Monthly water situation report

England

Summary – December 2021

Across England rainfall totals for December were around average for the time of year. Monthly rainfall totals were normal for the time of year in the majority of the catchments across England, although the north-west received above normal rainfall. Soil moisture deficits were generally close to or smaller than the long term average for the time of year. River flows increased at most of the indicator sites reported on, and the majority of sites were classed as normal or higher for the time of year. The end of December groundwater levels were classed as normal or higher for the time of year at almost all indicator sites. Reservoir stocks increased during December at the majority of the reservoirs and reservoir groups we report on.

Rainfall

The December rainfall total for England was 89mm, which represents 104% of the 1961-1990 long term average (LTA) (102% of the 1981-2010 LTA). The highest monthly totals were seen in north- and south-western areas of England (Figure 1.1).

Monthly rainfall totals were classed as normal for the time of year in the majority of catchments across England. The remaining catchments were mostly classed as above normal for the time of year, including those in the north-west. In the north-east conditions were mixed with two catchments classed as notably high, while another two were below normal. Over half of all catchments received more than 100% of the LTA rainfall for December. For a second month the highest rainfall total as a proportion of the LTA was over the Tweed catchment (in the Scottish Borders) with 114mm of rainfall representing 169% of the LTA. The lowest rainfall total as a proportion of the LTA was over Berkshire Downs in the south-east, with 62mm of rainfall, representing 76% of the December LTA. The 3 month cumulative rainfall totals were classed as normal in the majority of catchments across England, and the 12 month cumulative rainfall totals were classed as normal or higher across most of England (Figure 1.2).

At a regional scale, December rainfall totals ranged from 96% of the LTA in south-west England to 117% of the LTA in east England. All regional rainfall totals for December were normal for the time of year (Figure 1.3).

Soil moisture deficit

During December, soil moisture deficits (SMD) decreased across the east of England following above average rainfall in the region (Figure 2.1). End of December SMD values across the country were generally close to or smaller than the LTA for the time of year (soils were wetter than average). At a regional scale, the end of December SMD for all regions were at or lower than average (soils were wetter) for the time of year (Figure 2.2).

River flows

December monthly mean river flows increased at almost all of the indicator sites we report on, compared to November. Flows at the majority of sites across England were classed as normal for the time of year. Ten sites, mostly located in the east and north of the country, were classed as above normal for the time of year. In contrast, the Eamont at Pooley Bridge, the Tone at Bishops Tull and the Avon at Great Somerford were all classed as below normal for the time of year (Figure 3.1).
At the regional index sites, monthly mean flows were classed as normal for the time of year for all sites, with the exception of the Dove at Marston-on-Dove in central England which was classed as above normal (Figure 3.2).

Groundwater levels

Groundwater levels were in recession at less than half of the reported indicator sites during December, however end of month levels were classed as normal or higher for the time of year at all except two of the indicator sites reported on. Jackaments Bottom in the Jurassic limestone and Lea Lane in the Fylde and Preston sandstone were classed as below normal for the time of year (Figures 4.1). At Priors Heyes (West Cheshire sandstone) and Coxmoor (Permo-Triassic sandstone) the highest end of December levels on record were recorded (records go back to 1972 and 1969 respectively). Levels at Priors Heyes remain high compared to historic levels because the

aquifer is recovering from the effects of historic abstraction (Figures 4.1). December groundwater levels at the major aquifer index sites ranged from being classed as notably high at Weir Farm (central England) to below normal in the Jurassic limestone at Jackaments Bottom. The chalk index sites at Little Bucket, Stonor Park, Chilgrove, Dalton Holme and Redlands Hall were classed as normal (Figure 4.2).

Reservoir storage

End of December reservoir stocks increased at all bar four of the reservoirs and reservoir groups we report on. The largest increases of over 30% of total capacity were recorded at three reservoirs or groups, including Derwent Valley (central England), Blithfield reservoir (central England), and Bough Beech reservoir (south-east England). End of month reservoir stocks were classed as normal or higher for the time of year at the majority of reported reservoir sites, including those that recorded a decline in stocks.
Six reservoirs or reservoir groups were classed as below normal for the time of year, and one, the Teesdale group in north-east England, was notably low, although all had an increase in stocks in December (Figure 5.1).

At a regional scale, total reservoir stocks ranged from 79% in east England to 94% in central England. Total reservoir stocks for England were at 86% of total capacity at the end of December (Figure 5.2).

Forward look

January is forecast to be a slightly colder than normal however the chances of it being a wet month are lower than normal. Moving through the month, largely unsettled conditions are expected with an increased likelihood of spells of more significant cold weather with widespread frosts and a greater likelihood of impacts from snow and ice.

From January to March, a cold 3-month period remains possible, though less likely than normal. More likely is prevailing westerly or south-westerly winds bringing weather systems from the Atlantic meaning a greater chance of mild, wet and, at times, windy weather. Some colder spells may still occur during this period. The chances of wet weather are slightly higher than usual and a moderate increase in the potential for impacts from strong winds[1].

Projections for river flows at key sites[2]
By the end of both March and September 2022, over three-quarters of the modelled sites have a greater than expected chance of cumulative river flows being normal or higher for the time of year. Nearly a third 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 March and September 2022.

For scenario based projections of cumulative river flows at key sites by March 2022 see Figure 6.1
For scenario based projections of cumulative river flows at key sites by September 2022 see Figure 6.2
For probabilistic ensemble projections of cumulative river flows at key sites by March 2022 see Figure 6.3
For probabilistic ensemble projections of cumulative river flows at key sites by September 2022 see Figure 6.4

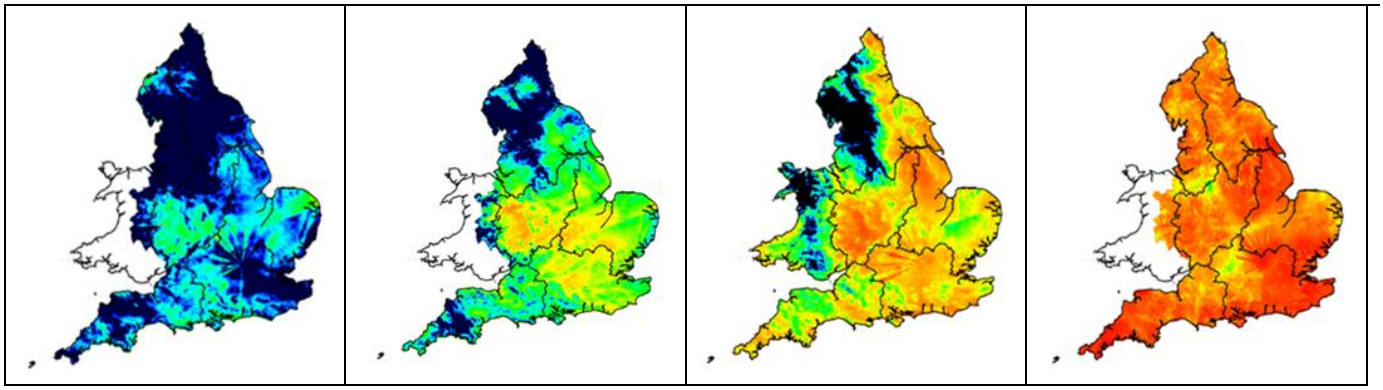
Projections for groundwater levels in key aquifers[2]
By the end of March 2022, more than three-quarters of the modelled sites have a greater than expected chance of groundwater levels being normal or higher for the time of year. By the end of September 2022, more than half of the modelled sites have 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 2022 see Figure 6.5
For scenario based projections of groundwater levels in key aquifers in September 2022 see Figure 6.6
For probabilistic ensemble projections of groundwater levels in key aquifers in March 2022 see Figure 6.7
For probabilistic ensemble projections of groundwater levels in key aquifers in September 2022 see Figure 6.8

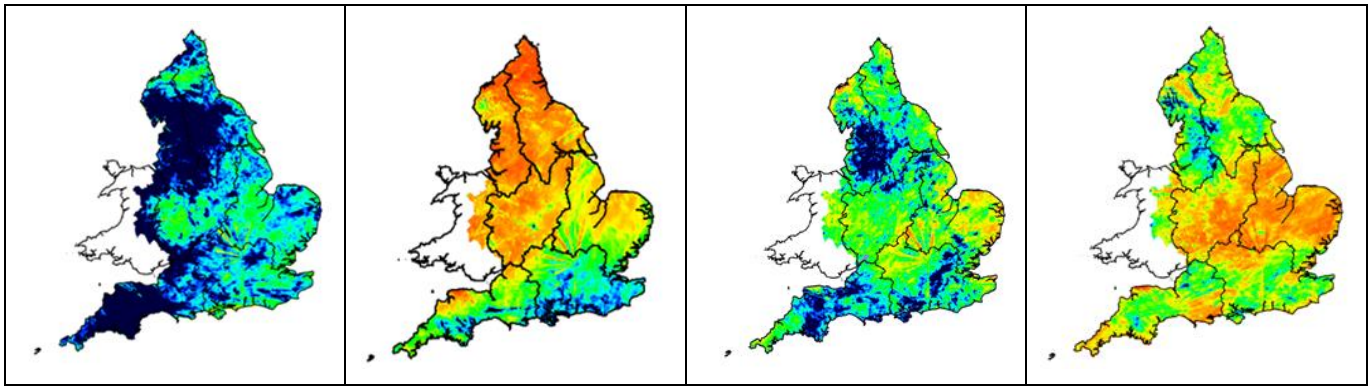
Authors: National Water Resources Hydrology Team

1 Source: Met Office
2 Information produced by the Hydrological Outlook, a partnership between UK Centre for Ecology and Hydrology, British Geological Survey, Met Office, Environment Agency and other devolved agencies.

