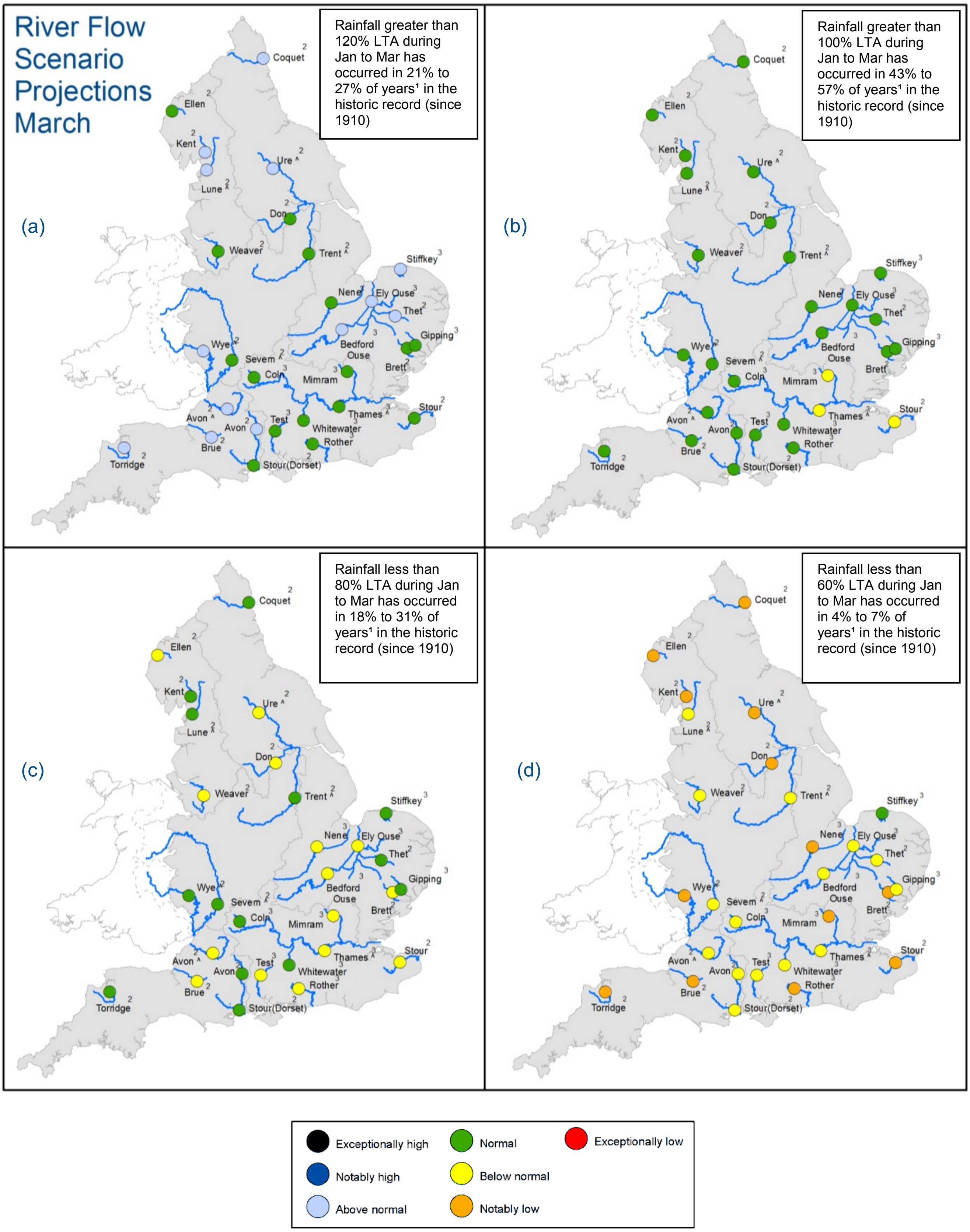


Figure 6.1: Projected river flows at key indicator sites up until the end of March 2018. Projections based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between January and March 2018 (Source: Centre for Ecology and Hydrology, Environment Agency).

