UK Hydrological Outlook

Delivered in partnership by: UK Centre for Ecology & Hydrology

Period: From November 2023

Issued on 07.11.2023 using data to the end of October 2023

HYDROLOGICAL OUTLOOK UK

November 2023

SUMMARY

The outlook for November and for Nov-Jan is for normal to above normal river flows on the eastern side of the country, and mostly normal for the western half, with the exception of some rivers in north-western Scotland where the flows are likely to be normal to below normal. For groundwater, the levels are likely to be above normal at most sites for the next 3 months.

Rainfall:

Rainfall in October for most of the UK was above normal, with over 150% the average precipitation for a large proportion of the country, except for western Scotland where it was below average.

The meteorological outlook (issued by the Met Office on 30.10.2023) for November and the November-January period shows similar likelihoods of wet and dry conditions. November has had a wet start with storm Ciarán bringing widespread rainfall, especially in the south of England.

River flows:

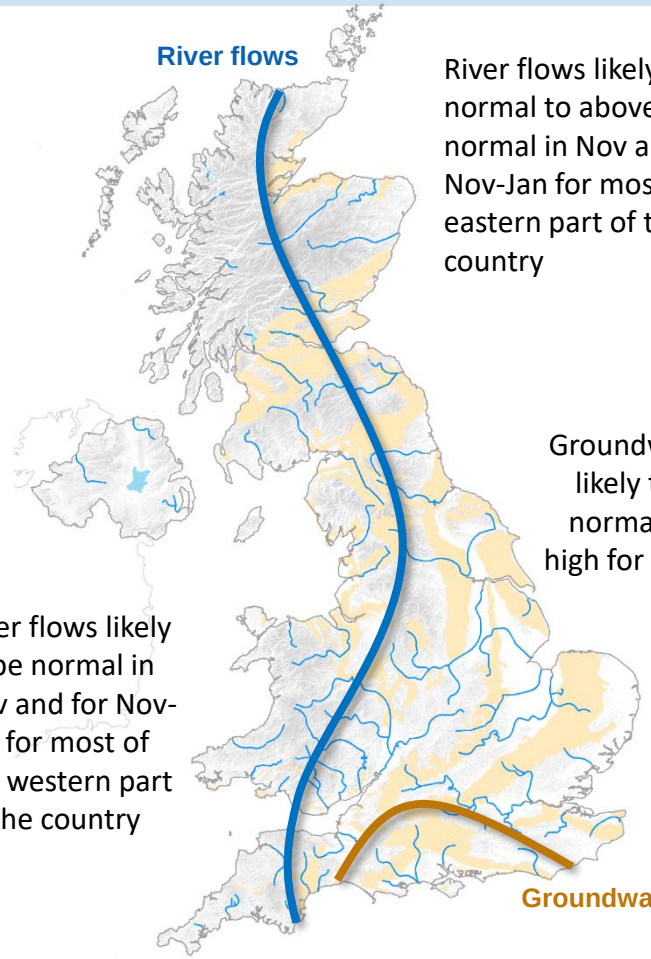
River flows in October were normal to above normal for most of the UK, except for western Scotland where they were mostly normal.

River flows in November are likely to be normal to above normal for the eastern side of the UK, and normal on the western side, including Wales and Northern Ireland, except for north-western Scotland where flows are likely to be normal to below normal. This pattern is expected to persist for the Nov-Jan period.

Groundwater:

Groundwater levels in October were generally normal to above normal across the UK, with levels in the Lincolnshire, Wessex, and South Downs Chalk most responsive to October's high rainfall.

Over the next month, groundwater levels are likely to be above normal to notably high at most sites, exceptionally so in some locations in Wessex and the South Downs Chalk with a risk of groundwater flooding. Groundwater levels in the more-slowly responding Chalk of Yorkshire, the Chilterns, Berkshire Downs, London, and Kent regions are anticipated to continue rising to reach notably high or exceptionally high levels by December. The three-month forecasts are similar with above normal to notably high levels forecast for much of the UK.



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 | 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

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:
https://www.hydoutuk.net/about/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.

Your use of the Content is entirely at your own risk. We make no warranty, representation or guarantee that the Content is error free or fit for your intended use.

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, July, UK Centre for Ecology and Hydrology, Oxfordshire UK, Online,
https://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
Natural Resources Wales: https://flood-warning.naturalresources.wales/
Scottish Environment Protection Agency: https://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: https://www.metoffice.gov.uk/#?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 · 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 Centre for Ecology & Hydrology

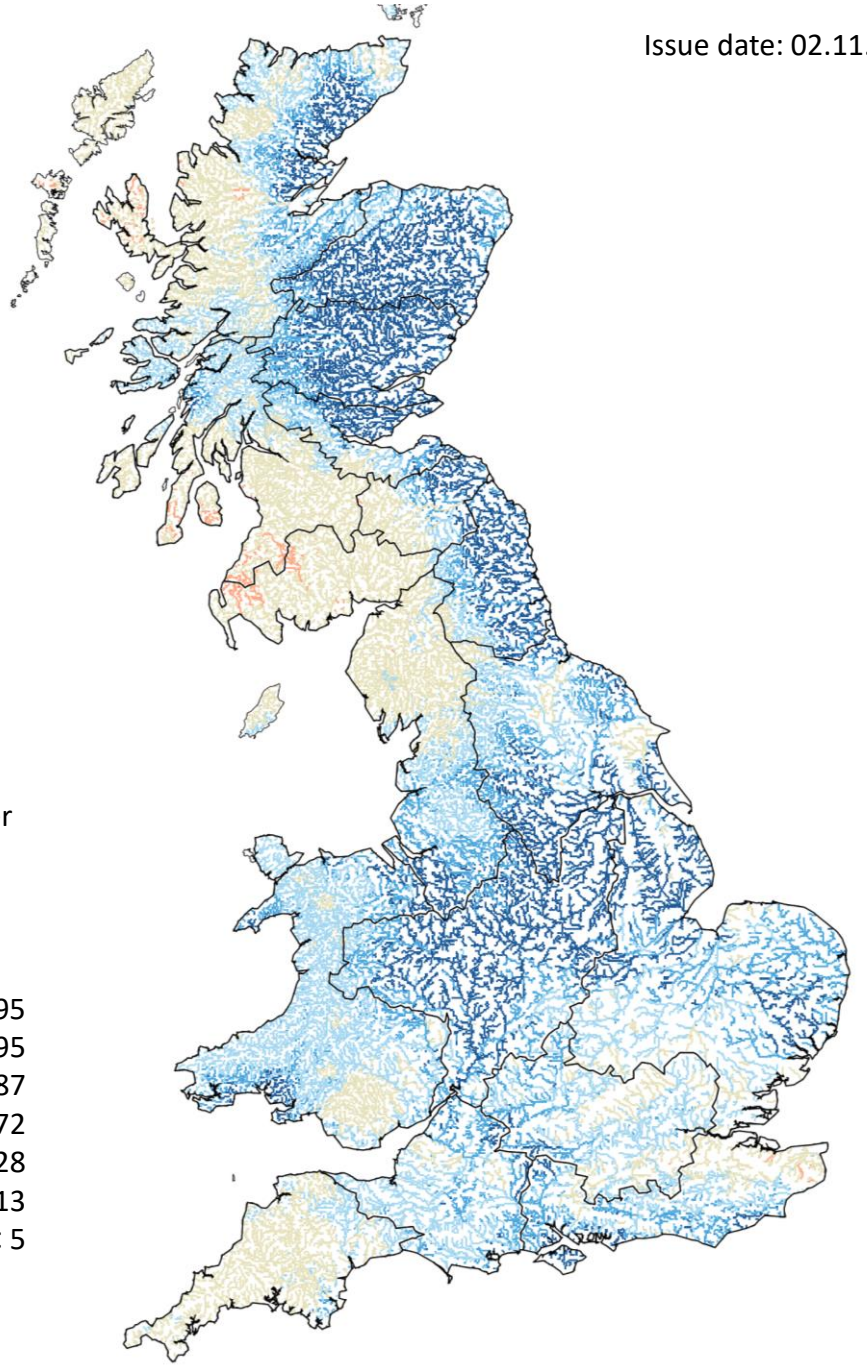
October's mean river flows as simulated by the Grid-to-Grid hydrological model

Issue date: 02.11.2023

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

These flows are produced by the 1km resolution Grid-to-Grid (G2G) hydrological model, which is run up to the end of each calendar month using observed rainfall and MORECS potential evaporation as input.

