UK Hydrological Outlook

Delivered in partnership by:
UK Centre for Ecology & Hydrology

Period: From May 2021   Issued on 10.05.2021 using data to the end of April 2021

SUMMARY

The outlook for May, and for the next three months, is for river flows to be normal to below normal, in most parts of the UK, the exception being the south-west of England where below normal river flows are likely to persist. Groundwater levels in May, and for the next three months, are likely to be normal to above normal across most of the UK. Again there is an exception, with groundwater levels in central southern England being normal to below normal in both May and the period to July.

Rainfall:

Precipitation in April was below average across the UK, ranging from less than 10% of the long-term average in south-east England, to 80% in the north of Scotland. May has started with a spell of wet weather, with heavy rainfall in central parts of the UK.

The rainfall outlook for May (issued by the Met Office on 24.04.2021) shows a reduction in the likelihood of dry conditions compared to normal while wet conditions show near-normal likelihood. Over the three month period to July, a similar shift is seen, albeit with a greater likelihood of wet conditions.

River flows:

River flows in April were normal to below normal across the UK, with many notably low flows especially in the south-west of England. Some small, groundwater-fed rivers associated with the Chalk aquifers in the south-east remain above normal.*

River flows in May are likely to be similar to those observed in April, i.e. generally normal to below normal with the exceptions mentioned above. Over the three month period May-June-July similar conditions will prevail, albeit with a trend back to more normal conditions especially in the north of England and Scotland.
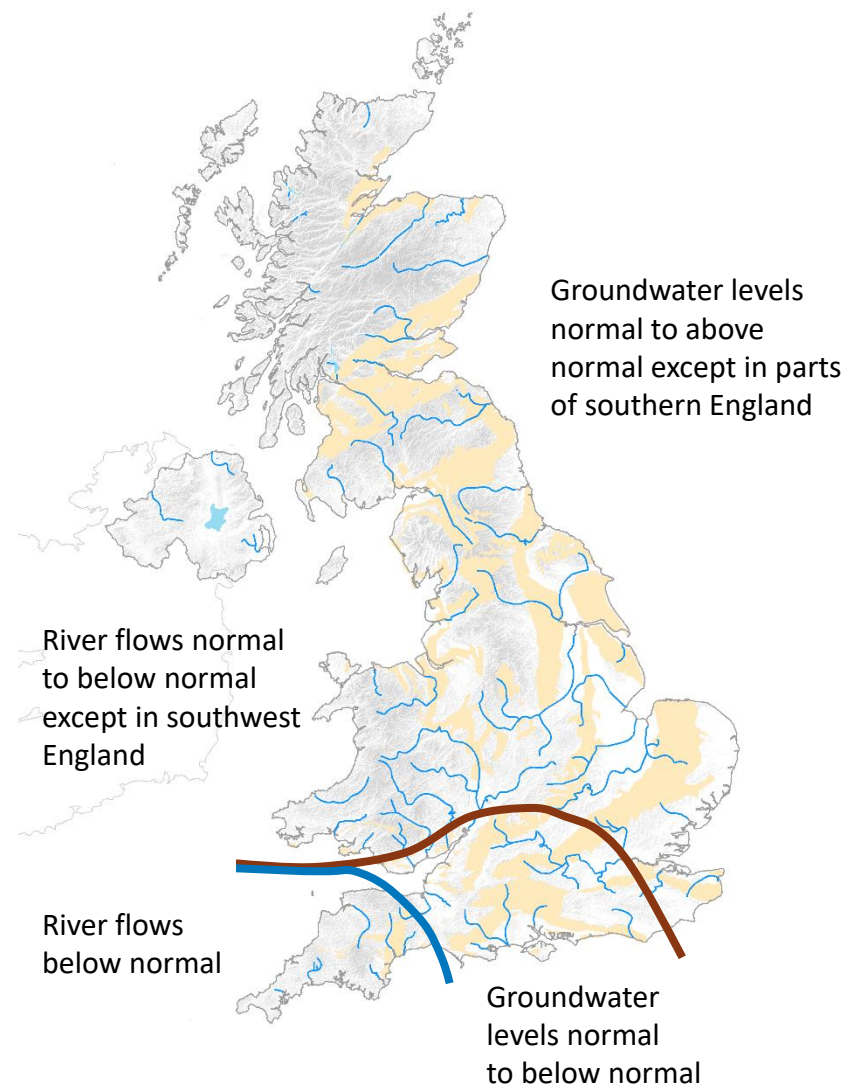
Groundwater:

Groundwater levels in April were normal to notably high. Normal levels were seen in most of the boreholes of central southern England, whilst higher levels were recorded in the Magnesian limestone and Permo-Triassic sandstones of northern England, as well as in the Chalk aquifers in Norfolk.*

The outlook is consistent across both the 1-month and 3-month forecast, with normal to below groundwater levels predicted across southern England and Wales. Below normal levels are forecast across the South Downs. However, there are exceptions, including above normal levels predicted several sites in the Chalk of East Anglia. In the north of England and Wales, normal to above normal levels are predicted. Exceptionally high levels are predicted in the Permo-Triassic sandstone.

* Note: Due to unforeseen circumstances no data are available for Scotland

The Hydrological Outlook UK provides an outlook for the water situation for the UK over the next three months and beyond. For guidance on how to interpret the outlook, a wider range of information, and a full description of underpinning methods, please visit the website: www.hydoutuk.net

Groundwater levels normal to above normal except in parts of southern England

River flows normal to below normal except in southwest England

River flows below normal

Groundwater levels normal to below normal

Shaded areas show principal aquifers

UK Centre for Ecology & Hydrology

British Geological Survey

Department for Infrastructure
An Roinn Bonneagair
www.infrastructure-ni.gov.uk

Environment Agency

Met Office

Cyfoeth Naturiol Cymru
Natural Resources Wales

SEPA
Scottish Environment Protection Agency

UK Hydrological Outlook

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About the Hydrological Outlook:

This document presents an outlook for the UK water situation for the next 1 – 3 months and beyond, using observational datasets, meteorological forecasts and a suite of hydrological modelling tools. The outlook is produced in a collaboration between the UK Centre for Ecology and Hydrology (UKCEH), British Geological Survey (BGS), the Met Office, the Environment Agency (EA), Natural Resources Wales (NRW), the Scottish Environment Protection Agency (SEPA), and for Northern Ireland, the Department for Infrastructure – Rivers (DfIR).
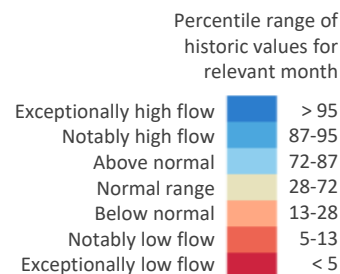
Data and Models:

The Hydrological Outlook depends on the active cooperation of many data suppliers. This cooperation is gratefully acknowledged. Historic river flow and groundwater data are sourced from the UK National River Flow Archive and the National Groundwater Level Archive. Contemporary data are provided by the EA, SEPA, NRW and DfIR. These data are used to initialise hydrological models, and to provide outlook information based on statistical analysis of historical analogues.

Climate forecasts are produced by the Met Office. Hydrological modelling is undertaken by UKCEH using the Grid-to-Grid, PDM and CLASSIC hydrological models and by the EA using CATCHMOD. Hydrogeological modelling uses the R-groundwater model run by BGS and CATCHMOD run by the EA. Supporting documentation is available from the Outlooks website:
http://www.hydoutuk.net/methods

Presentation:

The language used in the summary presented overleaf generally places flows and groundwater levels into just three classes, i.e. below normal, normal, and above normal. However, the underpinning methods use as many as seven classes as defined in the graphic to the right, i.e. the summary uses a simpler classification than some of the methods. On those occasions when it is appropriate to provide greater discrimination at the extremes the terminology and definitions of the seven class scheme will be adopted.

Percentile range of historic values for relevant month

Exceptionally high flow	> 95
Notably high flow	87-95
Above normal	72-87
Normal range	28-72
Below normal	13-28
Notably low flow	5-13
Exceptionally low flow	< 5

Disclaimer and liability:

The Hydrological Outlook partnership aims to ensure that all Content provided is accurate and consistent with its current scientific understanding. However, the science which underlies hydrological and hydrogeological forecasts and climate projections is constantly evolving. Therefore any element of the Content which involves a forecast or a prediction should not be relied upon as though it were a statement of fact. To the fullest extent permitted by applicable law, the Hydrological Outlook Partnership excludes all warranties or representations (express or implied) in respect of the Content.

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From April 2018 the Hydrological Outlook is supported by the Natural Environment Research Council funded UK-SCAPE and Hydro-JULES Programmes.

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Further information:

For more detailed information about the Hydrological Outlook, and the derivation of the maps, plots and interpretation provided in this outlook, please visit the Hydrological Outlook UK website.

The website features a host of other background information, including a wider range of sources of information which are used in the preparation of this Outlook.

Contact:

Hydrological Outlooks UK, UK Centre for Ecology & Hydrology, Wallingford, Oxfordshire, OX10 8BB
t: 01491 692371   e: enquiries@hydoutuk.net

Reference for the Hydrological Outlook:

Hydrological Outlook UK, 2021, May, UK Centre for Ecology and Hydrology, Oxfordshire UK, Online,
http://www.hydoutuk.net/latest-outlook/

Other Sources of Information:

The Hydrological Outlook should be used alongside other sources of up-to-date information on the current water resources status and flood risk.

Environment Agency Water Situation Reports: provides summary of water resources status on a monthly and weekly basis for England:
https://www.gov.uk/government/collections/water-situation-reports-for-england

Flood warnings are continually updated, and should be consulted for an up-to-date and localised assessment of flood risk:
Environment Agency: https://flood-warning-information.service.gov.uk/map
Scottish Environment Protection Agency: http://www.sepa.org.uk/flooding.aspx

Hydrological Summary for the UK: provides summary of current water resources status for the UK:
https://nrfa.ceh.ac.uk/monthly-hydrological-summary-uk