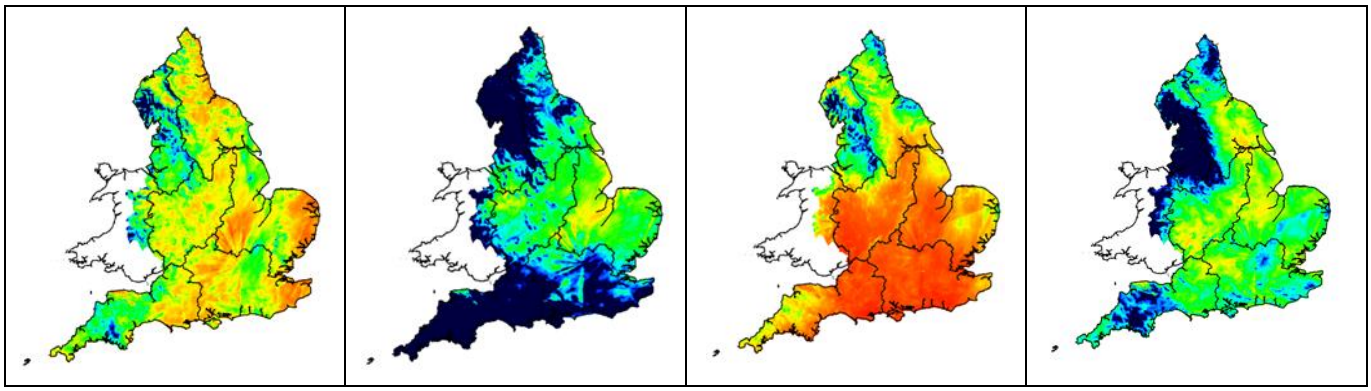
Rainfall



January 2021 | February 2021 | March 2021 | April 2021

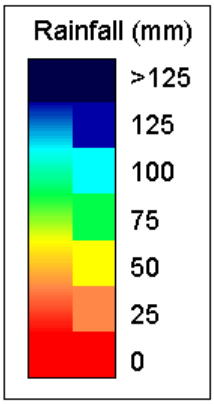


May 2021 | June 2021 | July 2021 | August 2021



September 2021 | October 2021 | November 2021 | December 2021

Figure 1.1: Monthly rainfall across England and Wales for the past 12 months. UKPP radar data (Source: Met Office © Crown Copyright, 2021). Note: Radar beam blockages in some regions may give anomalous totals in some areas. Crown copyright. All rights reserved. Environment Agency, 100024198, 2021.



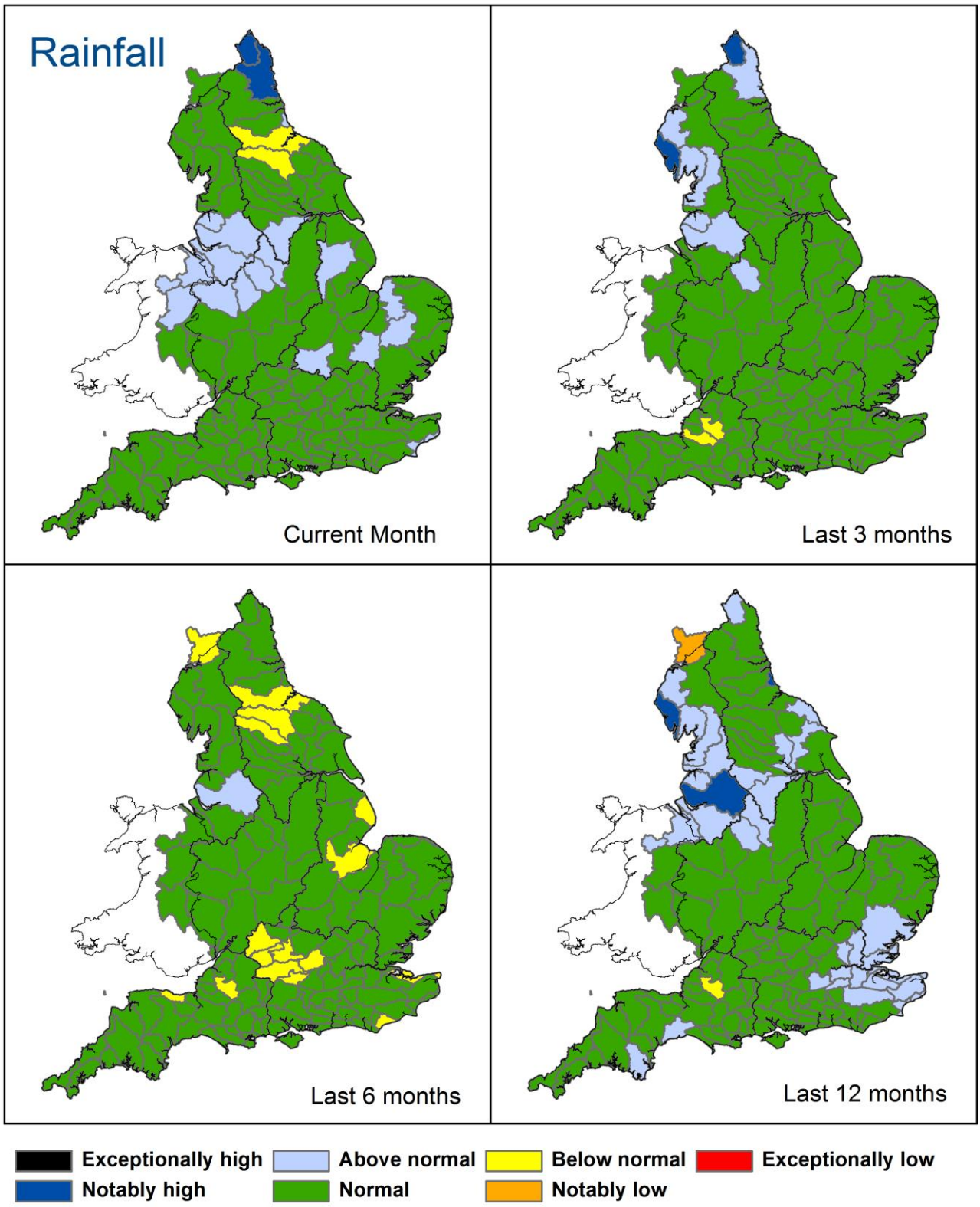


Figure 1.2: Total rainfall for hydrological areas across England for the current month (up to 31 December), the last 3 months, the last 6 months, and the last 12 months, classed relative to an analysis of respective historic totals. HadUK data based on the Met Office 1km gridded rainfall dataset derived from rain gauges *(Source: Met Office © Crown Copyright, 2021).* Provisional data based on Environment Agency 1km gridded rainfall dataset derived from Environment Agency intensity rain gauges. Crown copyright. All rights reserved. Environment Agency, 100024198, 2021.

Rainfall charts

Above average rainfall

Below average rainfall

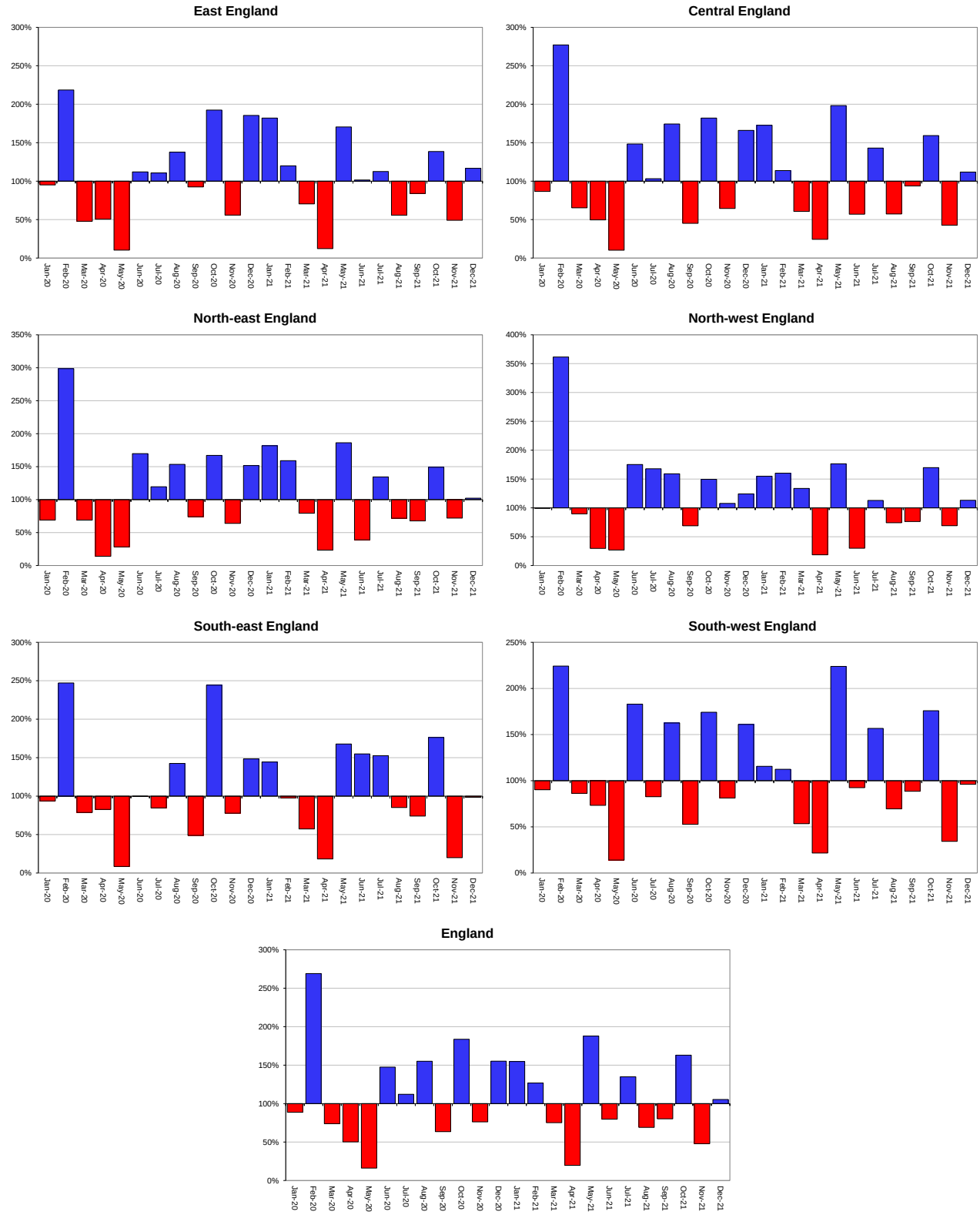


Figure 1.3: Monthly rainfall totals for the past 24 months as a percentage of the 1961 to 1990 long term average for each region and for England. HadUK rainfall data. (Source: Met Office © Crown Copyright, 2021).