Note that the G2G model provides estimates of natural flows.



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

Current Daily Simulated Subsurface Water Storage Conditions

Based on subsurface water storage estimated for 31 October 2023

Issue date: 02.11.2023

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 the "relative wetness" which combines maps previously shown separately as the "relative wetness" and "relative dryness".

These maps do not provide a forecast and are not maps of soil moisture. Instead they indicate areas which are particularly wet or dry. Rainfall in areas with high positive relative wetness could result in flooding in the coming days/weeks. Areas of negative relative wetness provide an indication of locations which are particularly dry, and little or no rain in these areas could potentially lead to (or prolong) a drought.

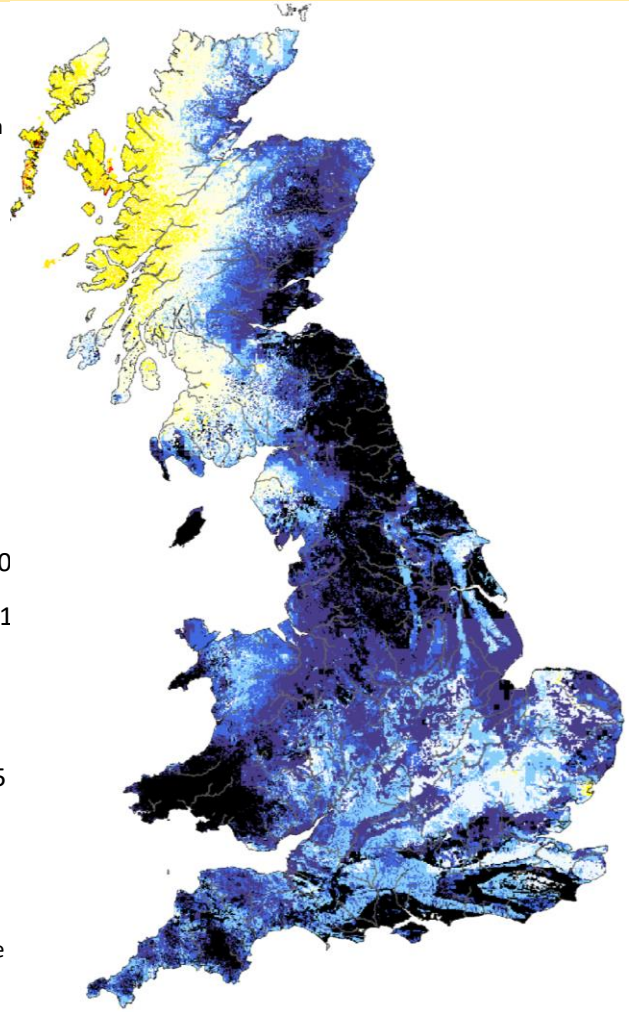
SUMMARY: Subsurface water stores are now much higher (wetter) than is typical for this time of year across most of Great Britain, with widespread areas of very high wetness across northeast England, west Scotland, south Wales and southern England. West Scotland is the exception, with generally average to slightly dry conditions.

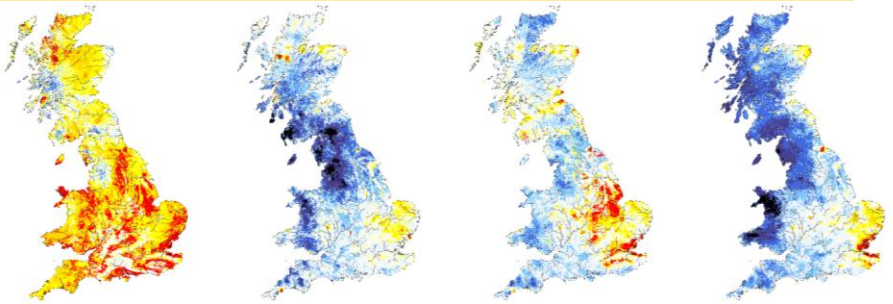
Relative wetness

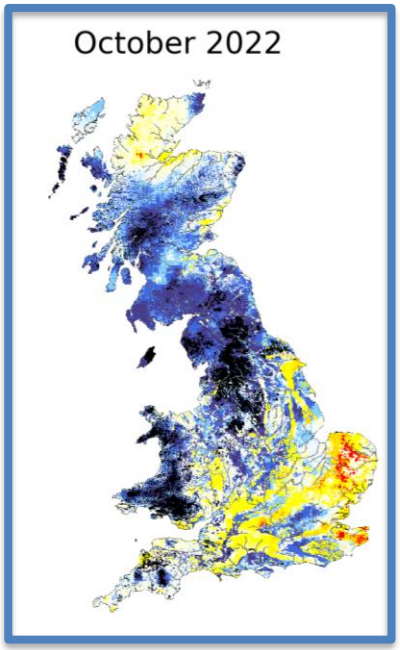
Water storage anomaly as a % of maximum (positive wetness) or minimum (negative wetness) storage anomaly (zero indicates average value)

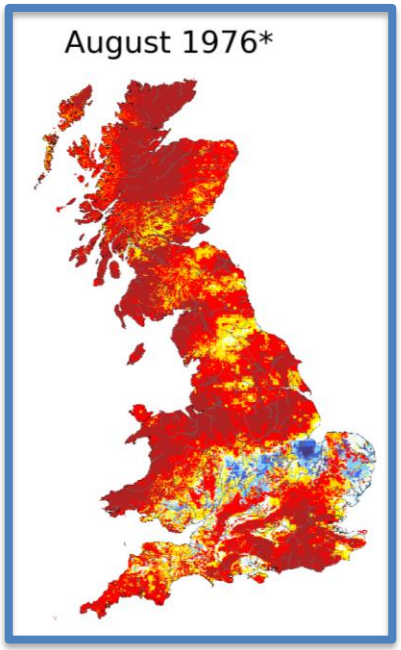
High (very wet)	>100
	75-100
Medium wetness	50-75
	25-50
Low wetness	0.01-25
Average conditions	-0.01-0.0
Low dryness	-25--0.01
	-50--25
Medium dryness	-75--50
	-100--75
High (very dry)	<-100
Major rivers	

Labels refer to estimated storage final day of named month









*Example month displaying extreme negative wetness

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

Current Daily Simulated SOIL MOISTURE Conditions

PROTOTYPE

Based on soil moisture estimated for 31 October 2023

Issue date: 02.11.2023

These maps are based on Grid-to-Grid (G2G) hydrological model simulated soil moisture, expressed as an anomaly from the historical monthly mean. To highlight areas that are particularly wet or dry, the soil moisture anomaly is presented here using a colour scale highlighting soil moisture relative to historical extremes. The maps below show the "relative wetness" which combines maps previously shown separately as the "relative wetness" and "relative dryness".

These maps do not provide a forecast. These maps are prototype representations of model estimates of soil moisture, which are currently under development.

Soil moisture will often look similar to total storage (shown on the previous slide), since total storage comprises both soil moisture and storage in the saturated zone.