UK Met Office forecasts for the UK:
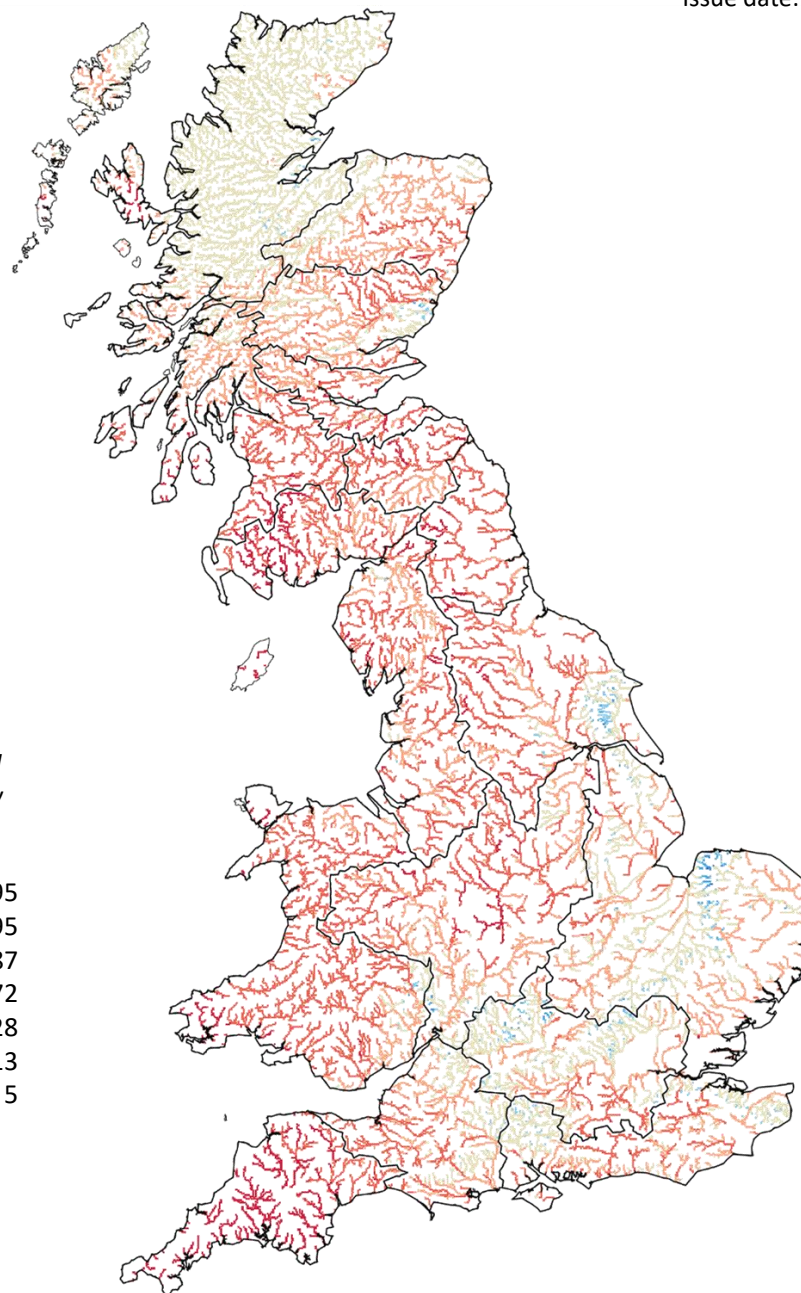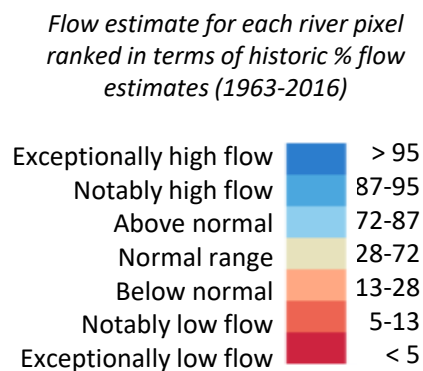www.metoffice.gov.uk/public/weather/forecast/#?tab=regionalForecast

UK Water Resources Portal: monitor the UK hydrological situation in near real-time including rainfall, river flow, groundwater and soil moisture from COSMOS-UK:
https://eip.ceh.ac.uk/hydrology/water-resources/

UK Centre for Ecology & Hydrology

BGS British Geological Survey

Department for Infrastructure An Roinn Bonneagair
www.infrastructure-ni.gov.uk

Environment Agency

Met Office

Cyfoeth Naturiol Cymru Natural Resources Wales

SEPA Scottish Environment Protection Agency

Monthly mean river flows simulated by the Grid-to-Grid hydrological model

Period: April 2021

Issue date: 05.05.2021

UK Centre for Ecology & Hydrology

The 1km resolution Grid-to-Grid (G2G) hydrological model is run up to the forecast origin with observed rainfall and potential evaporation to provide the hydrological initial condition for the HOUK seasonal river flow forecasts.

This map shows the simulated monthly mean flow across Great Britain ranked in terms of 54 years of historical flow estimates (1963 – 2016).

Note that the G2G provides estimates of natural flows.

Flow estimate for each river pixel ranked in terms of historic % flow estimates (1963-2016)

Exceptionally high flow	> 95
Notably high flow	87-95
Above normal	72-87
Normal range	28-72
Below normal	13-28
Notably low flow	5-13
Exceptionally low flow	< 5

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UK Centre for Ecology & Hydrology

Current Daily Simulated Subsurface Water Storage Conditions

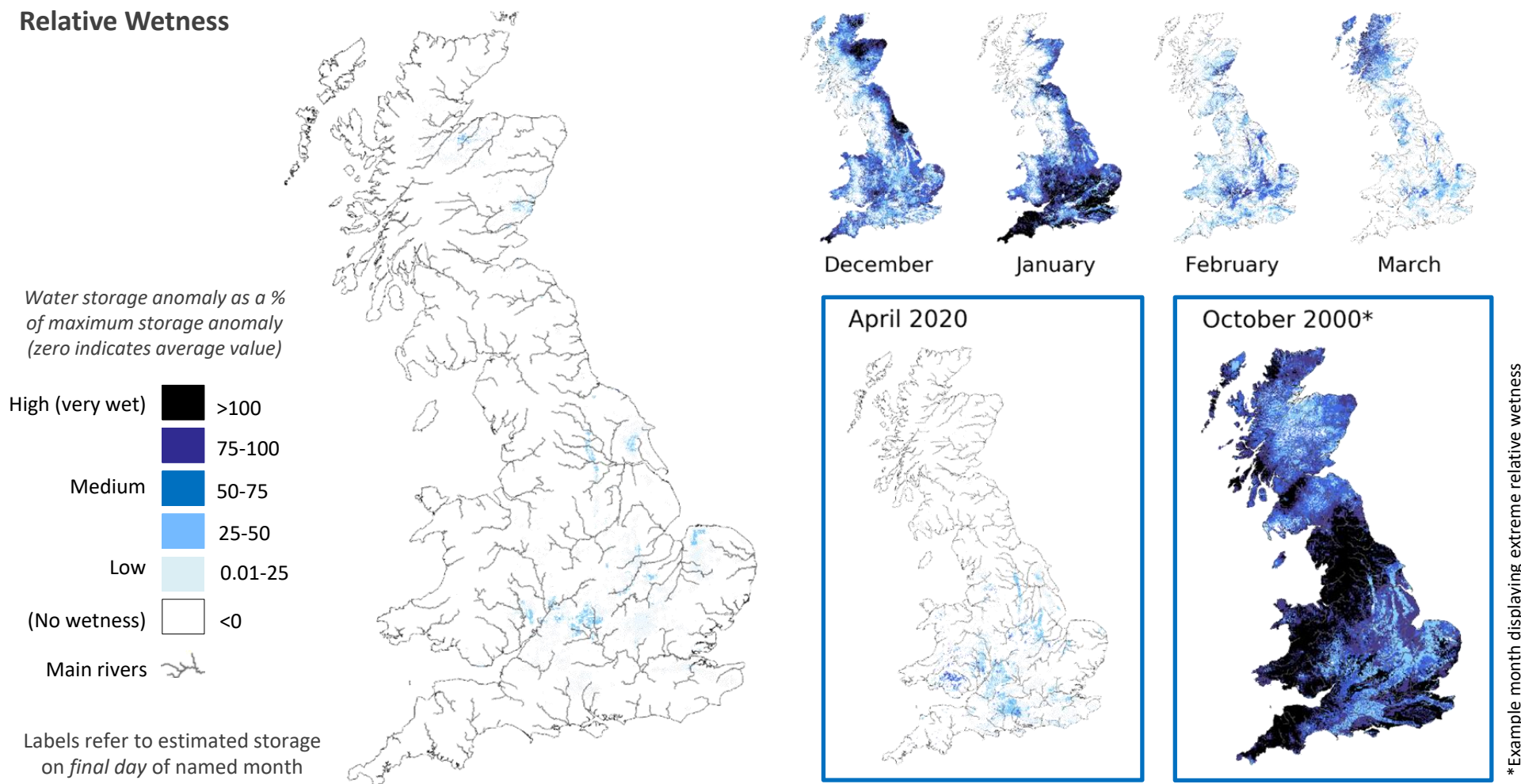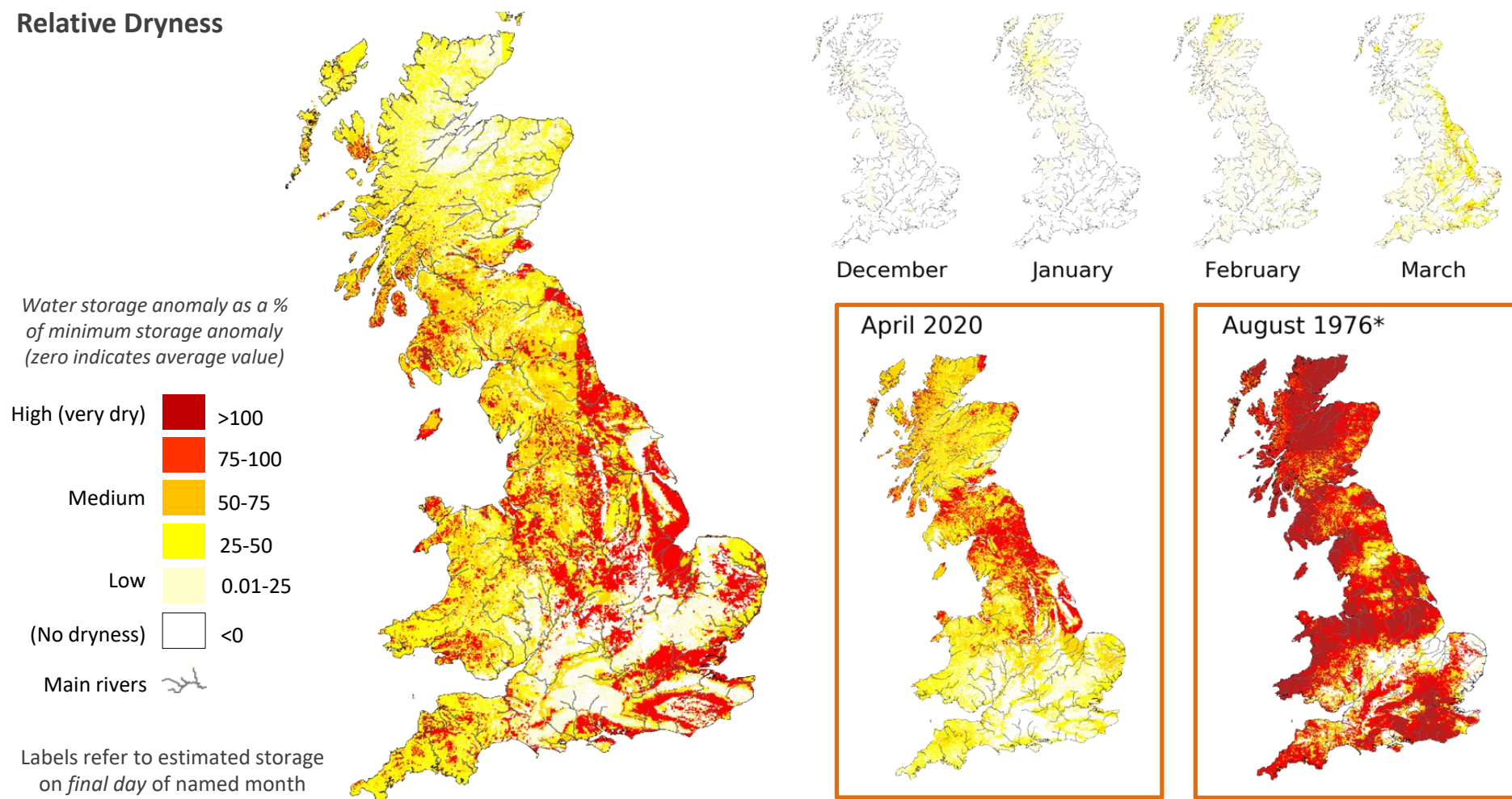Based on subsurface water storage estimated for 30th April 2021

Issue date: 05.05.2021

These maps are based on Grid-to-Grid (G2G) hydrological model simulated subsurface water storage, expressed as an anomaly from the historical monthly mean. To highlight areas that are particularly wet or dry, the storage anomaly is presented here using a colour scale highlighting water storage relative to historical extremes. The maps below show relative wetness.