[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*

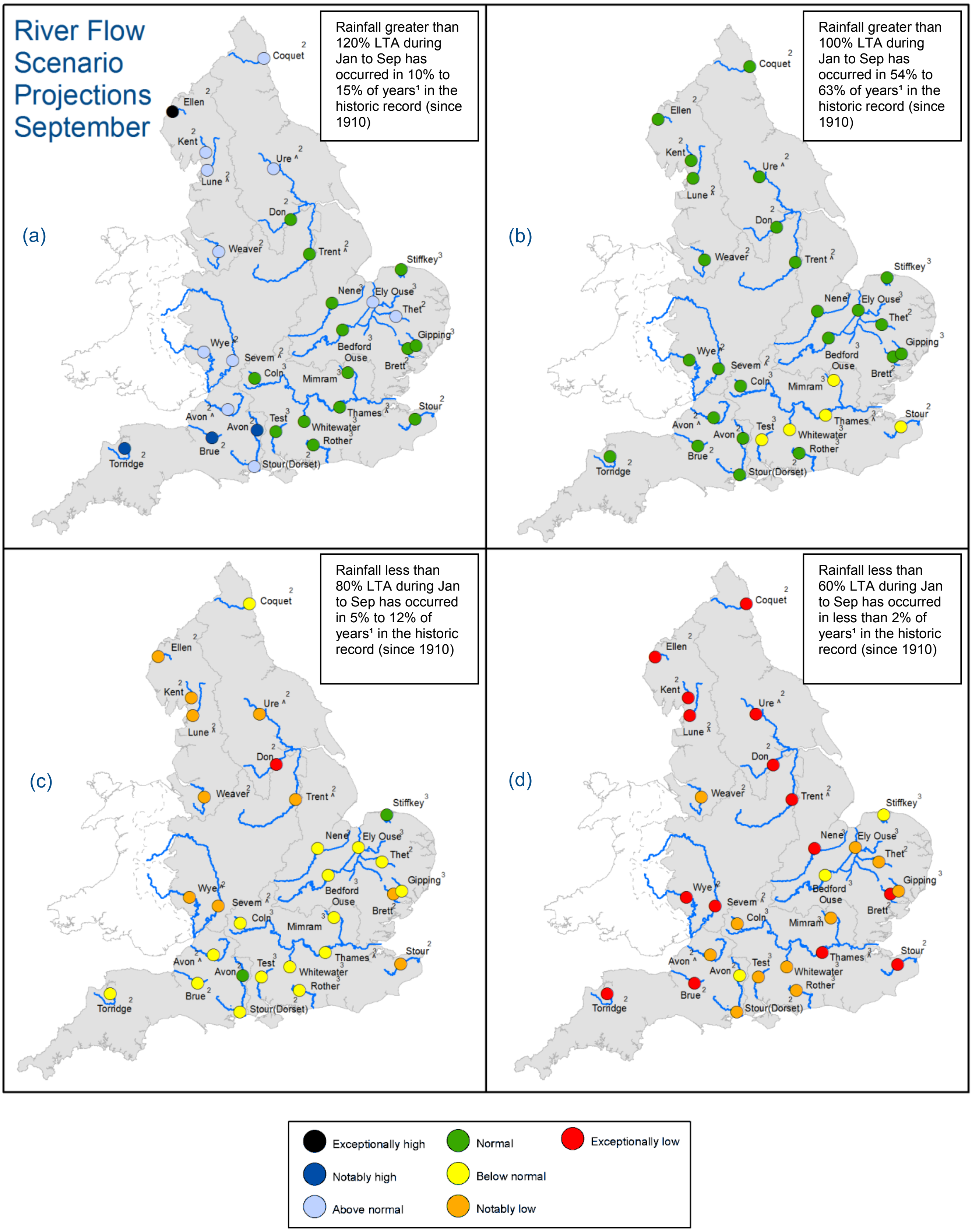


Figure 6.2: Projected river flows at key indicator sites up until the end of September 2018. Projections based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between January and September 2018 (Source: Centre for Ecology and Hydrology, Environment Agency).

