Monthly water situation report

England

Summary – December 2016

December rainfall totals were well below the long term average (LTA) for England at only 44%. Modest soil moisture deficits (SMDs) remain across England, and soils in east and south-east England are slightly drier than average. River flows decreased at the majority of indicator sites and are normal or lower for the time of year across England. Groundwater levels at half of the sites are normal or higher and the remaining sites are below normal or notably low. Reservoir stocks are normal for the time of year at one-third of reported reservoirs. Overall stocks for England increased marginally compared to the end of November and are 81% of total capacity.

Rainfall

December has been dry across much of England, although Storm Barbara brought rain to parts of England between 23 and 26 December, especially in the north of England. Rainfall totals were above 100mm in parts of north-west England and between 50 and 100mm in west and south-west England. Elsewhere, the average rainfall was approximately 25mm (Figure 1.1).

Rainfall totals were below the long term average for December in all hydrological areas, with four-fifths of catchments being below 50% of the December LTA. In all hydrological areas, December rainfall totals were below normal or lower for the time of year across England. For a little over a third of sites, predominantly in the east, south-east and parts of south-west England, monthly totals were exceptionally low for the time of year. The 3-month and 6-month accumulations to December were also exceptionally low for the time of year in many hydrological areas. For the South Essex and the Teign & Torbay hydrological areas, the 6-month accumulations were the driest July to December totals on record since 1910 and a further 12 hydrological areas were the second driest on record (since 1910) (Figure 1.2).

December rainfall totals were below average across all geographic regions of England. Month totals ranged from 26% of the LTA in south-east England to 64% in north-west England. Across England as a whole, monthly rainfall totals were 44% of the December long term average (Figure 1.3)

Soil moisture deficit

Soil moisture deficits (SMDs) for December decreased across much of England compared to November. At the end of the month, SMDs were less than 10mm across more than half of England. For east and south-east England, end of month values were predominantly between 10 and 40mm. End of month SMDs were close to the long term average (LTA) across much of England, although soils were slightly drier than average in parts of south-east and east England (Figure 2.1). At a regional scale, SMDs at the end of December were smaller than at the end of November, with end of month values of between 3mm (north-west England) and 9mm (east England) (Figure 2.2).

River flows

Monthly mean flows for December decreased at the majority of indicator sites across England compared with November. All sites are classed as normal or lower for the time of year, with almost two-thirds of sites being below normal or notably low and just over a quarter of sites being exceptionally low for the time of year. Four sites in south-east England (the River Ouse at Goldbridge, River Medway at Teston and Farleigh, River Great Stour at Horton, Rother at Udiam) and one in south-west England (Tone at Bishops Hull) have the lowest December monthly mean flow on record (Figure 3.1). Monthly mean river flows were below normal or lower for the time of year at all of the regional index sites (Figure 3.2).

Groundwater levels

At the end of December, groundwater levels had continued to decline at half of the indicator sites compared to the end of November. Levels increased at all indicator sites in central and north-west England.

End of month groundwater levels were normal or higher for the time of year at half of the sites, with the other half ranging from below normal to notably low (Figure 4.1). Levels at all indicator sites in south-west England and all but 2 sites in south-east England were below normal or lower. End of month groundwater levels at the major aquifer index sites ranged from notably low at Chilgrove (Chichester chalk aquifer) and Jackaments Bottom (Jurassic limestone aquifer) to above normal for the time of year at Heathlanes (Shropshire Middle Severn sandstone aquifer) (Figure 4.2).

Reservoir storage

During December, reservoir stocks increased and decreased in roughly equal proportions with a small number remaining unchanged. Grafham reservoir in east England experienced the largest decrease of 9% and Farmoor reservoir in south-east England experienced the largest increase of 9%. End of month stocks were classed as normal for the time of year at one third of reservoirs and reservoir groups, with the remaining two-thirds of sites being below normal or lower (Figure 5.1).

At a regional scale reservoir stocks decreased slightly in east and central England, remained unchanged in south-west England, but increased elsewhere by between 2 and 4%. At the end of December, stocks ranged from 63% of total capacity in south-west England to 86% in north-east and central England. Overall storage for England increased marginally to 81% of total capacity (Figure 5.2)

Forward look

Weather conditions in January are expected to be mixed, with colder settled periods interspersed with milder wetter weather. Over both January and the 3 month period January to March, there is broadly equal likelihood of below average and above average precipitation[1].

Projections for river flows at key sites[2]

There is a greater than expected chance of cumulative river flows being below normal or lower at more than four-fifths of the modelled sites at the end of both March and September 2017.

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

Projections for groundwater levels in key aquifers[2]

At the end of March 2017, just over two-thirds of modelled sites have a greater than expected chance of below normal or lower groundwater levels for the time of year. At the end of September 2017, just over a third of the modelled sites have a greater than expected chance of normal or higher groundwater levels for the time of year.

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

Authors: E&B 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

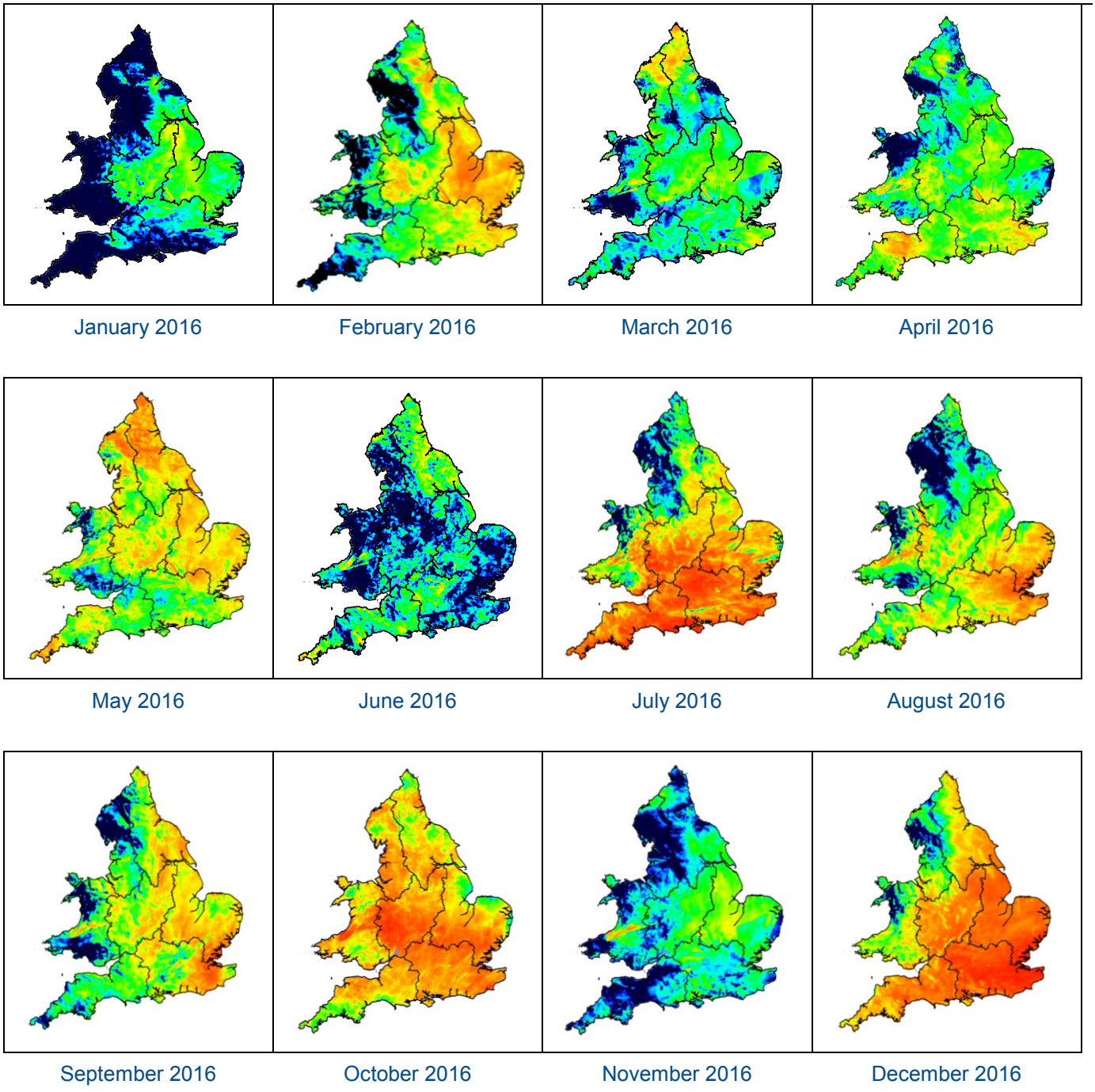


Figure 1.1: Monthly rainfall across England and Wales for the past 12 months. UKPP radar data (Source: Met Office © Crown Copyright, 2017). Note: Radar beam blockages in some regions may give anomalous totals in some areas. Crown copyright. All rights reserved. Environment Agency, 100026380, 2017.