Soil moisture deficit

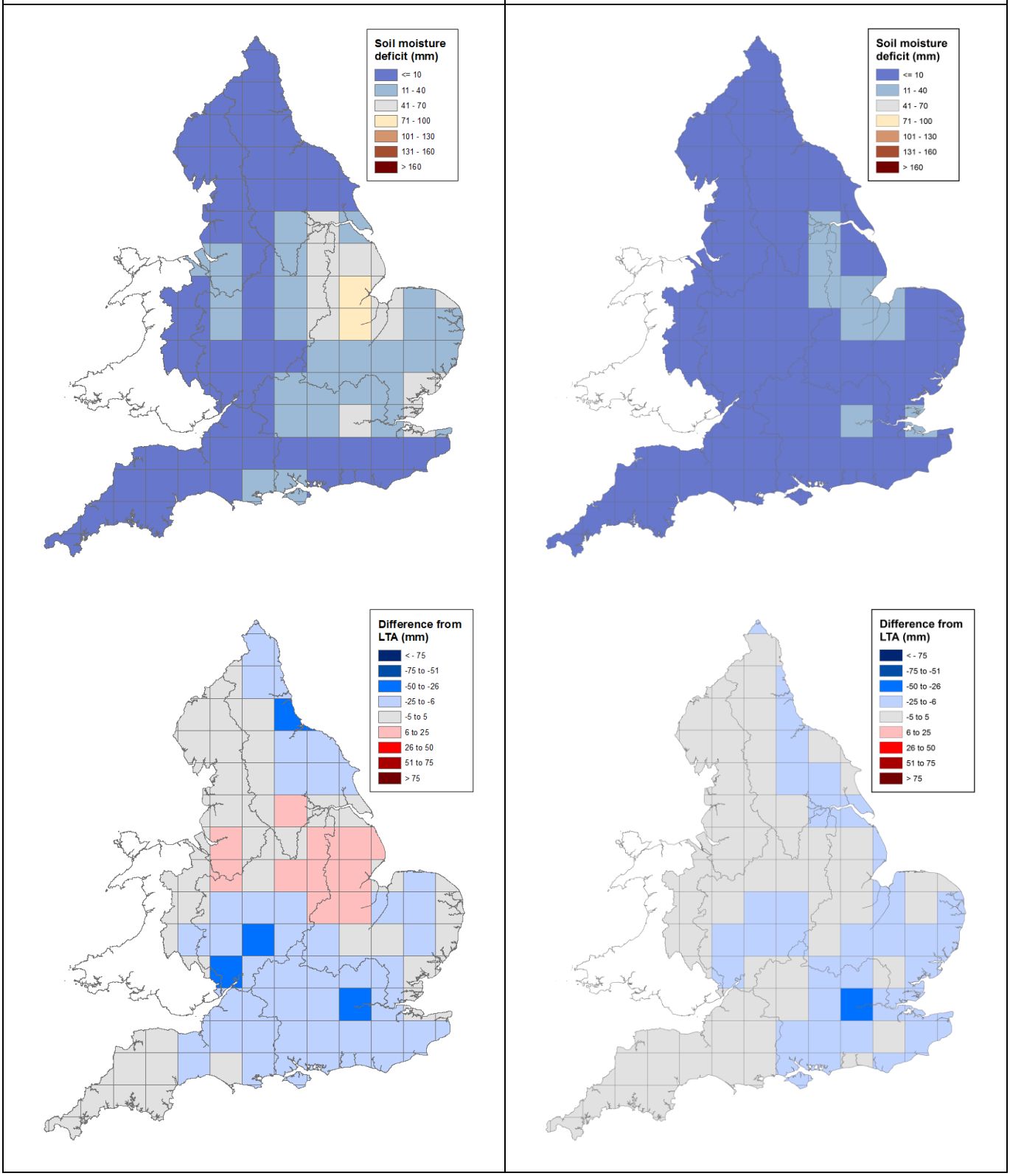
End of November 2021[1]	End of December 2021[2]
	

Figure 2.1: Soil moisture deficits for weeks ending 30 November 2021 [1] (left panel) and 04 January 2022 [2] (right panel). Top row shows actual soil moisture deficits (mm) and bottom row shows the difference (mm) of the actual from the 1961 to 90 long term average soil moisture deficits. MORECS data for real land use (Source: Met Office © Crown Copyright, 2021). Crown copyright. All rights reserved. Environment Agency, 100024198, 2021

Soil moisture deficit charts

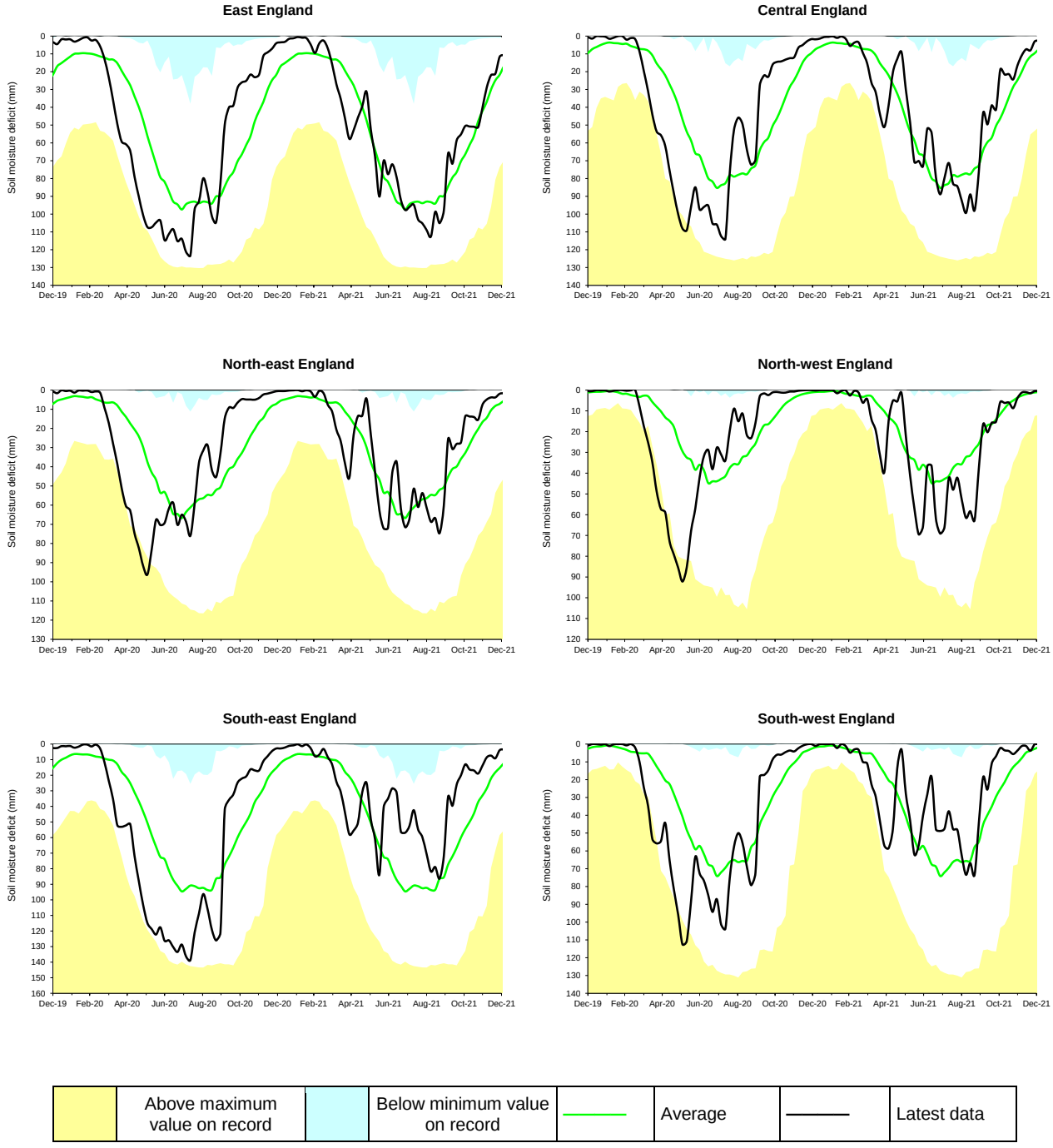
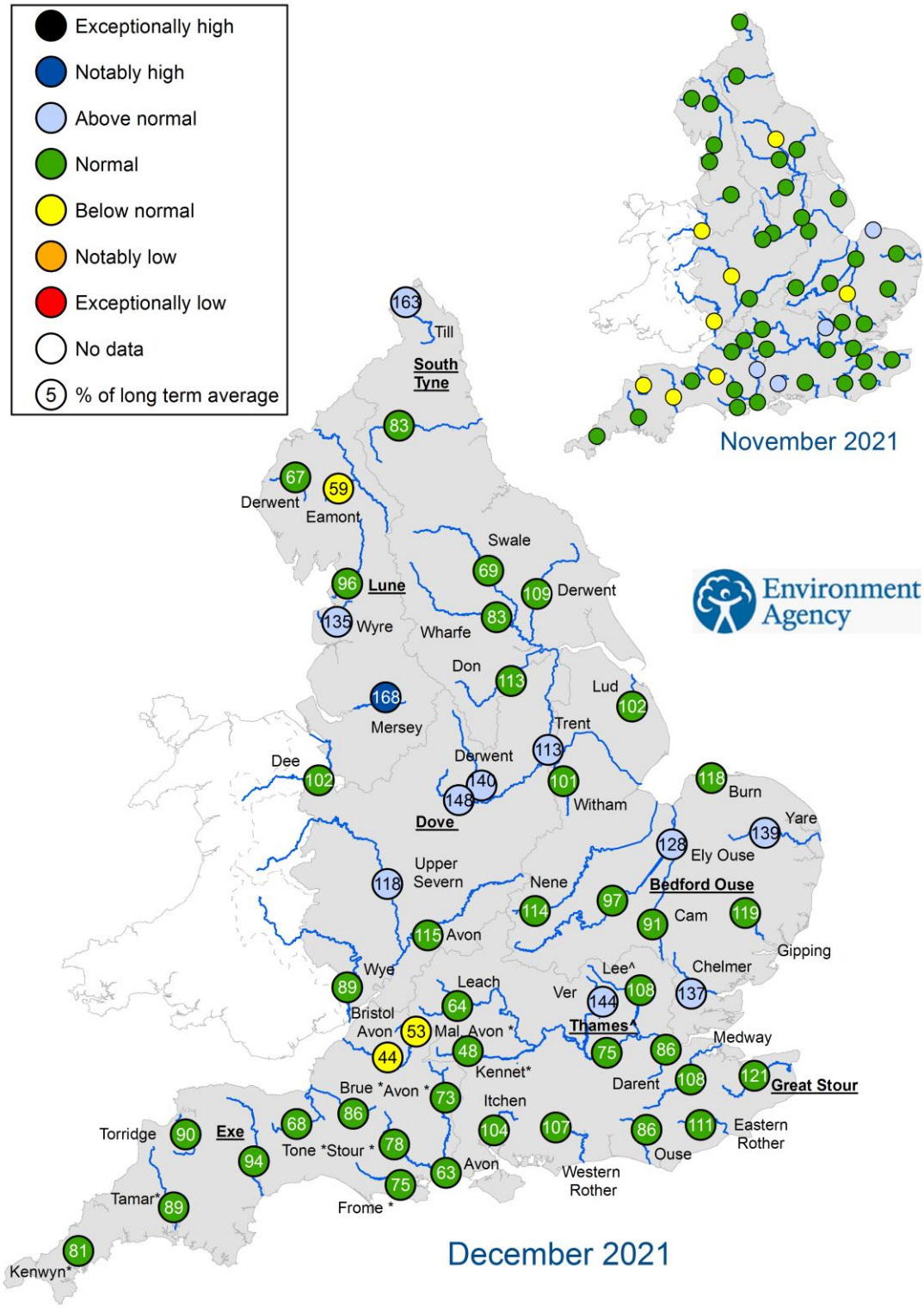


Figure 2.2: Latest soil moisture deficits for all geographic regions compared to maximum, minimum and 1961 to 90 long term average. Weekly MORECS data for real land use. (Source: Met Office © Crown Copyright, 2021).