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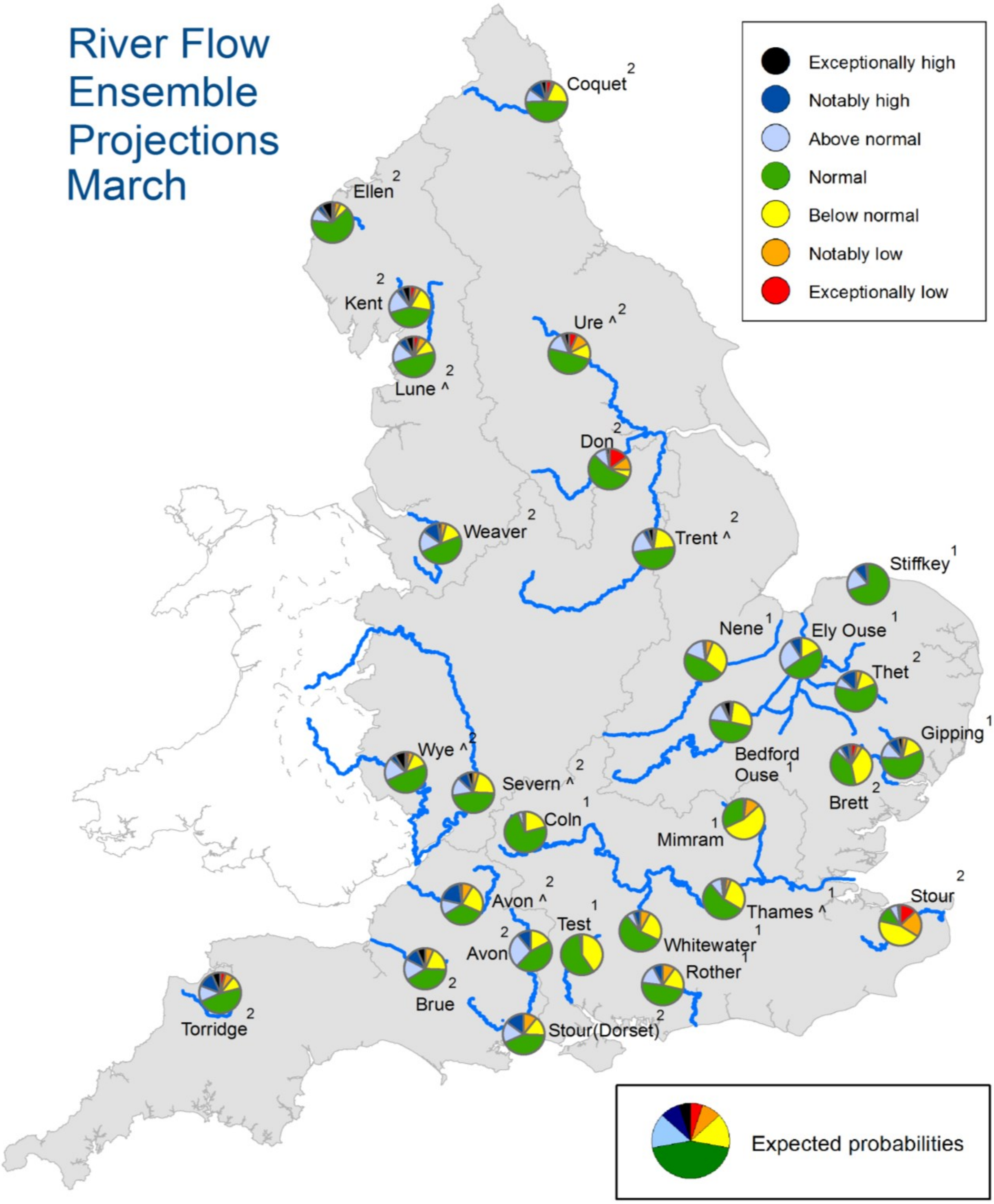
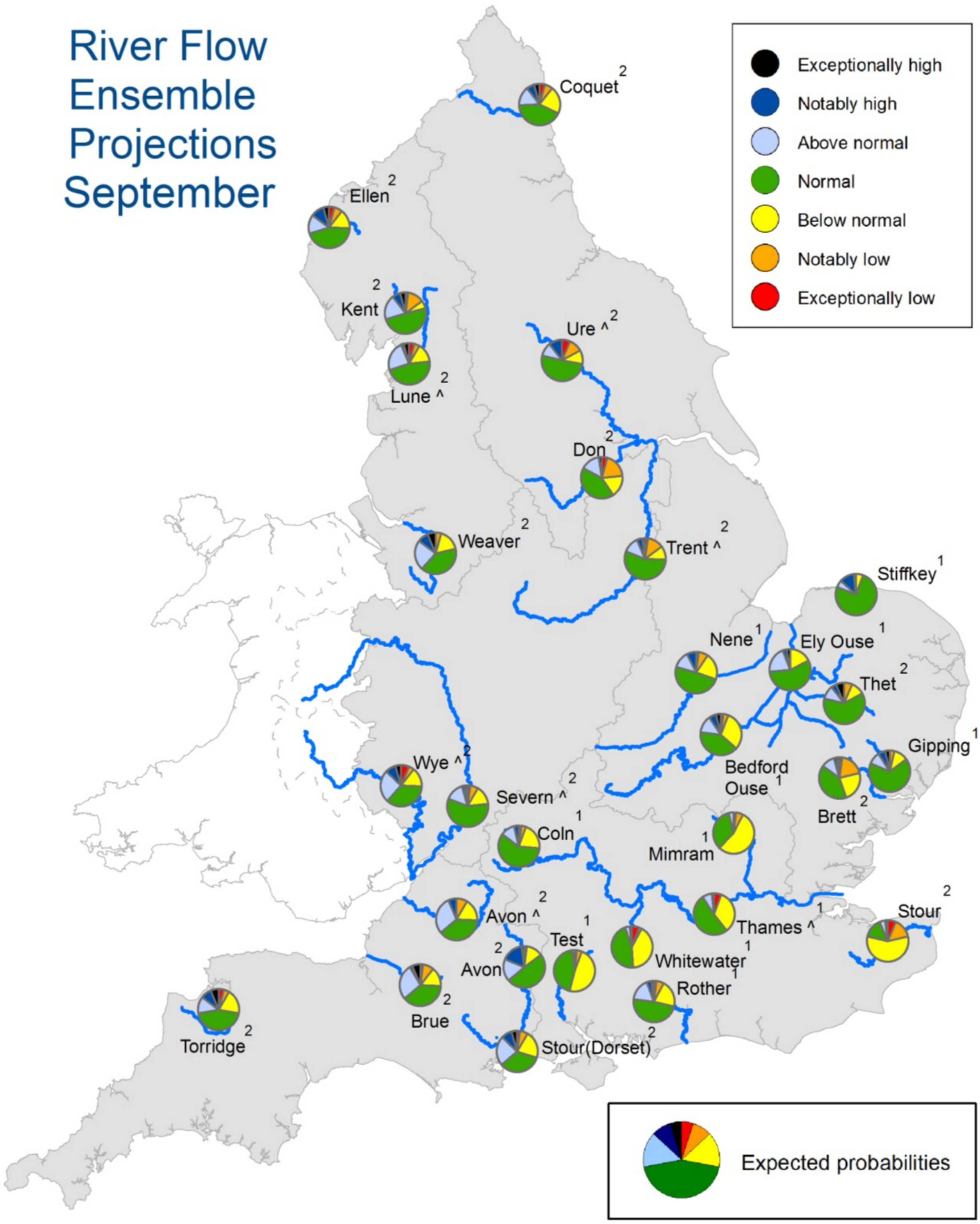


Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are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

[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



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

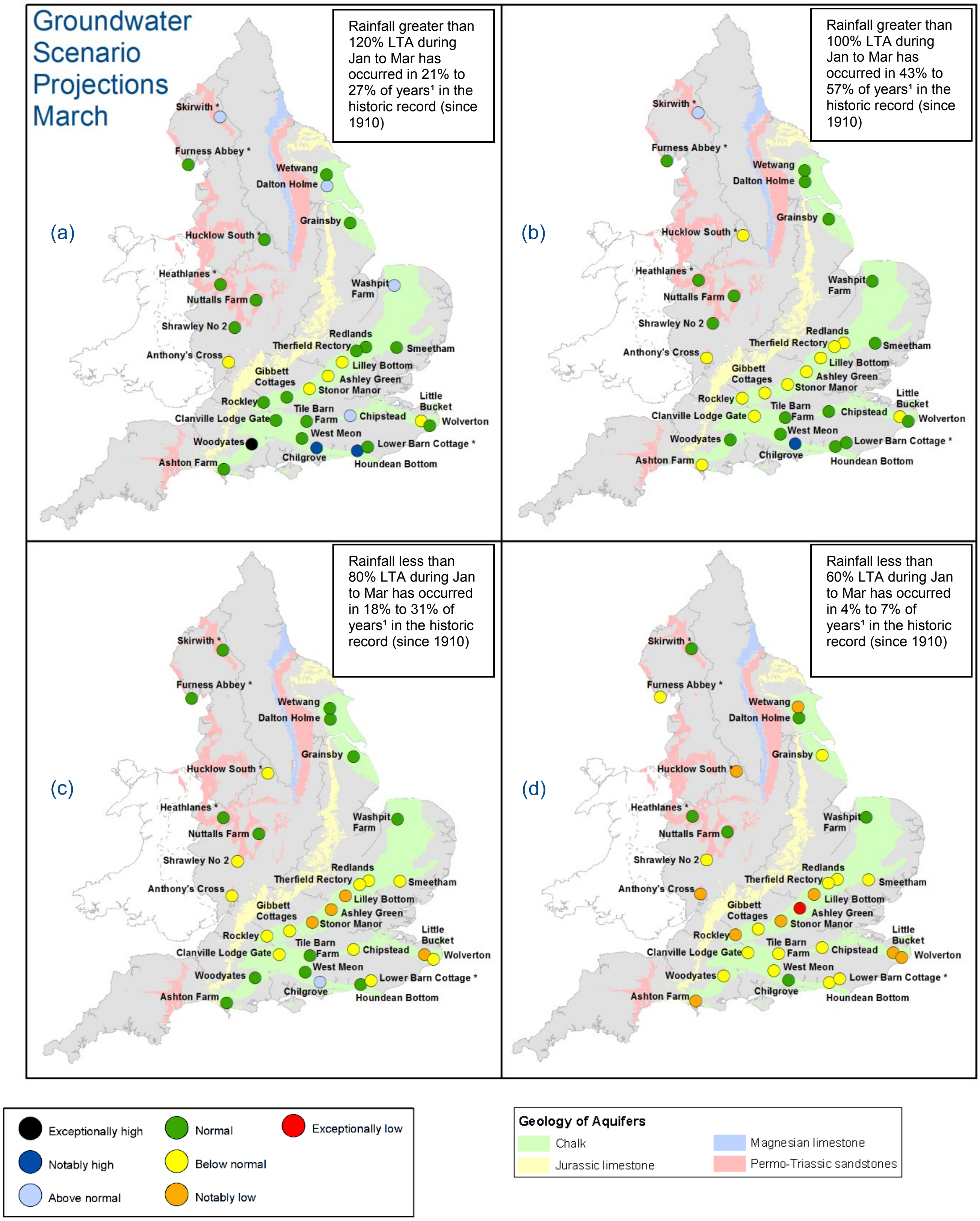


Figure 6.5: Projected groundwater levels at key indicator sites at the end of March 2018. Projections based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between January and March 2018 (Source: Environment Agency). Geological map reproduced with kind permission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

