UK Hydrological Outlook

Delivered in partnership by: UK Centre for Ecology & Hydrology

Period: From April 2021

Issued on 09.04.2021 using data to the end of March 2021

HYDROLOGICAL OUTLOOK UK

April 2021

SUMMARY

The outlook for April, and for the next three months is for river flows and groundwater levels in the south-east of England to be normal to above normal, with above normal flows being most likely in the groundwater fed catchments in this region. Elsewhere, river flows are likely to be within the normal range over the next three months. Groundwater levels across the UK are likely to show local variability over the April-May-June period.

Rainfall:

Rainfall in March was below normal across the majority of the UK, with less than 50% of average rainfall in parts of the south-west, and across eastern parts of the UK. North-west England, and north-western Scotland received above average rainfall, with parts of Cumbria seeing over 170% of average.

The rainfall outlook for April (issued by the Met Office on 25.03.2021) is that the chances of average and below-average precipitation are higher than the chance of above-average precipitation. For April-May-June as a whole, above-average precipitation is more likely than below-average precipitation. The probability that UK-average precipitation for April-May-June will fall into the driest of five categories is around 10% and the probability that it will fall into the wettest of five categories is around 20% (the 1981-2010 probability for each of these categories is 20%).

River flows:

March river flows mostly fell from their February levels and were normal to above normal across the majority of the UK. Above normal to notably high flows were seen in north-west England, north Wales and Norfolk. Some localised catchments recorded below normal flows.*

River flows in April, and April-May-June, are likely to be within the normal range across northern and western parts of the UK. Flows in groundwater fed catchments of the south-east of England are likely to remain above normal as they continue to be influenced by the wet winter. River flows in Devon and Cornwall are likely be normal to below normal for April, but will respond quickly to rainfall events. Similarly, river flows in north-western Scotland are likely to be normal to above normal for April, but will depend on April's rainfall patterns.

Groundwater:

Groundwater levels in March were normal to exceptionally high, with a diverse spatial pattern. Normal levels were seen in most of the boreholes of central southern England, whilst exceptionally high levels were recorded in the Magnesian limestone and Permo-Triassic sandstones of northern England, as well as in the chalk aquifers in Norfolk.*

Due to the onset of groundwater recession, groundwater levels for the April-May-June period are likely to be spatially varied. Boreholes in the chalk of the south-east of England are likely to show normal to above normal levels, particularly in April, though normal to below normal levels may be seen in parts of the South Downs over the three-month period. Groundwater levels in northern England and north Wales are likely to remain above normal for the next three months.

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

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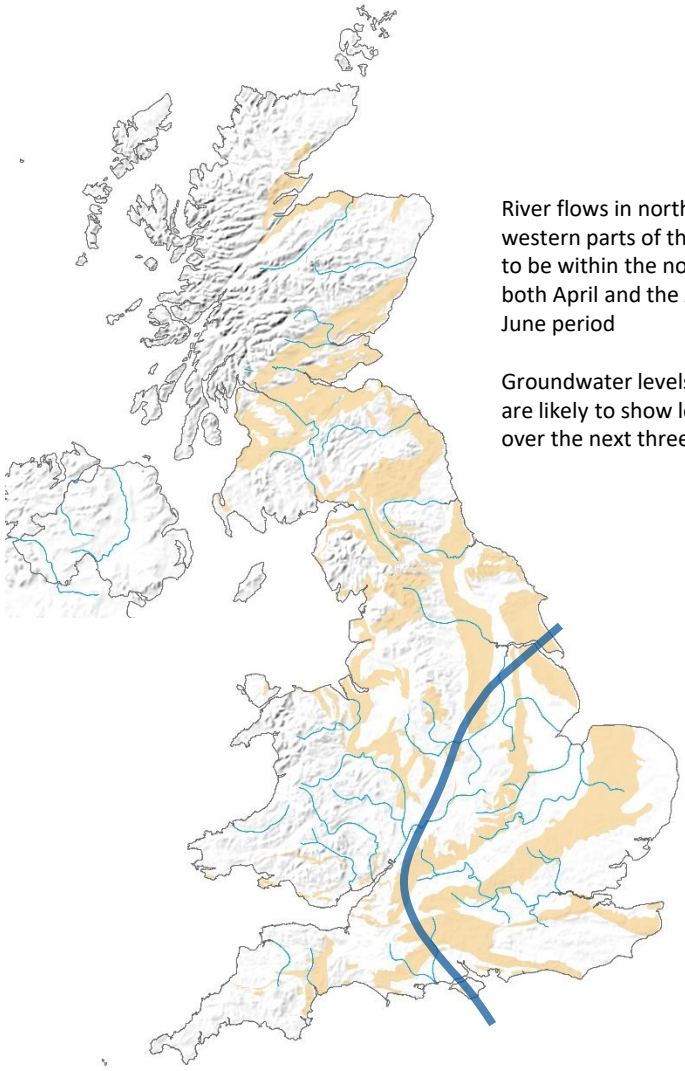

River flows in northern and western parts of the UK are likely to be within the normal range for both April and the April-May-June period

Groundwater levels in this area are likely to show local variation over the next three months

River flows and groundwater levels in south-east England are likely to be normal to above normal in April and the April-May-June period

Shaded areas show principal aquifers

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UK Hydrological Outlook

Delivered in partnership by: UK Centre for Ecology & Hydrology

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.

Copyright:

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, April, 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/

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HYDROLOGICAL OUTLOOK UK

UK Centre for Ecology & Hydrology

Outlook based on hydrological persistence and analogy

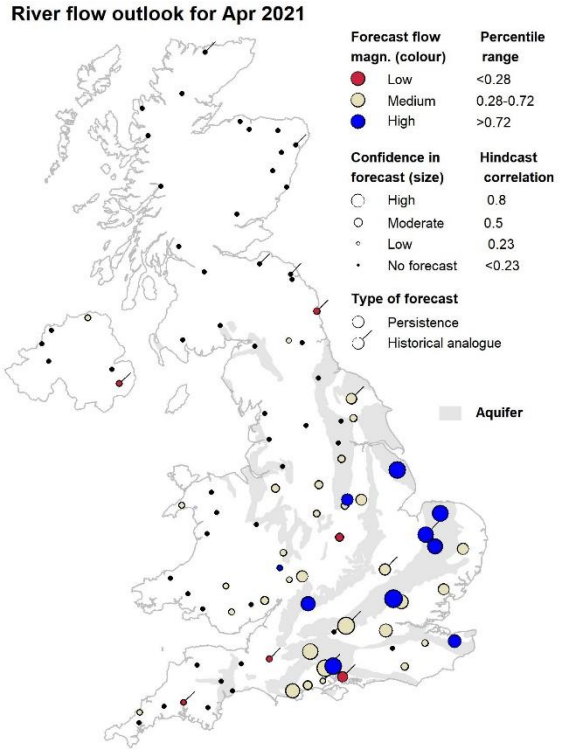
Overview

Period: April – June 2021

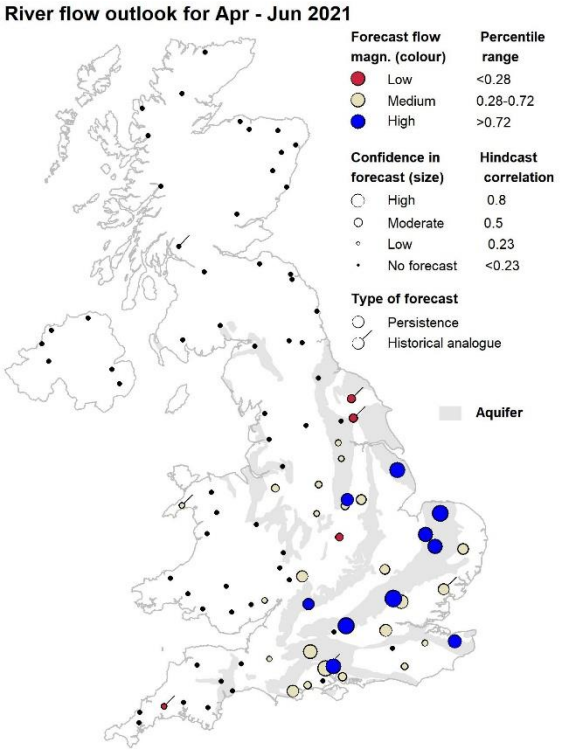
Issued on 07.04.2021 using data to the end of March 2021

SUMMARY

The outlooks for April and for April-June are for mainly normal to above normal flows in southeast England, with hardly any forecasts available for the rest of the UK.