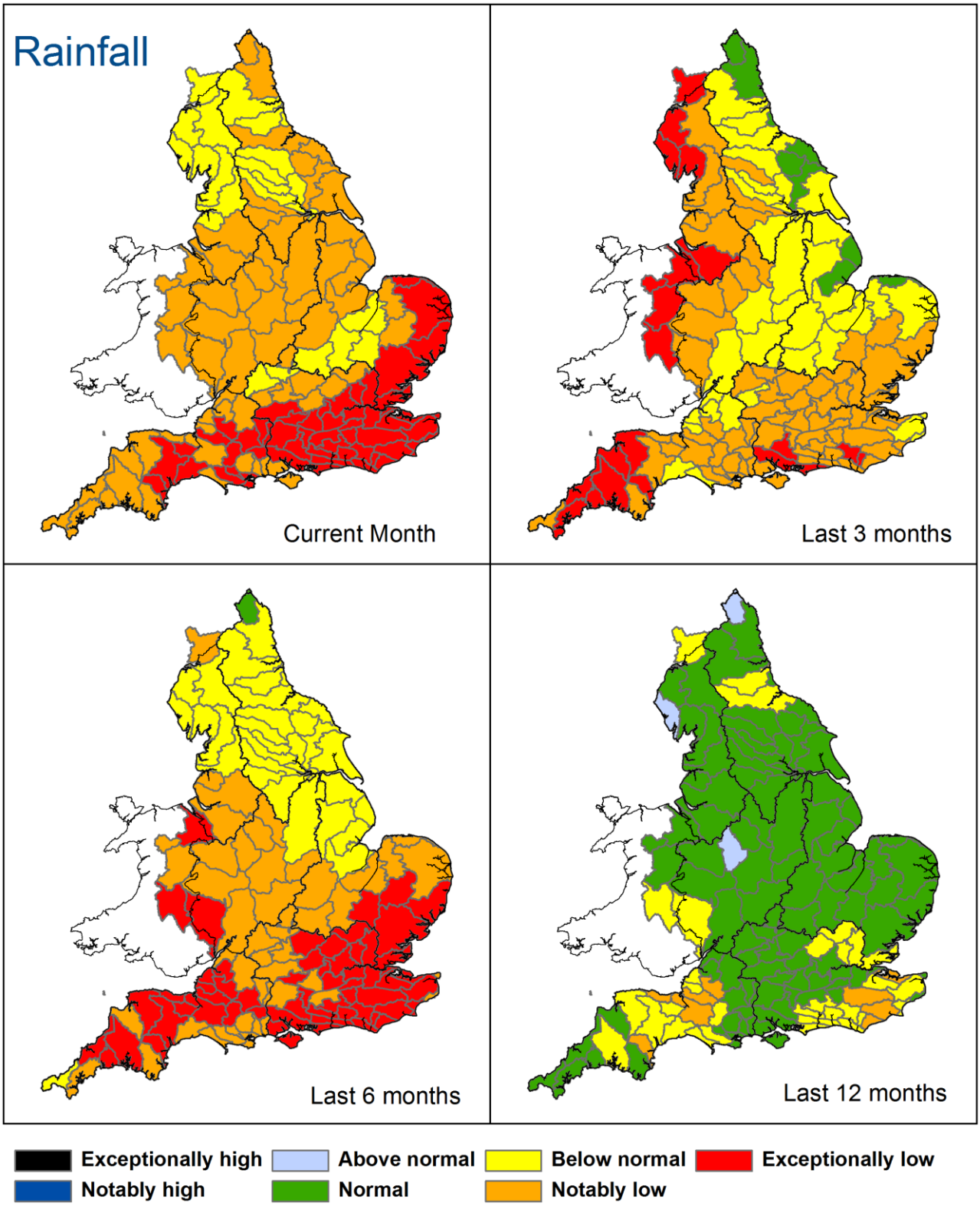


Figure 1.2: Total rainfall for hydrological areas across England for the current month (up to 31 December), the last 3 months, the last 6 months, and the last 12 months, classed relative to an analysis of respective historic totals. Final NCIC (National Climate Information Centre) data based on the Met Office 5km gridded rainfall dataset derived from rain gauges *(Source: Met Office © Crown Copyright, 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

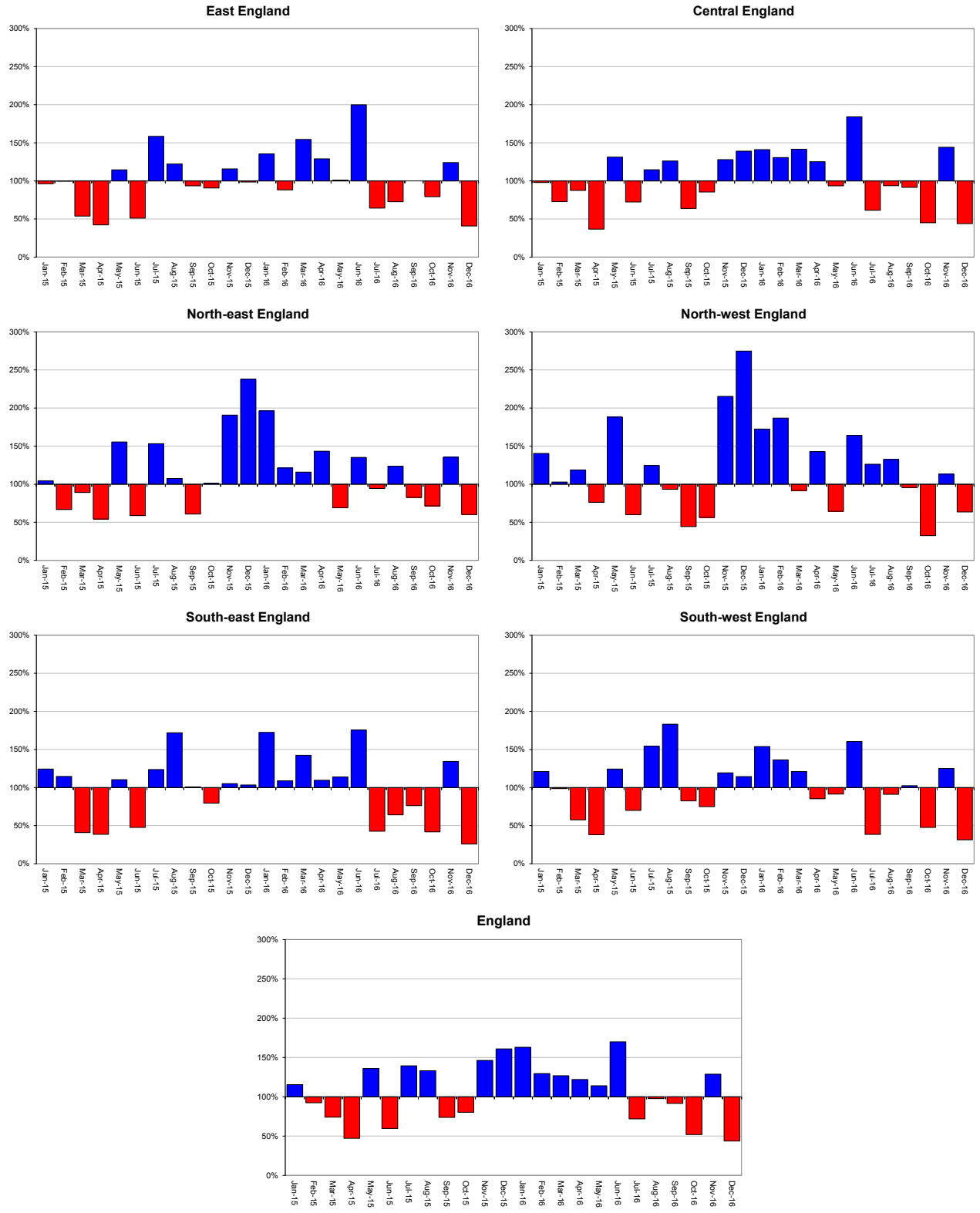


Figure 1.3: Monthly rainfall totals for the past 24 months as a percentage of the 1961 – 1990 long term average for each region and for England. NCIC (National Climate Information Centre) data. (Source: Met Office © Crown Copyright, 2017).

Soil moisture deficit

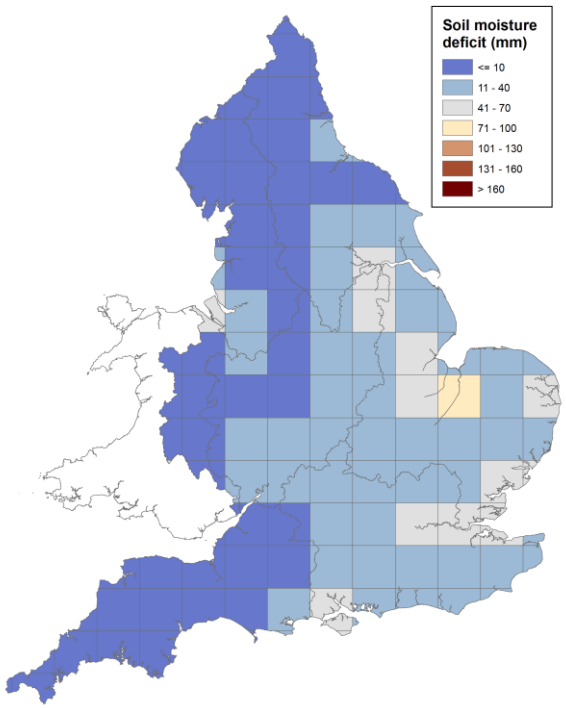
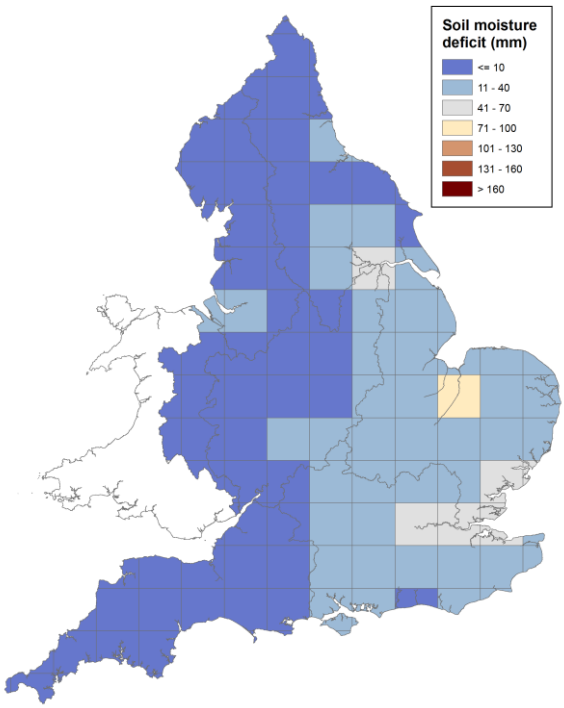
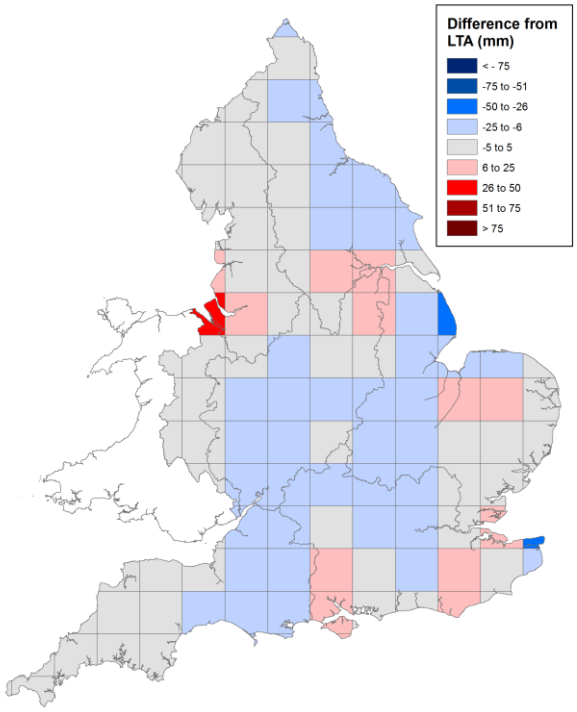
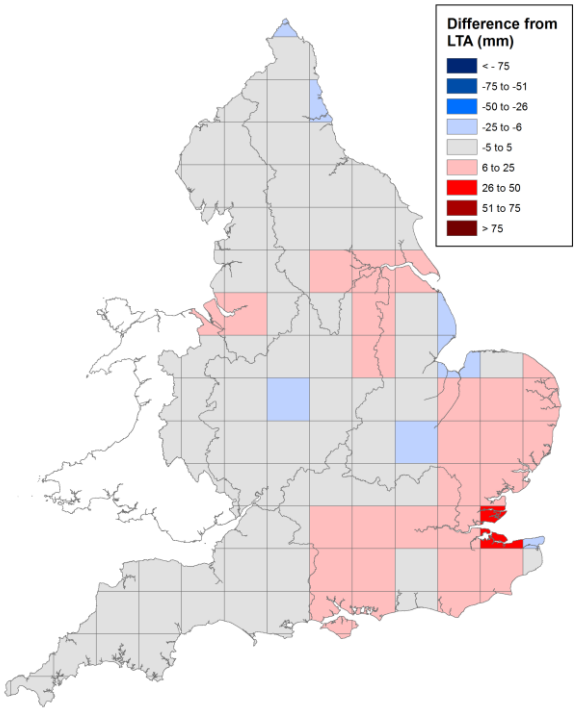
End of November 2016[1]	End of December 2016[2]
	