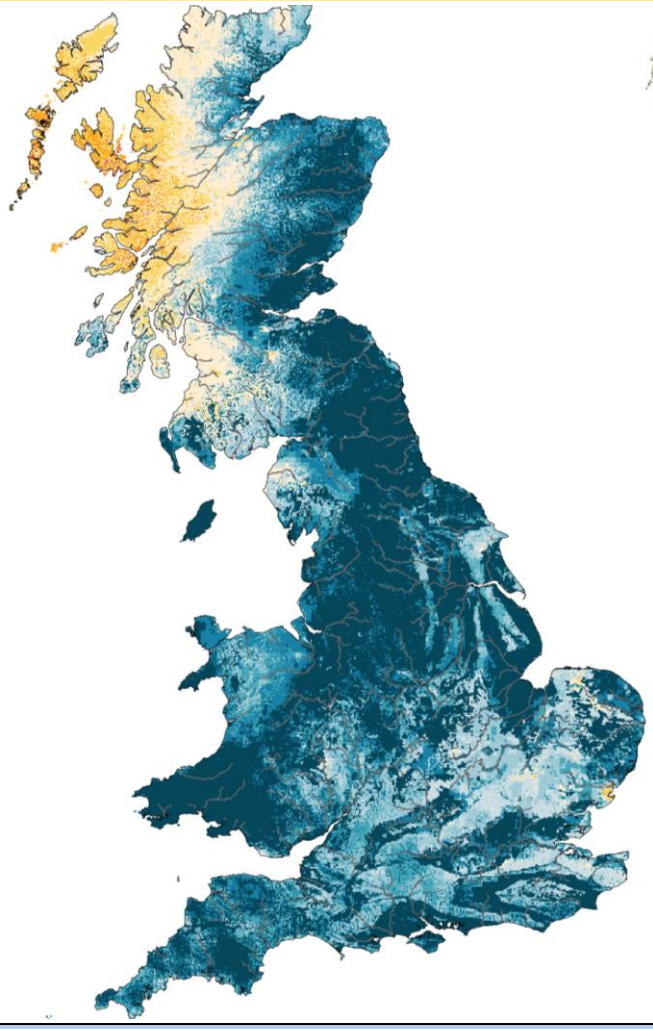
SUMMARY: Soil moisture levels are now much higher (wetter) than is typical for this time of year across the majority of Great Britain, with widespread areas of very high soil moisture. West Scotland is the exception, with generally average to slightly low soil moisture.

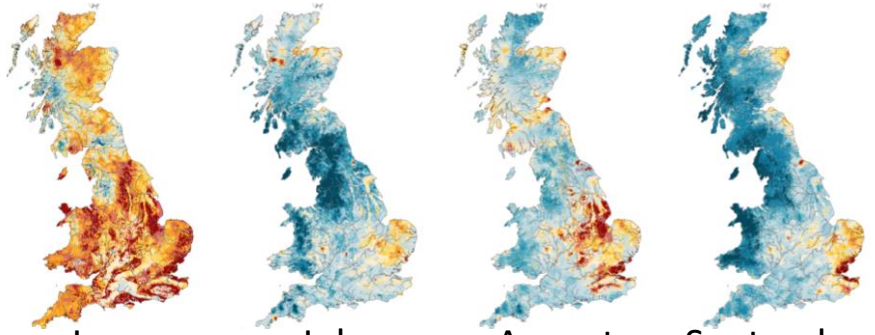
Relative soil wetness

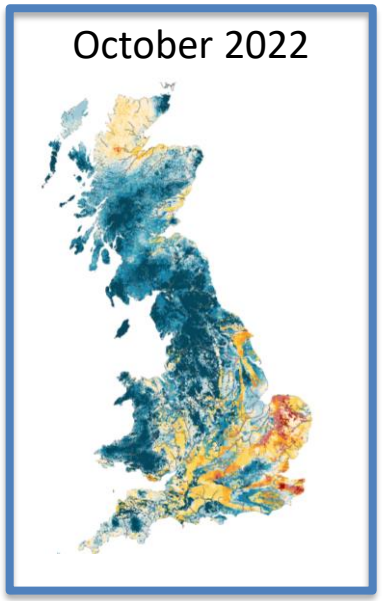
Soil moisture anomaly as a % of maximum (positive wetness) or minimum (negative wetness) moisture anomaly (zero indicates average value)

High (very wet)	>80
	60-80
Medium wetness	40-60
	20-40
Low wetness	0-20
Average conditions	0
Low dryness	-20-0
	-40--20
Medium dryness	-60--40
	-80--60
High (very dry)	<-80
Major rivers	

Labels refer to estimated soil moisture on final day of named month







*Example month displaying extreme negative wetness

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

Return Period of Rainfall Required to Overcome Dry Conditions

Period: November 2023 - April 2024

Issue date: 02.11.2023

CURRENT CONDITIONS

November 2023

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: There are few areas of the country with a subsurface water storage deficit, and no region requires unusually high rainfall (with a >5-year return period) to replenish these deficits.

Nov

Dec

Jan

Feb

Mar

Apr

Rainfall amount (Probability)		Return period (years)
Low (Likely)	>20%	<5
	<20%	5-10
	<10%	10-25
	< 4%	25-50
High (Less likely)	< 2%	50-100
	< 1%	100-200
Extreme (Unlikely)	<0.5%	>200

SCOTLAND

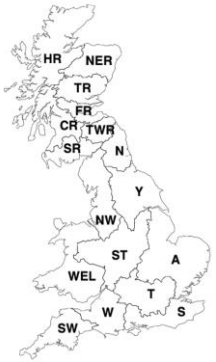
HR	Highlands Region
NER	North East Region
TR	Tay Region
FR	Forth Region
CR	Clyde Region
TWR	Tweed Region
SR	Solway Region

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

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

Estimate of Additional Rainfall Required to Overcome Dry Conditions

Based on subsurface water storage estimated for 31 October 2023

Issue date: 02.11.2023

CURRENT CONDITIONS

November 2023

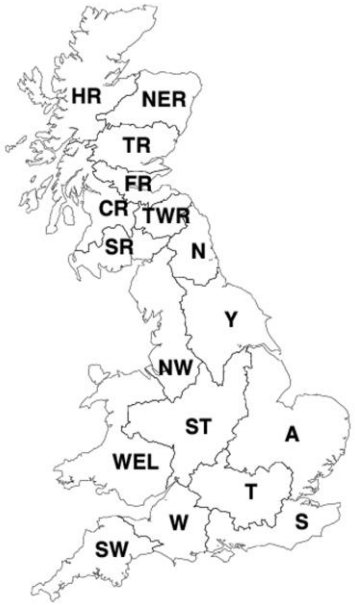
These maps show the Grid-to-Grid (G2G) hydrological model simulated subsurface water storage, expressed as an anomaly from the historical monthly mean (1981-2010), presented on a 1km grid and as regional means.

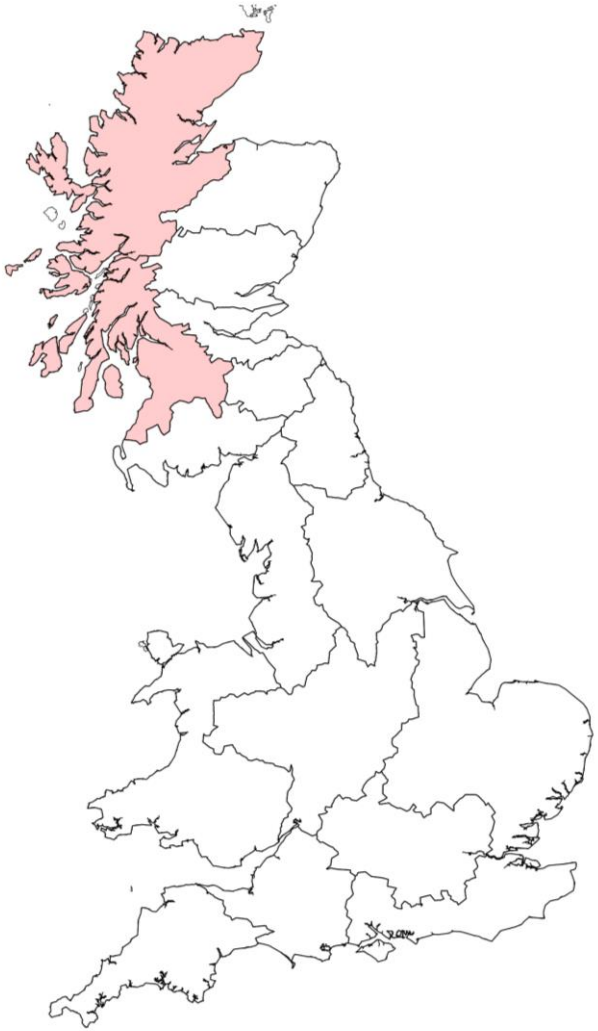
Subsurface storage deficits, i.e. where the subsurface water storage anomaly is less than zero, are highlighted by the red/pink colours.