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.

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 hydrological persistence and analogy

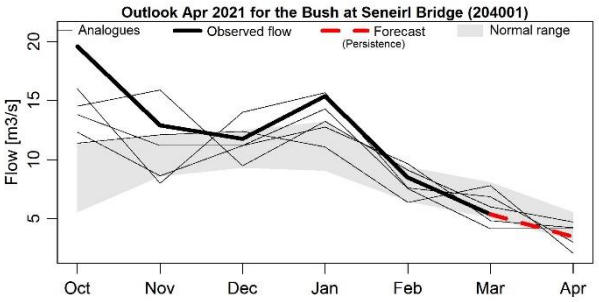
Site-based: 1 month outlook

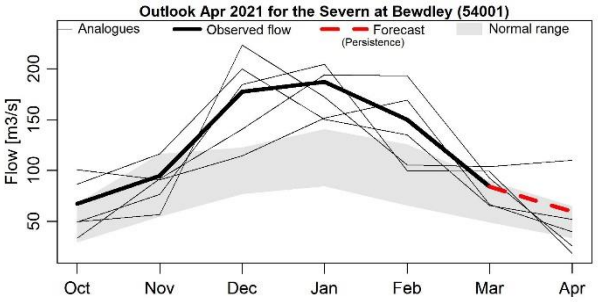
Period: April 2021

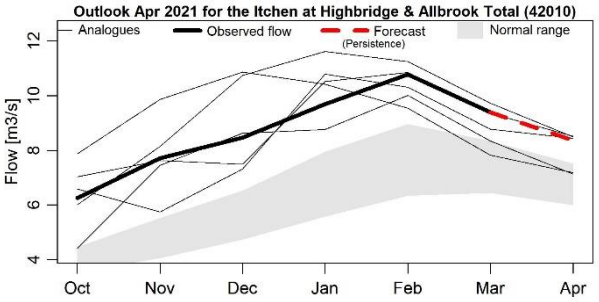
Issued on 07.04.2021 using data to the end of March 2021

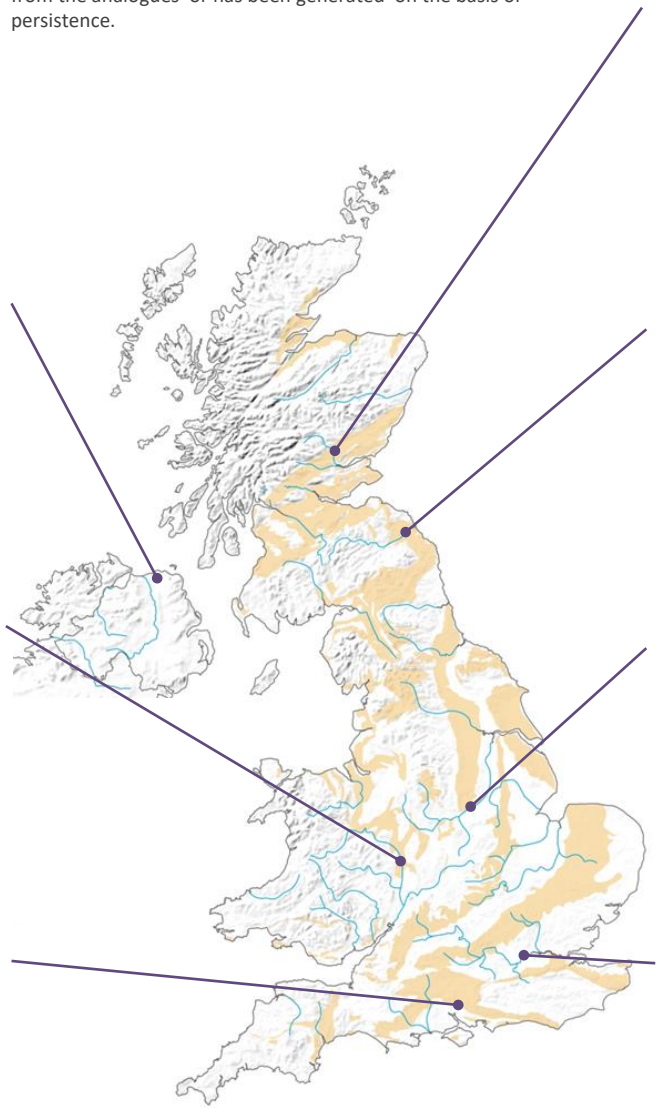
These figures provide insight into the hydrological analogue methodology for a set of sites from across the UK.

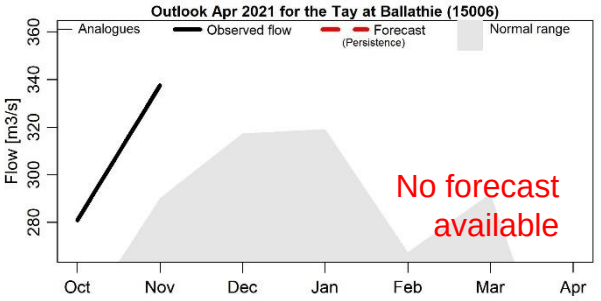
In each of the time series graphs the bold black line represents the observed flow during the past six months. The grey band indicates the normal flow range (the normal band includes 44% of observed flows in each month). The selected analogues are shown as thin lines and the trajectories that flows took 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.

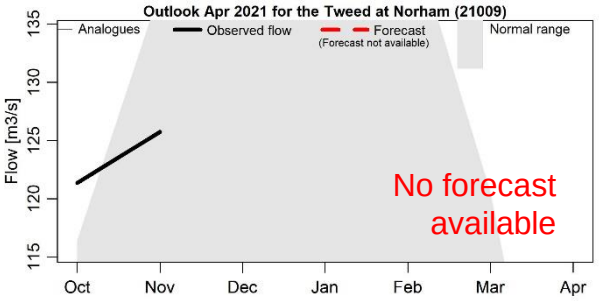


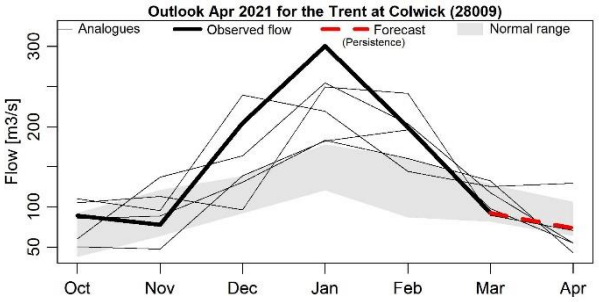


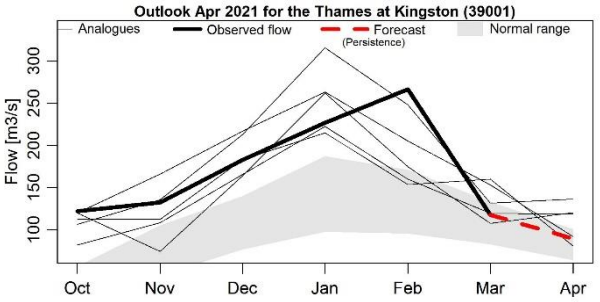












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UK Centre for Ecology & Hydrology

Outlook based on hydrological persistence and analogy

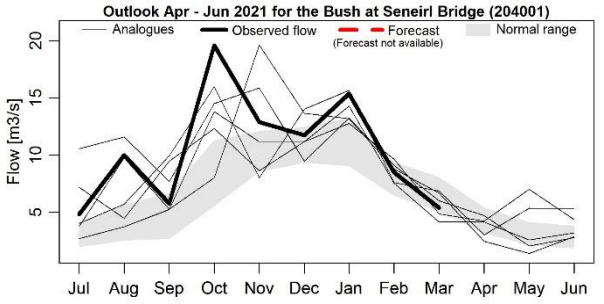
Site-based: 3 month outlook

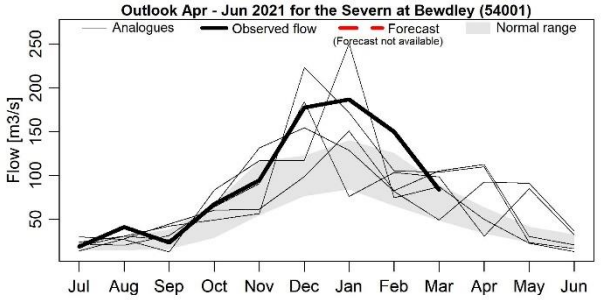
Period: April – June 2021

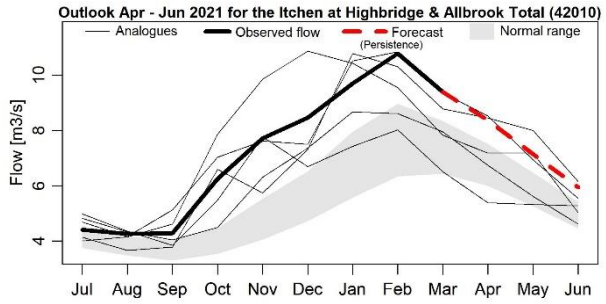
Issued on 07.04.2021 using data to the end of March 2021