	

Figure 2.1: Soil moisture deficits for weeks ending 29 November 2016 [1] (left panel) and 27 December 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, 2017). Crown copyright. All rights reserved. Environment Agency, 100026380, 2017

Soil moisture deficit charts

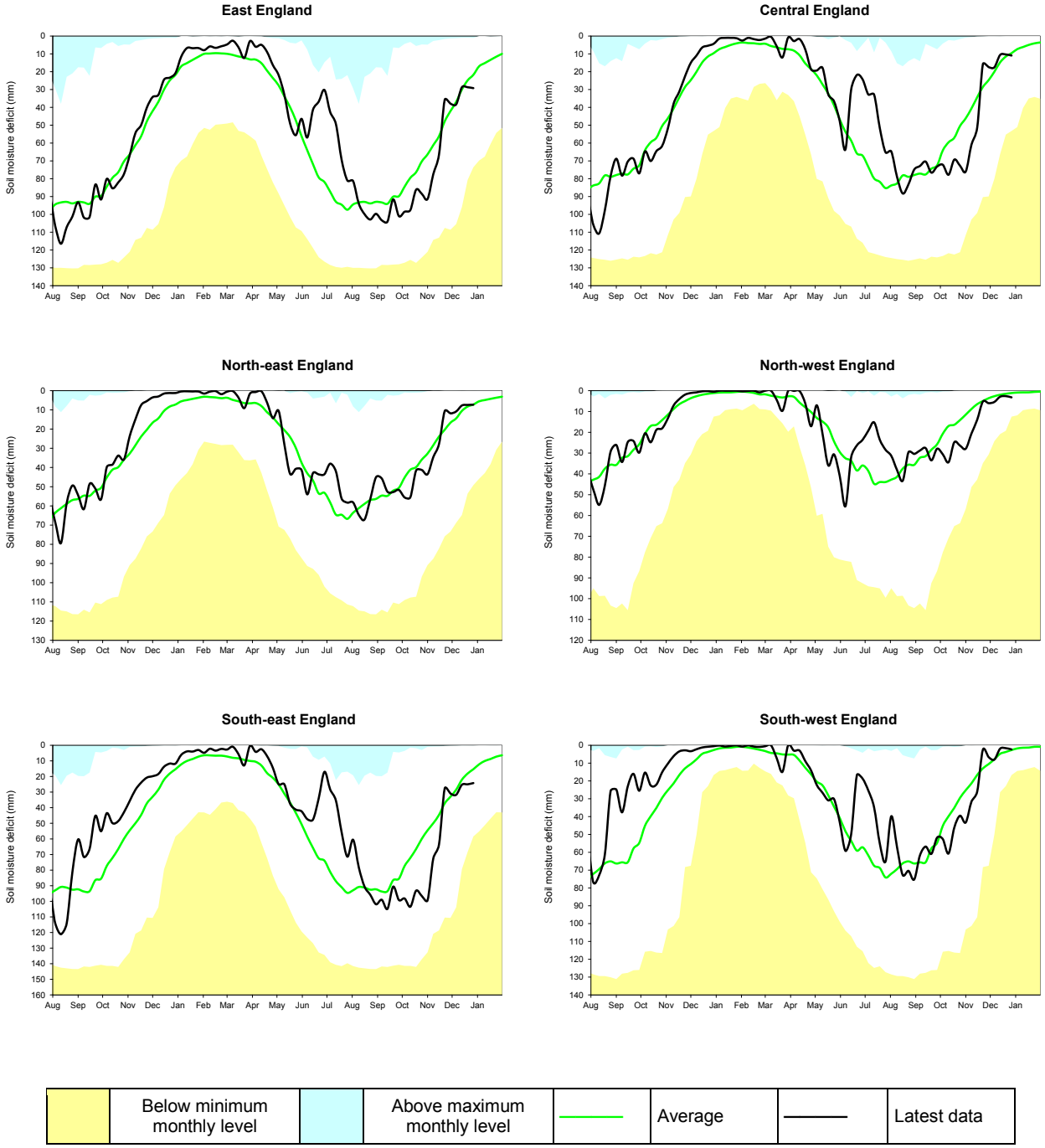
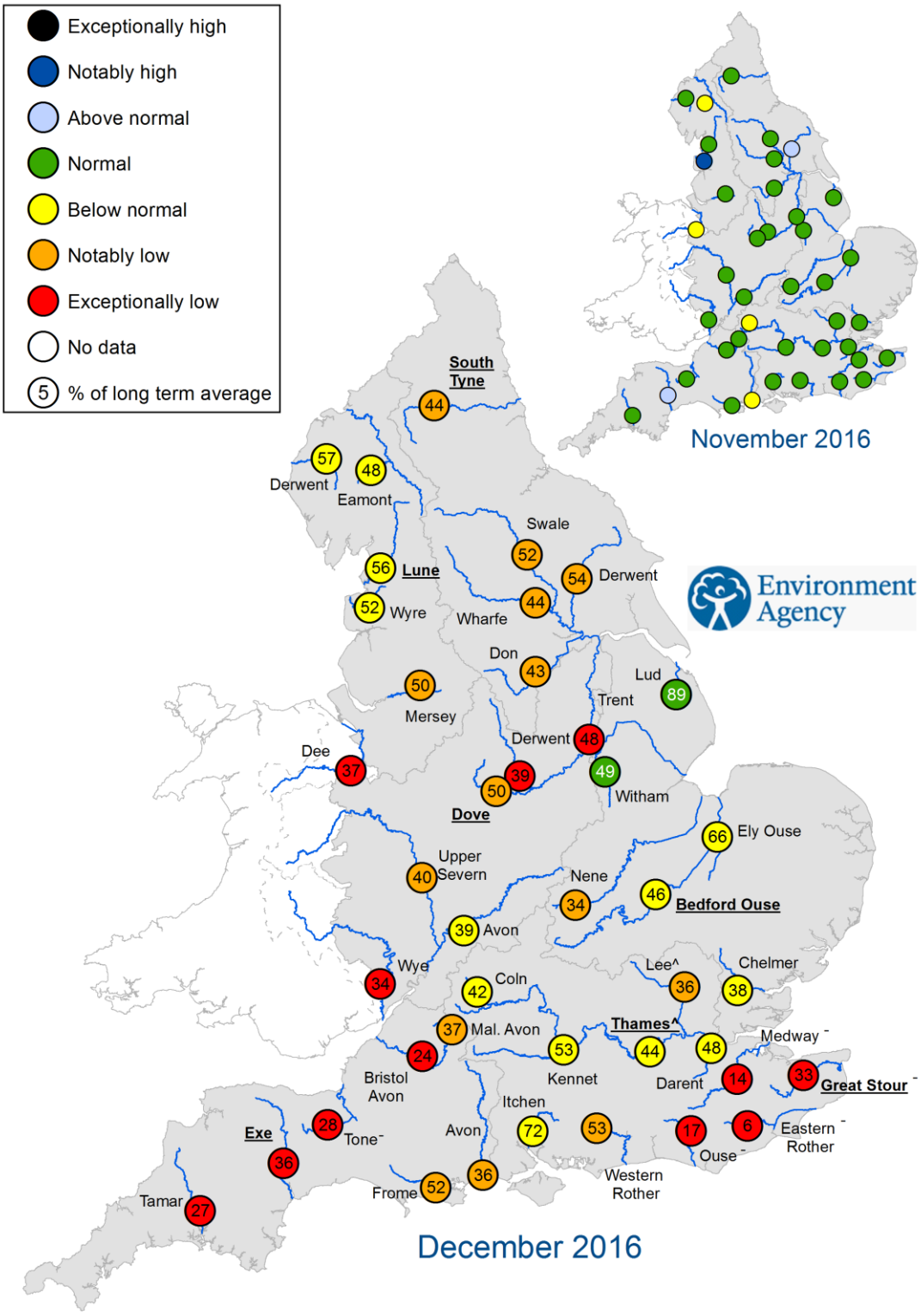


Figure 2.2: Latest soil moisture deficits for all geographic regions compared to maximum, minimum and 1961-90 long term average. Weekly MORECS data for real land use. (Source: Met Office © Crown Copyright, 2017).

River flows



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

\- Monthly mean flow is the 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 November 2016 and December 2016, 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). Crown copyright. All rights reserved. Environment Agency, 100026380, 2017.