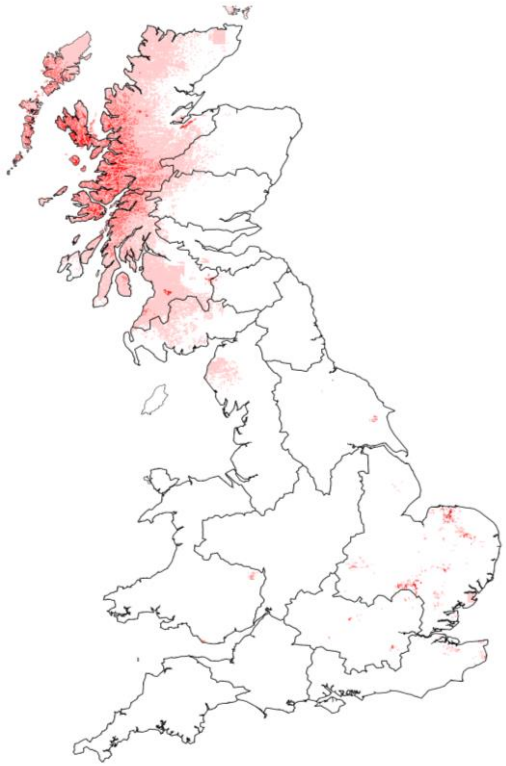
The subsurface storage deficit (mm) can be interpreted as an estimate of additional rainfall that would be required in future months to overcome dry conditions (i.e. rainfall in addition to what is expected on average). Regional mean values of additional rainfall required are provided in the table below.

Regional estimate of additional rainfall required (mm)

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







Water storage deficit (anomaly; mm)

- >125
- 100-125
- 75-100
- 50-75
- 25-50
- 0-25
- <0

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

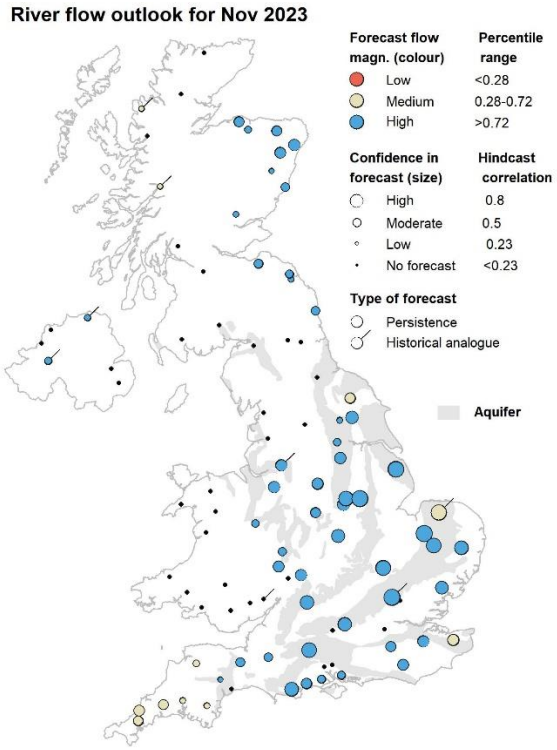
Outlook based on hydrological persistence and analogy

Overview

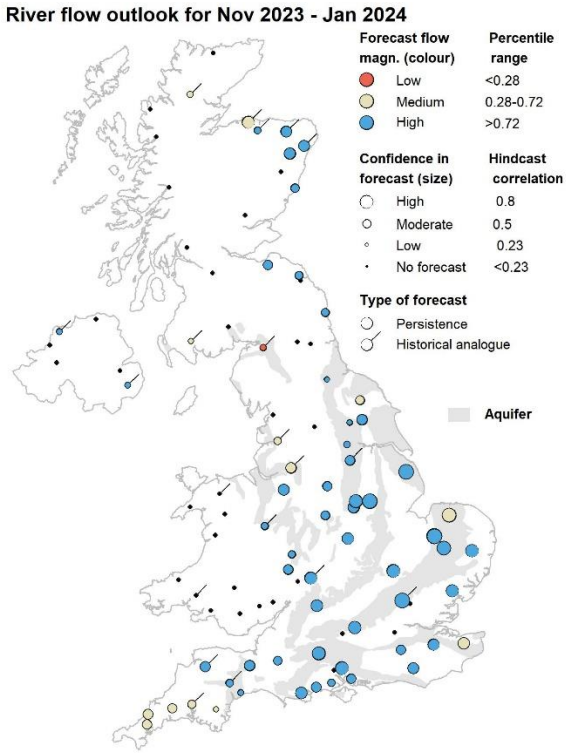
Period: November 2023 – January 2024

Issued on 07.11.2023 using data to the end of October 2023

SUMMARY:
The November and November – January outlook indicate river flows across the country are going to be above normal. Note that there are few forecasts available for western Britain.



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: November 2023

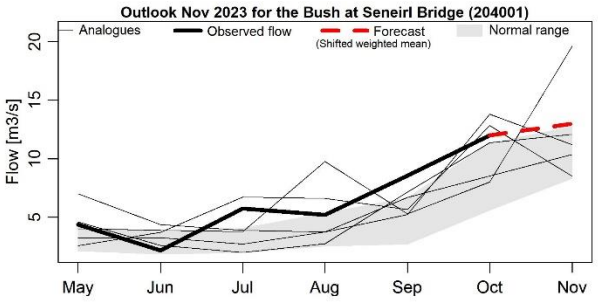
Issued on 07.11.2023 using data to the end of October 2023

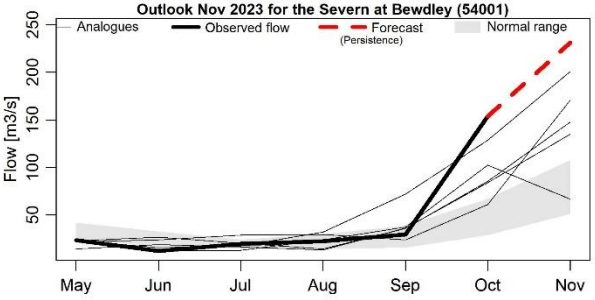
RIVER FLOW ANALOGY

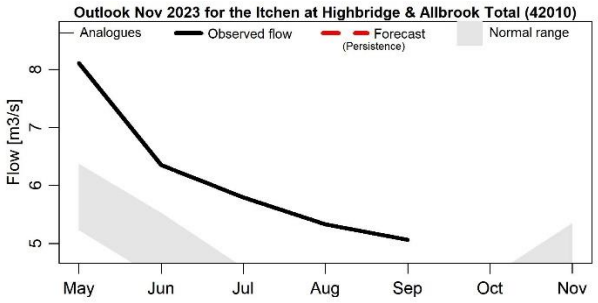
November 2023

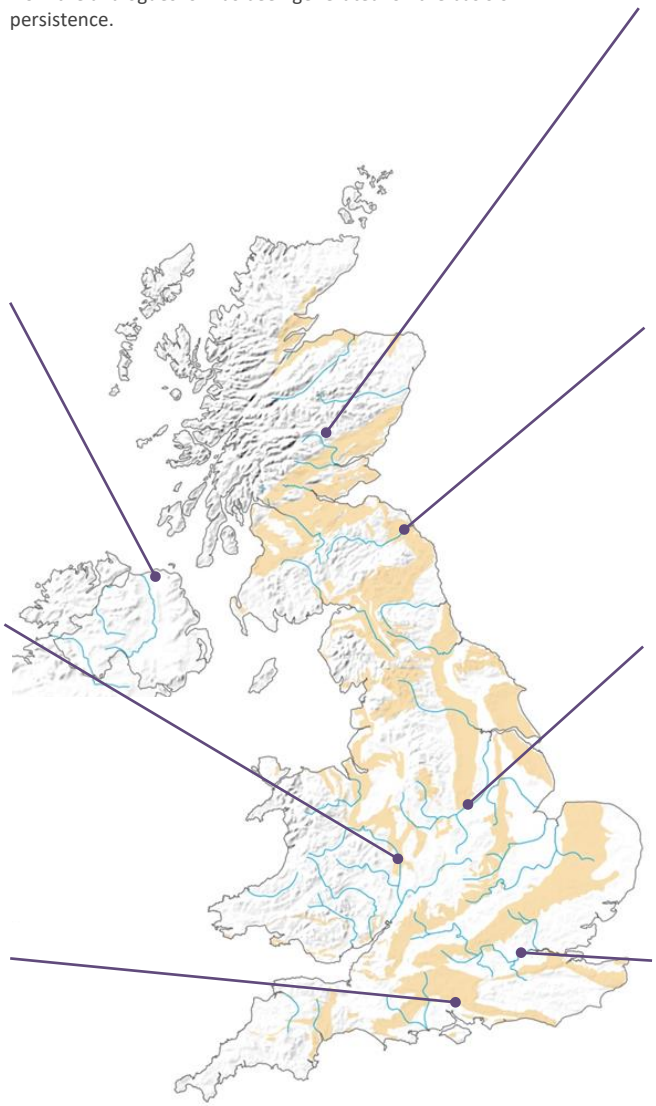
These figures provide insight into the hydrological analogue methodology for a set of sites from across the UK.