These maps do not provide a flood forecast and are not maps of soil moisture. Instead they indicate areas where subsurface water storage approaches or exceeds its historical maximum. Rainfall in the high 'relative wetness' areas could result in flooding.

SUMMARY: At the end of April, subsurface water levels across the country were mostly near average for this time of year with low or no relative wetness.

Relative Wetness

Water storage anomaly as a % of maximum storage anomaly (zero indicates average value)

High (very wet)	>100
	75-100
Medium	50-75
	25-50
Low	0.01-25
(No wetness)	<0
Main rivers	

Labels refer to estimated storage on *final day* of named month

December   January   February   March

April 2020

October 2000*

*Example month displaying extreme relative wetness

May 2021

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Current Daily Simulated Subsurface Water Storage Conditions

Based on subsurface water storage estimated for 30th April 2021

Issue date: 05.05.2021

These maps are based on Grid-to-Grid (G2G) hydrological model simulated subsurface water storage, expressed as an anomaly from the historical monthly mean. To highlight areas that are particularly wet or dry, the storage anomaly is presented here using a colour scale highlighting water storage relative to historical extremes. The maps below show relative dryness.

These maps do not provide a drought forecast and are not maps of soil moisture. Instead they indicate areas where subsurface water storage approaches or exceeds its historical minimum. A lack of rainfall in the high 'relative dryness' areas could lead to (or prolong) a drought.

SUMMARY: At the end of April, subsurface water levels across much of the country were lower than normal for this time of year, with widespread low-medium relative dryness and areas of medium-high relative dryness.

Relative Dryness

Water storage anomaly as a % of minimum storage anomaly (zero indicates average value)

High (very dry)		>100
		75-100
Medium		50-75
		25-50
Low		0.01-25
(No dryness)		<0
Main rivers		

Labels refer to estimated storage on *final day* of named month

December   January   February   March

April 2020

August 1976*

*Example month displaying extreme relative dryness

May 2021

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Current Daily Simulated Subsurface Water Storage Conditions

Relative Dryness

- The relative dryness map highlights areas where current estimates of **subsurface water storage** (from the G2G hydrological model, calculated for the last day of last month) are particularly *low*.

- The map indicates areas where the ground is dry compared to the monthly **average** storage (for the period 1981 to 2010), and shows this relative to the historical **minimum** storage level (for 1971 to 2010).

- Relative dryness calculation: R_d (%) $= \dfrac{(S_{average} - S)}{(S_{average} - S_{min})}$ x 100

  $= \dfrac{\text{(average storage for this month - storage at end of last month)}}{\text{(average storage for this month - historical minimum storage)}}$ x 100

- A value of R_d **= 100** shows that a region is very dry, and indicates that the storage is as low as the minimum value ever estimated by the model for this month.

- A value of R_d **= 0** indicates that the storage in the region matches the monthly average value. *Negative relative dryness values will show up as part of the relative wetness map.*

- The map **does not provide a drought forecast**. A lack of rainfall in the high 'relative dryness' areas **could** lead to (or prolong) a drought.

Relative Wetness

- The relative wetness map highlights areas where current estimates of **subsurface water storage** (from the G2G hydrological model, calculated for the last day of last month) are particularly *high*.

- The map indicates areas where the ground is wet compared to the monthly **average** storage (for the period 1981 to 2010), and shows this relative to the historical **maximum** storage level (for 1971 to 2010).

- Relative wetness calculation: R_w (%) $= \dfrac{(S - S_{average})}{(S_{max} - S_{average})}$ x 100

  $= \dfrac{\text{(storage at end of last month - average storage for this month)}}{\text{(historical maximum storage - average storage for this month)}}$ x 100

- A value of R_w **= 100** shows that a region is very wet, and indicates that the storage is as high as the maximum value ever estimated by the model for this month.

- A value of R_w **= 0** indicates that the storage in the region matches the monthly average value. *Negative relative wetness values will show up as part of the relative dryness map.*

- The map **does not provide a flood forecast**. Rainfall in the high 'relative wetness' areas **could** result in flooding.

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Return Period of Rainfall Required to Overcome Dry Conditions

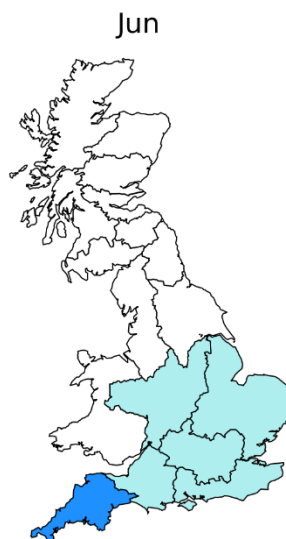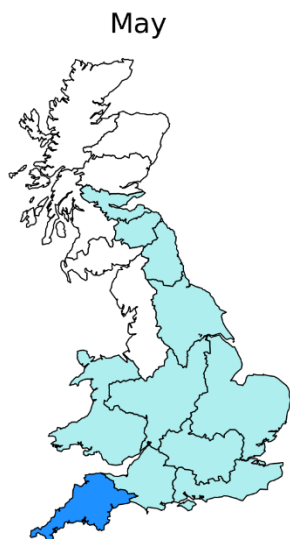**UK Centre for Ecology & Hydrology**

Period: May 2021 – October 2021

Issue date: 05.05.2021

These maps show the **return period** of the rainfall required to overcome dry conditions simulated using the Grid-to-Grid (G2G) hydrological model. The maps are coloured according to the return period of accumulated rainfall required to overcome the estimated current subsurface water storage deficit over the next few months.

These maps do not provide a drought forecast. Instead they indicate the return period of rainfall required to overcome the dry conditions for the following 6 months based on current conditions.

SCOTLAND
HR   Highlands Region
NER   North East Region
TR   Tay Region
FR   Forth Region
CR   Clyde Region
TWR   Tweed Region
SR   Solway Region
ENGLAND
N   Northumbria
NW   North West
Y   Yorkshire
ST   Severn Trent
A   Anglian
T   Thames
S   Southern
W   Wessex
SW   South West
WALES
WEL   Welsh

NORTHERN IRELAND
This method cannot currently be used in Northern Ireland

SUMMARY: During May multiple regions across Great Britain will require a rainfall amount with a 5-10 year return period in order to return to average conditions for the time of year. The South West region will require rainfall with a higher 10-25 year return period to return to average conditions.

Some of this anticipated dryness persists into June across southern and central England, but from July until October Britain will not require particularly unusual rainfall to return to average conditions.

May

Jun

Jul

Aug

Sep

Oct
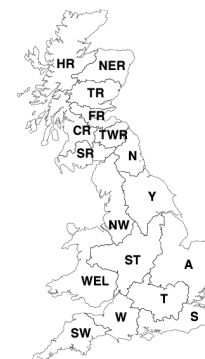
Rainfall amount / Probability		Return period (years)
Low (this rain is likely to occur)	> 20%	< 5
	< 20%	5 - 10
	< 10%	10 - 25
	< 4%	25 - 50
High (less likely)	< 2%	50 - 100
	< 1%	100 - 200
Extreme (unlikely but still possible)	< 0.5%	> 200

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Method

- These maps show the **return period** of the rainfall required to overcome dry conditions simulated using the Grid-to-Grid (G2G) hydrological model. The maps are coloured according to the return period of rainfall required to overcome the estimated current subsurface water storage deficit.

- For **dry areas** within a Hydrological Outlook region, i.e. where subsurface water storage anomaly < 0, we estimate *regional average subsurface water storage deficit (mm)* from the last day of the most recent G2G model run.

- For each region we also estimate the *regional monthly average rainfall total (mm)* (for the period 1971-2000).

- For each of the next 6 months, we estimate the rainfall total (including what is normally expected for each month) required to overcome the dry conditions.
    - To overcome the dry conditions by the end of month 1:

        rainfall required (mm) = regional monthly average rainfall for month 1 + regional average storage deficit
    - To overcome the dry conditions by the end of month 2 (more likely):

        rainfall required (mm) = regional monthly average rainfall for months 1 and 2 + regional average storage deficit
    - To overcome the dry conditions by the end of month n (likely):

        rainfall required (mm) = regional monthly average rainfall for months 1 to n + regional average storage deficit

- Using Tabony tables we estimate the return period of the *rainfall required* in each region and over the next 1 to 6 months to overcome the dry conditions.

- The return period results are displayed as regional maps with the colour scale based on the return period (years) of the rainfall required to replenish subsurface stores over the next 1, 2, .., 6 months ahead.

- Note: These maps do not provide a drought forecast. Instead they indicate the return period of rainfall required to overcome the dry conditions for the following 6 months based on current conditions.

Estimate of Additional Rainfall Required to Overcome Dry Conditions

Based on subsurface water storage estimated for 30th April 2021

Issue date: 05.05.2021

UK Centre for Ecology & Hydrology

These maps show the Grid-to-Grid (G2G) hydrological model simulated subsurface water storage, expressed as an anomaly from the historical monthly mean (1981-2010), presented on a 1km grid and as regional means.
Subsurface storage deficits, i.e. where the subsurface water storage anomaly is less than zero, **are highlighted by the red/pink colours**.

The **subsurface storage deficit (mm)** can be interpreted as an estimate of additional rainfall that would be required in future months to overcome dry conditions (i.e. rainfall in addition to what is expected on average). Regional mean values of additional rainfall required are provided in the table below.

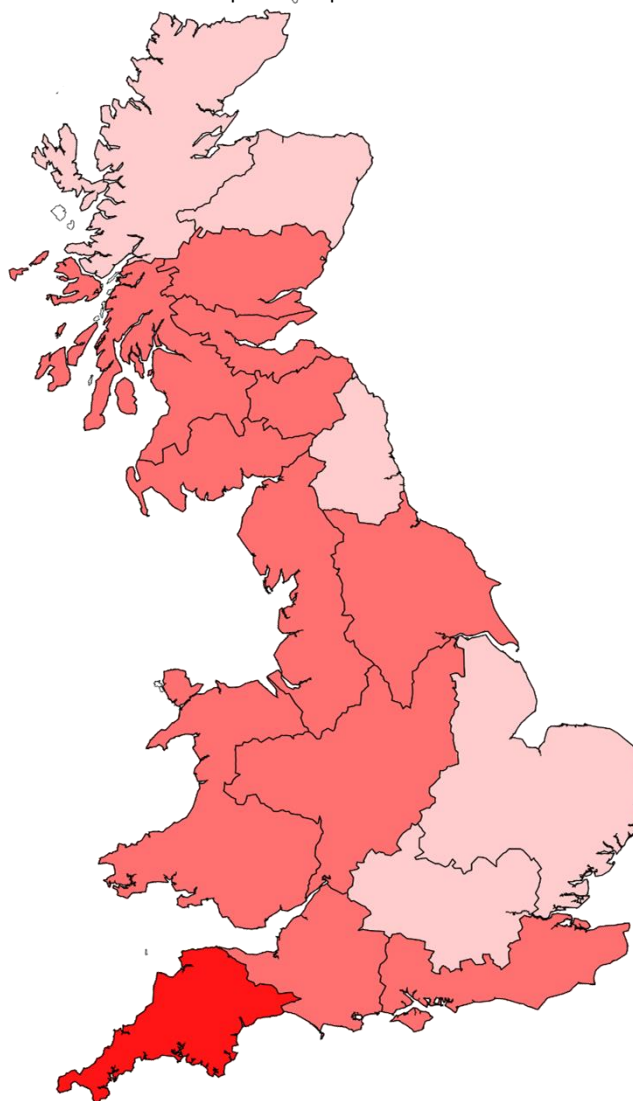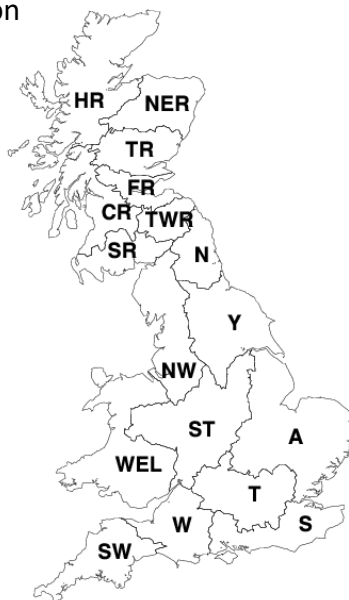*Regional estimate of additional rainfall required (mm)*