River flow charts

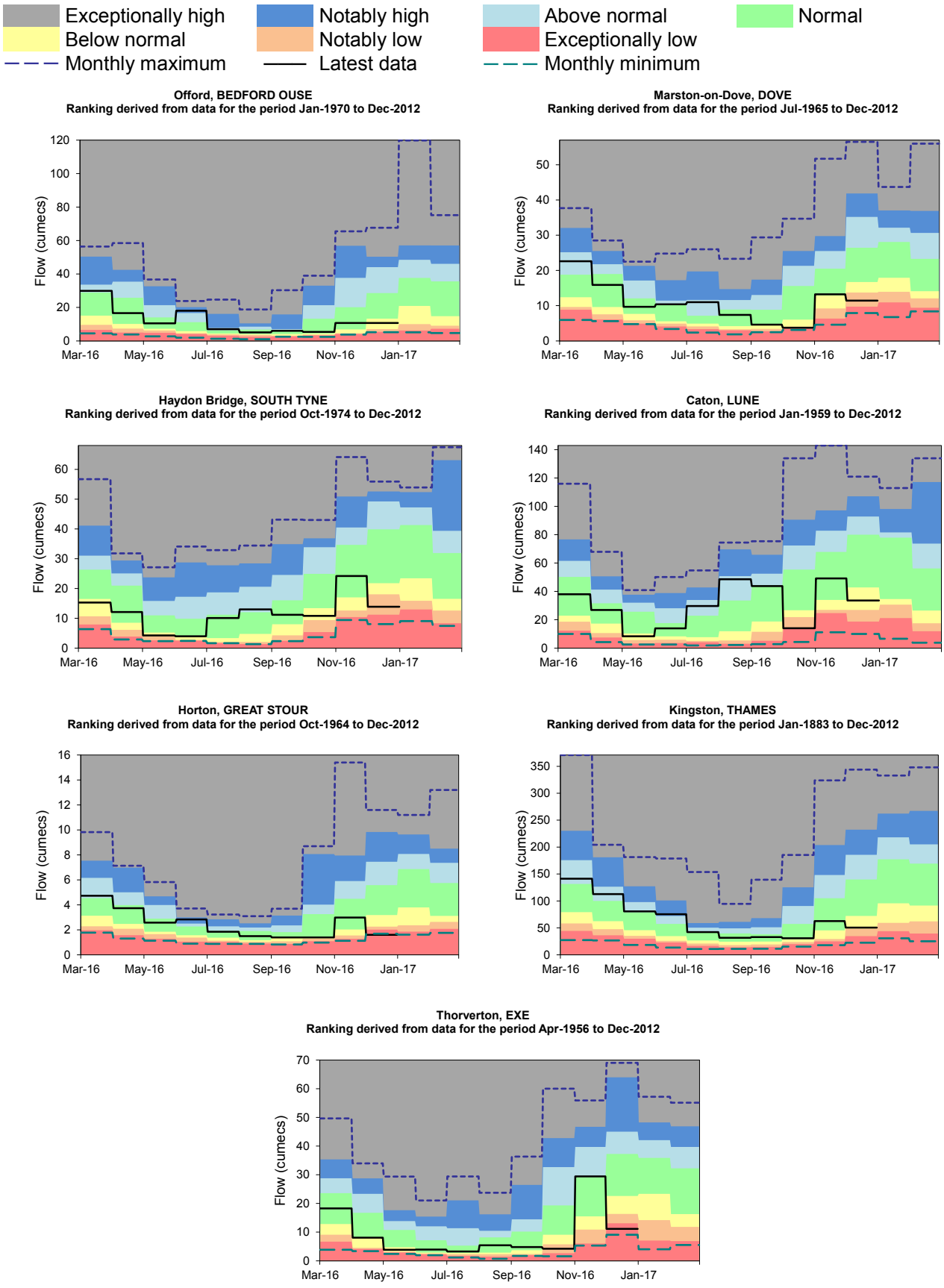
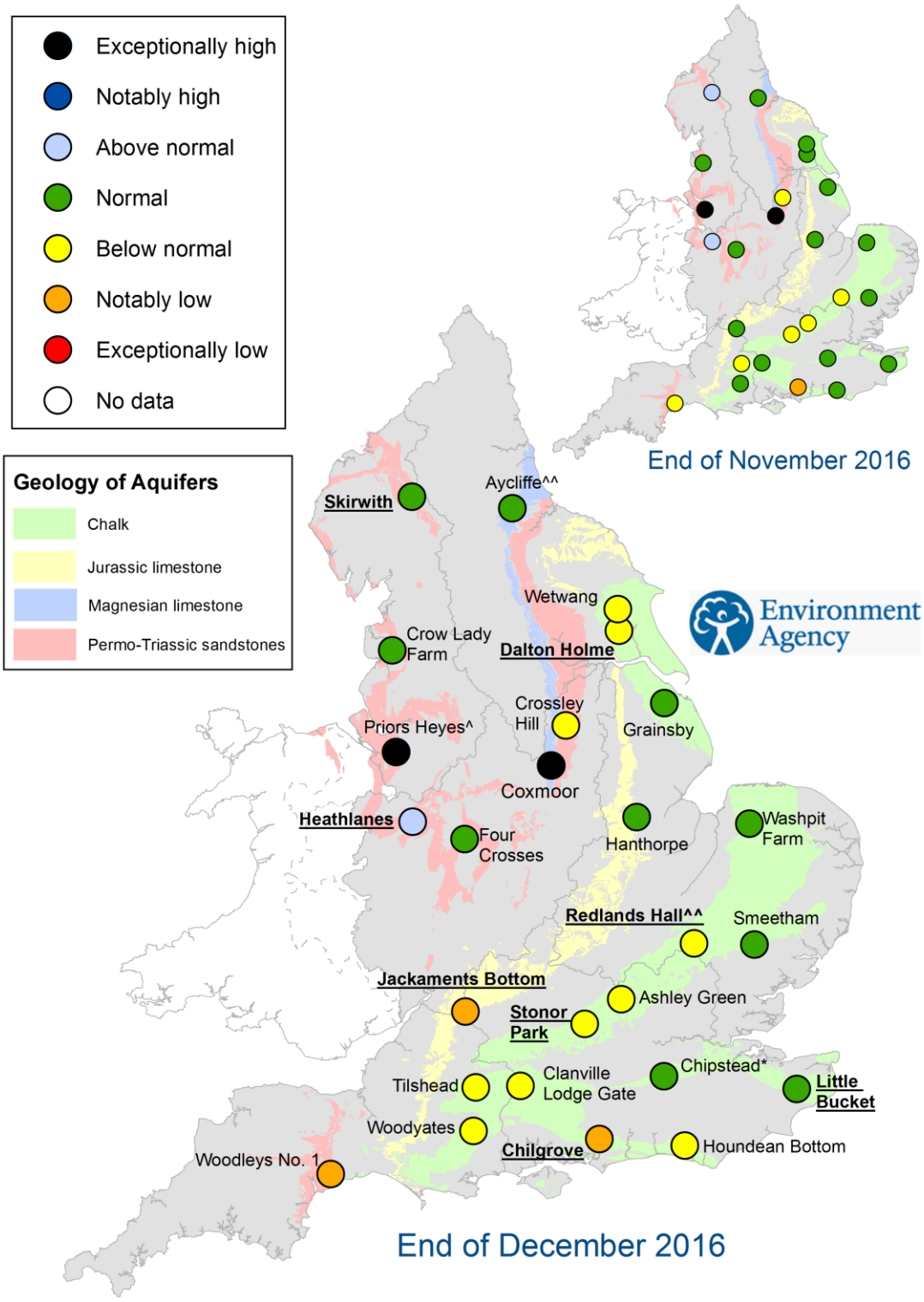


Figure 3.2: Index river flow sites for each geographic region. Monthly mean flow compared to an analysis of historic monthly mean flows, long term maximum and minimum flows. (Source: Environment Agency).

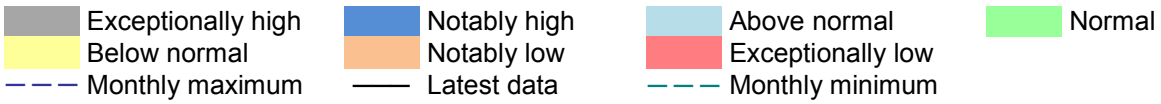
Groundwater levels



^ 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
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 November 2016 and December 2016, 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, 2017.