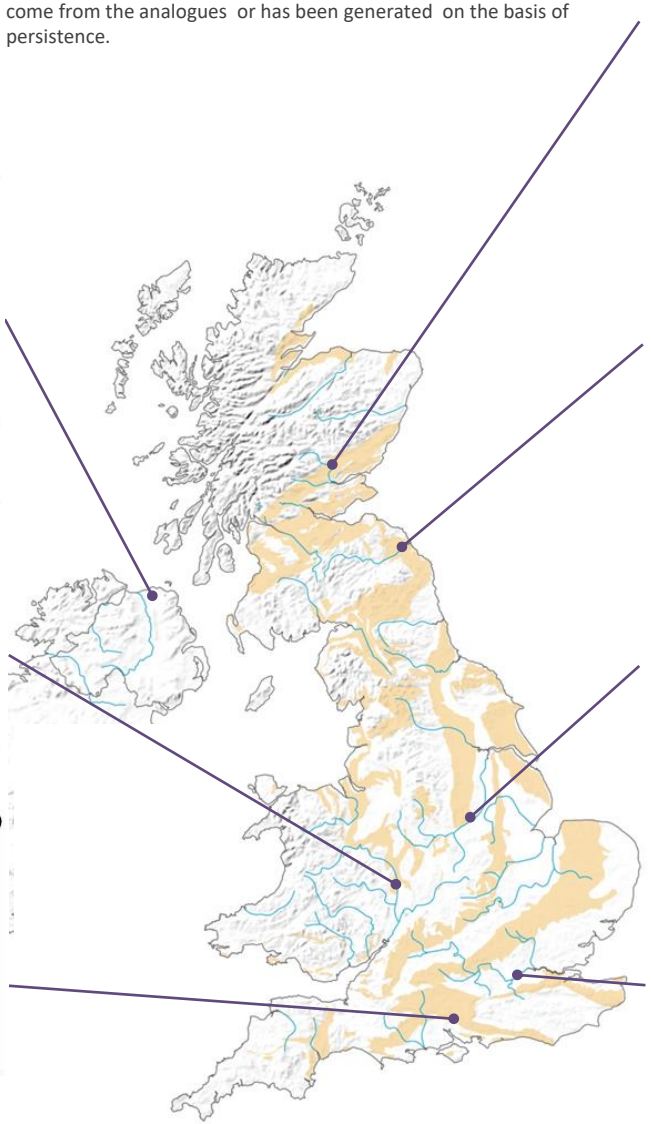
These figures provide insight into the hydrological analogue methodology for a set of sites from across the UK.

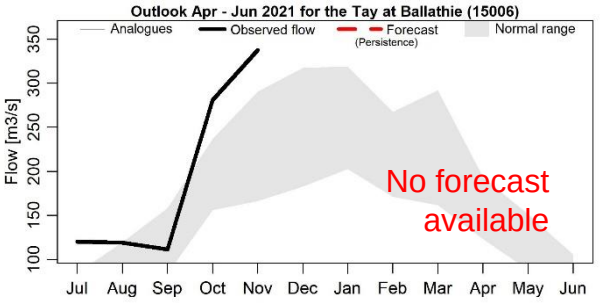
In each of the time series graphs the bold black line represents the observed flow during the past nine months. The grey band indicates the normal flow range (the normal band includes 44% of observed flows in each month). The selected analogues are shown as thin lines and the trajectories that flows 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.