SCOTLAND

19	HR	Highlands Region
23	NER	North East Region
26	TR	Tay Region
34	FR	Forth Region
36	CR	Clyde Region
34	TWR	Tweed Region
36	SR	Solway Region

ENGLAND

24	N	Northumbria
29	NW	North West
26	Y	Yorkshire
30	ST	Severn Trent
22	A	Anglian
22	T	Thames
36	W	Wessex
35	S	Southern
62	SW	South West

WALES

39	WEL	Welsh

Water storage deficit (anomaly, mm)

	>125
	100-125
	75-100
	50-75
	25-50
	0.1-25
	≤0

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Outlook based on hydrological persistence and analogy

Overview

Period: May – July 2021

Issued on 07.05.2021 using data to the end of April 2021

SUMMARY

The outlooks for May and for May-July are for normal to above normal flows on most of the Chalk outcrops in southeast England, with flows normal to below normal elsewhere. Note there are no forecasts available for Scotland.
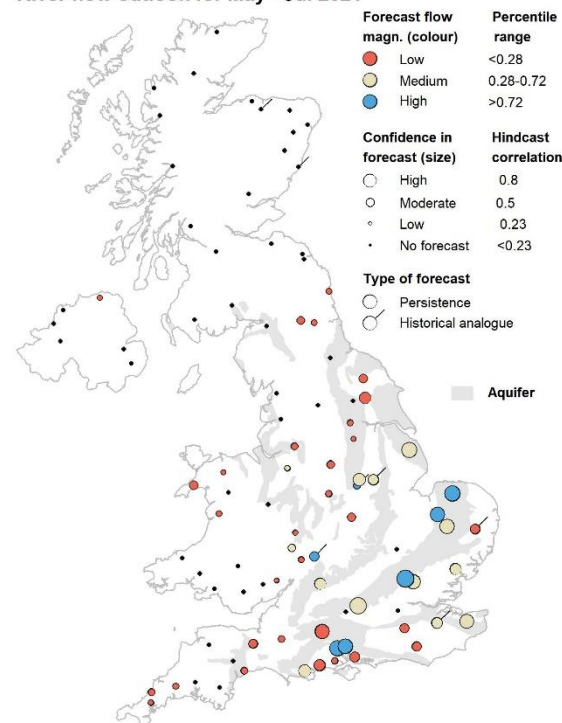

1-month flow outlook
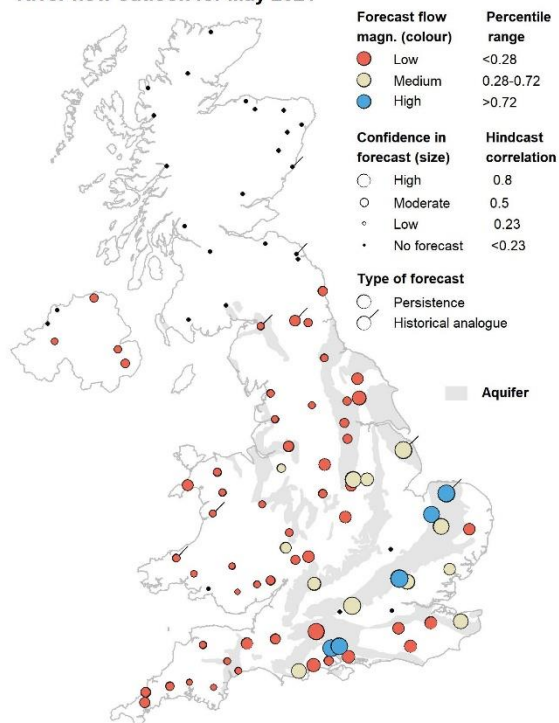
3-month flow outlook

Outlooks from hydrological analogues are based on a comparison of river flow during recent months with flows during the same months in previous years at a set of approximately 90 sites from across the UK. These sites are depicted on the two maps. Years with observed flows that most closely resemble current conditions are identified as the best analogues and the outlook is based on extrapolating from current conditions based on these analogues.

It is, however, often the case that a simpler forecast based on the persistence of river flow provides a better forecast than provided by analogy. This is particularly true for slowly responding catchments associated with aquifer outcrops.

Both methods are considered at each site and the forecast from the method with the higher confidence is presented. A simple classification of flows is used (high, medium and low) as indicated by the colours of the dots, with the confidence

of the forecast being represented by the size of the dot. A tag on the dot indicates which method has been used in each instance.

May 2021

Outlook based on hydrological persistence and analogy

Site-based: 1 month outlook

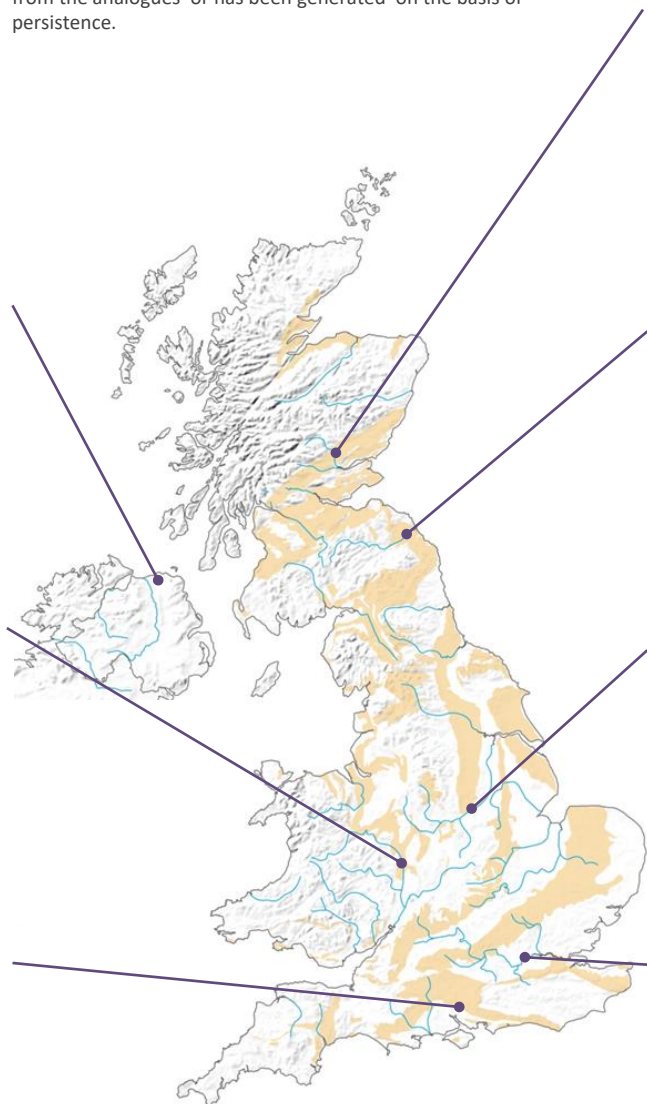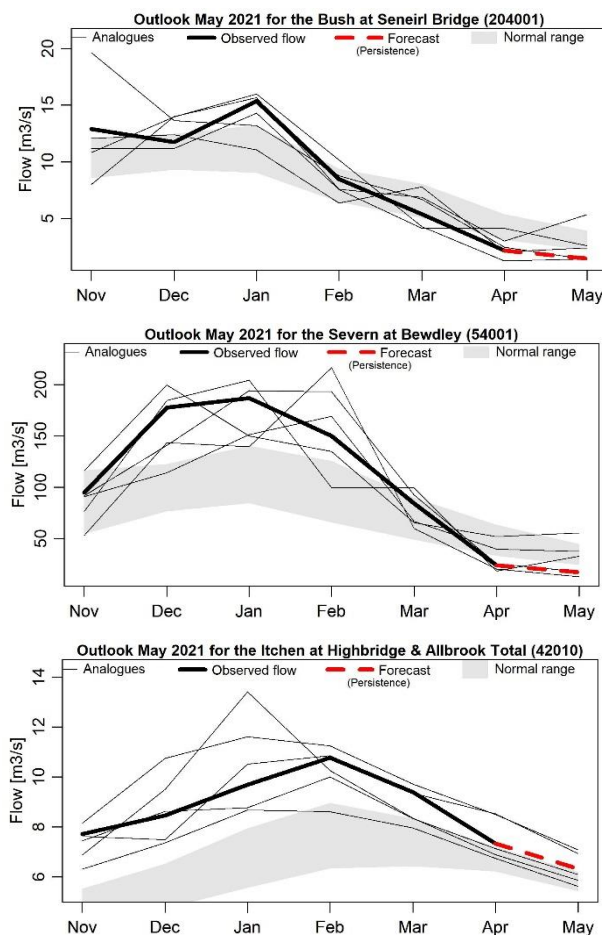**Period: May 2021**

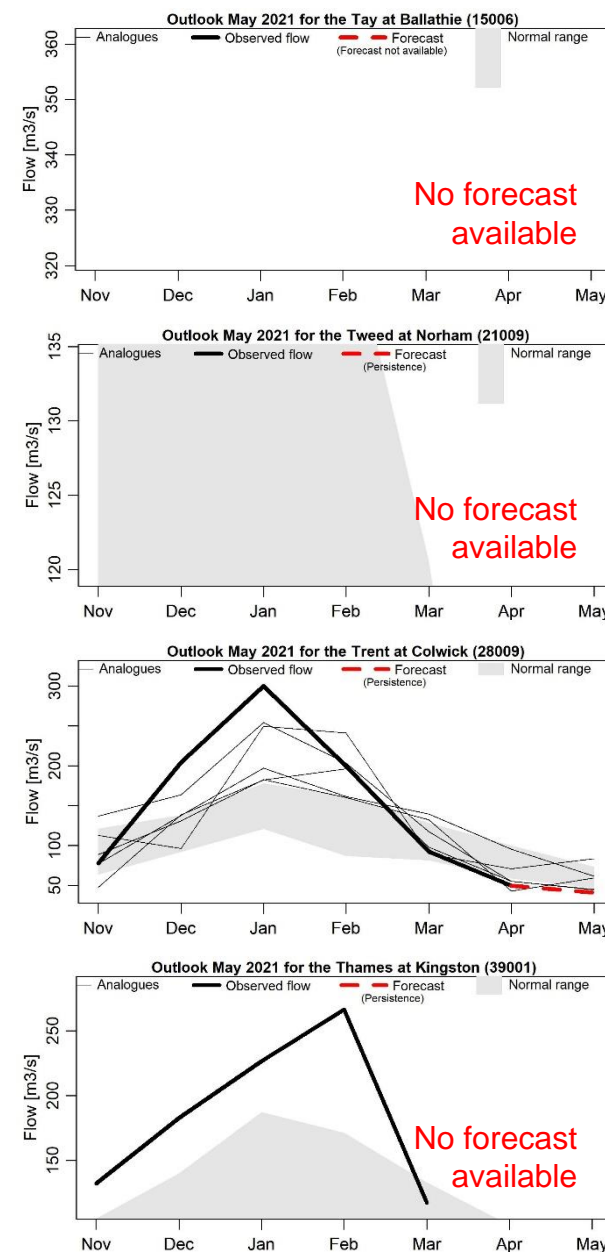**Issued on 07.05.2021 using data to the end of April 2021**

These figures provide insight into the hydrological analogue methodology for a set of sites from across the UK.