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

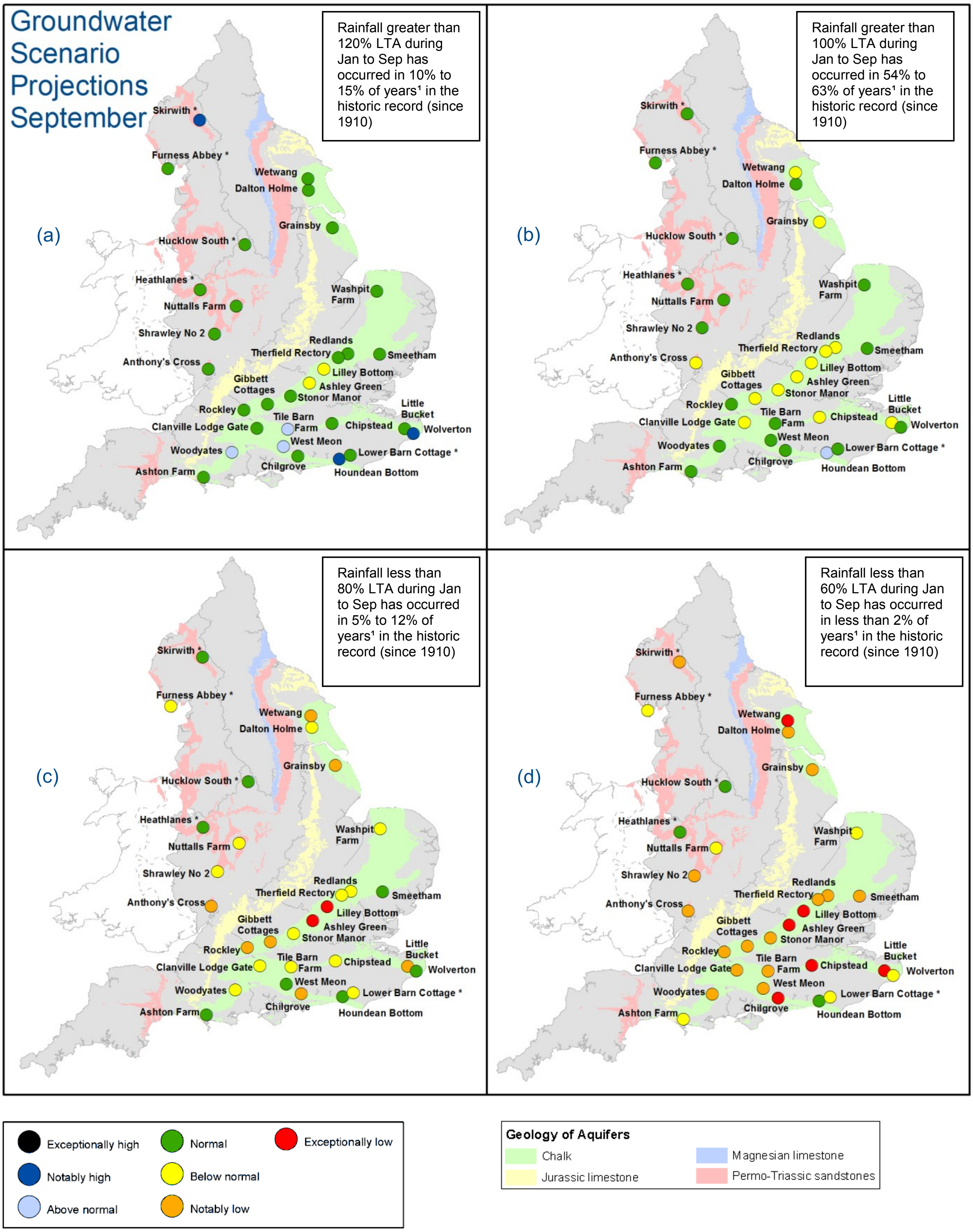
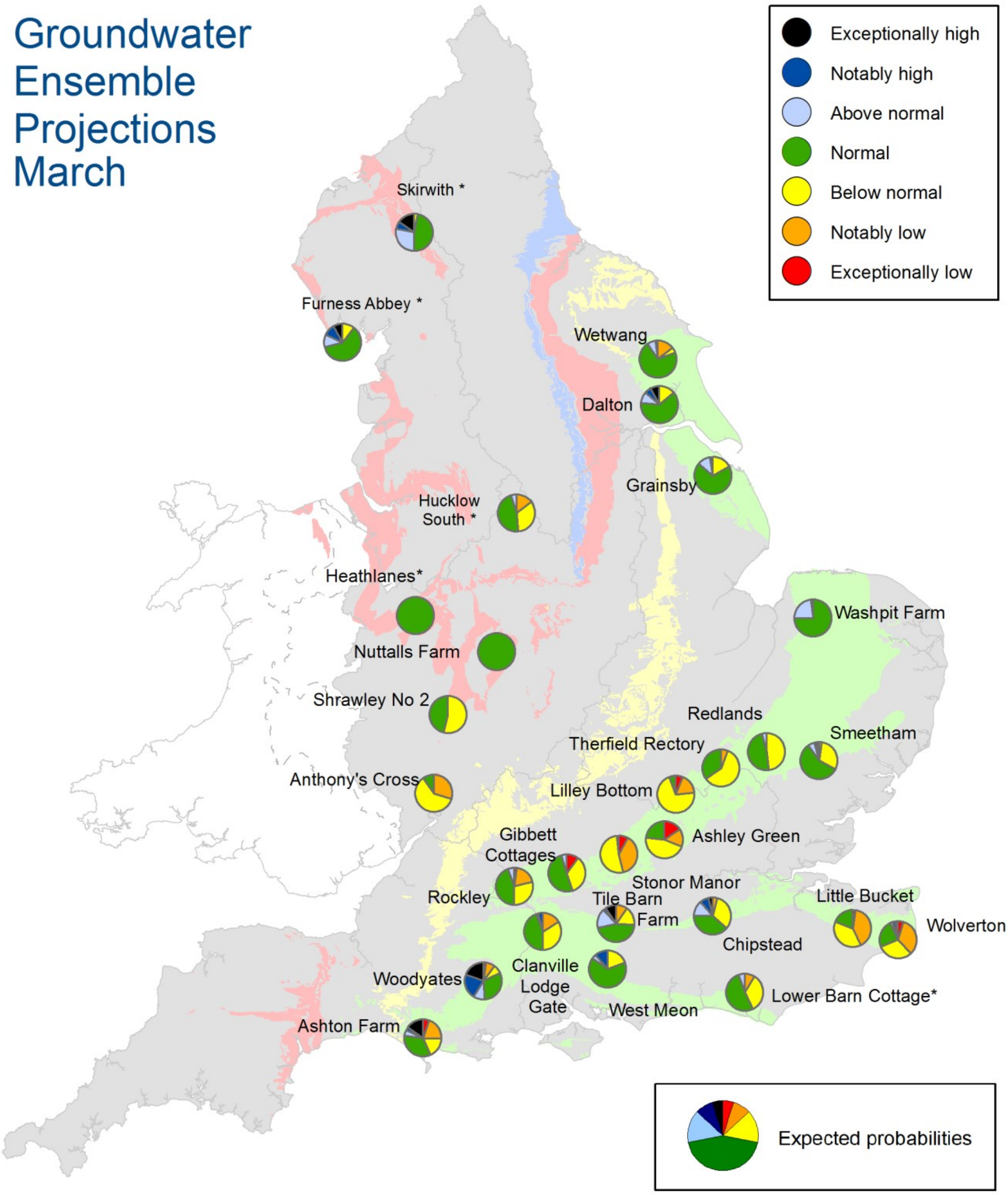