River flows



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

* Flows may be overestimated at these sites – data should be treated with caution

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 2021 and December 2021, 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, 100024198, 2021.

River flow charts

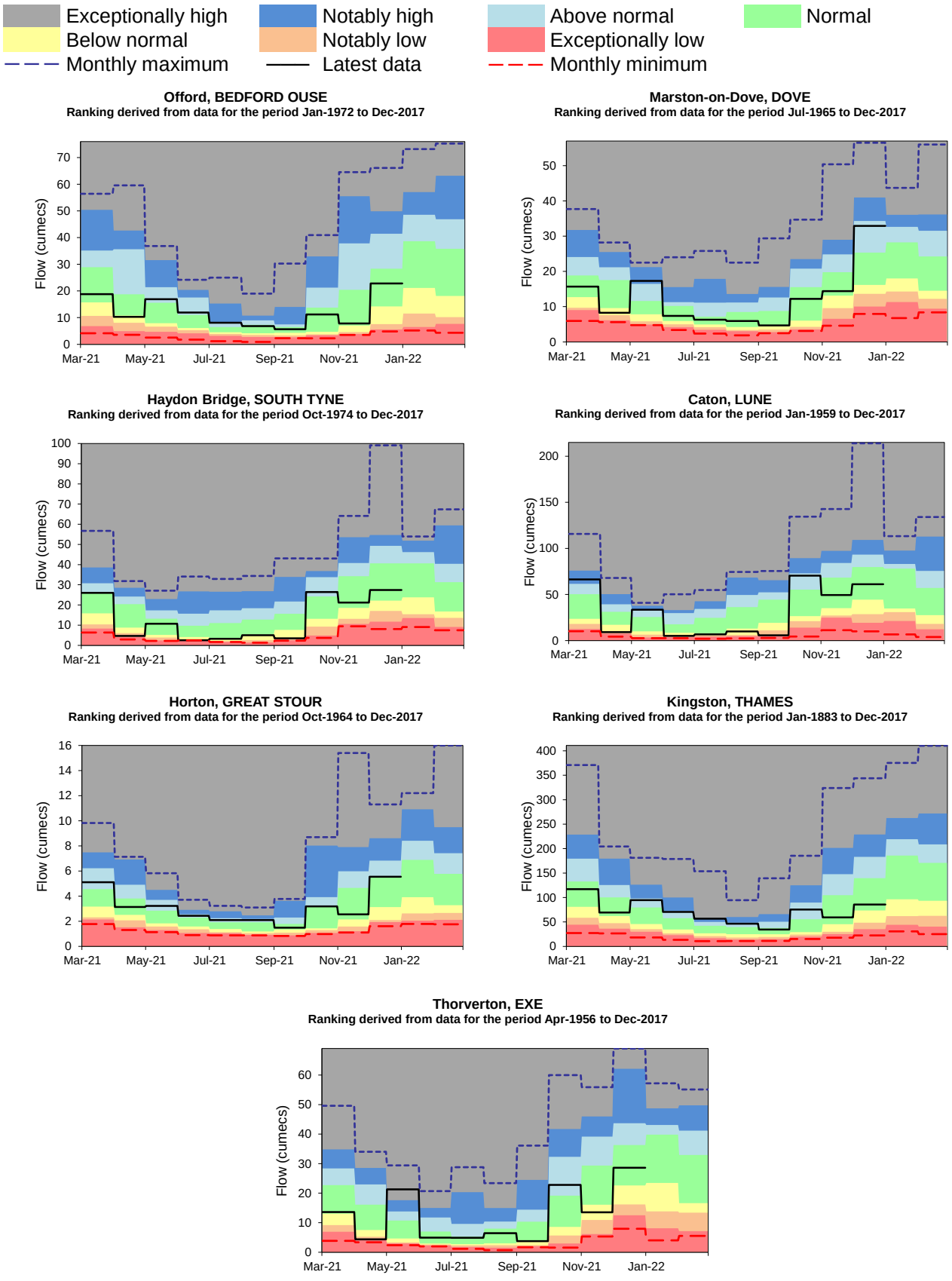
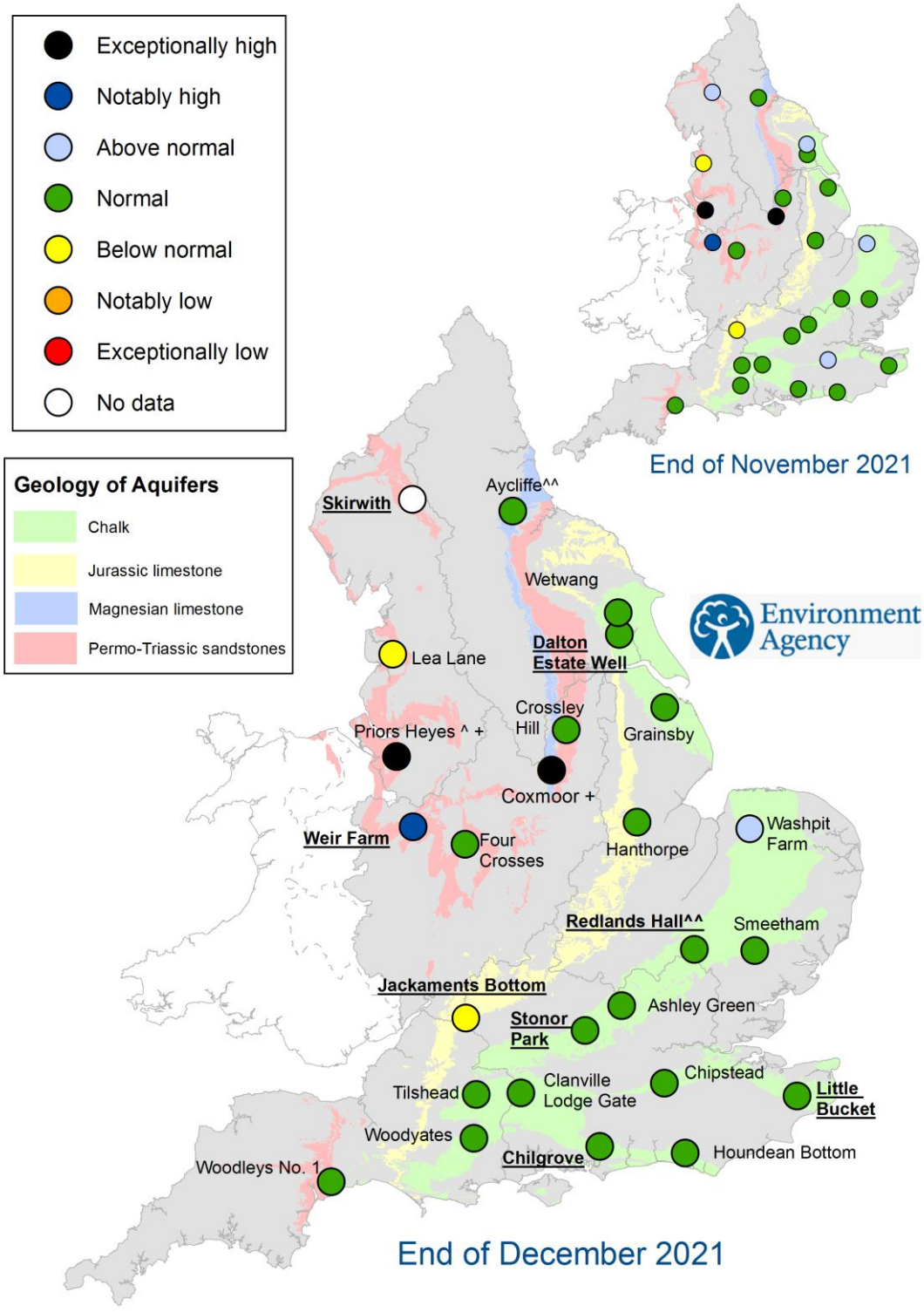


Figure 3.2: Index river flow sites for each geographic region. Monthly mean flow compared to an analysis of historic monthly mean flows, long term maximum and minimum flows. (Source: Environment Agency).

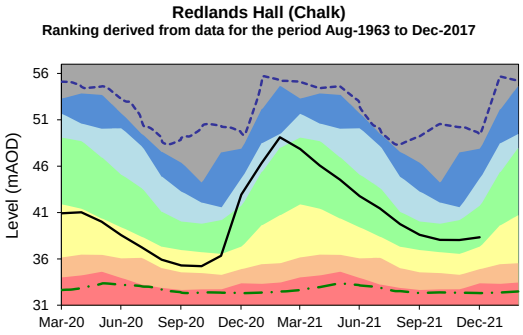
Groundwater levels

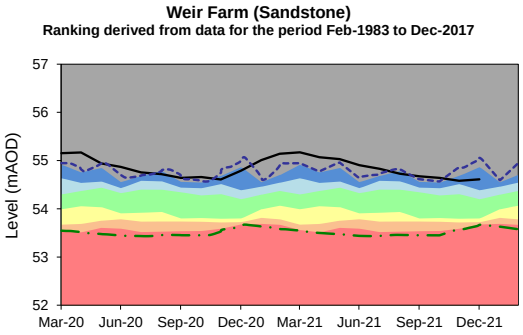


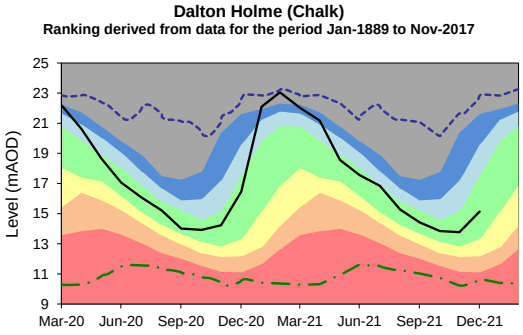
^ The level at Priors Heyes remains high compared to historic levels because the aquifer is recovering from the effects of historic abstraction
^^ Sites are manually dipped at different times during the month. They may not be fully representative of levels at the month end
\+ End of month groundwater level is the highest on record for the current month (note that record length varies between sites).
Underlined sites are major aquifer index sites and are shown in the groundwater level charts in Figure 4.2

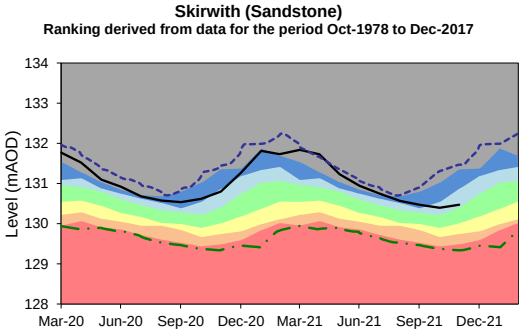
Figure 4.1: Groundwater levels for indicator sites at the end of November 2021 and December 2021, classed relative to an analysis of respective historic November and December levels (Source: Environment Agency). Geological map reproduced with kind permission from UK Groundwater Forum, BGS © NERC. Crown copyright. All rights reserved. Environment Agency, 100024198, 2021.