In each of the time series graphs the bold black line represents the observed flow during the past six months. The grey band indicates the normal flow range (the normal band includes 44% of observed flows in each month). The selected analogues are shown as thin lines and the trajectories that flows took in the following month are also shown. The forecast is shown as the dashed red line, and in each plot it states whether this has come from the analogues or has been generated on the basis of persistence.

Outlook May 2021 for the Tay at Ballathie (15006)

No forecast available

Outlook May 2021 for the Bush at Seneirl Bridge (204001)

Outlook May 2021 for the Tweed at Norham (21009)

No forecast available

Outlook May 2021 for the Severn at Bewdley (54001)

Outlook May 2021 for the Trent at Colwick (28009)

Outlook May 2021 for the Itchen at Highbridge & Allbrook Total (42010)

Outlook May 2021 for the Thames at Kingston (39001)

No forecast available

May 2021

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Outlook based on hydrological persistence and analogy

Site-based: 3 month outlook

Period: May – July 2021

Issued on 07.05.2021 using data to the end of April 2021

UK Centre for Ecology & Hydrology

These figures provide insight into the hydrological analogue methodology for a set of sites from across the UK.

In each of the time series graphs the bold black line represents the observed flow during the past nine months. The grey band indicates the normal flow range (the normal band includes 44%

of observed flows in each month). The selected analogues are shown as thin lines and the trajectories that flows took in the following three months are also shown. The forecast is shown as the dashed red line, and in each plot it states whether this has come from the analogues or has been generated on the basis of persistence.
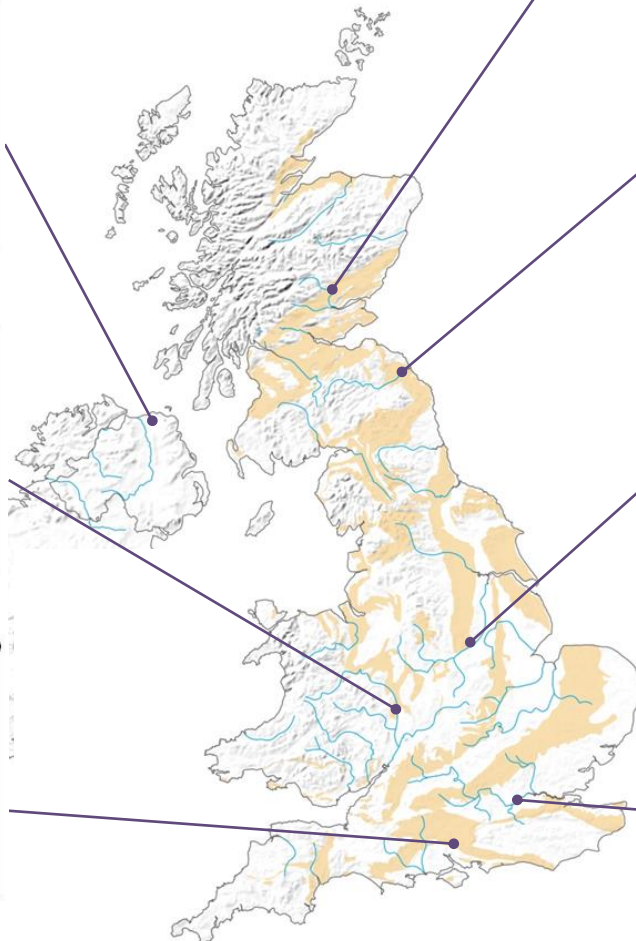

Outlook May - Jul 2021 for the Tay at Ballathie (15006)

Outlook May - Jul 2021 for the Bush at Seneirl Bridge (204001)

Outlook May - Jul 2021 for the Tweed at Norham (21009)

Outlook May - Jul 2021 for the Severn at Bewdley (54001)

Outlook May - Jul 2021 for the Trent at Colwick (28009)

Outlook May - Jul 2021 for the Itchen at Highbridge & Allbrook Total (42010)

Outlook May - Jul 2021 for the Thames at Kingston (39001)

May 2021

Outlook based on modelled flow from historical climate

Overview

Period: May 2021 – October 2021

Issued on **05.05.2021** using data to the end of April 2021

UK Centre for Ecology & Hydrology

British Geological Survey

Environment Agency
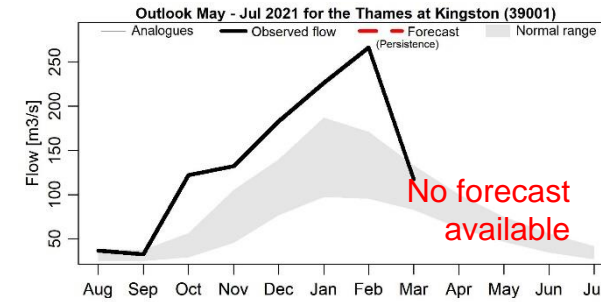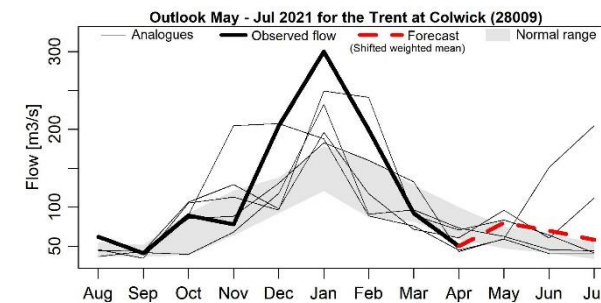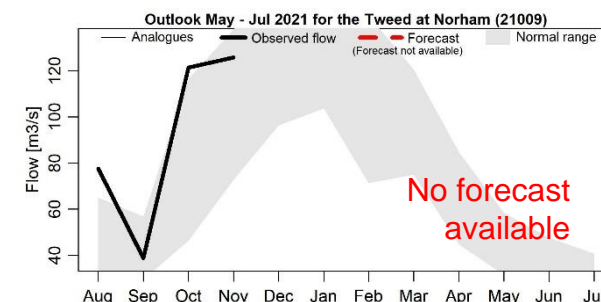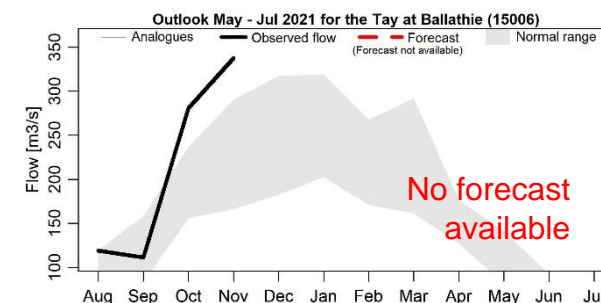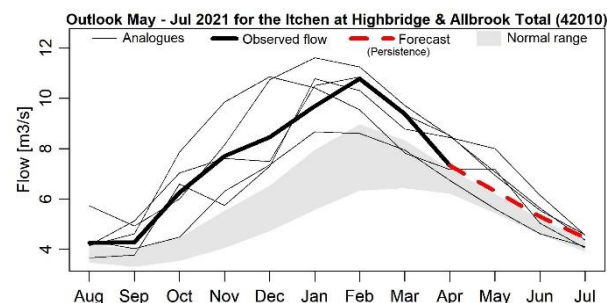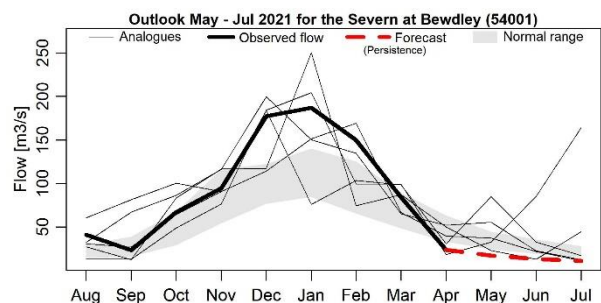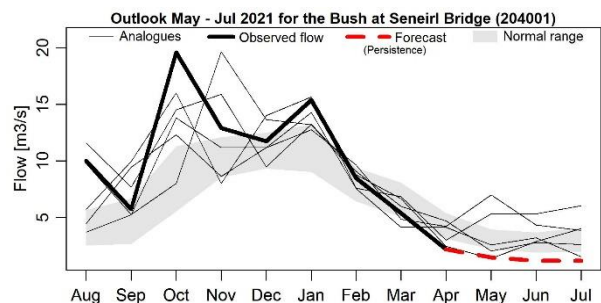
> Following an exceptionally dry April, river flows in south-west England are likely to be below normal to low for May and over the next three months. Flows across Scotland, central and northern England and Wales were predicted to be normal to below normal for May, however rivers are already responding to heavy early May rainfall, such that normal to above normal flows are now likely. In south-eastern England, flows are likely to be within the normal range for May-June-July

1-month river flow outlook starting May 2021
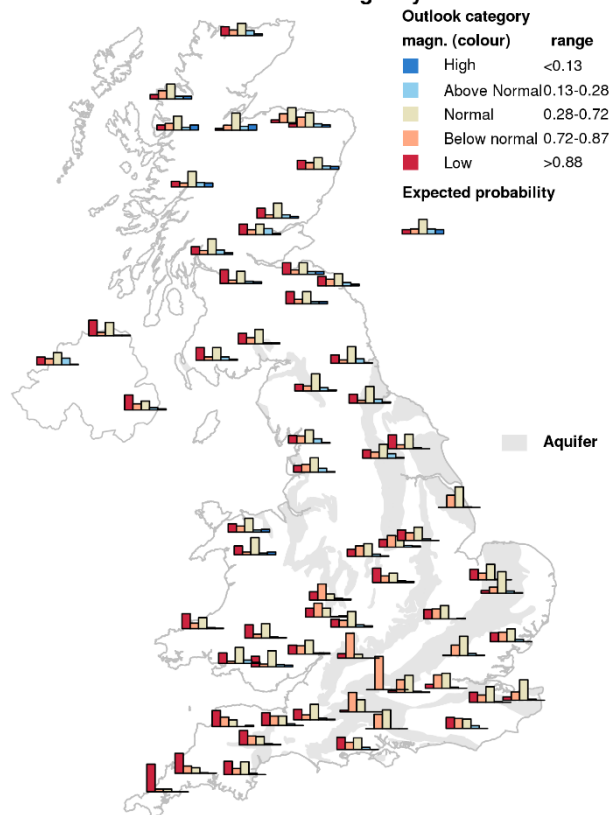
Outlook category		
magn. (colour)		**range**
High		<0.13
Above Normal		0.13-0.28
Normal		0.28-0.72
Below normal		0.72-0.87
Low		>0.88

Expected probability

Aquifer

3-month river flow outlook starting May 2021

Outlook category		
magn. (colour)		**range**
High		<0.13
Above Normal		0.13-0.28
Normal		0.28-0.72
Below normal		0.72-0.87
Low		>0.88