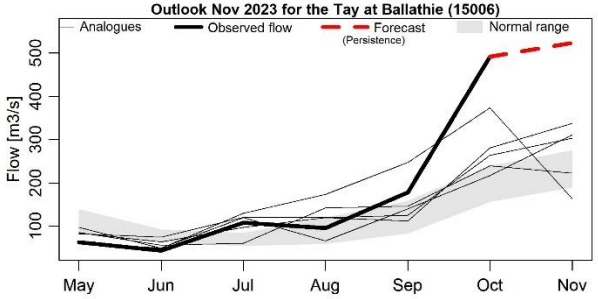
In each of the time series graphs the bold black line represents the observed flow during the past six months. The grey band indicates the normal flow range (the normal band includes 44% of observed flows in each month). The selected analogues are shown as thin lines and the trajectories that flows took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

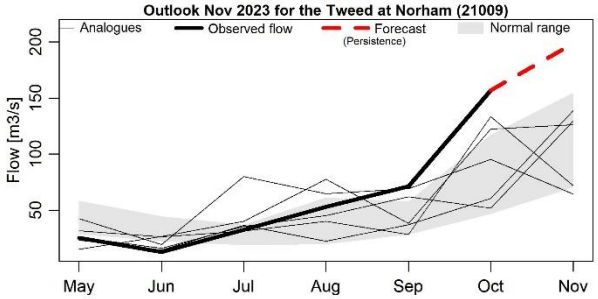


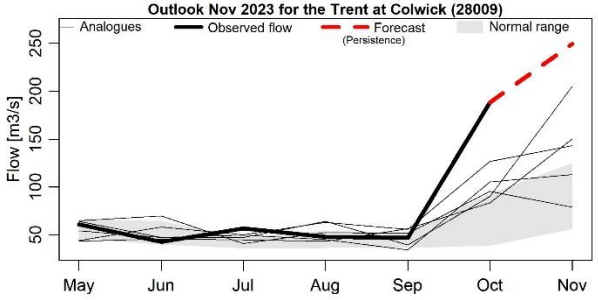


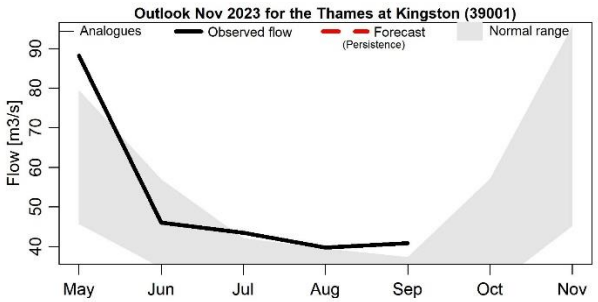












The Hydrological Outlook UK provides an outlook for the water situation for the UK over the next three months and beyond. For guidance on how to interpret the outlook, a wider range of information, and a full description of underpinning methods, please visit the website: www.hydoutuk.net

UK Centre for Ecology & Hydrology

Outlook based on hydrological persistence and analogy

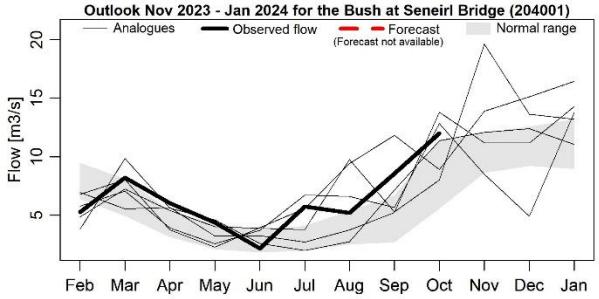
Site-based: 3 month outlook

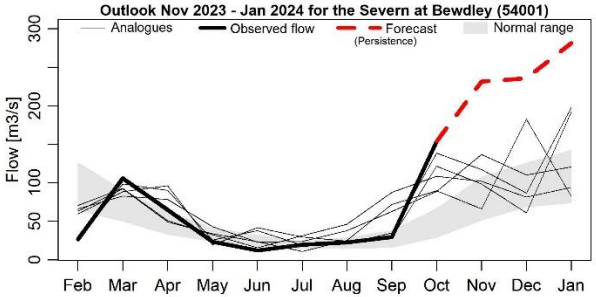
Period: November 2023 – January 2024

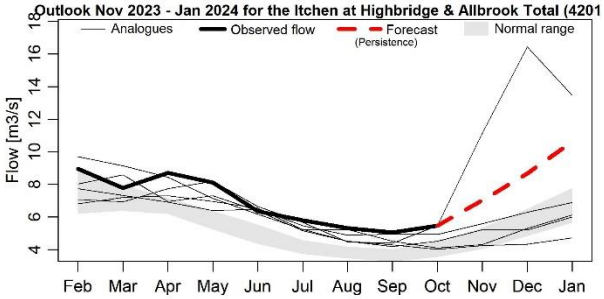
Issued on 07.11.2023 using data to the end of October 2023

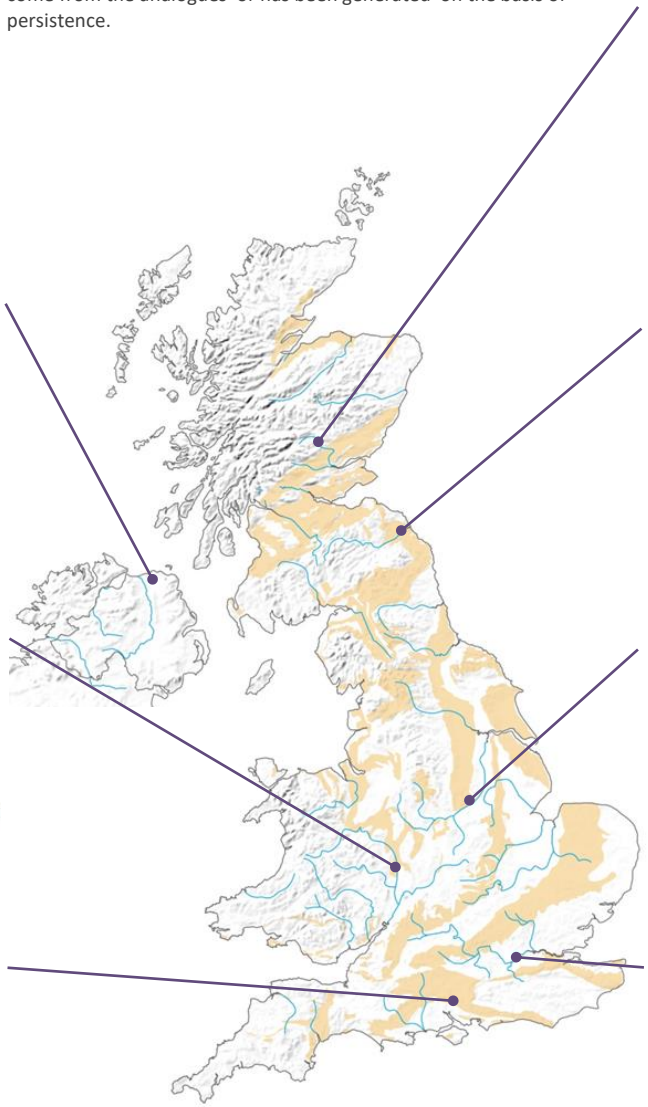
These figures provide insight into the hydrological analogue methodology for a set of sites from across the UK.