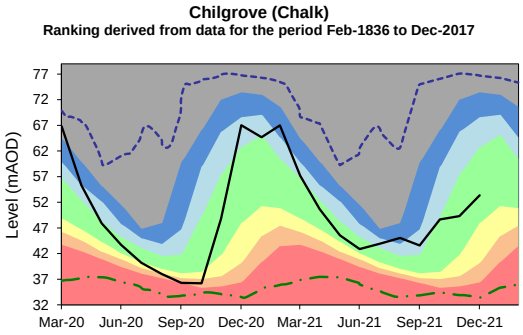
Groundwater level charts

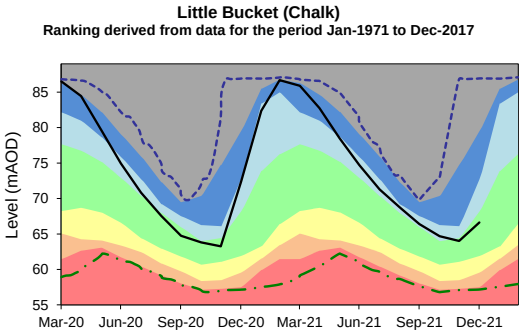


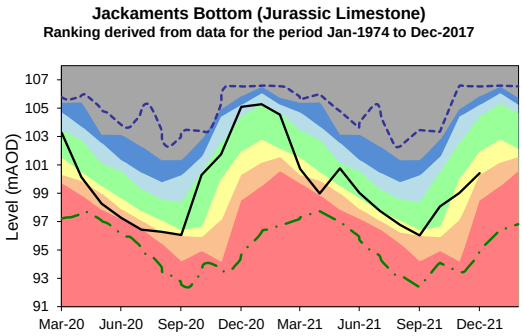












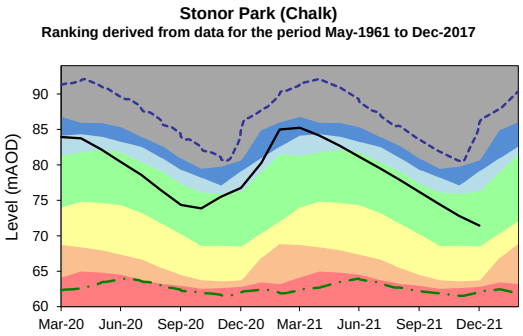
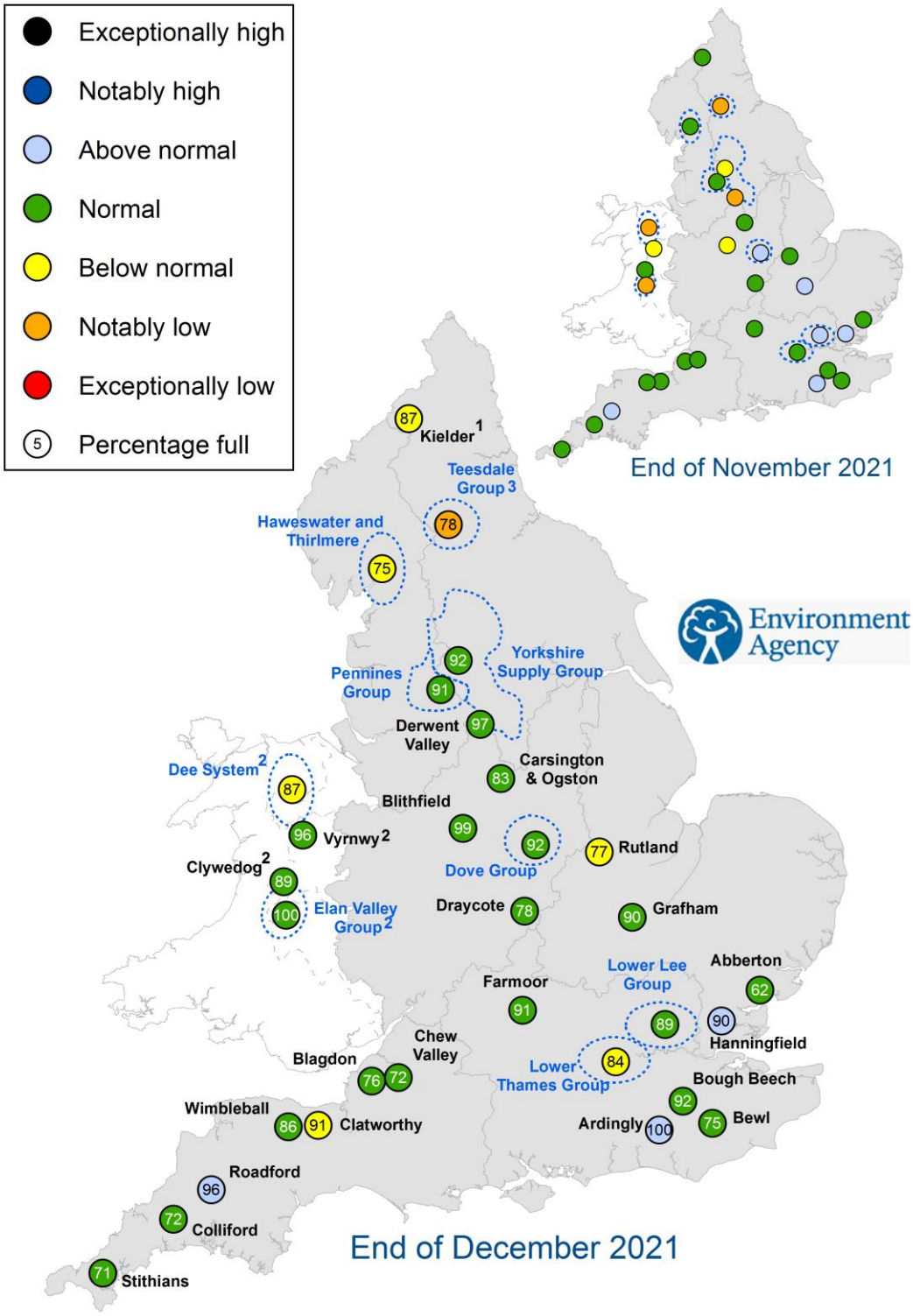


Figure 4.2: Index groundwater level sites for major aquifers. End of month groundwater levels months compared to an analysis of historic end of month levels and long term maximum and minimum levels. (Source: Environment Agency, 2021).

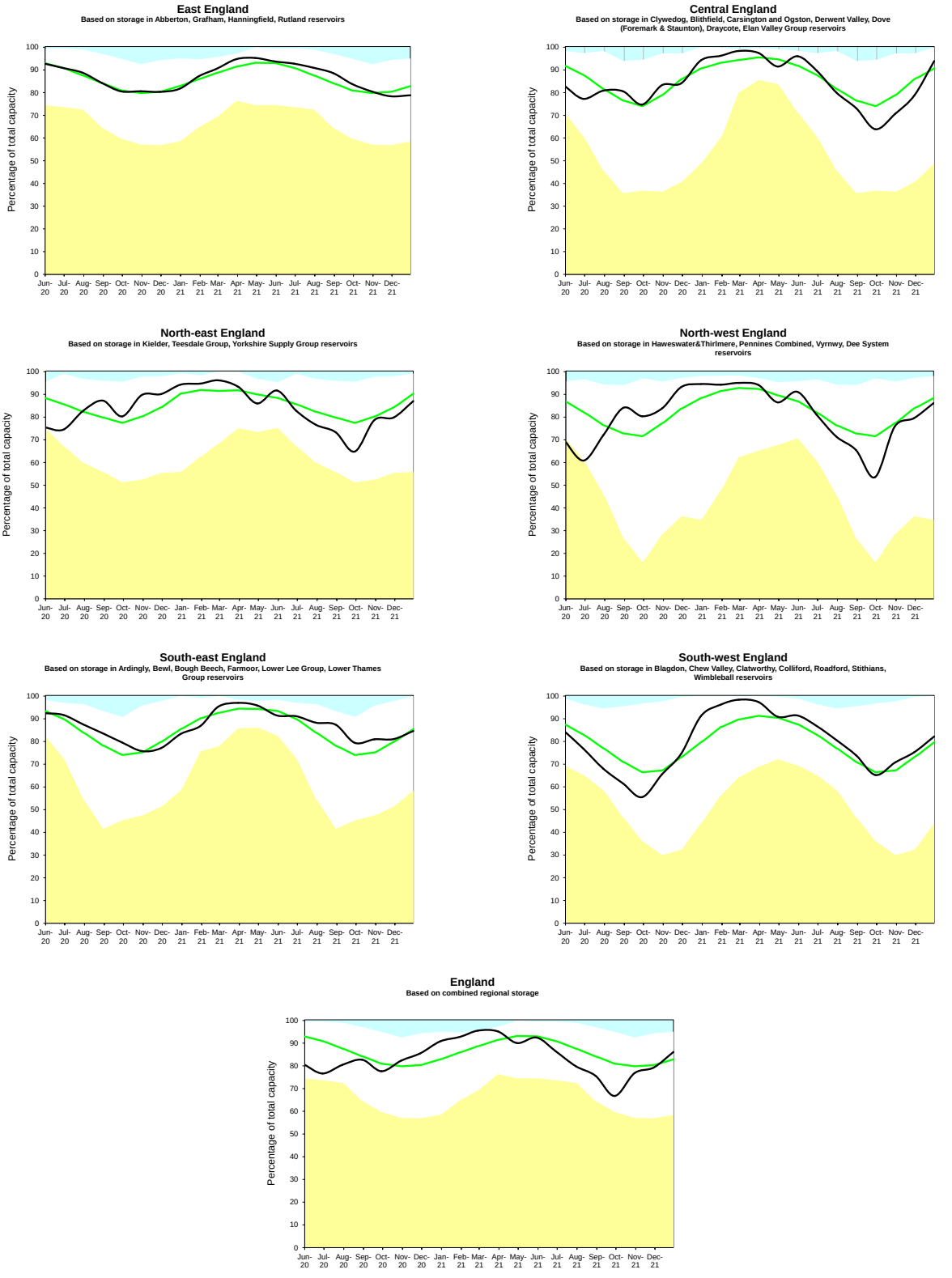
Reservoir storage



1. Current levels at Kielder are lower than historical levels due to the implementation of a new flood alleviation control curve
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 2021 and December 2021 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.