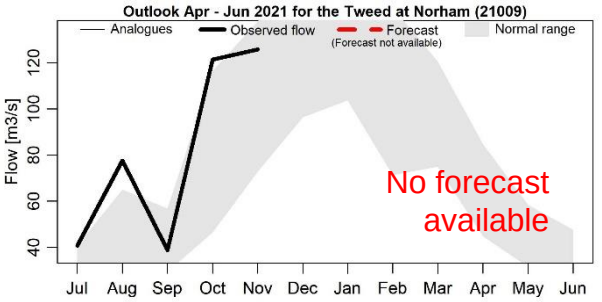


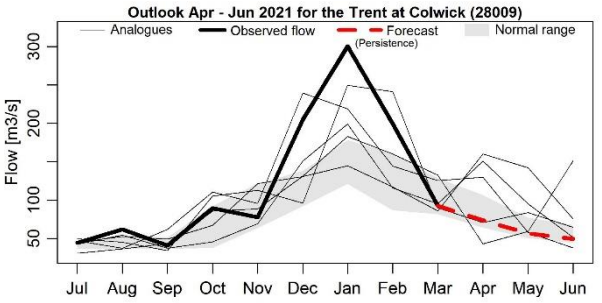


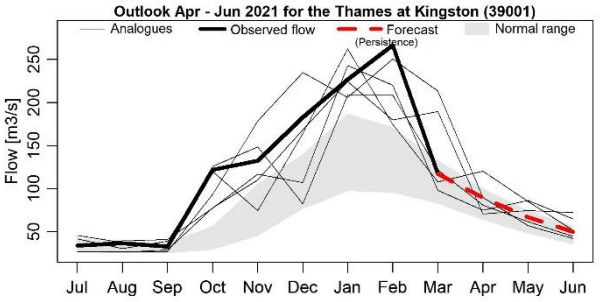












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RIVER FLOW ANALOGY

April 2021

UK Centre for Ecology & Hydrology

British Geological Survey

Environment Agency

Outlook based on modelled flow from historical climate

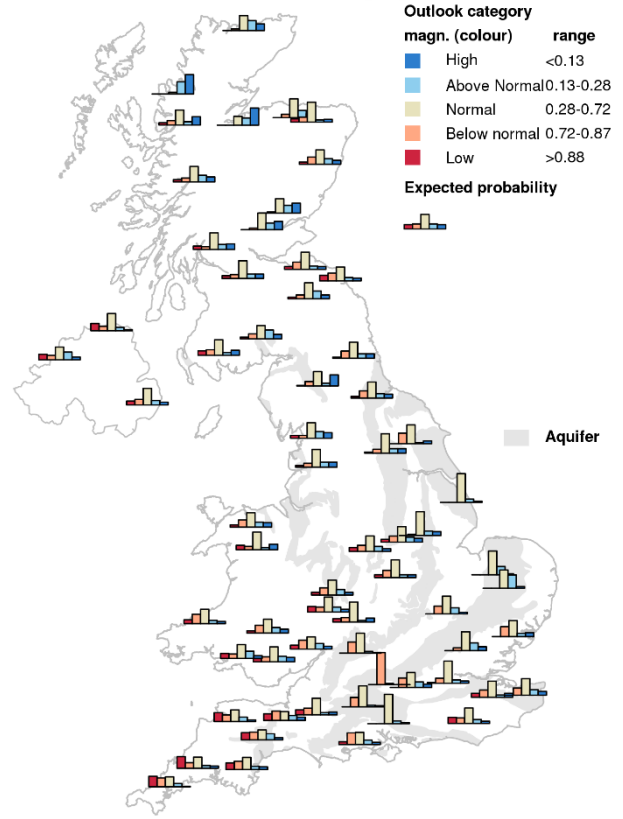
Overview

Period: April 2021 – September 2021

Issued on 06.04.2021 using data to the end of March 2021

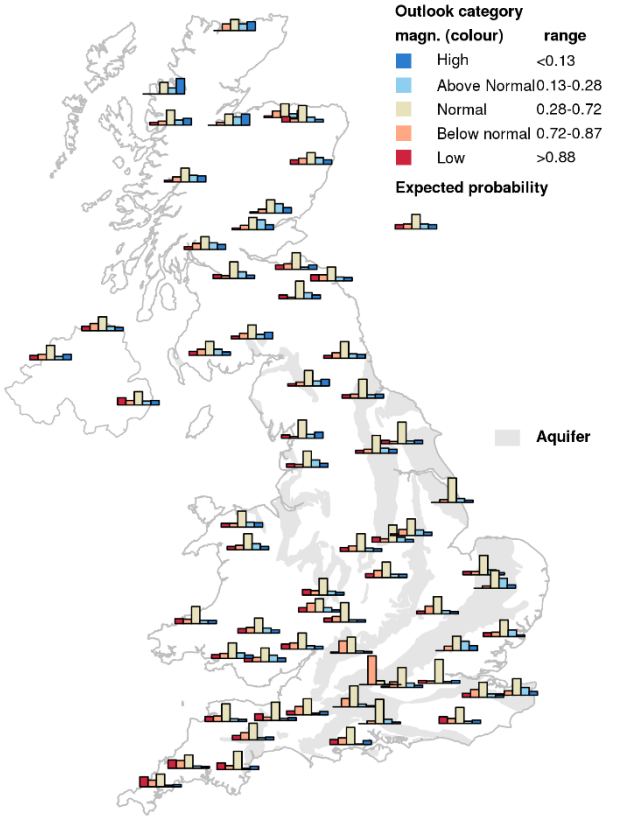
River flows in the southwest of England are likely to be below normal for April, with flows within the normal range for the rest of England and Wales. In Scotland flows are likely to be normal to above normal over the next one-to-three months, with high flows possible in some northern catchments. River flows in the southwest of England are likely to be normal to below normal over the next three months, and normal across the majority of England and Wales for this period.

1-month river flow outlook starting Apr 2021



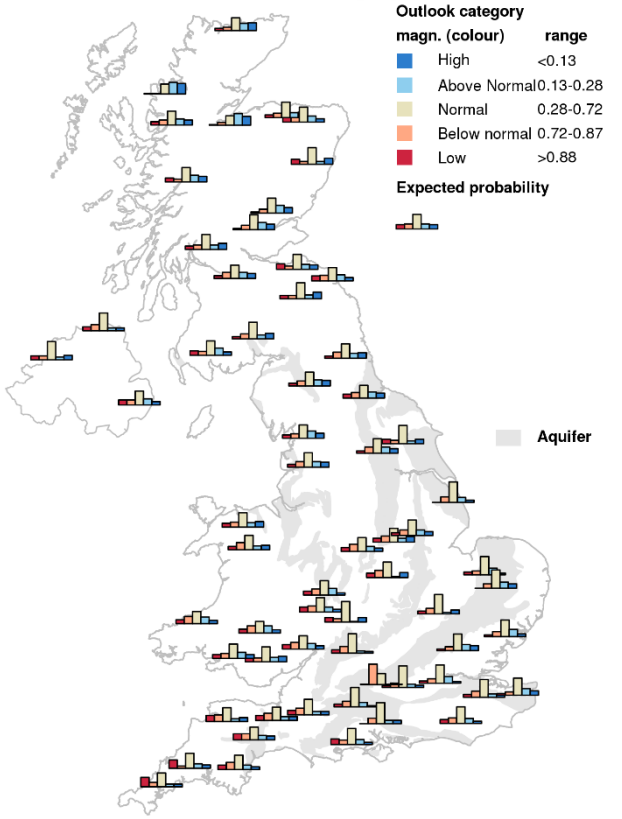
This outlook is based on monthly ensembles of historical sequences of observed climate (rainfall and potential evapotranspiration) that form input to a hydrological model. The outputs are probabilistic simulations of the average river flow over the forecast period (1 to 12 months ahead), at each location.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

3-month river flow outlook starting Apr 2021



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.

6-month river flow outlook starting Apr 2021



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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British Geological Survey

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Outlook based on modelled flow from historical climate

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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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UK Centre for Ecology & Hydrology

Current Daily Simulated Subsurface Water Storage Conditions

Based on subsurface water storage estimated for 31st March 2021

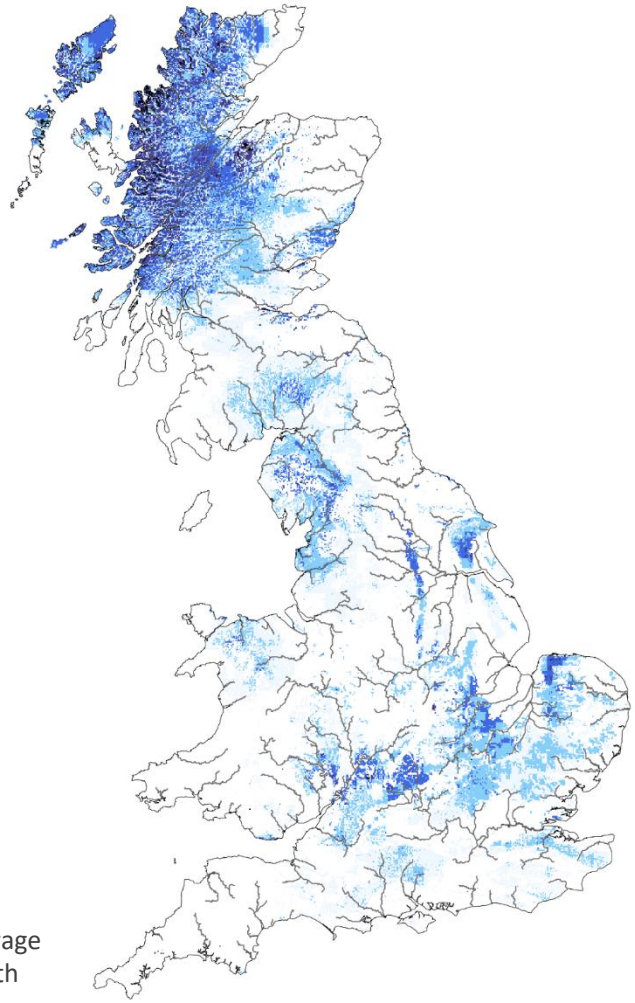
Issue date: 06.04.2021

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 March, subsurface water levels across much of the country were mostly near average for this time of year with pockets of low to high relative wetness, particularly in Central England and Western and Central Scotland.

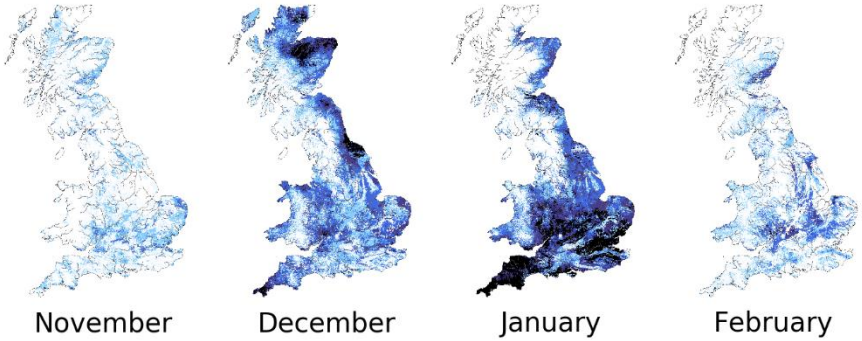
Relative Wetness

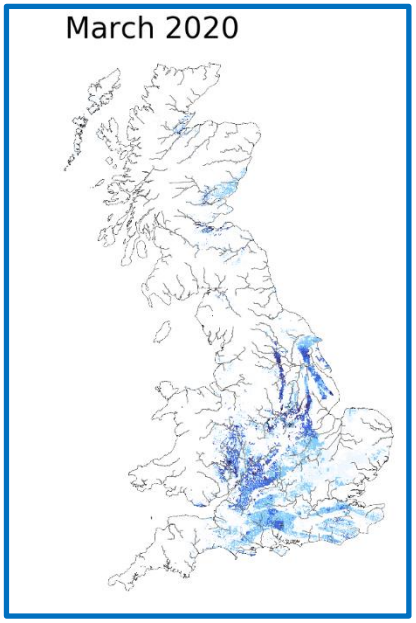


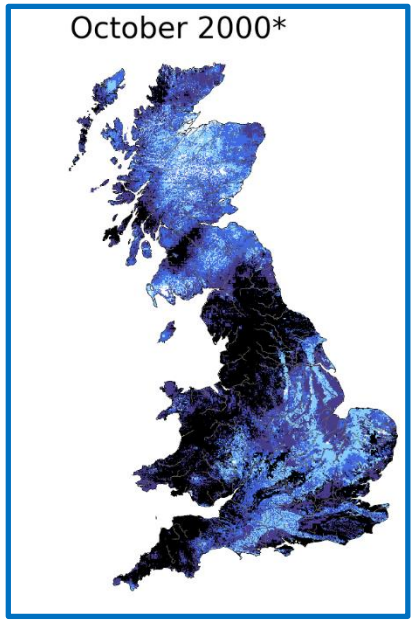
Water storage anomaly as a % of maximum storage anomaly (zero indicates average value)