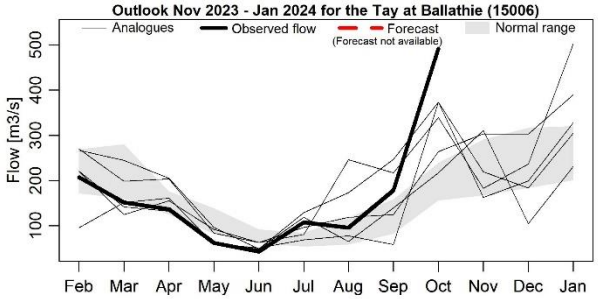
In each of the time series graphs the bold black line represents the observed flow during the past nine months. The grey band indicates the normal flow range (the normal band includes 44% of observed flows in each month). The selected analogues are shown as thin lines and the trajectories that flows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

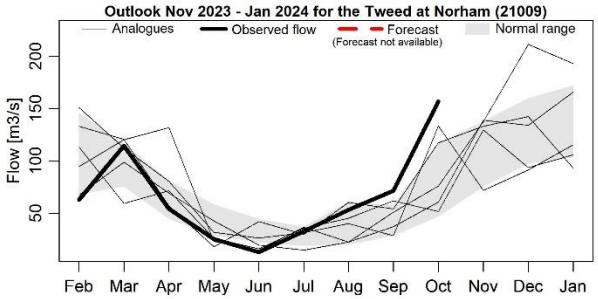


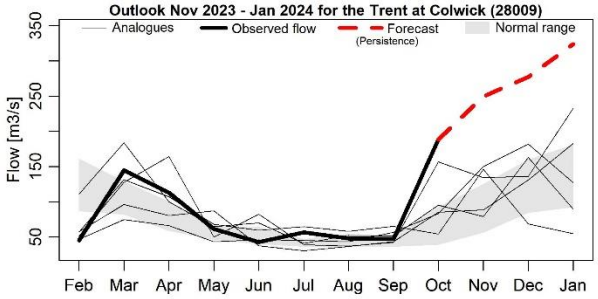


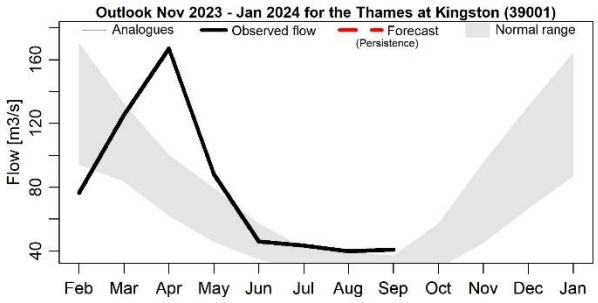












The Hydrological Outlook UK provides an outlook for the water situation for the UK over the next three months and beyond. For guidance on how to interpret the outlook, a wider range of information, and a full description of underpinning methods, please visit the website: www.hydoutuk.net

RIVER FLOW ANALOGY

November 2023

UK Centre for Ecology & Hydrology

British Geological Survey

Environment Agency

Outlook based on modelled flow from historical climate

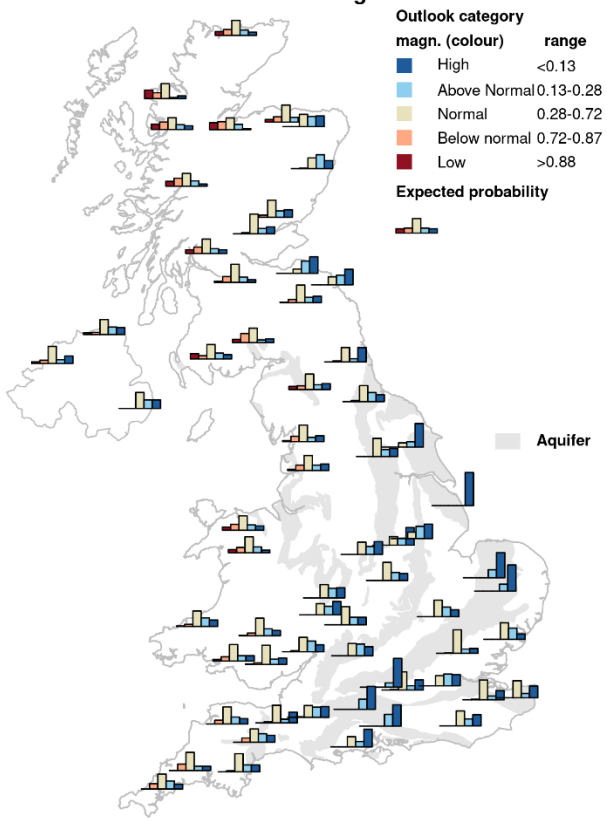
Overview

Period: November 2023 – April 2024

Issued on 03.11.2023 using data to the end of October 2023

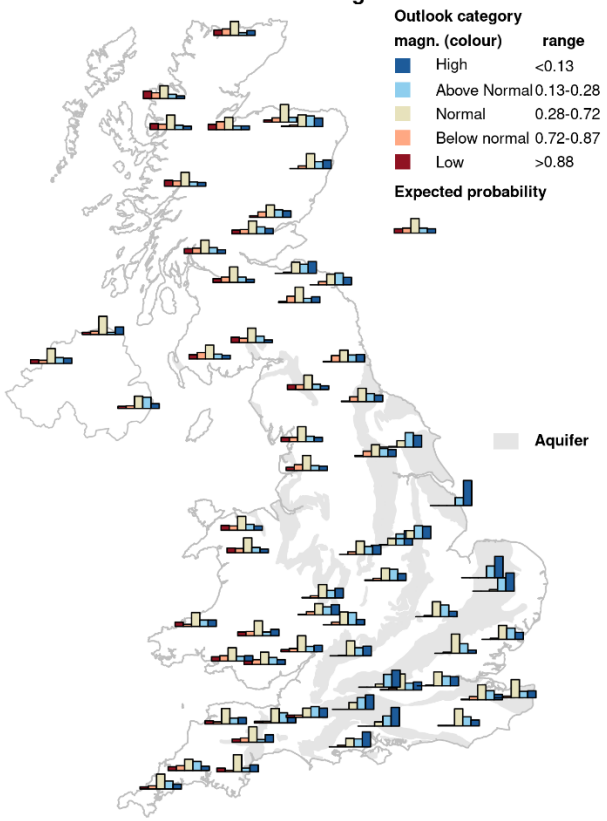
The outlook for November indicates that flows are likely to be generally normal to above normal across the UK, with the exception of a few catchments in southern England and on the east coast of England where they are likely to be above normal, and in northwestern Scotland where they are likely to be normal to below normal. The October-December outlook shows that this pattern is likely to persist of the coming few months.

1-month river flow outlook starting Nov 2023



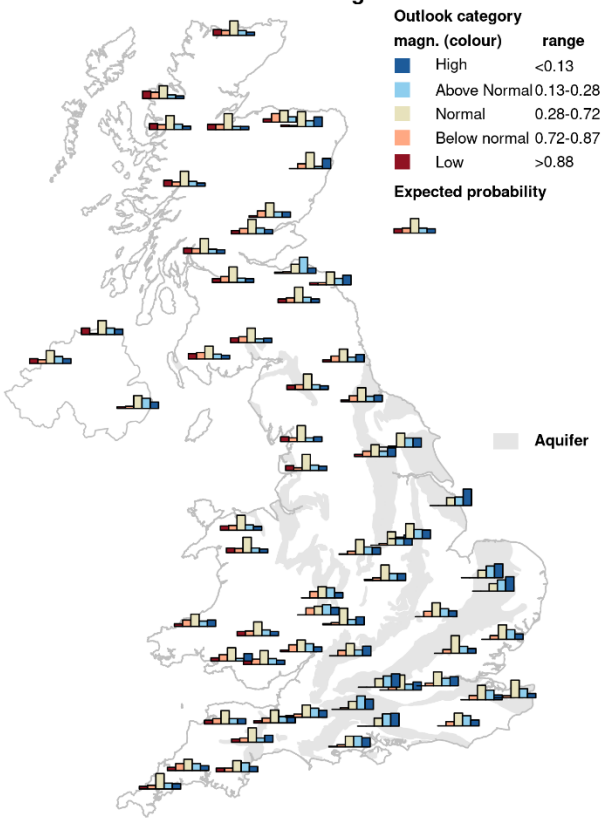
This outlook is based on monthly ensembles of historical sequences of observed climate (rainfall and potential evapotranspiration) that form input to a hydrological model. The outputs are probabilistic simulations of the average river flow over the forecast period (1 to 12 months ahead), at each location. The simulations are generated by the GR6J conceptual rainfall-runoff model from INRAE (France) calibrated on observed or naturalised flows.