Expected probability

Aquifer

6-month river flow outlook starting May 2021

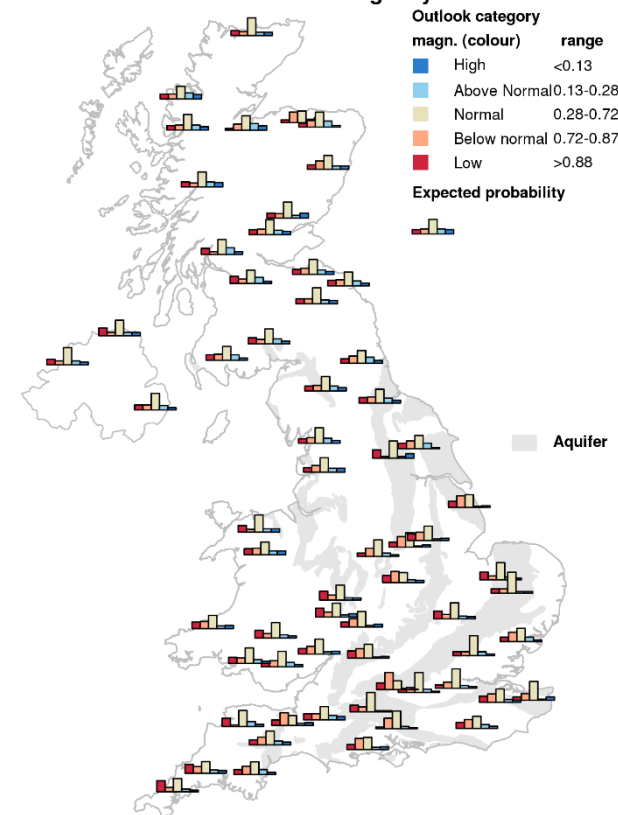| Outlook category		
magn. (colour)		**range**
High		<0.13
Above Normal		0.13-0.28
Normal		0.28-0.72
Below normal		0.72-0.87
Low		>0.88

Expected probability

Aquifer

This outlook is based on monthly ensembles of historical sequences of observed climate (rainfall and potential evapotranspiration) that form input to a hydrological model. The outputs are probabilistic simulations of the average river flow over the forecast period (1 to 12 months ahead), at each location. The simulations are generated by the GR4J conceptual rainfall-runoff model from IRSTEA (France) calibrated on observed or naturalised flows.
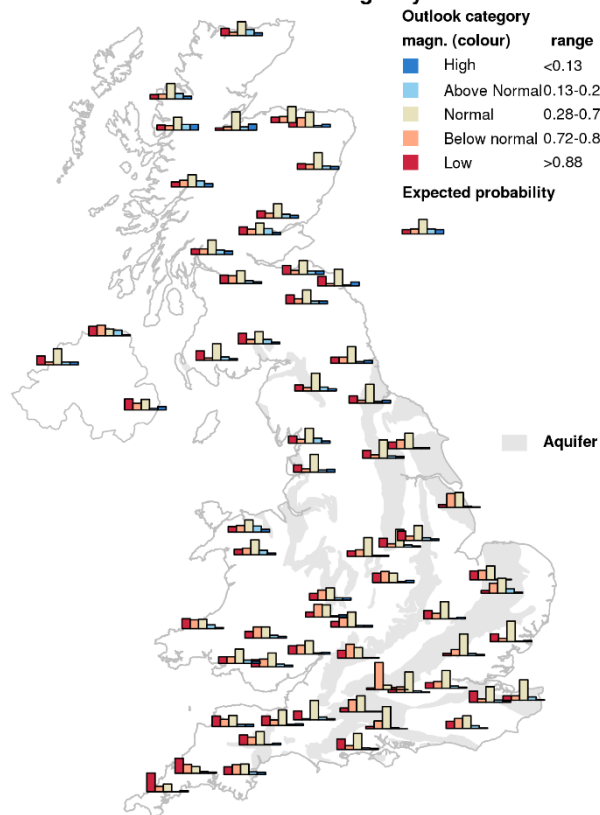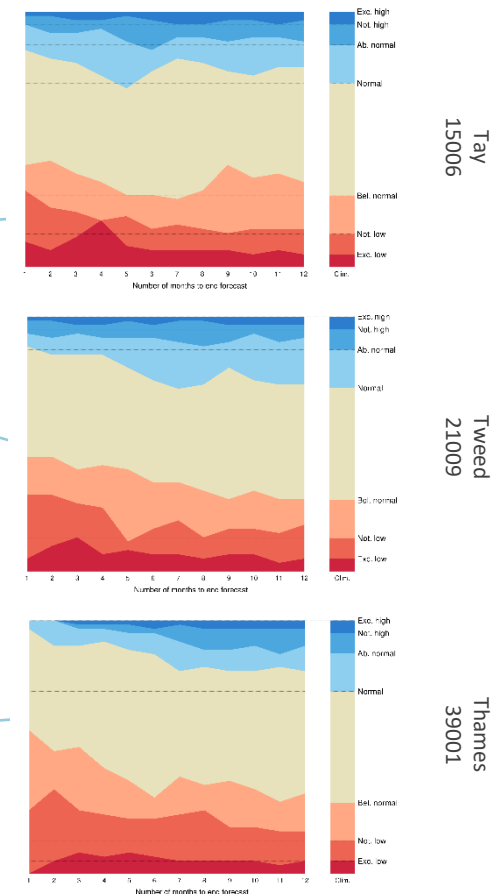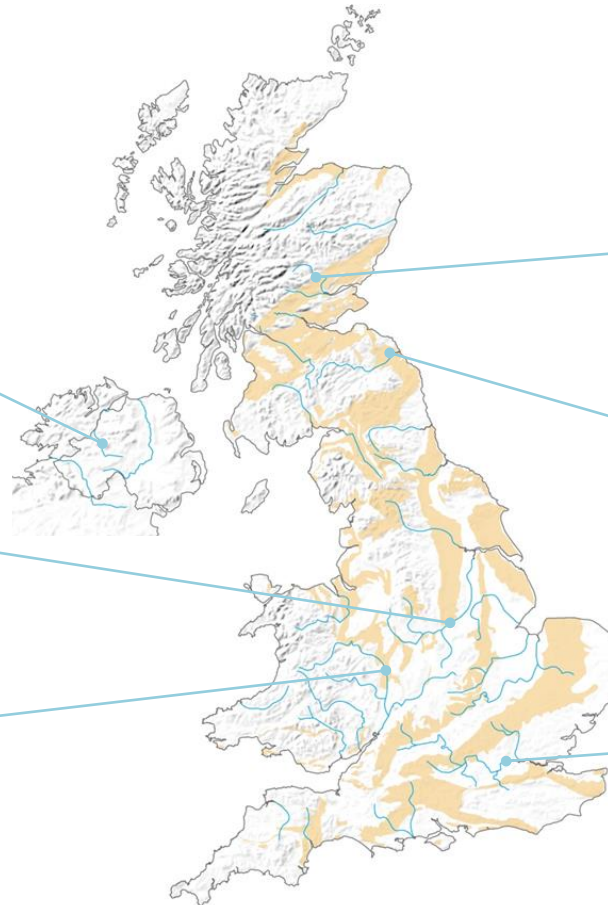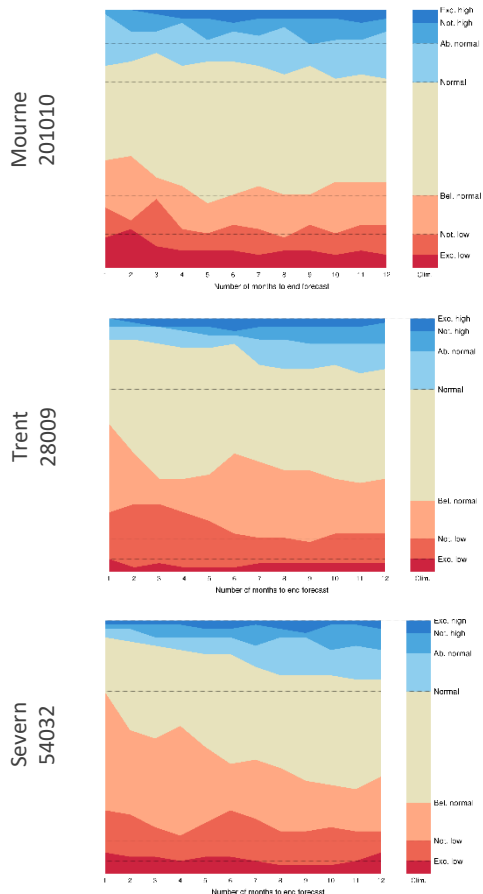
The bar plot maps show the outlook distribution for 1, 3 and 6-month period for 64 catchments across England and Wales. Each bar plot represents the probabilistic distribution of the simulated river flow compared to the historical river flow, for the same n-month period. The probabilities fall within five categories, classified as: low, below normal, normal, above normal and high.

This outlook is based entirely on historical sequences and therefore does not contain any knowledge of the state of the atmosphere and ocean. It is hence possible that some of the historical sequences used might be inconsistent with current large-scale atmospheric conditions and would therefore be unlikely to occur in the next few months.

May 2021

The Hydrological Outlook UK provides an outlook for the water situation for the UK over the next three months and beyond. For guidance on how to interpret the outlook, a wider range of information, and a full description of underpinning methods, please visit the website: www.hydoutuk.net

Outlook based on modelled flow from historical climate

Overview

UK Centre for Ecology & Hydrology

British Geological Survey

Environment Agency

May 2021

Mourne 201010

Trent 28009

Severn 54032

Tay 15006

Tweed 21009

Thames 39001

This outlook is based on monthly ensembles of historical sequences of observed climate (rainfall and potential evapotranspiration) that form input to a hydrological model. The outputs are probabilistic simulations of the average river flow over the forecast period (1 to 12 months ahead), at each location. The simulations are generated by the GR4J conceptual rainfall-runoff model from IRSTEA (France) calibrated on observed or naturalised flows.

The stack diagrams show the variation over time of the outlook distribution for a number of individual catchments. Each graph represents variation over time of the number of simulated river flows, in each month ensemble, that fall within each of seven categories: exceptionally low, notably low, below normal, normal, above normal, notably high and exceptionally high. The categories represent cumulative flow conditions, e.g. For 3-month, the simulated total 3-month flow compared to the historical 3-month flow distribution. The monthly variations can be compared to the long-term average distribution of river flows (shown as columns

on the right of each timeline graph).

This outlook is based entirely on historical sequences and therefore does not contain any knowledge of the state of the atmosphere and ocean. It is hence possible that some of the historical sequences used might be inconsistent with current large-scale atmospheric conditions and would therefore be unlikely to occur in the next few months.

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Outlook Based on Modelled Flow from Rainfall Forecasts

Overview

Period: May 2021 – July 2021

Issued on 05.05.2021 using data to the end of April

SUMMARY: During May, river flows across the country are most likely to be in the *Normal range* or *Below normal.* Flows in the South West region are most likely to be in the *Normal range* to *Notably low.*

Over the next 3 months river flows across the country are most likely to be in the *Normal range* or below.

These forecasts are produced by using five members of the Met Office rainfall forecast ensemble as input to a water balance hydrological model to provide the five estimates of river flows shown on the left for one month and three months ahead.

Regional forecast monthly-mean river flows are derived from the average of 1km river flow estimates within each region and ranked in terms of 54 years of historical flow estimates (1963 – 2016).