Reservoir storage charts



	Below minimum monthly level		Above maximum monthly level		Average		Latest data

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

Forward look: river flow

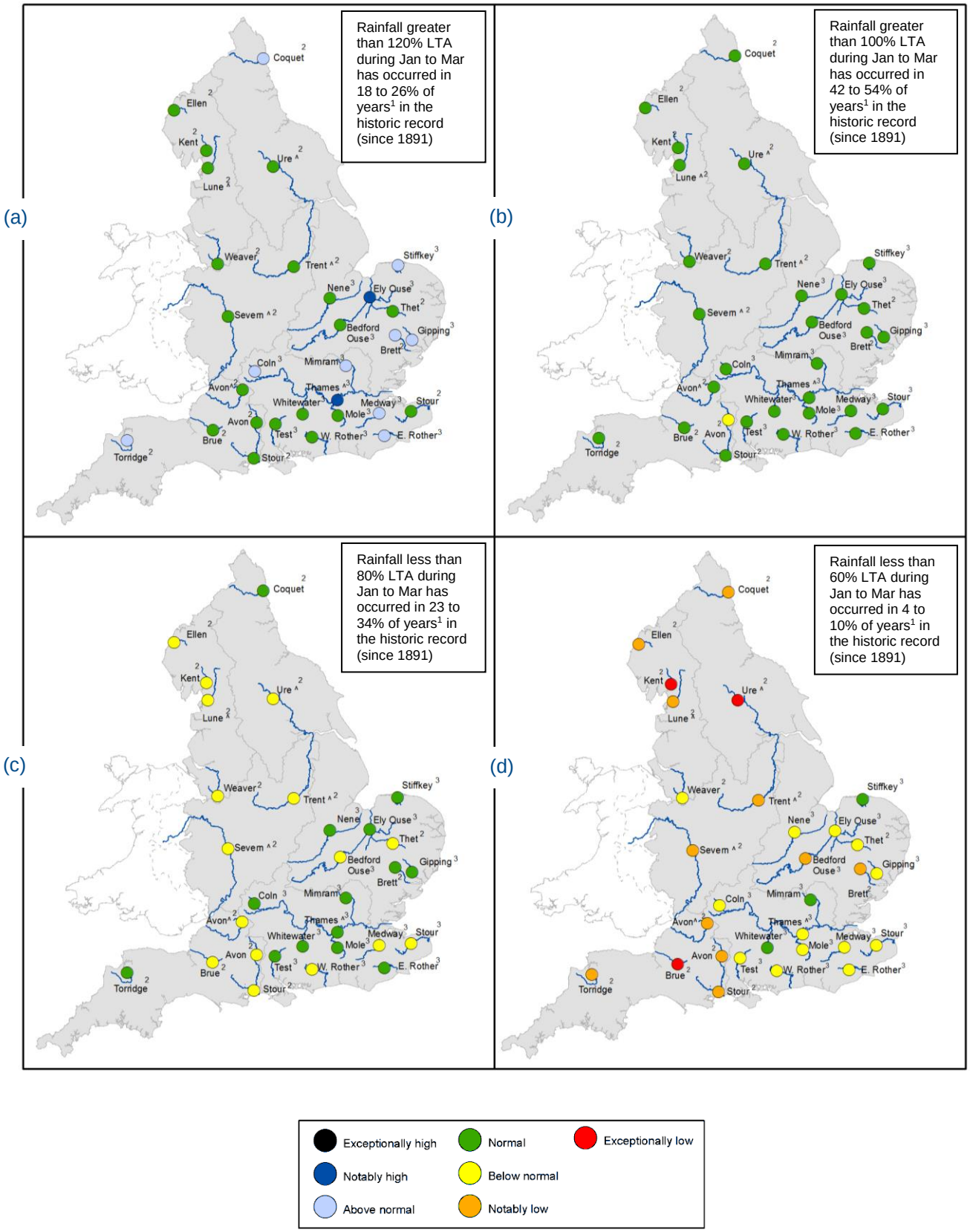


Figure 6.1: Projected river flows at key indicator sites up until the end of March 2022. Projections based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between January 2022 and March 2022 (Source: UK Centre for Ecology and Hydrology, Environment Agency)

[1] This range of probabilities is a regional analysis
[2] Projections for these sites are produced by UK CEH
[3] Projections for these sites are produced by the Environment Agency
^ *"Naturalised" flows are projected for these sites*

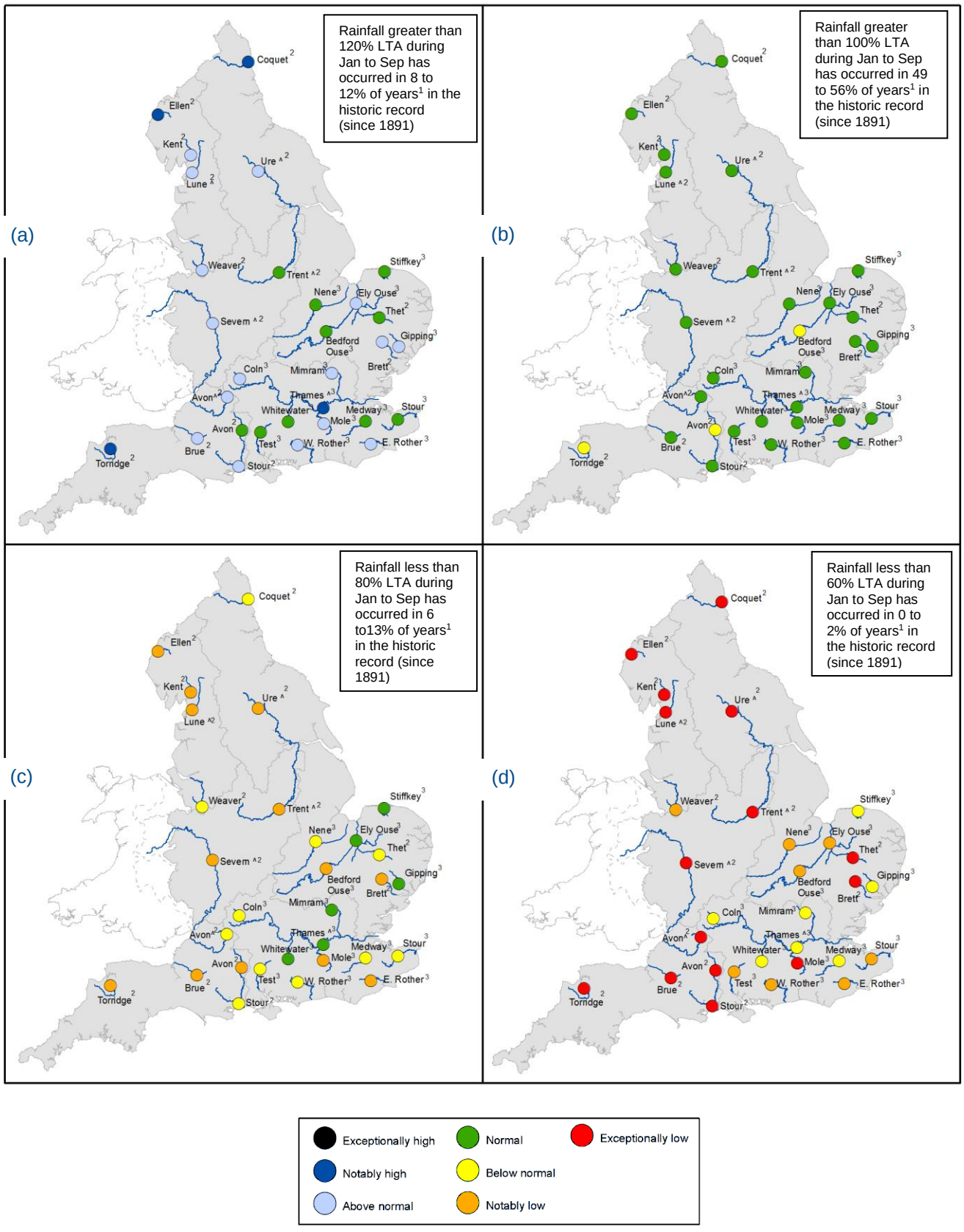


Figure 6.2: Projected river flows at key indicator sites up until the end of September 2022. Projections based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between January 2022 and September 2022 (Source: UK Centre for Ecology and Hydrology, Environment Agency)

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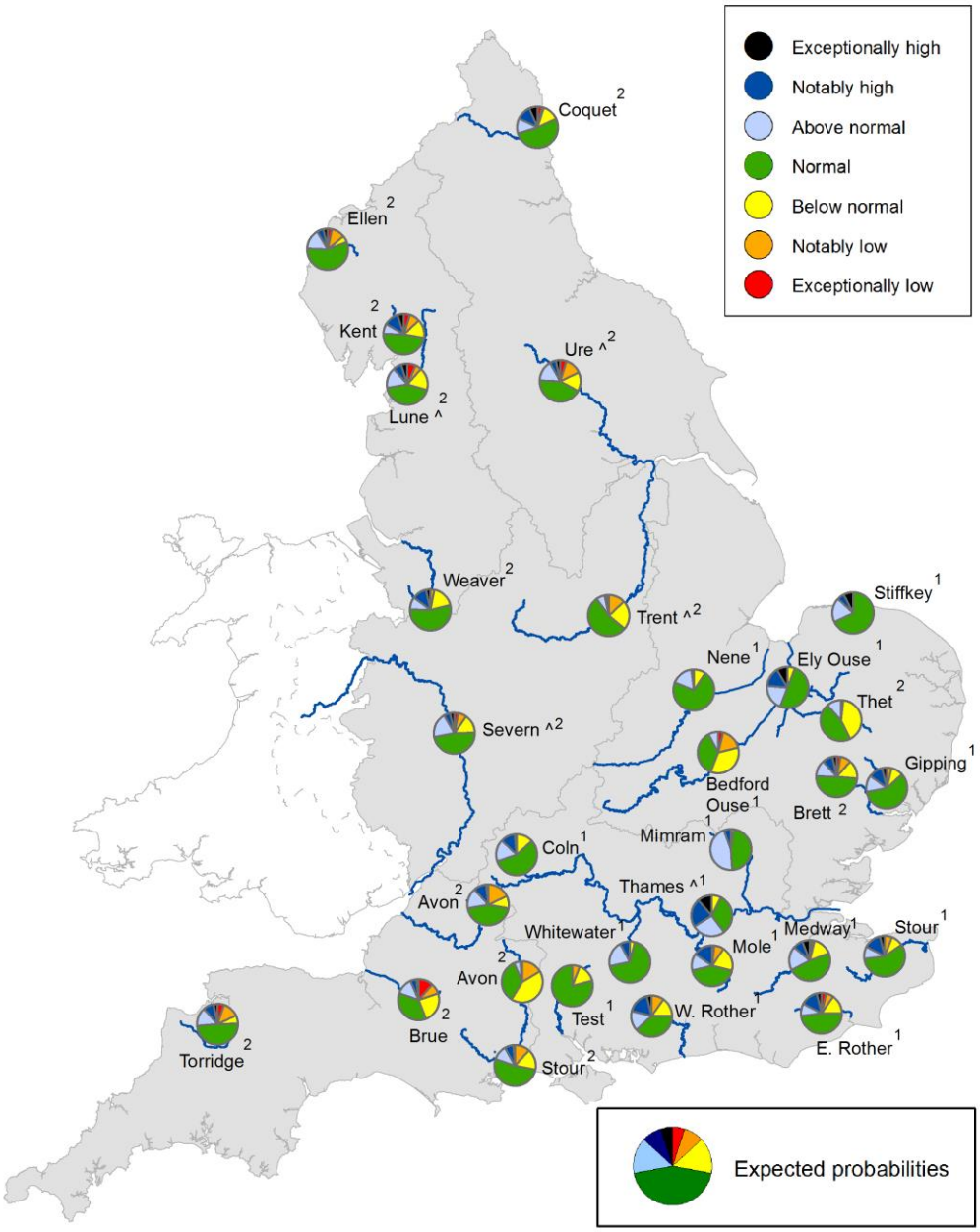

Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are 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 2022. 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: UK Centre for Ecology and Hydrology, Environment Agency).