Groundwater level charts



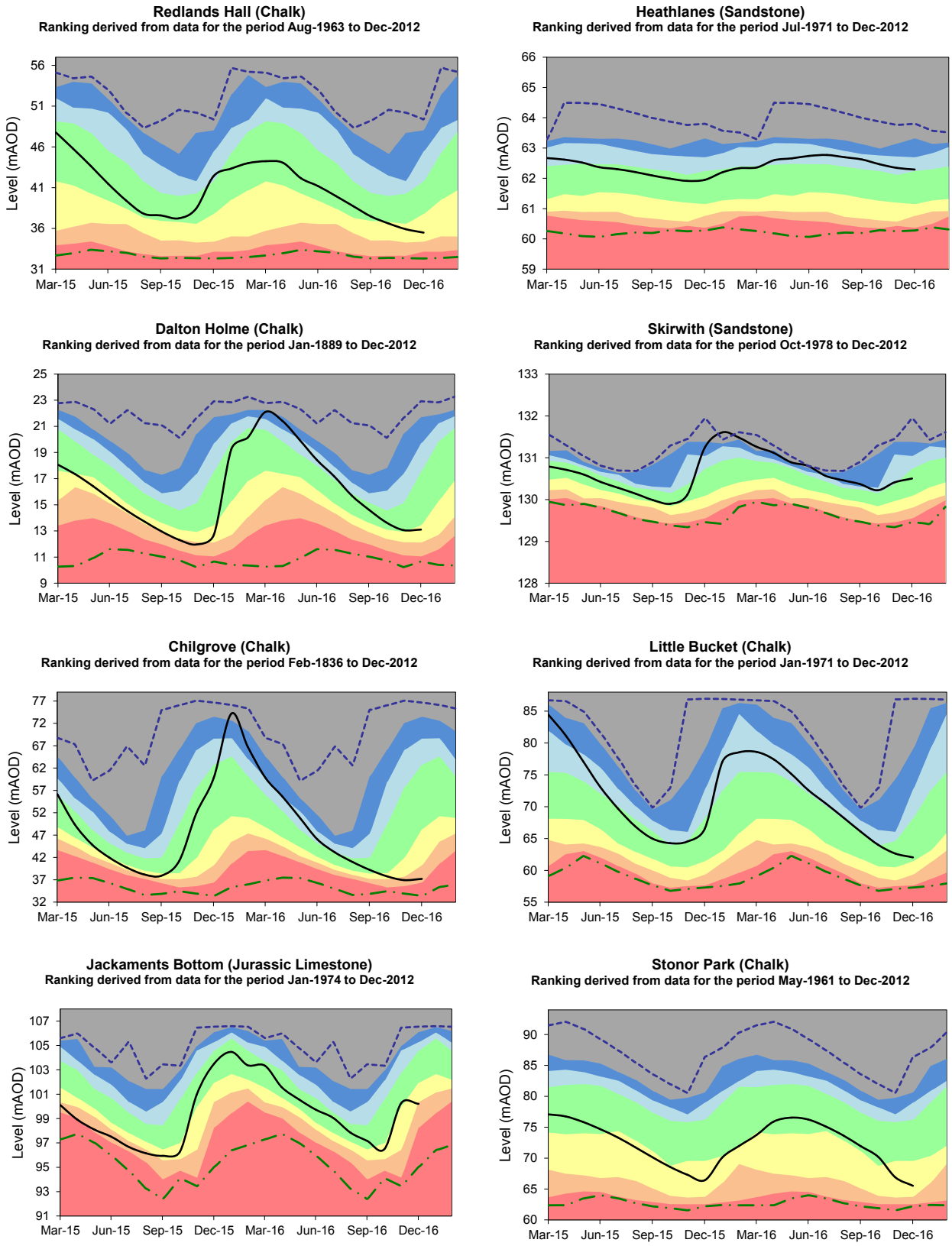
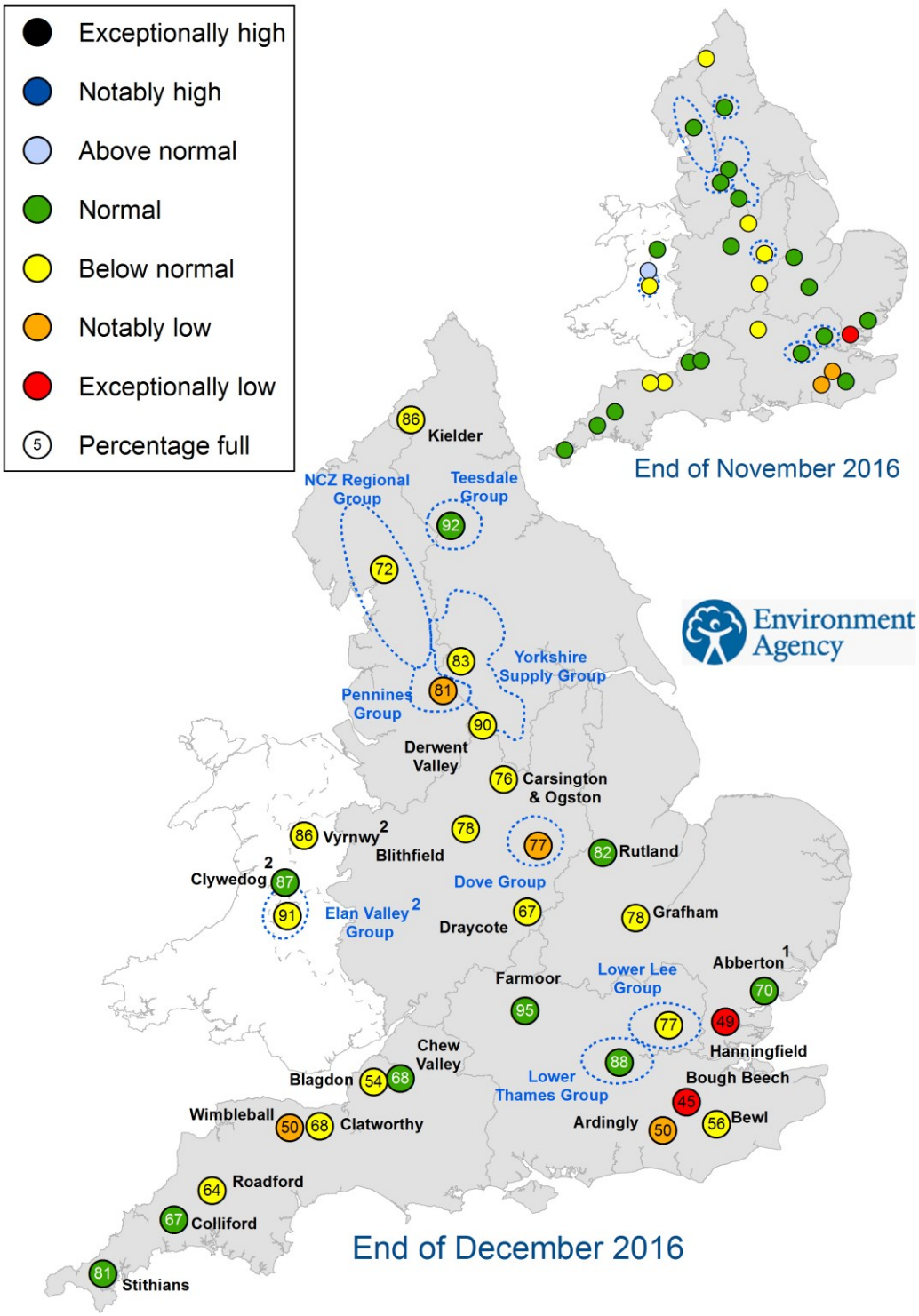


Figure 4.2: Index groundwater level sites for major aquifers. End of month groundwater levels months compared to an analysis of historic end of month levels and long term maximum and minimum levels. (Source: Environment Agency, 2017).

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

Figure 5.1: Reservoir stocks at key individual and groups of reservoirs at the end of November 2016 and December 2016 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, 2017.

Reservoir storage charts

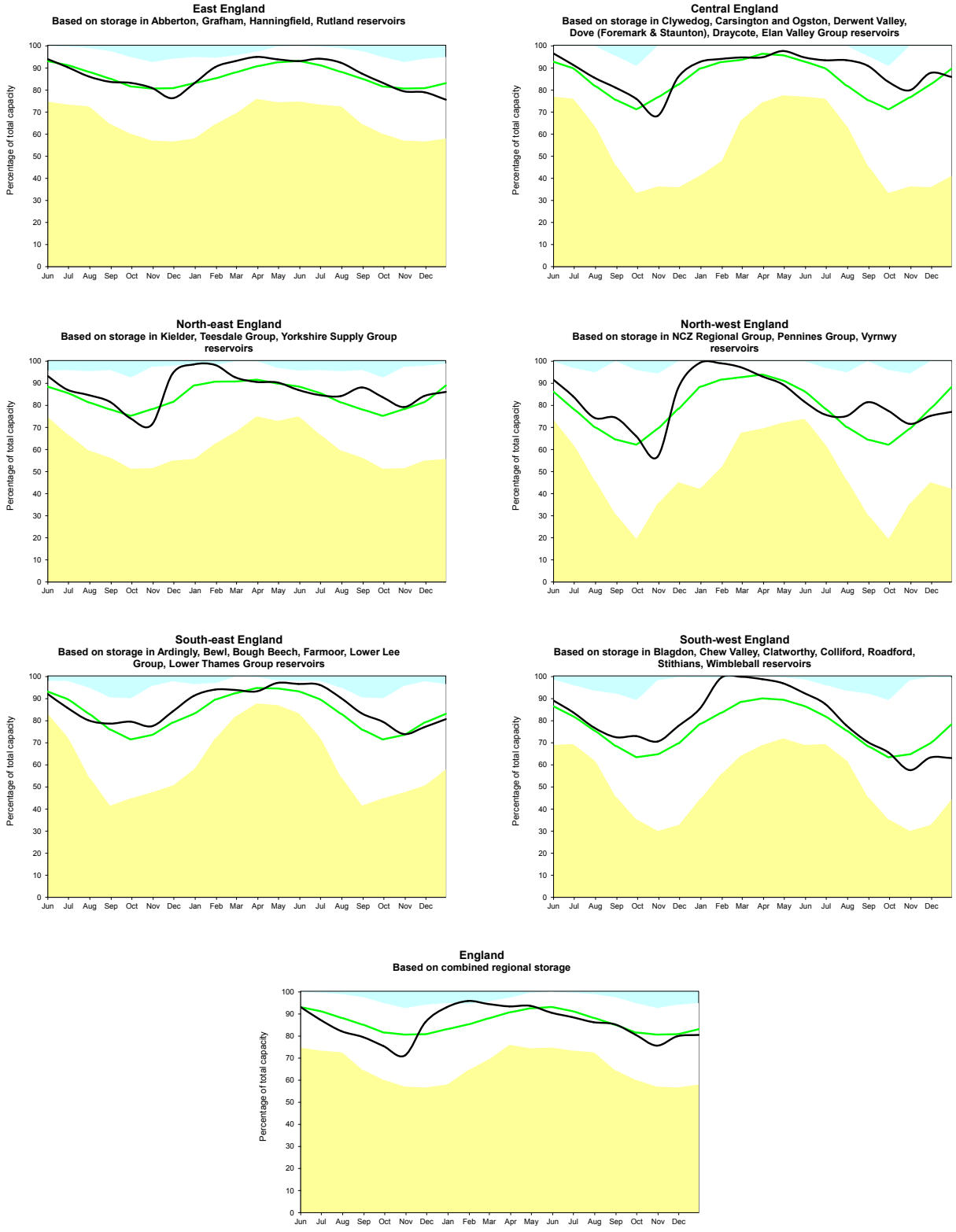


Figure 5.2: Regional reservoir stocks. End of month reservoir stocks compared to long term maximum, minimum and average stocks (Source: Water Companies). Note: Historic records of individual reservoirs/reservoir groups making up the regional values vary in length.