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







*Example month displaying extreme relative wetness

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OUTLOOK BASED ON CURRENT CONDITIONS

April 2021

UK Centre for Ecology & Hydrology

Current Daily Simulated Subsurface Water Storage Conditions

Based on subsurface water storage estimated for 31st March 2021

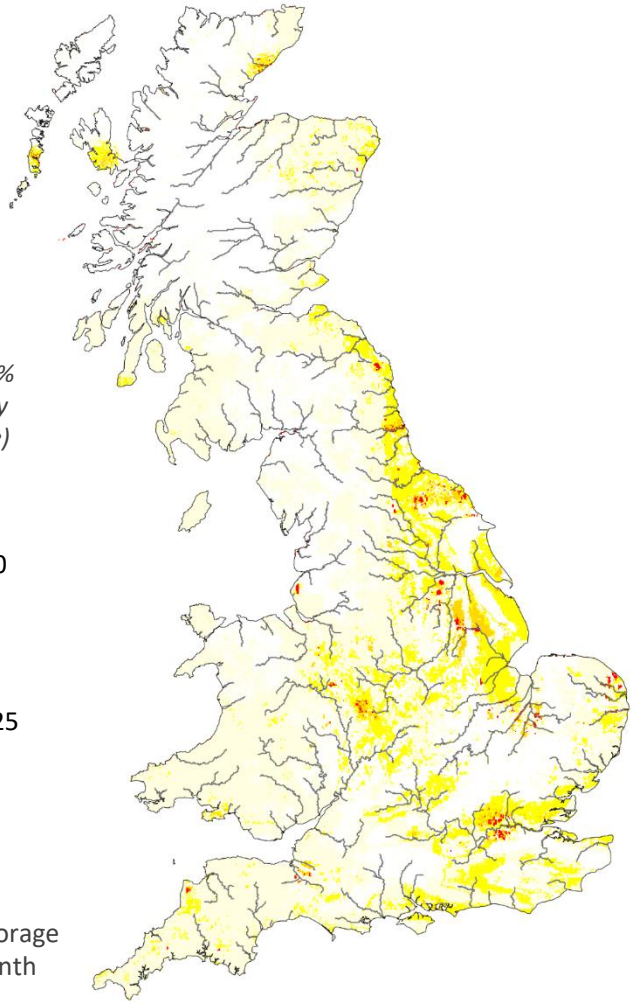
Issue date: 06.04.2021

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 March, subsurface water levels across much of the country were mostly near average for this time of year, reflected in the no or low levels of relative dryness. Areas of exception include parts of Eastern England which have low to medium relative dryness.

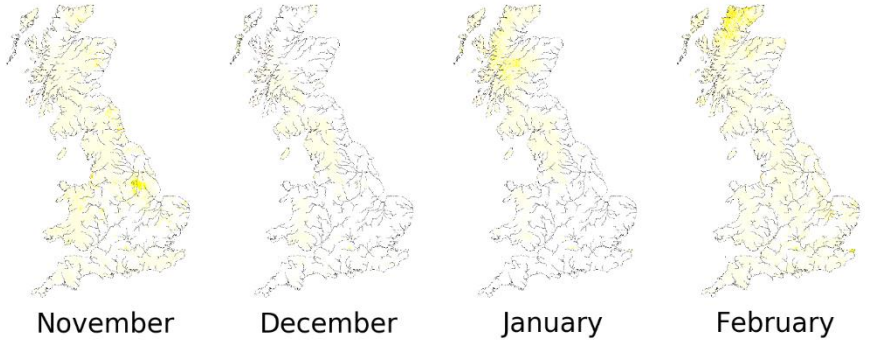
Relative Dryness

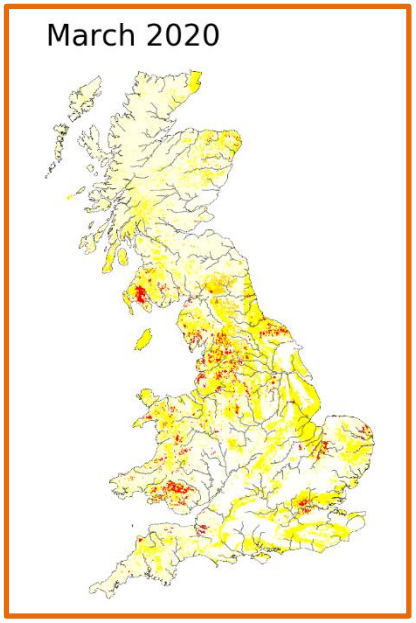


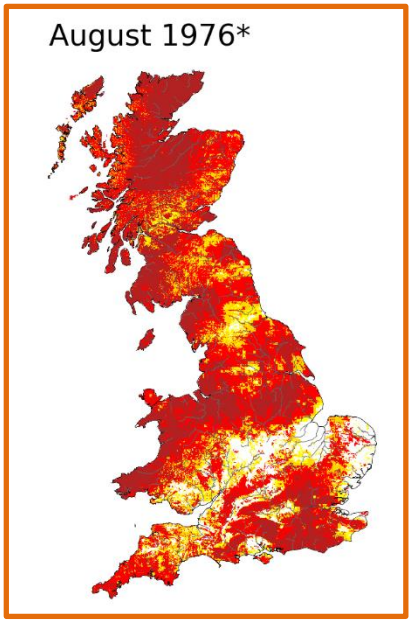
Water storage anomaly as a % of minimum storage anomaly (zero indicates average value)

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







*Example month displaying extreme relative dryness

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OUTLOOK BASED ON CURRENT CONDITIONS

April 2021

UK Centre for Ecology & Hydrology

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: $R_d\,(\%) = \frac{(S_{average} - S)}{(S_{average} - S_{min})} \times 100$

  $= \frac{\text{(average storage for this month - storage at end of last month)}}{\text{(average storage for this month - historical minimum storage)}} \times 100$
- A value of $\boldsymbol{R_d = 100}$ 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 $\boldsymbol{R_d = 0}$ 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: $R_w\,(\%) = \frac{(S - S_{average})}{(S_{max} - S_{average})} \times 100$

  $= \frac{\text{(storage at end of last month - average storage for this month)}}{\text{(historical maximum storage - average storage for this month)}} \times 100$
- A value of $\boldsymbol{R_w = 100}$ 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 $\boldsymbol{R_w = 0}$ 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.

UK Centre for Ecology & Hydrology

Return Period of Rainfall Required to Overcome Dry Conditions

Period: April 2021 – September 2021

Issue date: 06.04.2021

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.

SUMMARY: During April to September, Britain will not require particularly unusual rainfall (<5 year return periods) to return to average conditions for the time of year.

Apr

May

Jun

Jul

Aug

Sep

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

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

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OUTLOOK BASED ON CURRENT CONDITIONS

April 2021

Return Period of Rainfall Required to Overcome the Dry Conditions

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.

UK Centre for Ecology & Hydrology

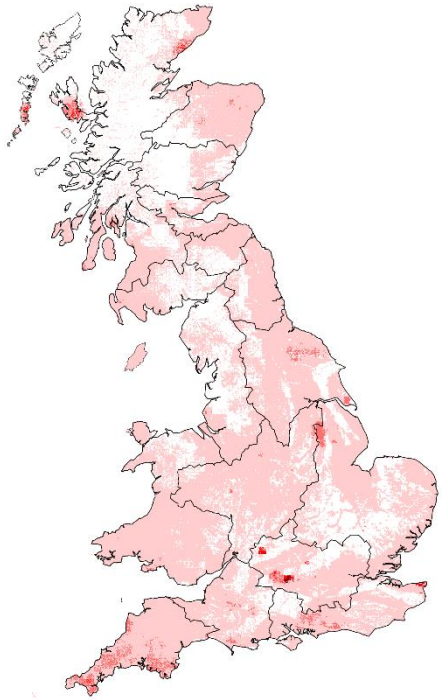
Estimate of Additional Rainfall Required to Overcome Dry Conditions