[1] Projections for these sites are produced by the Environment Agency
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^"Naturalised" flows are projected for these sites

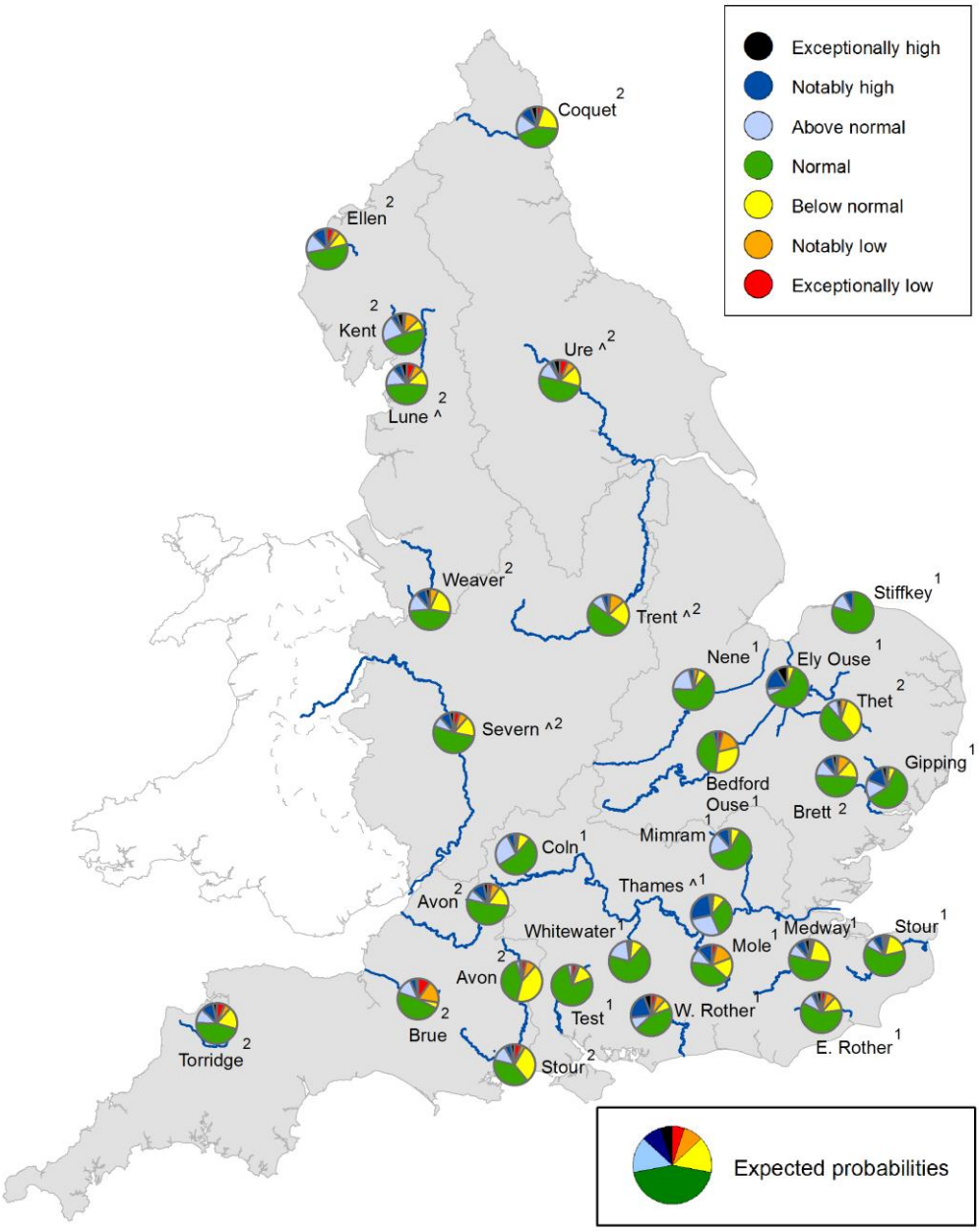

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Figure 6.4: Probabilistic ensemble projections of river flows at key indicator sites up until the end of September 2022. Pie charts indicate probability, based on climatology, of the surface water flow at each site being e.g. exceptionally low for the time of year. (Source: UK 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 UK CEH
^"Naturalised" flows are projected for these sites

Forward look: groundwater

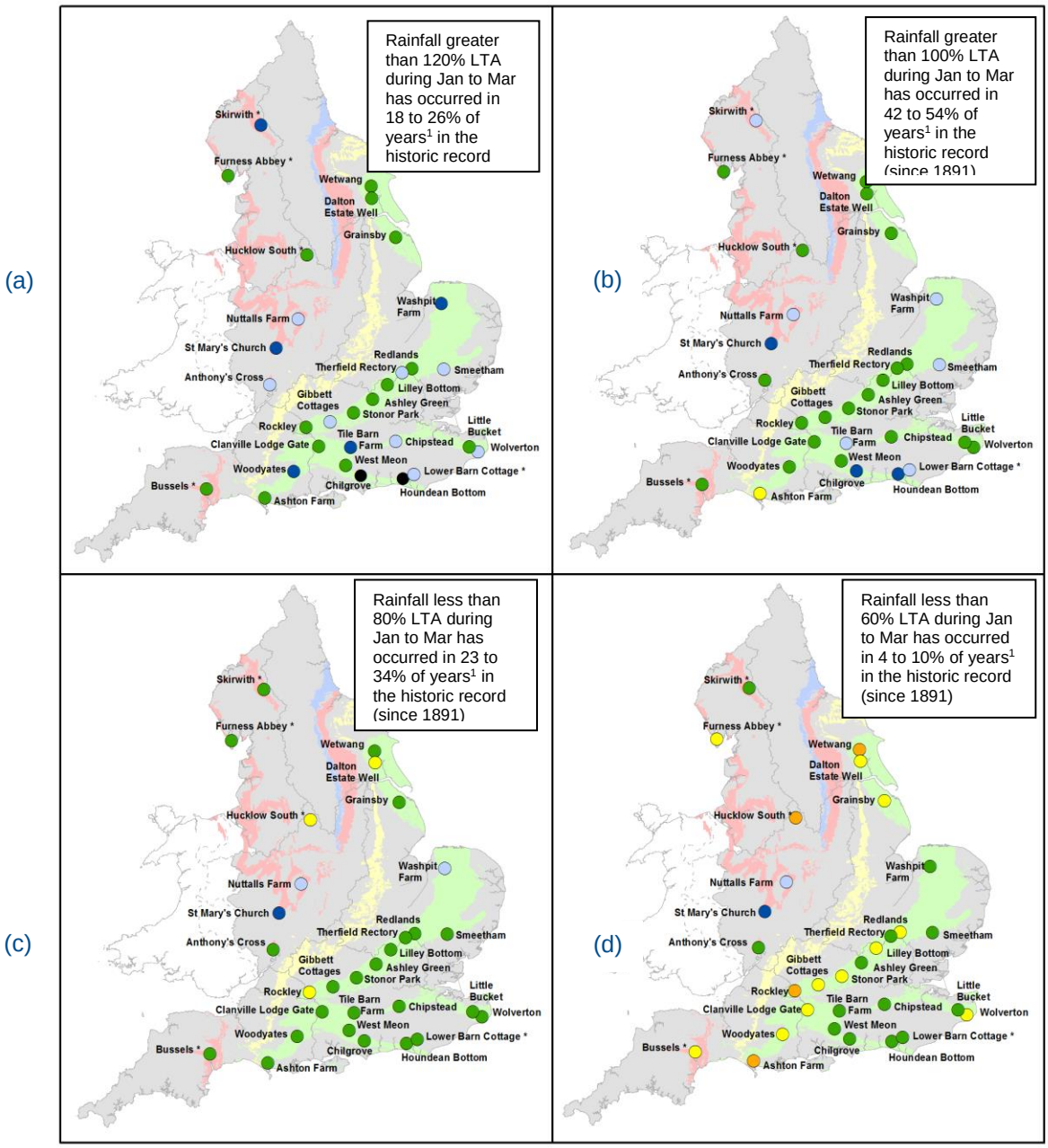


Figure 6.5: Projected groundwater levels at key indicator sites at the end of March 2022. Projections based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between January 2022 and March 2022 (Source: Environment Agency) Geological map reproduced with kind permission from UK Groundwater Forum BGS © NERC. Crown copyright all rights reserved. Environment Agency 100024198, 2021.