Forward look – river flow

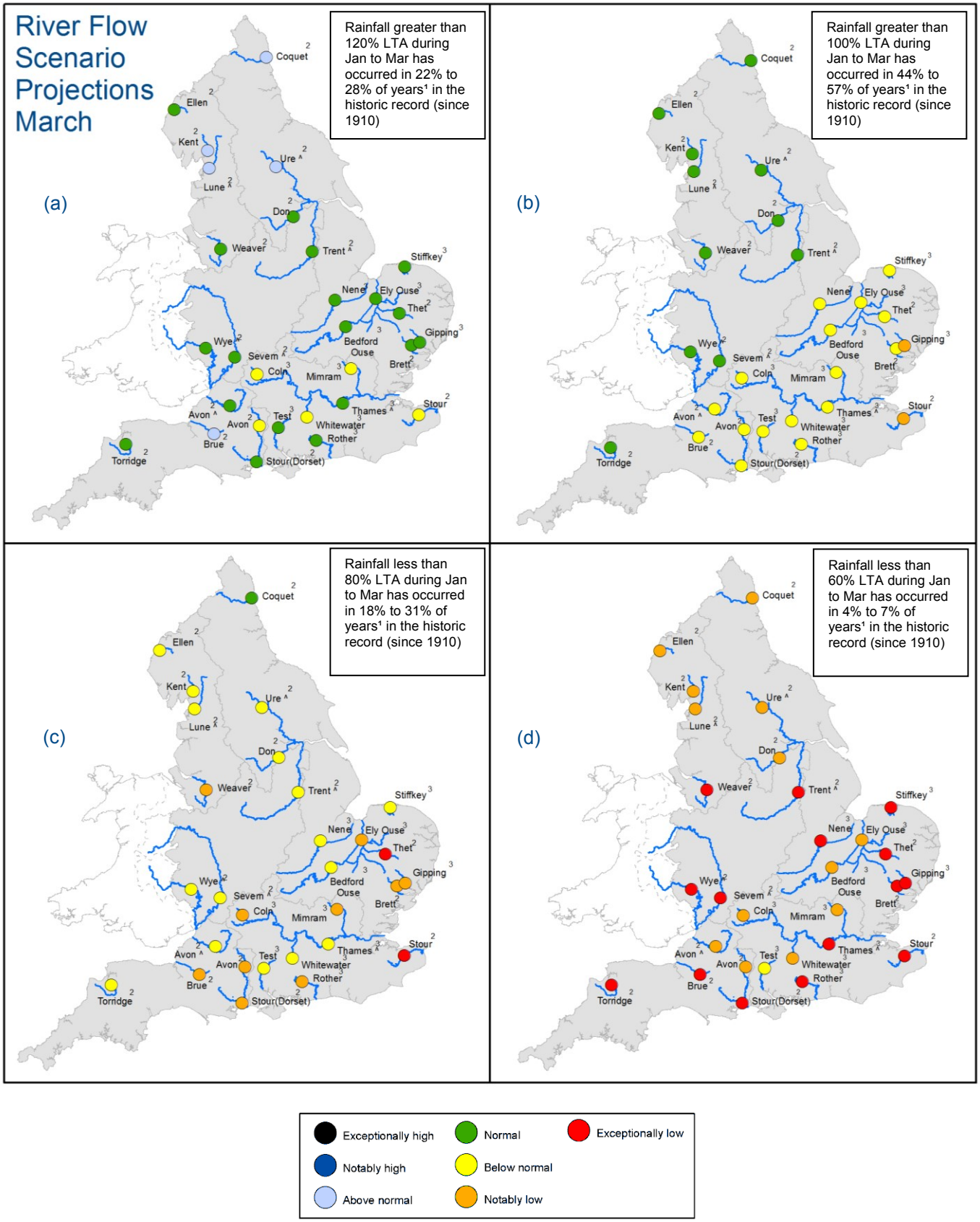
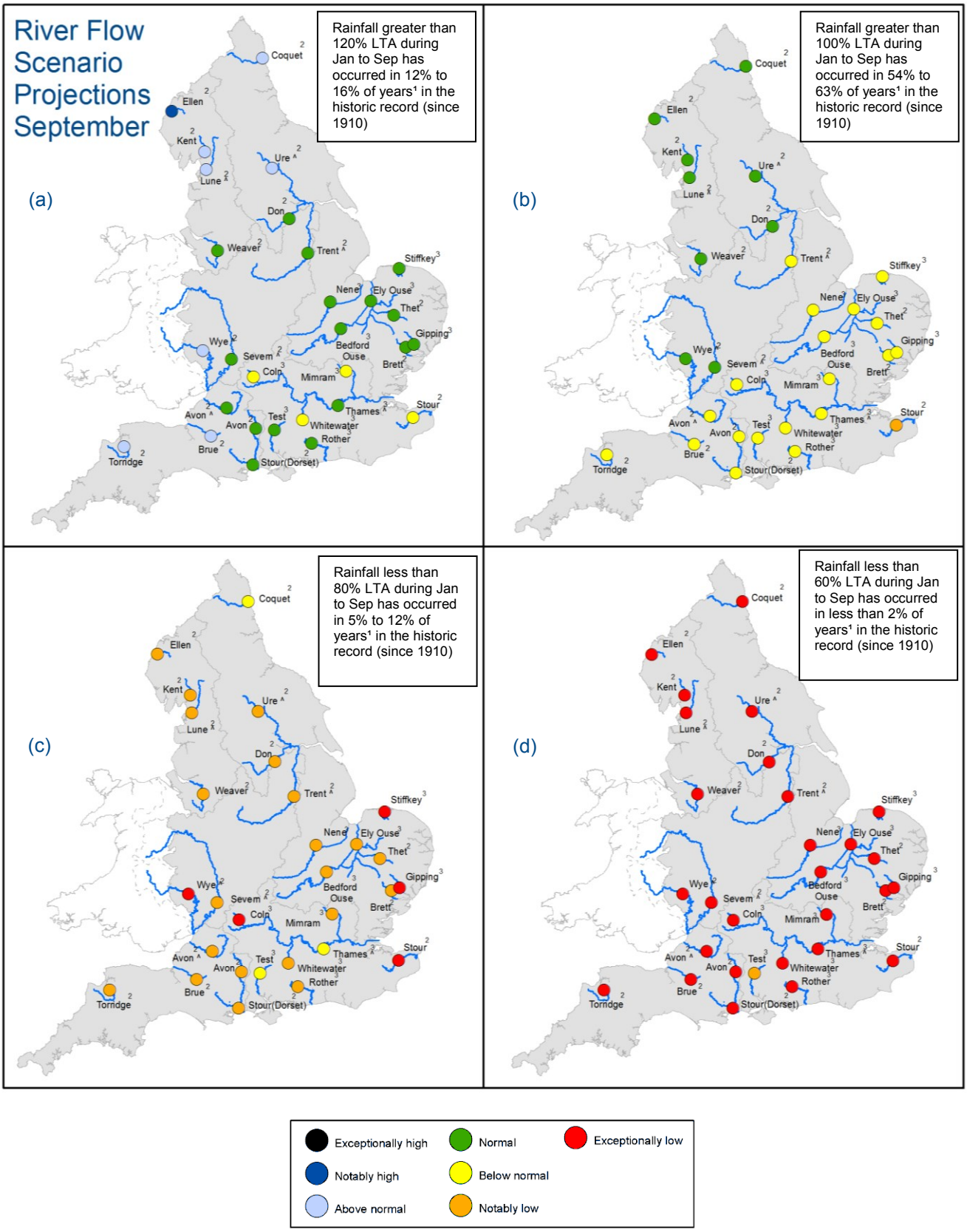


Figure 6.1: Projected river flows at key indicator sites up until the end of March 2017. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between January and March 2017 (Source: Centre for Ecology and Hydrology, Environment Agency).

[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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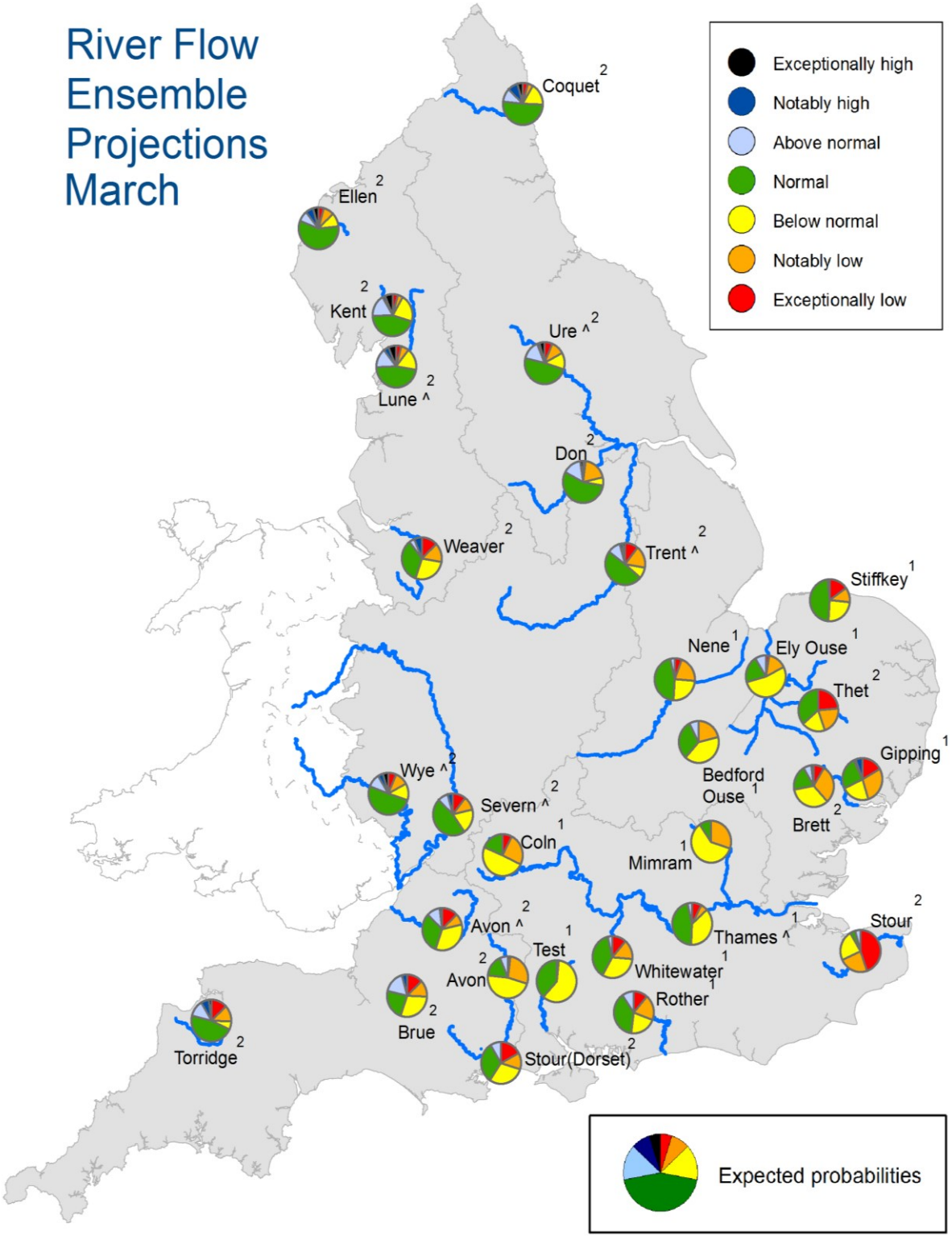

Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are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

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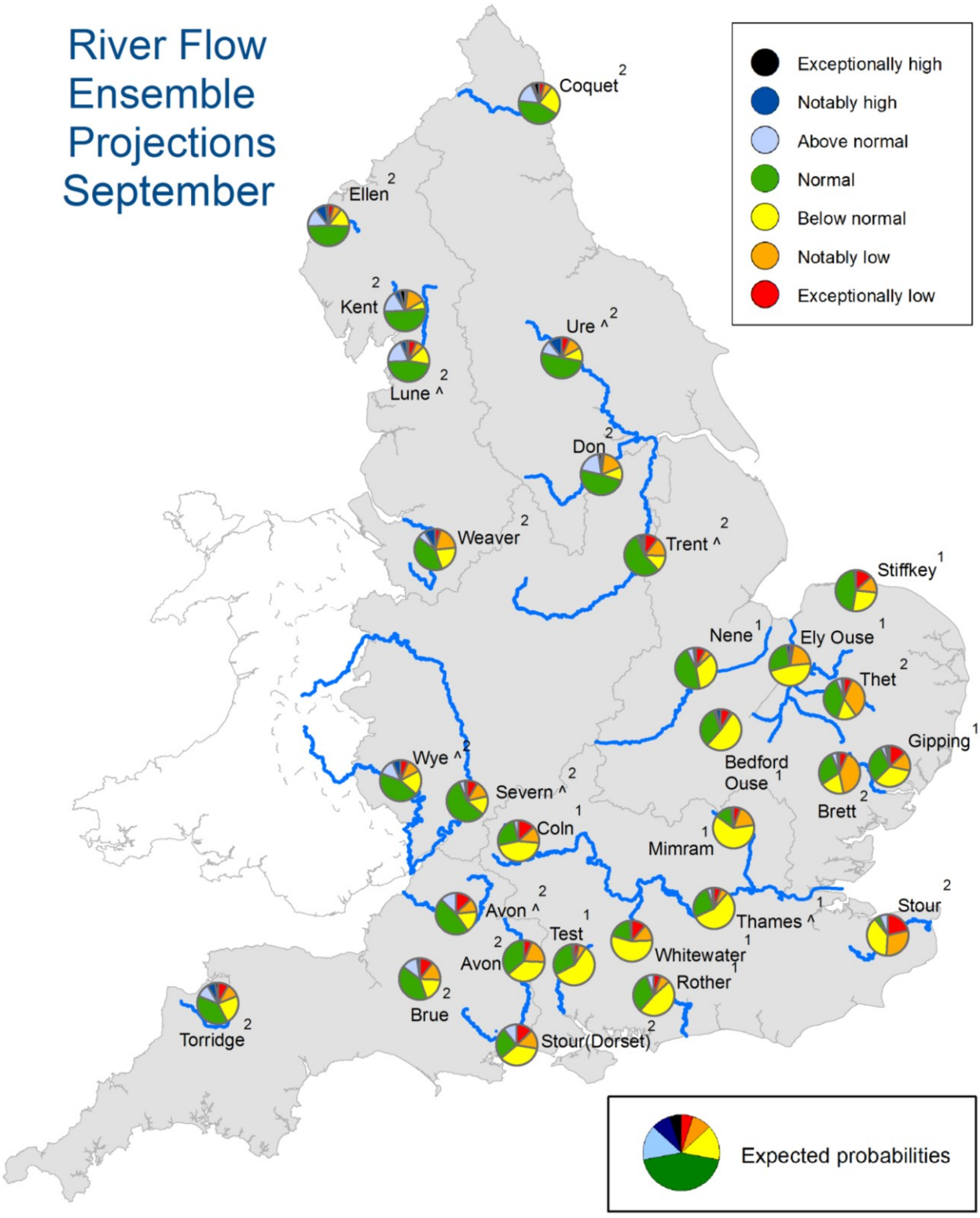

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Figure 6.4: Probabilistic ensemble projections of river flows at key indicator sites up until the end of September 2017. Pie charts indicate probability, based on climatology, of the surface water flow at each site being e.g. exceptionally low for 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

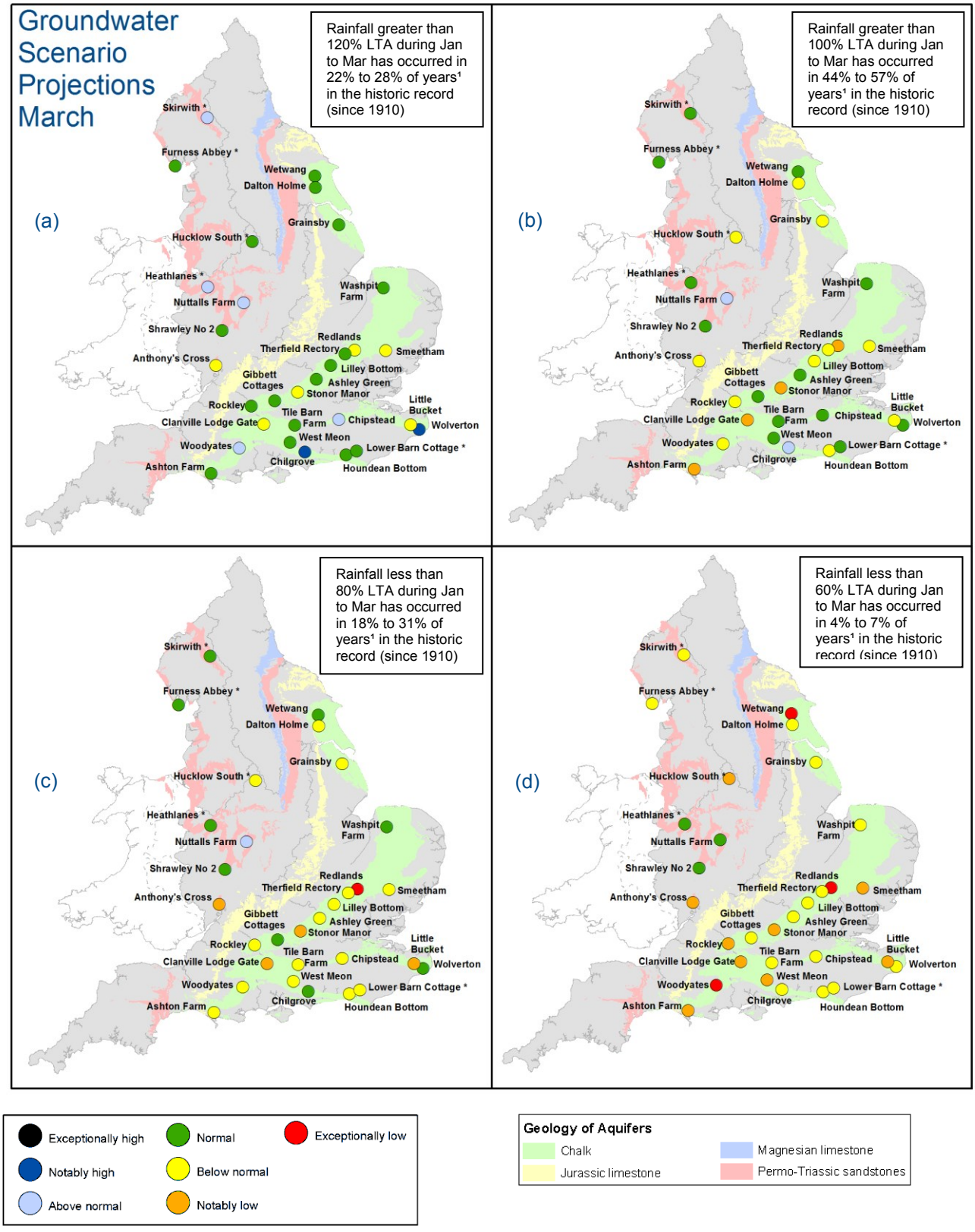

Figure 6.5: Projected groundwater levels at key indicator sites at the end of March 2017. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between January and March 2017 (Source: Environment Agency) Geological map reproduced with kind permission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