Based on subsurface water storage estimated for 31st March 2021

Issue date: 06.04.2021

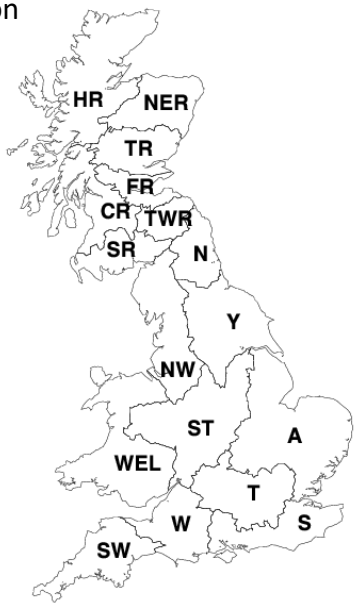
These maps show the Grid-to-Grid (G2G) hydrological model simulated subsurface water storage, expressed as an anomaly from the historical monthly mean (1981-2010), presented on a 1km grid and as regional means.
Subsurface storage deficits, i.e. where the subsurface water storage anomaly is less than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

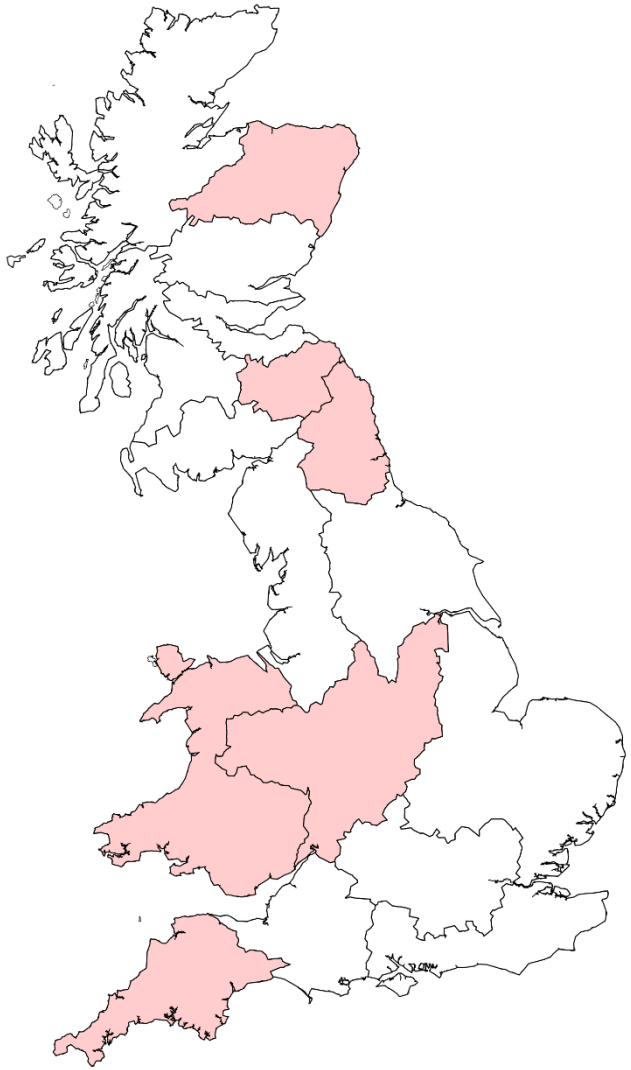
The **subsurface storage deficit (mm)** can be interpreted as an estimate of additional rainfall that would be required in future months to overcome dry conditions (i.e. rainfall in addition to what is expected on average). Regional mean values of additional rainfall required are provided in the table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



Regional estimate of additional rainfall required (mm)

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





Water storage deficit (anomaly, mm)

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

OUTLOOK BASED ON CURRENT CONDITIONS

April 2021

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UK Centre for Ecology & Hydrology

Outlook Based on Modelled Flow from Rainfall Forecasts

Overview

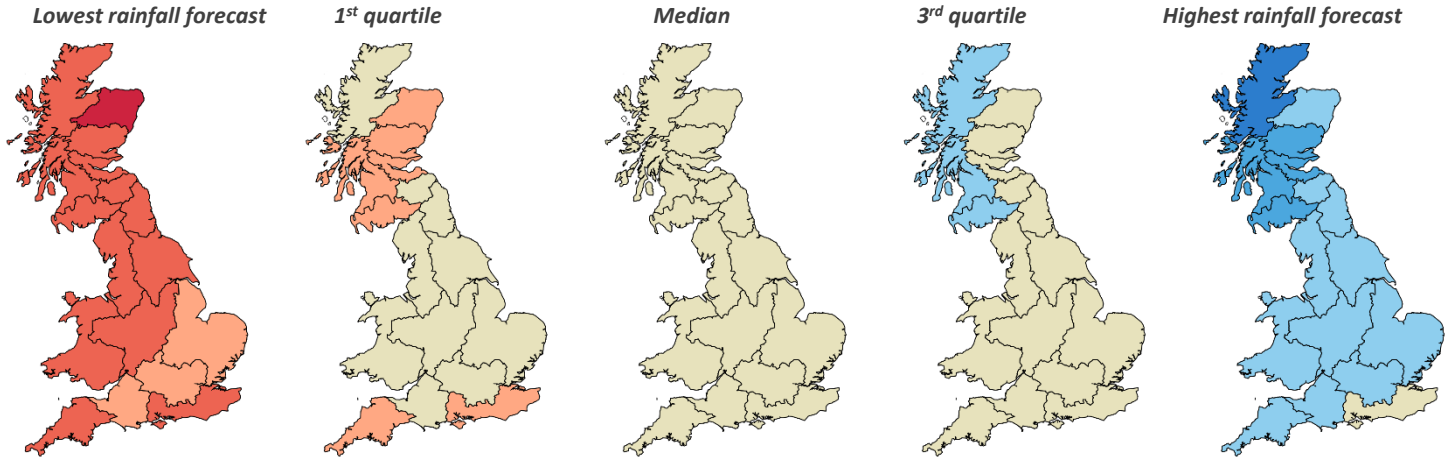
Period: April 2021 – June 2021

Issued on 06.04.2021 using data to the end of March

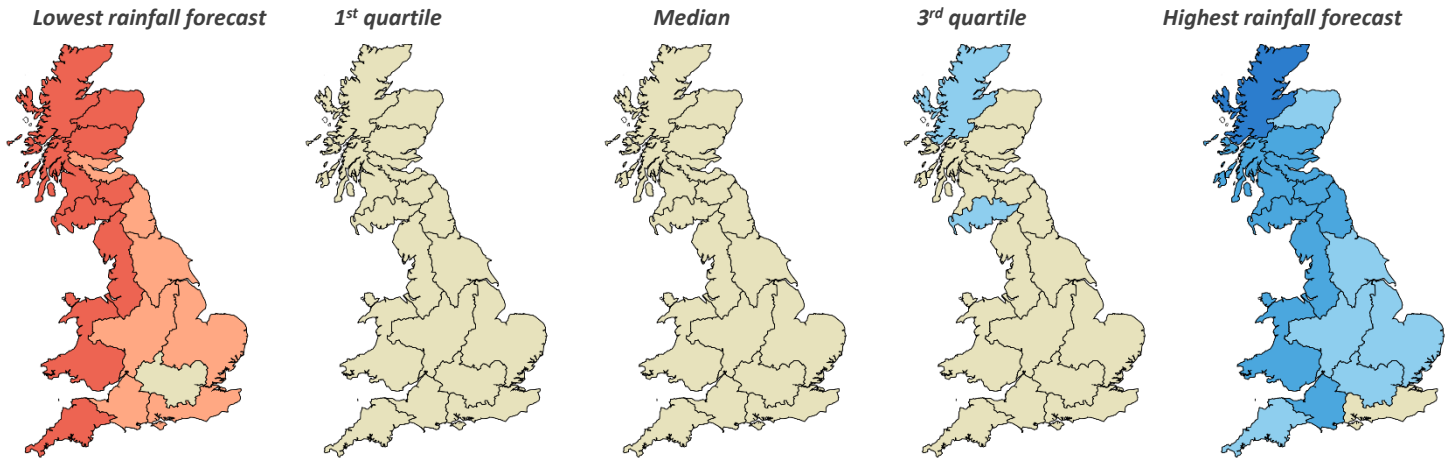
SUMMARY: During April, river flows across much of the country are most likely to be in the *Normal range*. Southern and South West Regions are most likely to be in the *Normal range* or *Below normal*.

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

1-month flow outlook



3-month flow outlook



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.