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

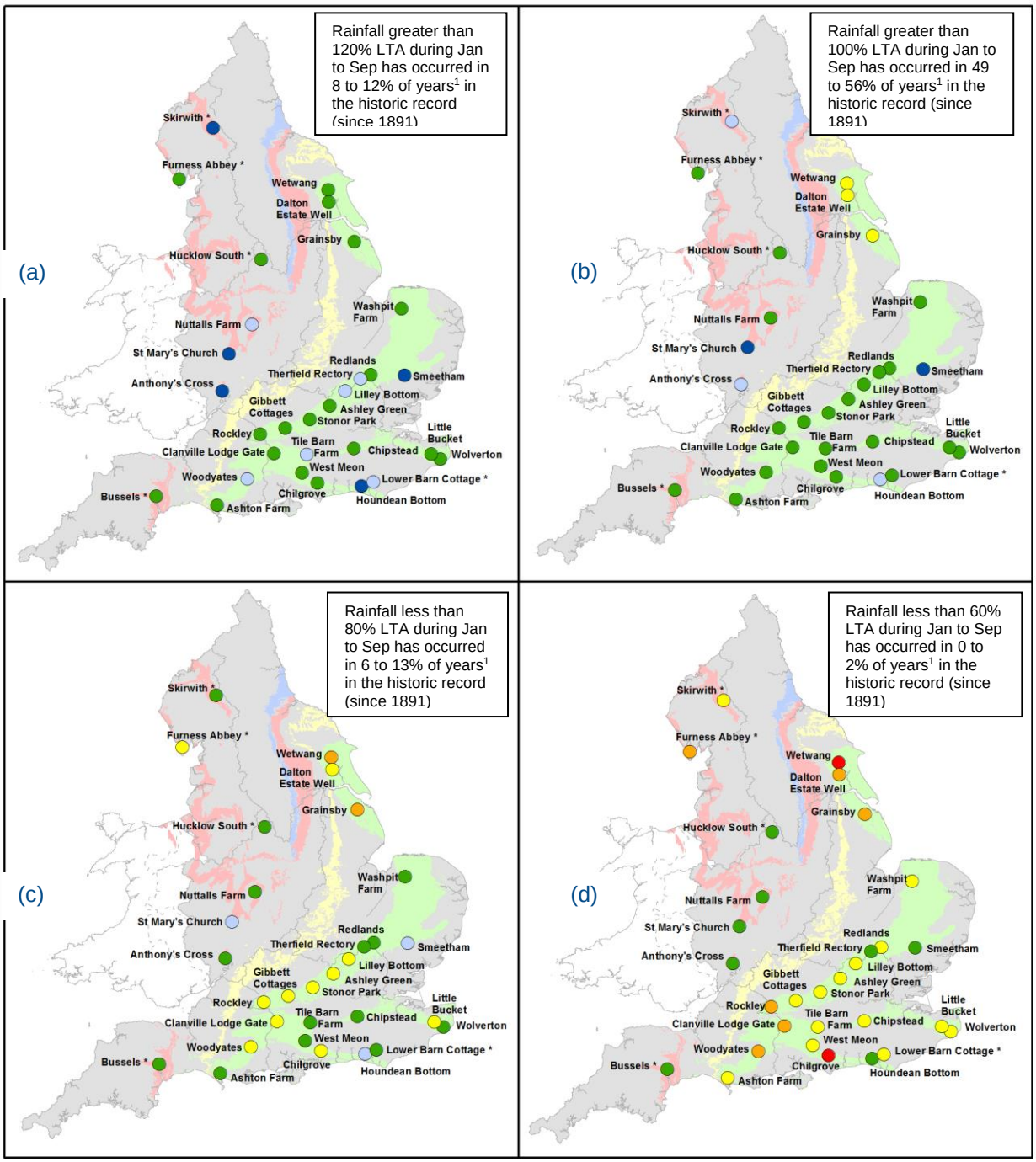
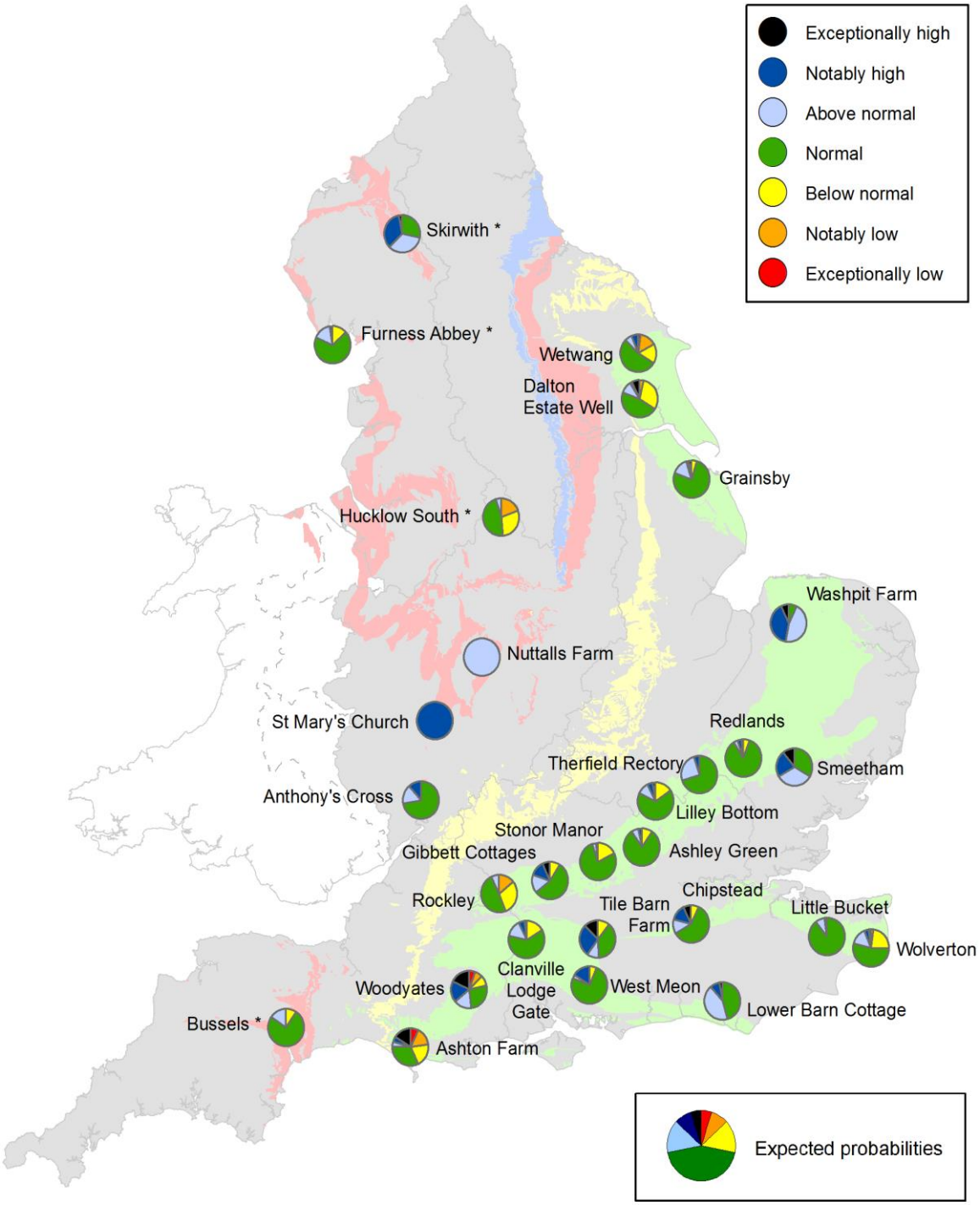


Figure 6.6: Projected groundwater levels at key indicator sites at the end of September 2022. Projections based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between January 2022 and September 2022 (Source: Environment Agency) Geological map reproduced with kind permission from UK Groundwater Forum BGS © NERC Crown copyright. All rights reserved. Environment Agency 100024198 2022.

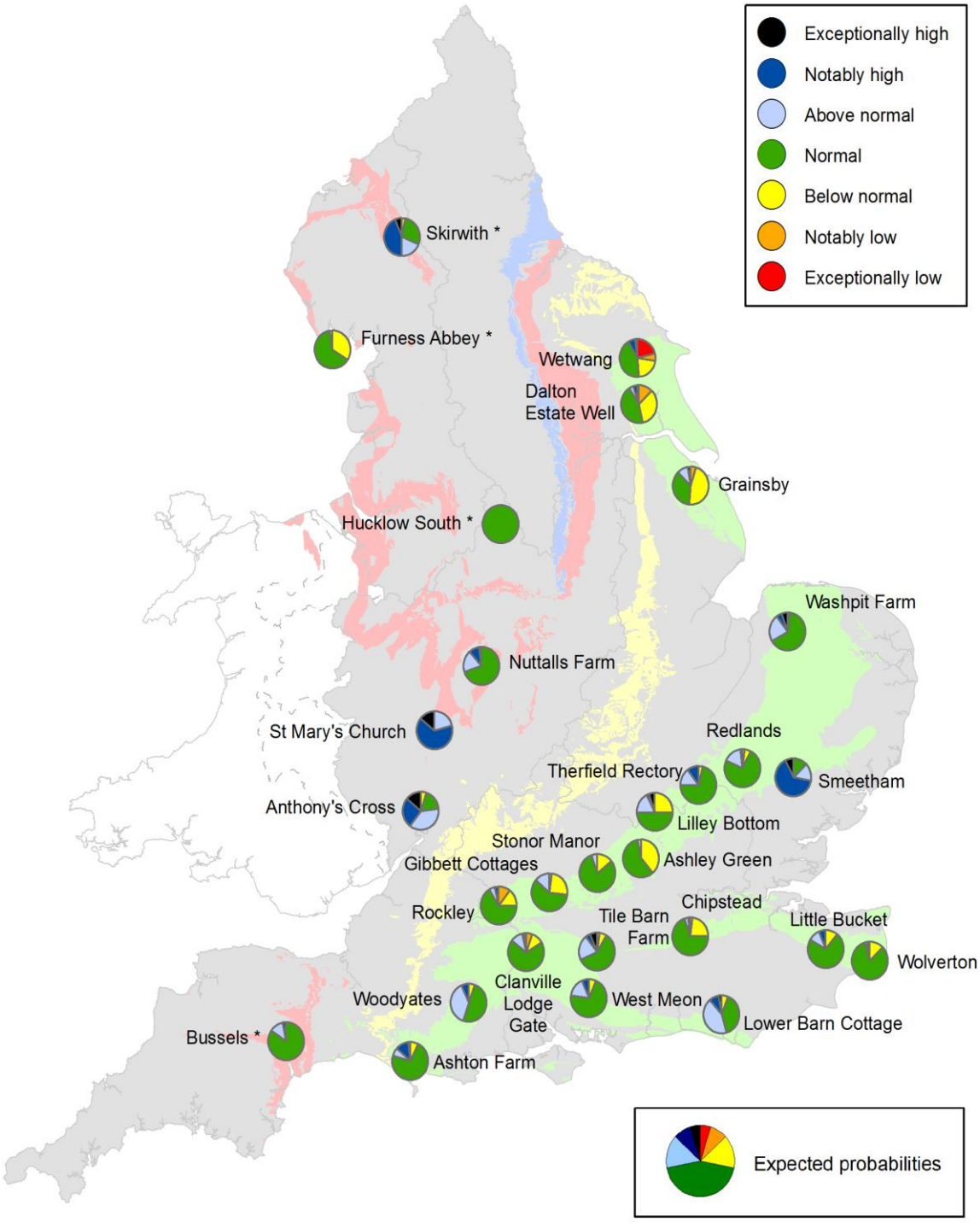
* Projections for these sites are produced by BGS
[1] This range of probabilities is a regional analysis



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 2022. 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, 100024198, 2021.

** 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 2022. 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, 100024198, 2021.

* 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 to 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