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

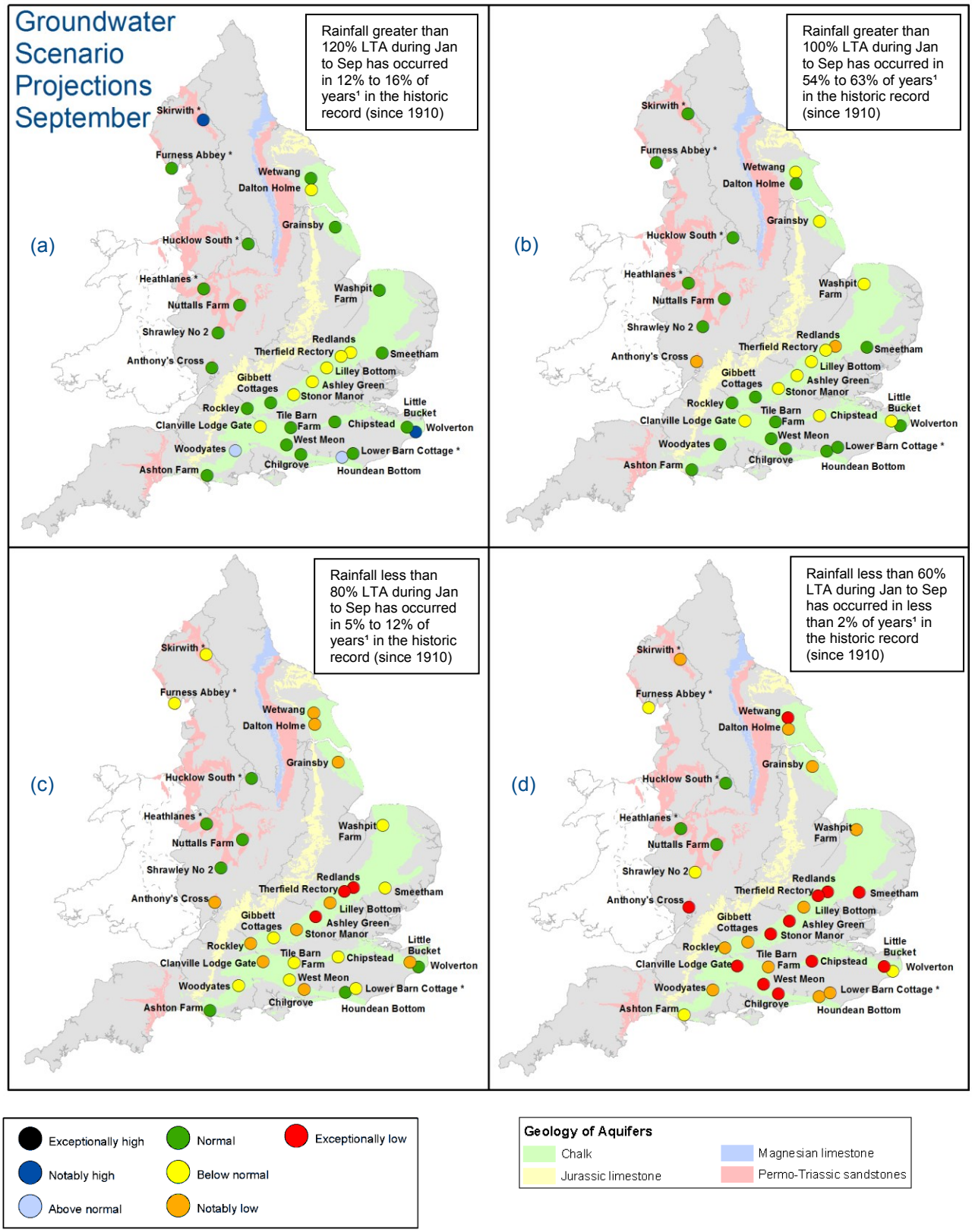

Figure 6.6: Projected groundwater levels at key indicator sites at the end of September 2017. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between January and September 2017 (Source: Environment Agency) Geological map reproduced with kind permission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

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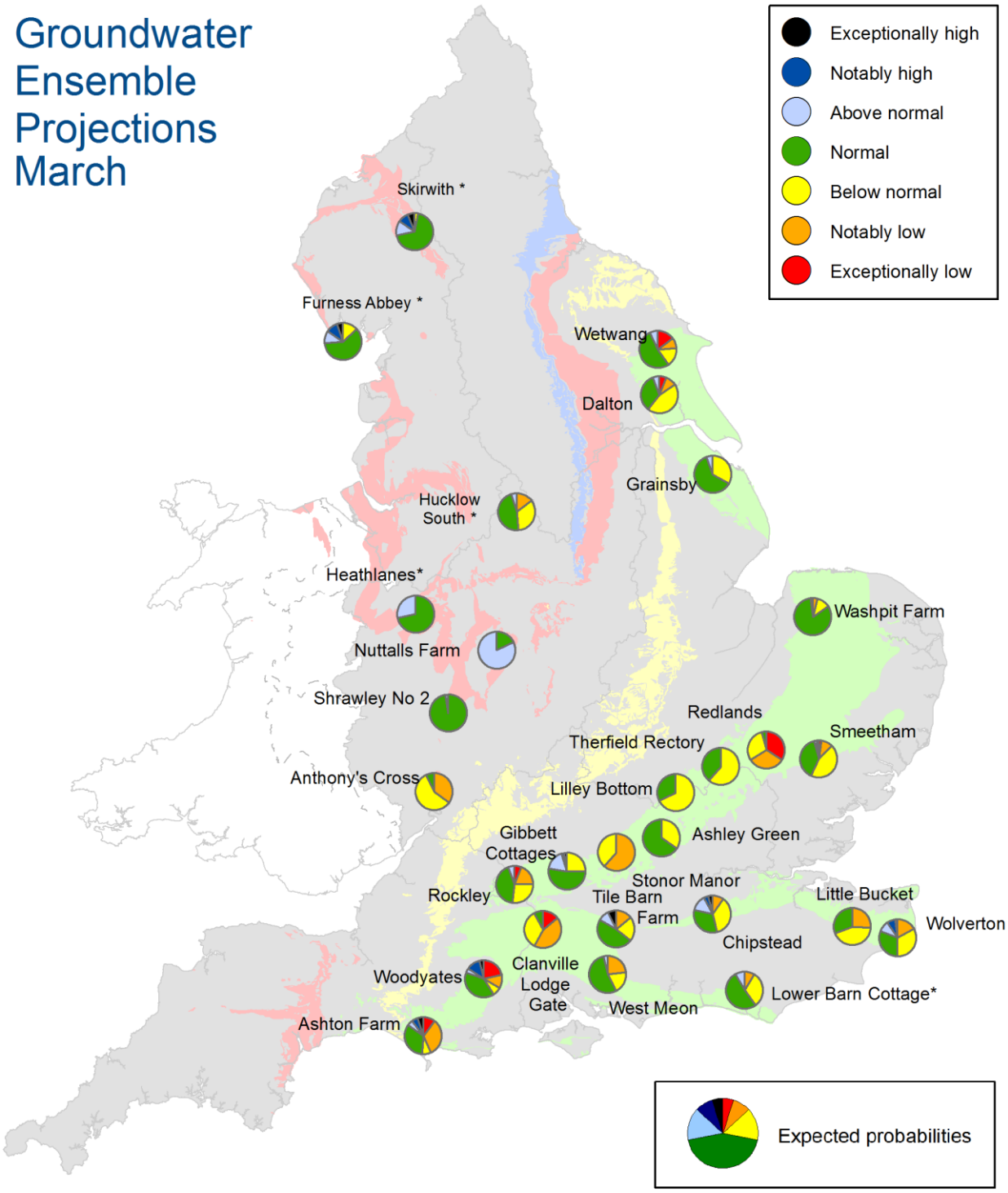

Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are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

** Projections for these sites are produced by BGS*

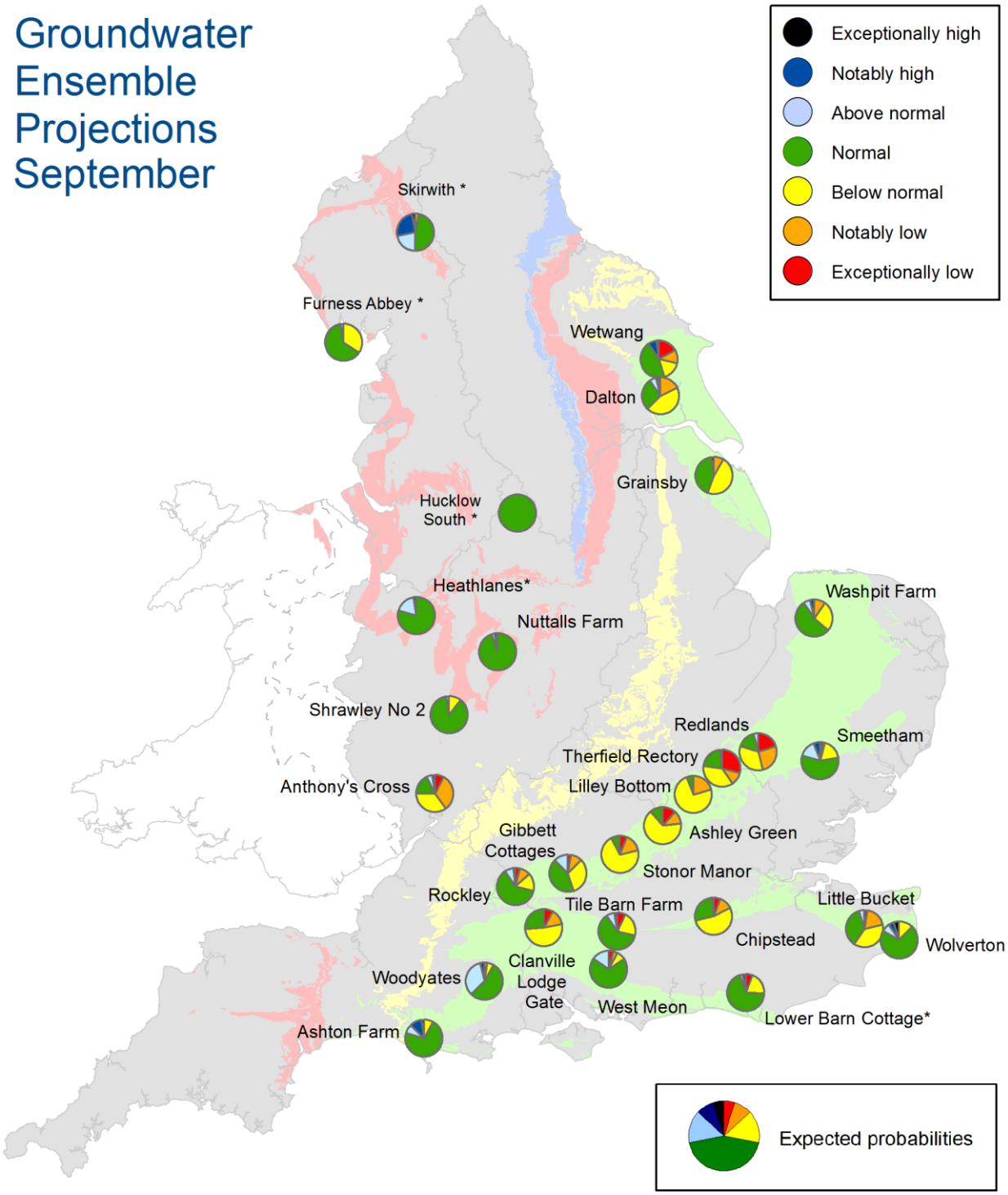

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Figure 6.8: Probabilistic ensemble projections of groundwater levels at key indicator sites at the end of September 2017. Pie charts indicate probability, based on climatology, of the groundwater level at each site being e.g. exceptionally low for 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, 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, 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