3-month river flow outlook starting Nov 2023



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 Nov 2023



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.

Please note that *Outlooks based on modelled flow from historical climate* from October 2023 onwards were generated using GR6J model, whereas until September 2023, they were produced using GR4J model. For more details, please see the section on River flow from historical climate at this link: https://hydoutuk.net/about/methods/river-flows

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

British Geological Survey

Environment Agency

Outlook based on modelled flow from historical climate

Overview

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 GR6J conceptual rainfall-runoff model from INRAE (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.

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

November 2023

UK Centre for Ecology & Hydrology

Outlook based on Modelled Flow from Rainfall Forecasts

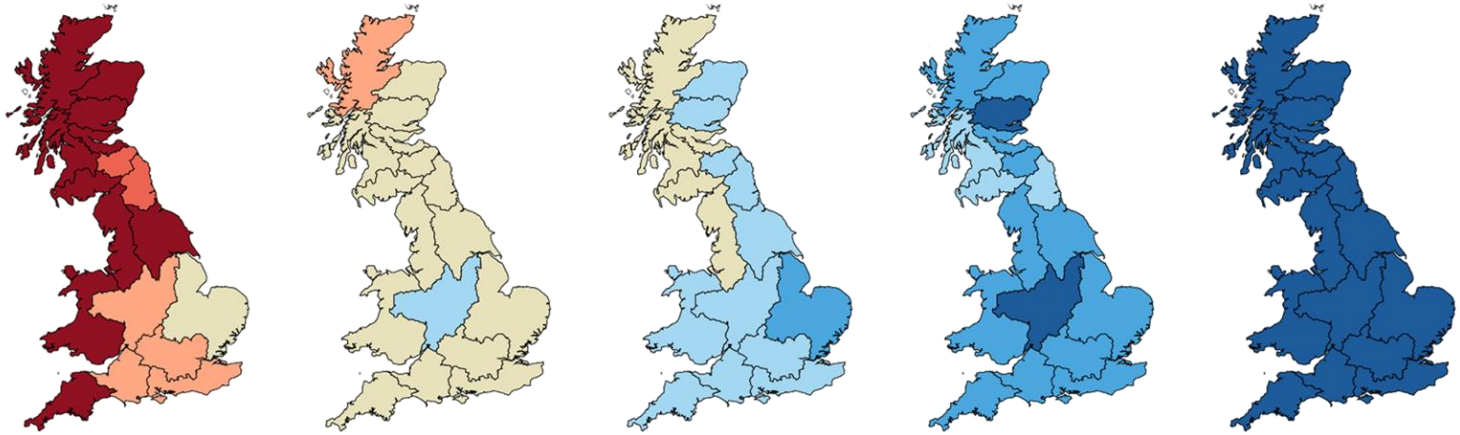
Period: November 2023 – January 2024

Issued on 02.11.2023 using data to the end of October

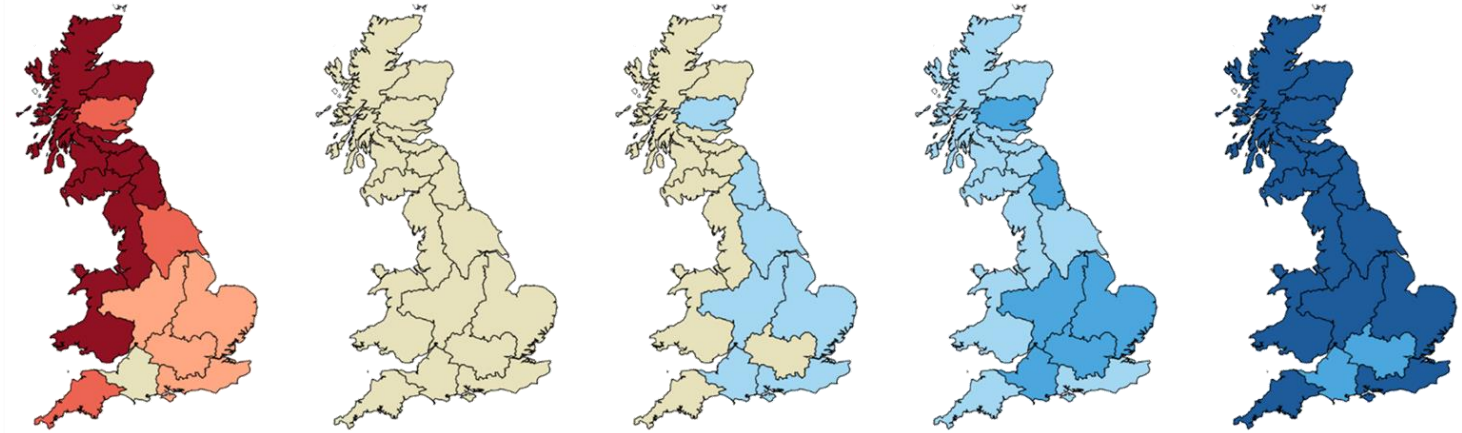
SUMMARY: During November, river flows are likely to be in the *Normal range* or above across north-western England and Scotland, and *Above normal* to *exceptionally high* elsewhere.

Over the next 3 months river flows for regions in the west of Great Britain, most of Scotland and the Thames are likely to be in the *Normal range* or above, and *Above normal* or higher elsewhere.

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



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



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
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

RIVER FLOW FROM RAINFALL FORECASTS

November 2023

UK Centre for Ecology & Hydrology

Outlook based on Modelled Flow from Rainfall Forecasts

Period: November 2023 - January 2024

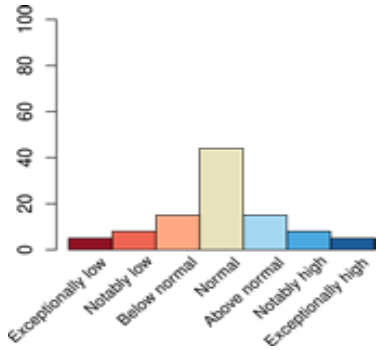
Issue date: 02.11.2023

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.

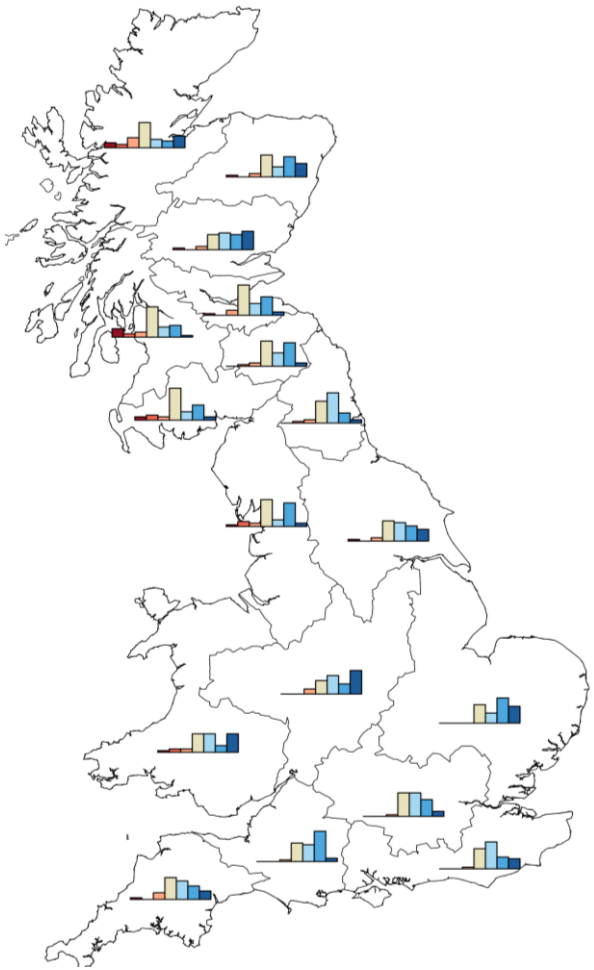
The bar charts (below) give further insight into the range of river flow forecasts by considering all members of the forecast rainfall ensemble. The regional bar charts show the percentage of ensemble forecasts falling in each of the flow categories as generated by the monthly-resolution water-balance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

SUMMARY: During November, river flows are likely to be in the *Normal range* or above across north-western England and Scotland, and *Above normal* to *exceptionally high* elsewhere.