Figure 6.6: Projected groundwater levels at key indicator sites at the end of September 2018. Projections based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between January and September 2018 (Source: Environment Agency). Geological map reproduced with kind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

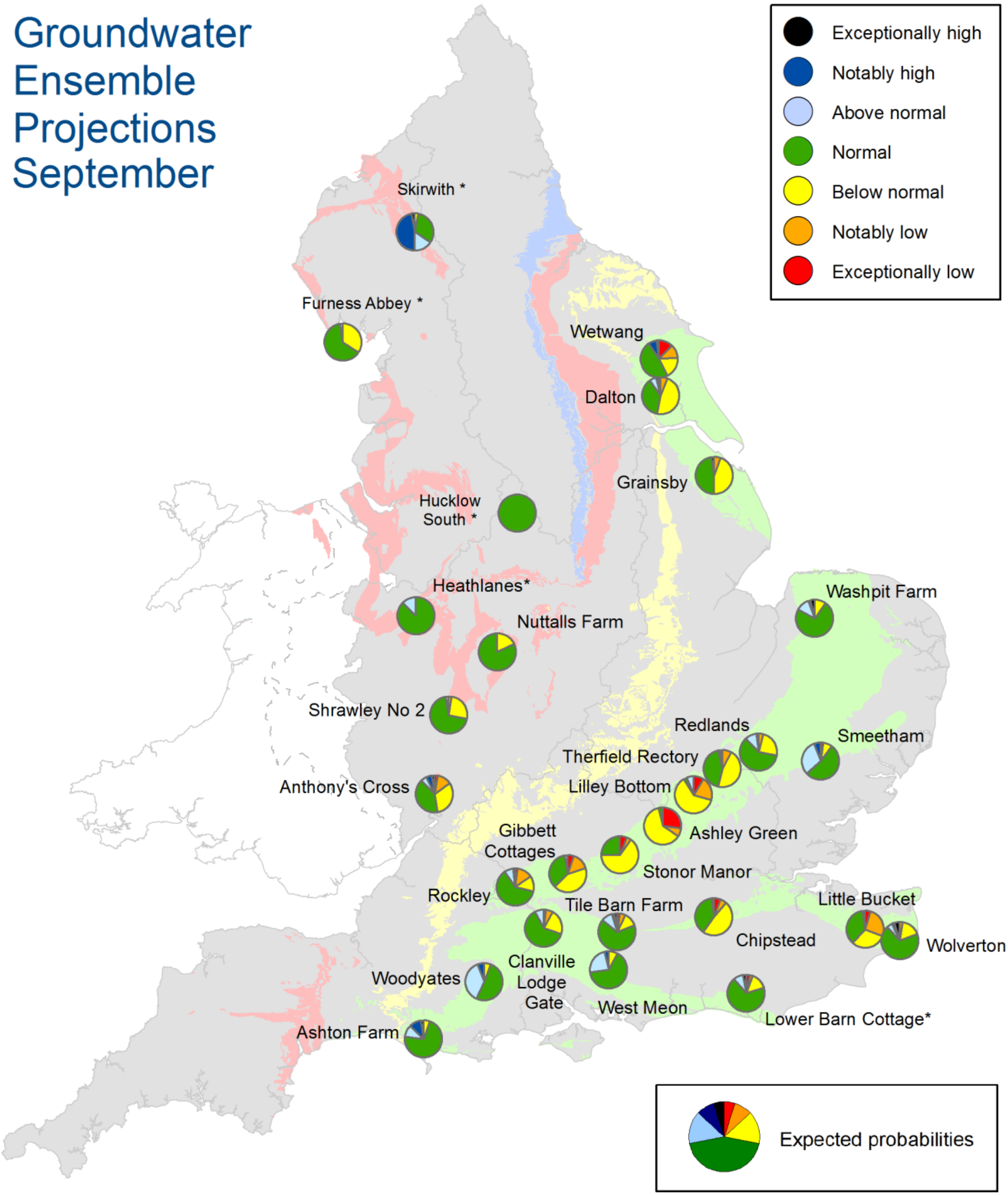
* Projections for these sites are produced by BGS
[1] This range of probabilities is a regional analysis



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, 2018.

* 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, 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