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
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WALES

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NORTHERN IRELAND

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RIVER FLOW FROM RAINFALL FORECASTS

April 2021

UK Centre for Ecology & Hydrology

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

Period: April 2021 – June 2021

Issue date: 06.04.2021

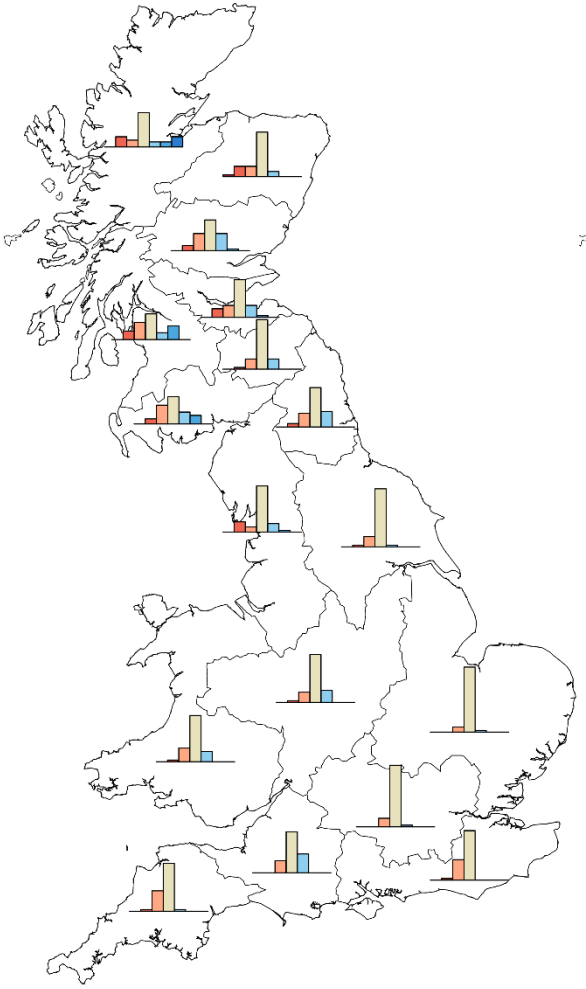
The regional maps illustrating the regional river flows for five members of the Met Office ensemble of rainfall forecasts give some indication of the range of possible river flows in the coming months. As noted previously, the actual flows could be more extreme than the flows generated by either the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

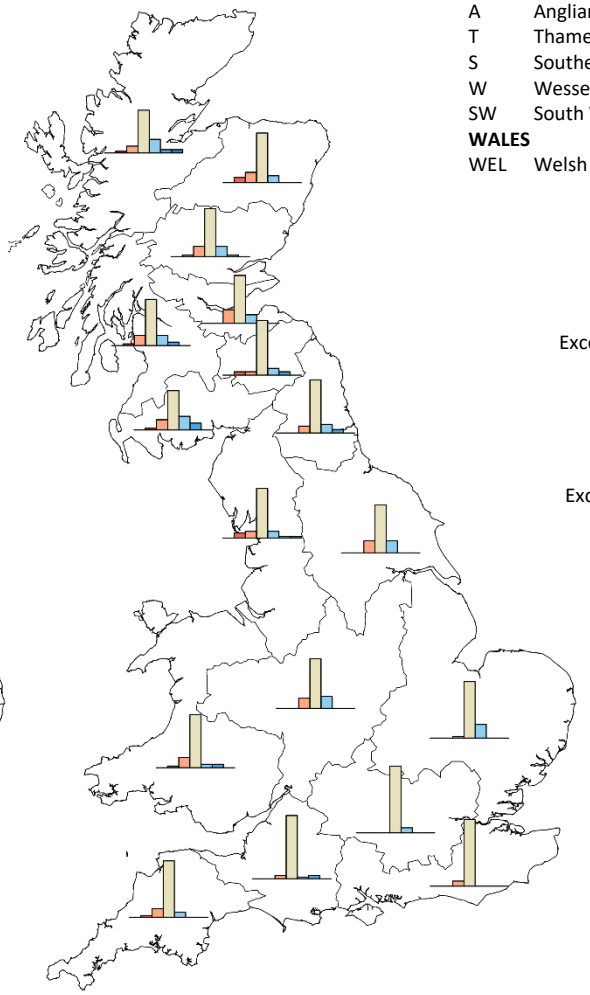
SUMMARY: During April, river flows across much of the country are most likely to be in the *Normal range*. Southern and South West Regions are most likely to be in the *Normal range* or *Below normal*.

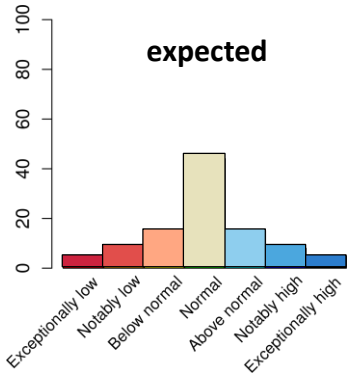
Over the next 3 months river flows across the country are most likely to be in the *Normal range.*

1-month



3-month





SCOTLAND

HR	Highlands Region
NER	North East Region
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WALES

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NORTHERN IRELAND

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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

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RIVER FLOW FROM RAINFALL FORECASTS

April 2021

UK Centre for Ecology & Hydrology

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

Period: April 2021 – June 2021

Issue date: 06.04.2021

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 April, river flows across much of the country are most likely to be in the *Normal range*. Southern and South West Regions are most likely to be in the *Normal range* or *Below normal*.

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

SCOTLAND

HR	Highlands Region
NER	North East Region
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FR	Forth Region
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TWR	Tweed Region
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S	Southern
W	Wessex
SW	South West

WALES

WEL	Welsh

NORTHERN IRELAND

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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	14	0	0	0	0
Notably high flow	0	2	0	0	0	0	0	0	0	0	19	2	7	0	12	2	0
Above normal	2	12	21	17	2	0	2	14	26	2	10	17	7	7	17	24	14
Normal range	90	64	55	67	67	69	86	64	57	81	36	52	48	62	38	43	69
Below normal	7	7	19	14	29	29	12	19	17	14	24	17	10	14	26	24	14
Notably low flow	0	14	5	2	2	2	0	2	0	2	12	12	14	14	7	7	2
Exceptionally low flow	0	0	0	0	0	0	0	0	0	0	0	0	0	2	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	0	0	0	0	0	5	0	0	0	0
Notably high flow	0	2	5	0	0	0	0	5	5	0	5	2	5	0	10	2	5
Above normal	19	10	12	17	7	0	7	5	2	17	14	12	19	10	19	14	10
Normal range	79	69	74	69	79	93	93	74	88	67	64	67	60	69	55	67	76
Below normal	2	10	10	14	12	7	0	14	5	17	14	19	10	14	14	14	5
Notably low flow	0	7	0	0	2	0	0	2	0	0	2	0	2	7	2	2	5
Exceptionally low flow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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Outlook based on modelled groundwater level & climate forecast