The five maps illustrate the wide range of possible flows and while there is a 50% chance of flows between the 1st and 3rd quartiles, actual flows may be more extreme than the flows derived using the highest or lowest rainfall forecasts.
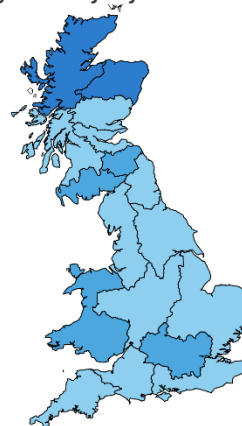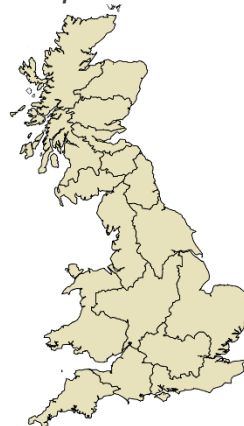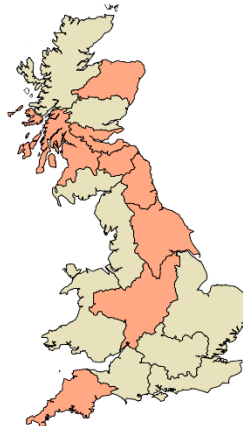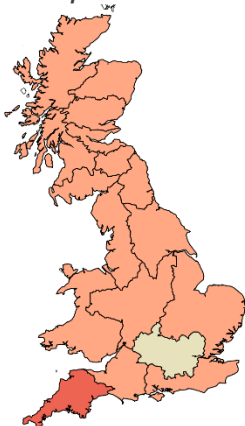
1-month flow outlook

Lowest rainfall forecast	1st quartile	Median	3rd quartile	Highest rainfall forecast

3-month flow outlook

Lowest rainfall forecast	1st quartile	Median	3rd quartile	Highest rainfall forecast

Key

	Percentile range of historic values for relevant month
Exceptionally high flow	> 95
Notably high flow	87-95
Above normal	72-87
Normal range	28-72
Below normal	13-28
Notably low flow	5-13
Exceptionally low flow	< 5

SCOTLAND
HR   Highlands Region
NER   North East Region
TR   Tay Region
FR   Forth Region
CR   Clyde Region
TWR   Tweed Region
SR   Solway Region

ENGLAND
N   Northumbria
NW   North West
Y   Yorkshire
ST   Severn Trent
A   Anglian
T   Thames
S   Southern
W   Wessex
SW   South West

WALES
WEL   Welsh

NORTHERN IRELAND
This method cannot currently be used in Northern Ireland

The Hydrological Outlook UK provides an outlook for the water situation for the UK over the next three months and beyond. For guidance on how to interpret the outlook, a wider range of information, and a full description of underpinning methods, please visit the website: www.hydoutuk.net

![UK Centre for Ecology & Hydrology]

Outlook Based on Modelled Flow from Rainfall Forecasts   1- and 3-month variability

Period: May 2021 – July 2021   Issue date: 05.05.2021

The regional maps illustrating the regional river flows for five members of the Met Office ensemble of rainfall forecasts give some indication of the range of possible river flows in the coming months. As noted previously, the actual flows could be more extreme than the flows generated by either the lowest or highest members of the rainfall ensemble.

The bar charts (below) give further insight into the range of river flow forecasts by considering all members of the forecast rainfall ensemble. The regional bar charts show the percentage of ensemble forecasts falling in each of the flow categories as generated by the monthly-resolution water-balance model. As before results are averaged by region then ranked in terms of 54 years of historical regional flow estimates (1963 – 2016).

SCOTLAND
HR	Highlands Region
NER	North East Region
TR	Tay Region
FR	Forth Region
CR	Clyde Region
TWR	Tweed Region
SR	Solway Region

ENGLAND
N	Northumbria
NW	North West
Y	Yorkshire
ST	Severn Trent
A	Anglian
T	Thames
S	Southern
W	Wessex
SW	South West

WALES
WEL	Welsh

NORTHERN IRELAND
This method cannot currently be used in Northern Ireland

SUMMARY: During May, river flows across the country are most likely to be in the *Normal range* or *Below normal.* Flows in the South West region are most likely to be in the *Normal range* to *Notably low.*

Over the next 3 months river flows across the country are most likely to be in the *Normal range* or below.

1-month   *3-month*

Percentile range of historic values for relevant month

Exceptionally high flow		> 95
Notably high flow		87-95
Above normal		72-87
Normal range		28-72
Below normal		13-28
Notably low flow		5-13
Exceptionally low flow		< 5

expected

Outlook Based on Modelled Flow from Rainfall Forecasts   1- and 3-month variability

UK Centre for Ecology & Hydrology
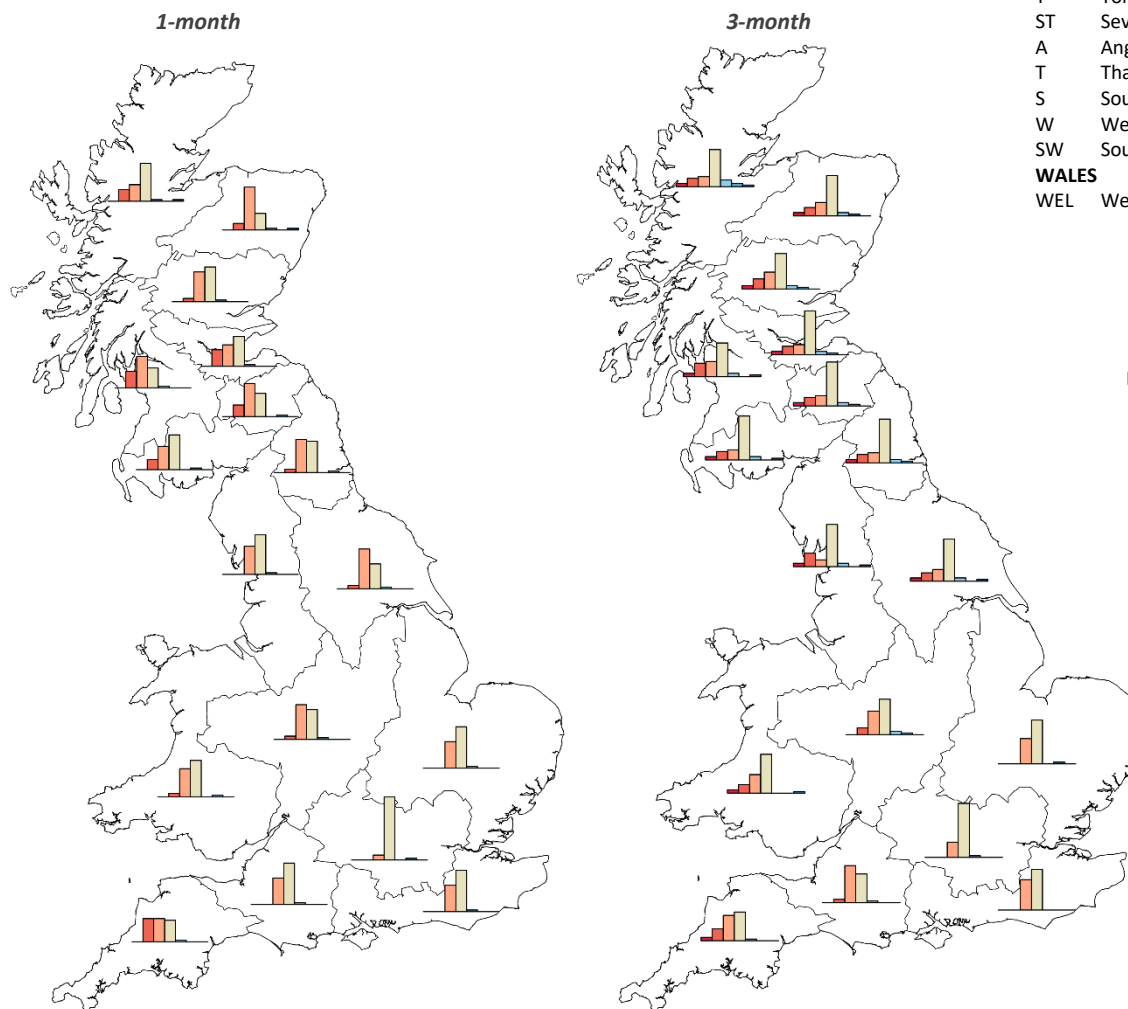
Period: May 2021 – July 2021   Issue date: 05.05.2021
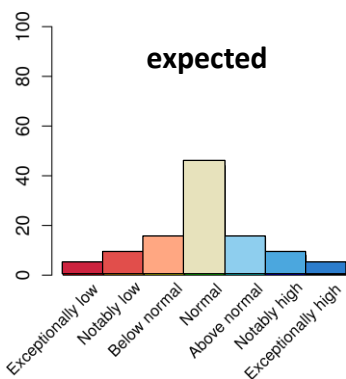
The maps illustrating the regional river flows for five members of the Met Office ensemble of rainfall forecasts give some indication of the range of possible river flows in the coming months. As noted previously, the actual flows could be more extreme than the flows generated by either the lowest or highest members of the rainfall ensemble.

The tables below give further insight into the range of river flow forecasts by considering all members of the forecast rainfall ensemble. The numbers in the tables are the percentage of ensemble forecasts falling in each of the flow categories as generated by the monthly-resolution water-balance model. As before results are averaged by region then ranked in terms of 54 years of historical regional flow estimates (1963 – 2016).

SUMMARY: During May, river flows across the country are most likely to be in the *Normal range* or *Below normal.* Flows in the South West region are most likely to be in the *Normal range* to *Notably low.*

Over the next 3 months river flows across the country are most likely to be in the *Normal range* or below.

SCOTLAND
HR	Highlands Region
NER	North East Region
TR	Tay Region
FR	Forth Region
CR	Clyde Region
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SR	Solway Region

ENGLAND
N	Northumbria
NW	North West
Y	Yorkshire
ST	Severn Trent
A	Anglian
T	Thames
S	Southern
W	Wessex
SW	South West

WALES
WEL	Welsh

NORTHERN IRELAND
This method cannot currently be used in Northern Ireland

1-month ahead

	A	NW	N	ST	SW	S	T	Welsh	W	Y	CR	FR	HR	NER	SR	TR	TWR
Exceptionally high flow	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0
Notably high flow	0	0	2	0	0	0	2	2	0	0	0	0	0	0	2	0	2
Above normal	2	2	0	2	2	2	0	0	2	2	2	2	2	2	0	2	0
Normal range	60	57	45	43	31	60	90	52	60	36	29	43	55	24	50	50	33
Below normal	38	40	48	50	33	38	7	40	38	57	45	31	24	62	33	43	48
Notably low flow	0	0	5	5	33	0	0	5	0	5	24	24	17	10	14	5	17
Exceptionally low flow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

3-months ahead

	A	NW	N	ST	SW	S	T	Welsh	W	Y	CR	FR	HR	NER	SR	TR	TWR
Exceptionally high flow	0	2	0	0	0	0	0	2	0	2	2	0	2	0	0	2	0
Notably high flow	2	0	2	2	0	0	0	0	0	0	0	2	5	2	2	0	2
Above normal	0	5	5	5	2	0	2	0	2	5	5	5	10	5	0	5	5
Normal range	62	60	62	50	40	57	76	55	40	60	48	62	52	57	62	60	62
Below normal	36	10	14	33	36	43	21	26	52	17	21	14	14	19	36	10	14
Notably low flow	0	19	12	10	17	0	0	12	5	12	19	12	12	12	0	19	12
Exceptionally low flow	0	5	5	0	5	0	0	5	0	5	5	5	5	5	0	5	5