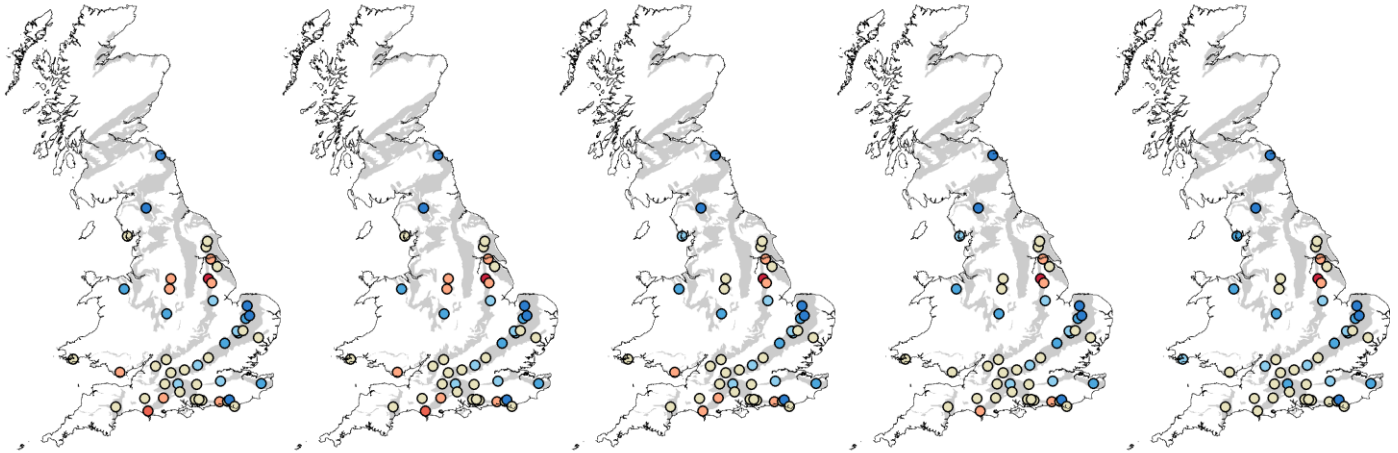
Overview

Period: April 2021 – June 2021

Issued on 09. 04.2021 using data to the end of February

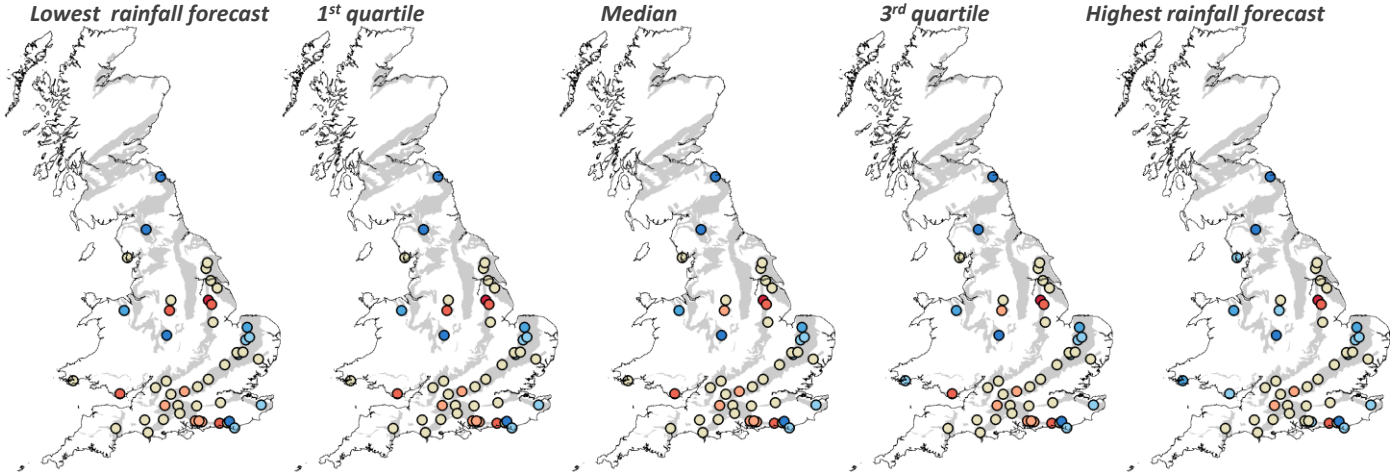
Variability in the 1- to 3-month forecasts is associated with the sensitivity of individual boreholes to the onset of groundwater recession. Notwithstanding this, over the next month, above normal to below normal groundwater levels are predicted across England and Wales, with more normal to below normal levels in the 3-month forecast. Notably and exceptionally high levels are predicted in the 1-month forecast at several sites in the Chalk. Exceptionally high levels are predicted under all rainfall scenarios at the Skirwith (Permo-Triassic sandstone) and Royalty Observatory (Fell Sandstone) sites in both the 1-month and 3-month forecasts. Exceptionally low levels are predicted under all rainfall scenarios at the Grange de Lings (Jurassic limestone) site in the 1- and 3-month forecasts. 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.

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*

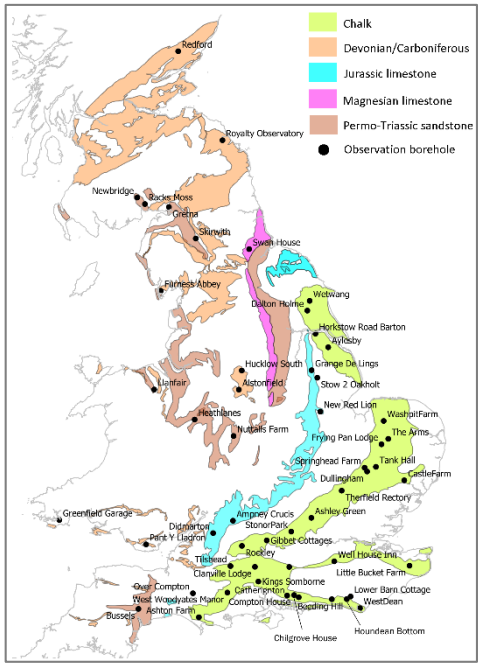


3-month outlook

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



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GROUNDWATER FROM CLIMATE FORECASTS

April 2021

UK Centre for Ecology & Hydrology

British Geological Survey

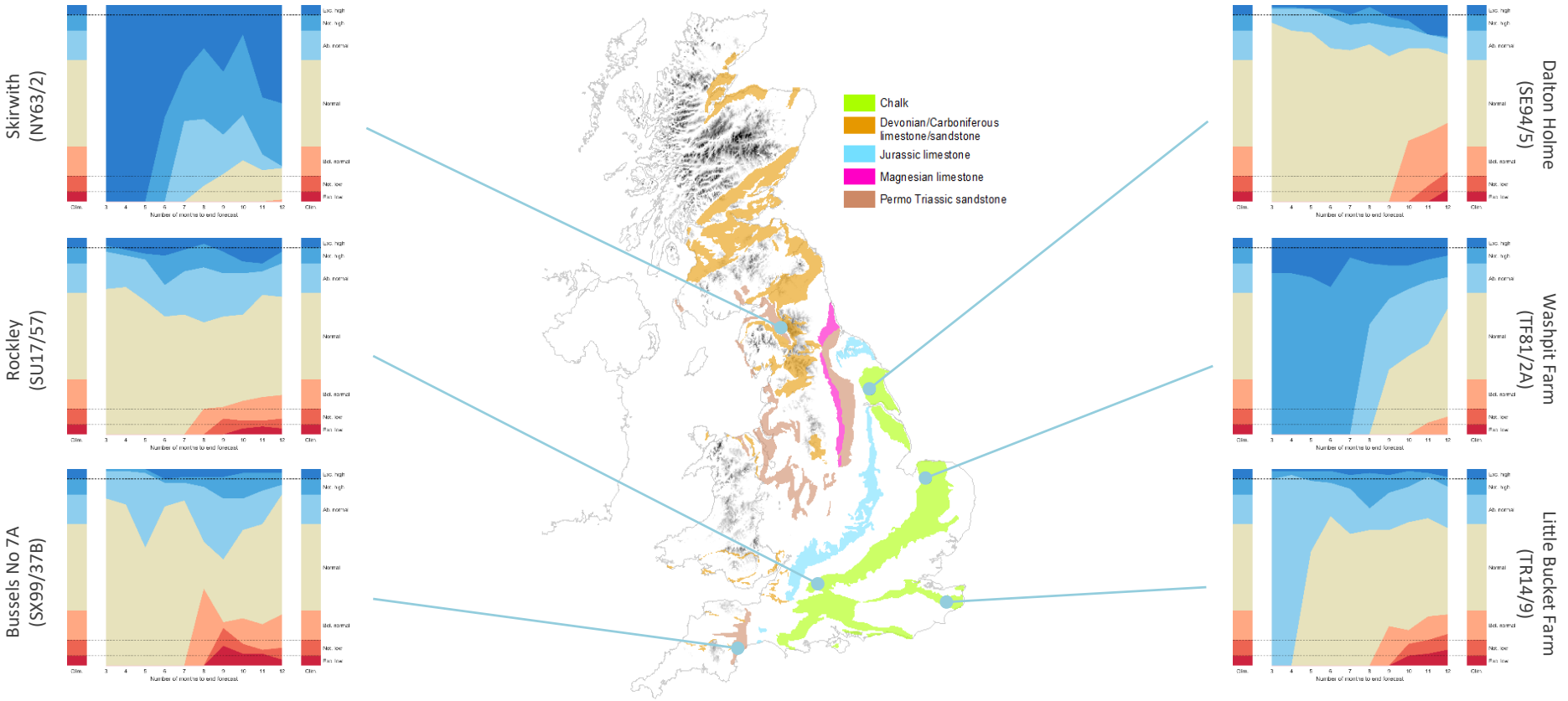
Environment Agency

Outlook based on modelled groundwater from historical climate

Period: April 2021 – March 2022

Issued on 09.04.2021 using data to the end of March

In the Permo-Triassic sandstone at Skirwith in North West England notably high to exceptionally high groundwater levels are predicted over the next 6 months. At most Chalk sites normal to above normal levels are forecast for the next 12 months with the exception of Washpit Farm where levels are likely to be notably to exceptionally high in the next 6 months.



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.

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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