May 2021

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Outlook based on modelled groundwater level & climate forecast
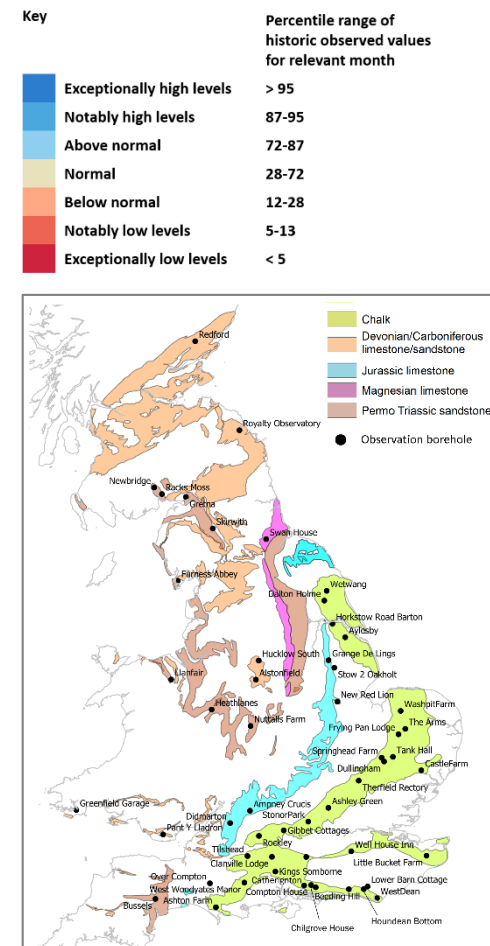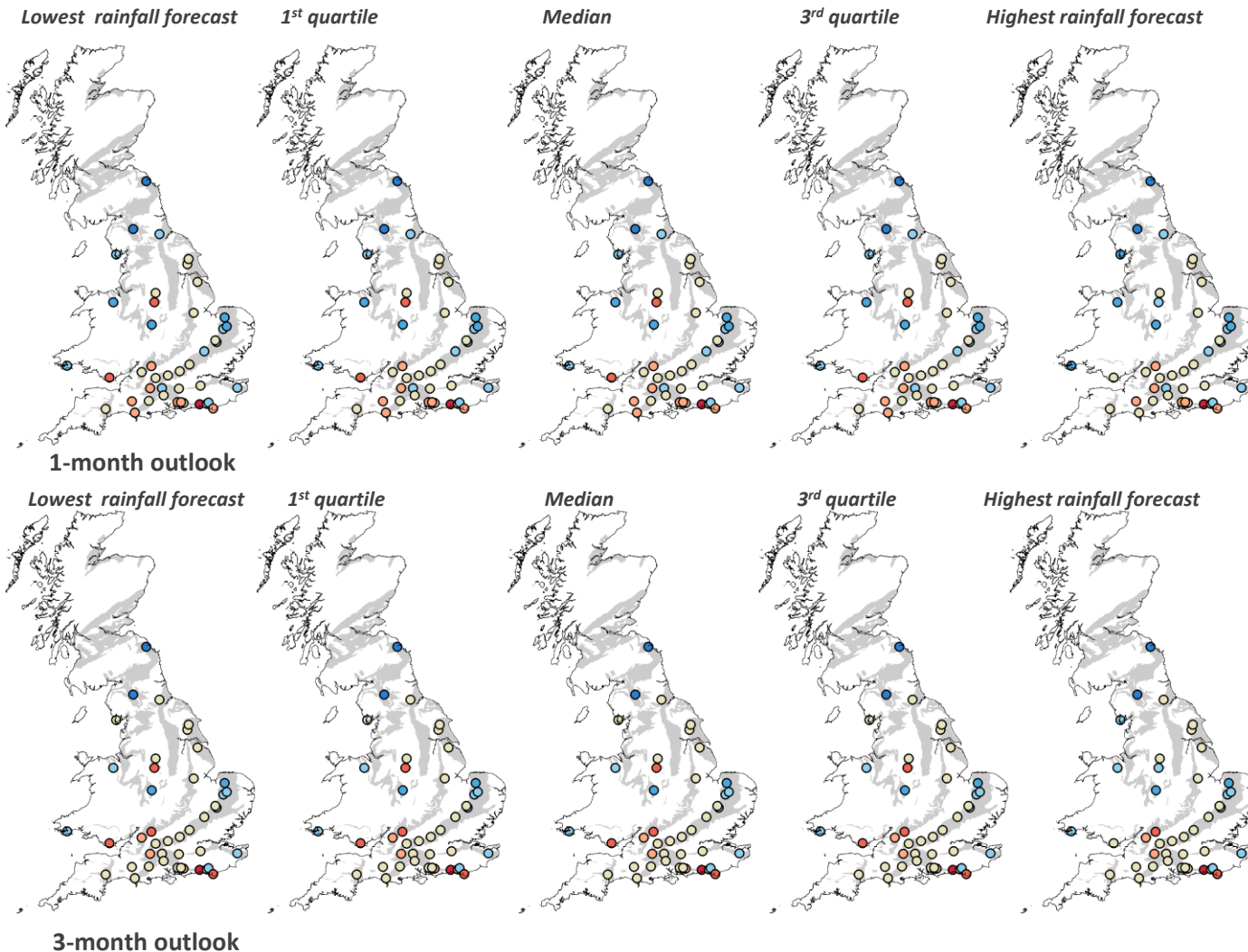
Overview

Period: May 2021 – July 2021

Issued on 10. 05.2021 using data to the end of April

The outlook is consistent across both the 1-month and 3-month forecast, with normal to exceptionally low groundwater levels are predicted across the majority of sites in southern England and Wales. Below normal to exceptionally low levels are forecast across the South Downs, with exceptionally low levels forecasts at Beeding Hill (Chalk) under all rainfall scenarios. However, there are exceptions, including above normal levels predicted at Little Bucket Farm (Chalk) and notably high levels forecast at several sites in the Chalk of East Anglia. In the north of England and Wales, above normal to exceptionally high levels are predicted. Exceptionally high levels are predicted under all rainfall scenarios at the Skirwith (Permo-Triassic sandstone) and Royalty Observatory (Fell Sandstone) sites. Note there are a reduced number of modelled sites. This is due to Covid-19 restrictions on access to sites in England and IT issues in Scotland.

These forecasts are produced by running five members of the Met Office ensemble climate forecast through groundwater models of observation borehole hydrographs at 42 sites across the country. The sites are distributed across the principal aquifers.

Based on the distribution of observed historical groundwater levels in a given month, seven categories have been derived for each site: very low, low, below normal, normal, above normal, high, and very high. The forecast groundwater level is assigned to one of these seven categories depending on where it falls within the distribution of the historically observed values.

Key	Percentile range of historic observed values for relevant month
Exceptionally high levels	> 95
Notably high levels	87-95
Above normal	72-87
Normal	28-72
Below normal	12-28
Notably low levels	5-13
Exceptionally low levels	< 5

Lowest rainfall forecast **1st quartile** **Median** **3rd quartile** **Highest rainfall forecast**

1-month outlook

Lowest rainfall forecast **1st quartile** **Median** **3rd quartile** **Highest rainfall forecast**

3-month outlook

Legend	
Chalk	
Devonian/Carboniferous limestone/sandstone	
Jurassic limestone	
Magnesian limestone	
Permo Triassic sandstone	
● Observation borehole	

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UK Centre for Ecology & Hydrology

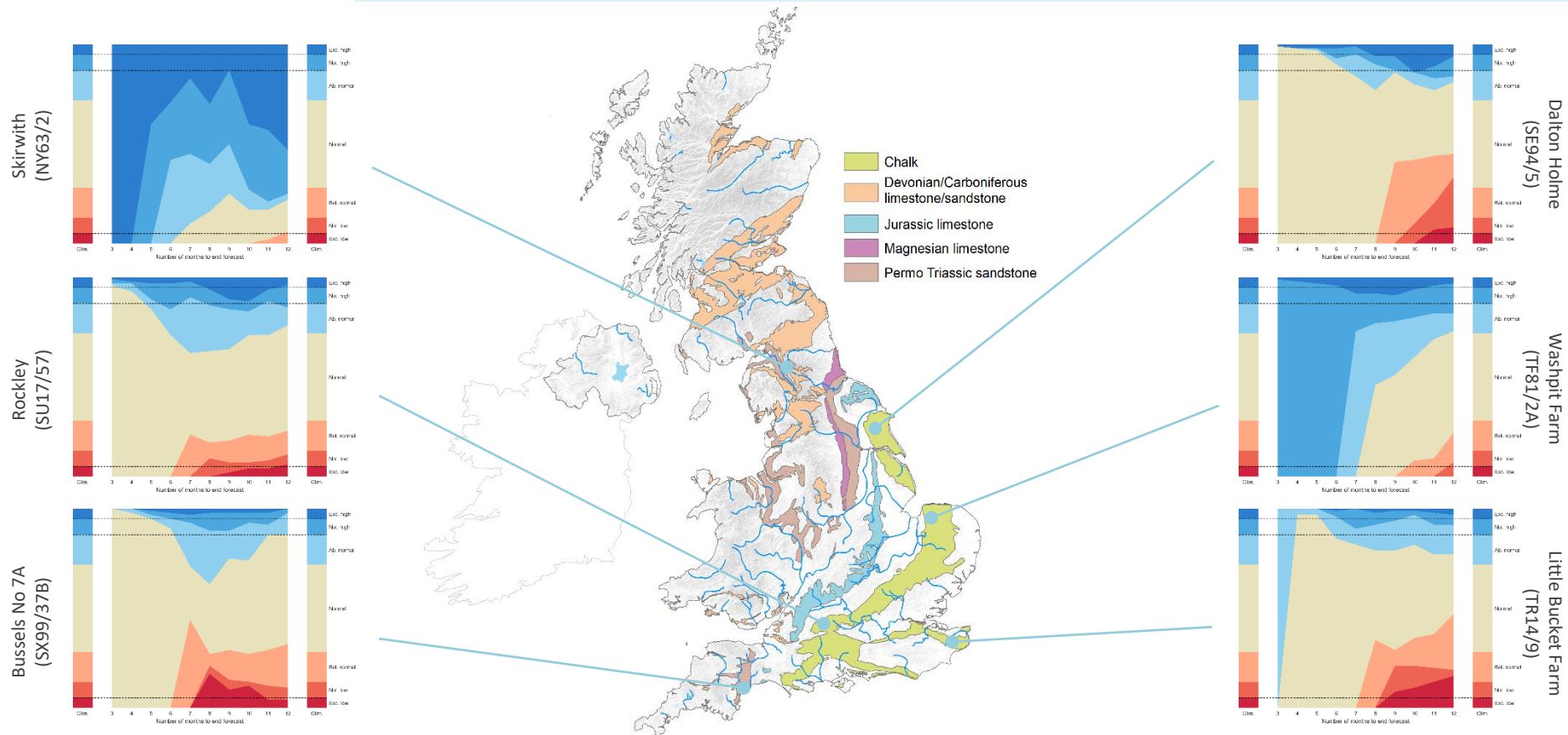**BGS British Geological Survey**

Environment Agency

Outlook based on modelled groundwater from historical climate

Period: May 2021 – April 2021

Issued on 10.05.2021 using data to the end of April

In the Chalk aquifers, normal to above normal levels are forecast for the next 6 months with the exception of Washpit Farm where levels are likely to be notably to exceptionally high in the next 6 months. Levels are predicted to become normal to below normal at these sites from 6-12months. In the Permo-Triassic sandstone at Skirwith levels are predicted to be above normal to exceptionally high over the next 6 months, trending towards normal in the following 6 month period.

Skirwith (NY63/2)

Rockley (SU17/57)

Bussels No 7A (SX99/37B)

Dalton Holme (SE94/5)

Washpit Farm (TF81/2A)

Little Bucket Farm (TR14/9)

Legend:
- Chalk
- Devonian/Carboniferous limestone/sandstone
- Jurassic limestone
- Magnesian limestone
- Permo Triassic sandstone

May 2021

This outlook is based on monthly ensembles of historical sequences of observed climate (rainfall and potential evpotranspiration) that form input to hydrological models. The outputs are probabilistic simulations of the average groundwater level over the forecast horizon (3 to 12 months ahead), at each location.

The graphs show variation over time of the number of simulated groundwater levels in each monthly ensemble,

that fall within each the seven categories: exceptionally low, notably low, below normal, normal, above normal, notably high and exceptionally high. The monthly variations can be compared to the long-term average distribution of levels, which are shown as columns on the left and right of each graph.

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