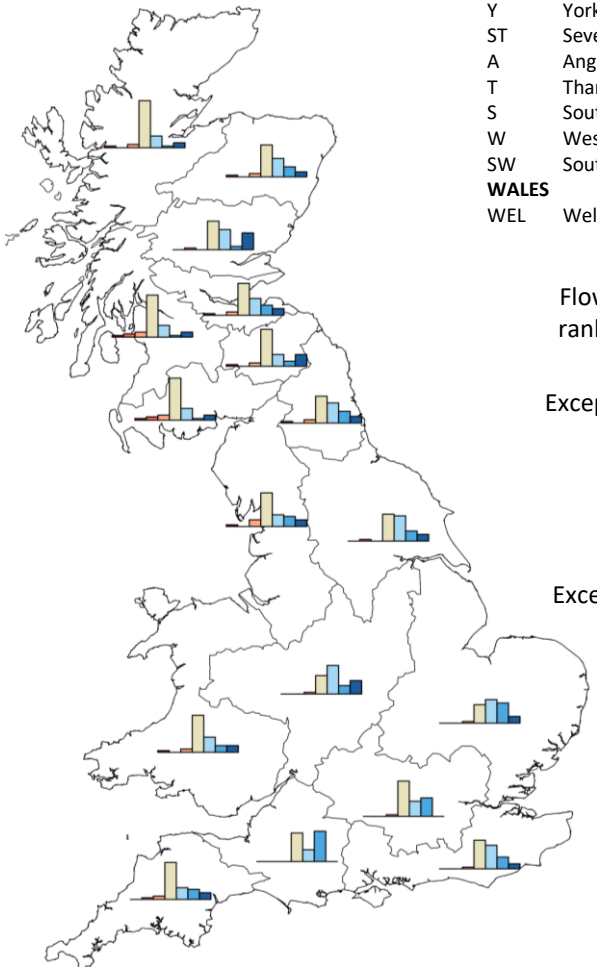
Over the next 3 months river flows for regions in the west of Great Britain, most of Scotland and the Thames are likely to be in the *Normal range* or above, and *Above normal* or higher elsewhere.



1-month



3-month



SCOTLAND

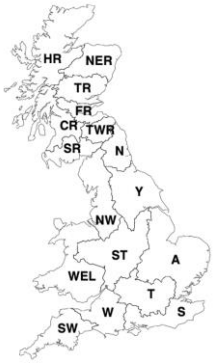
HR	Highlands Region
NER	North East Region
TR	Tay Region
FR	Forth Region
CR	Clyde Region
TWR	Tweed Region
SR	Solway Region

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

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

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

Period: November 2023 - January 2024

Issue date: 02.11.2023

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 November, river flows are likely to be in the *Normal range* or above across north-western England and Scotland, and *Above normal* to *exceptionally high* elsewhere.

Over the next 3 months river flows for regions in the west of Great Britain, most of Scotland and the Thames are likely to be in the *Normal range* or above, and *Above normal* or higher elsewhere.

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

1-month ahead	A	NW	N	ST	SW	S	T	WEL	W	Y	CR	FR	HR	NER	SR	TR	TWR
Exceptionally high flow	24	5	5	33	12	14	7	26	5	17	2	5	17	19	5	26	5
Notably high	36	33	14	14	19	17	24	10	43	21	17	26	10	29	21	21	33
Above normal	14	10	43	26	26	38	33	26	24	26	14	17	12	14	12	24	19
Normal range	26	38	31	19	31	29	33	26	26	29	43	43	36	31	45	21	36
Below normal	0	5	5	7	10	2	2	5	2	5	7	7	14	5	5	5	5
Notably low	0	7	2	0	0	0	0	5	0	0	5	0	5	0	7	0	2
Exceptionally low flow	0	2	0	0	2	0	0	2	0	2	12	2	7	2	5	2	0

3-month ahead	A	NW	N	ST	SW	S	T	WEL	W	Y	CR	FR	HR	NER	SR	TR	TWR
Exceptionally high flow	10	10	10	19	10	7	0	10	0	10	7	10	7	7	7	24	17
Notably high	29	14	17	12	14	17	26	10	43	14	2	14	2	14	2	5	7
Above normal	33	17	29	40	17	33	21	21	17	36	17	24	17	26	17	29	17
Normal range	26	48	38	26	52	40	50	52	40	38	60	45	67	45	60	40	52
Below normal	2	10	5	2	5	2	2	5	0	0	7	5	5	5	7	0	5
Notably low	0	0	0	0	2	0	0	0	0	2	5	0	0	0	5	2	0
Exceptionally low flow	0	2	2	0	0	0	0	2	0	0	2	2	2	2	2	0	2

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

British Geological Survey

Outlook based on modelled groundwater level & climate forecast

Overview

Period: November 2023 – January 2024

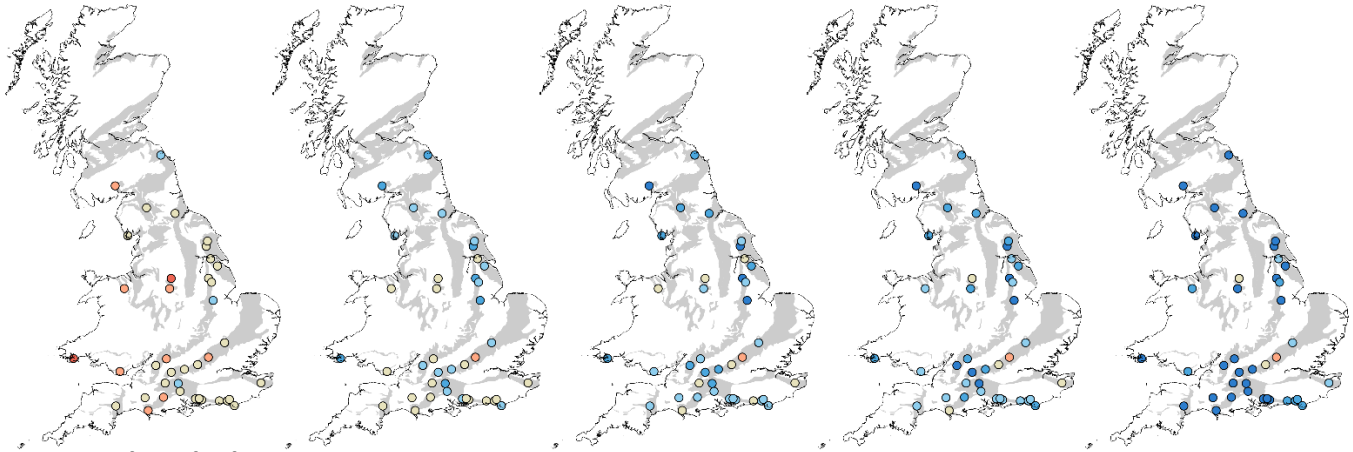
Issued on 07.11.2023 using data to the end of October

Under median rainfall conditions, groundwater levels are forecast to be above normal to notably high at most sites over the next month, with a few exceptions in the Chalk and at Llanfair DC in the Permo-Triassic sandstone where levels are expected to be normal. Given the high rainfall already experience in early November, notably to exceptionally high levels, and potential groundwater flooding, cannot be ruled out. The three month forecasts are similar but with a general shift to somewhat higher levels for the time of year. Most groundwater levels in the South Downs Chalk and Lincolnshire Chalk are likely to persist with above normal levels, with some regions within the Wessex Chalk, Jurassic Limestones, and Permo-Triassic Sandstones of the north-west, forecast to have notably high levels.

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*

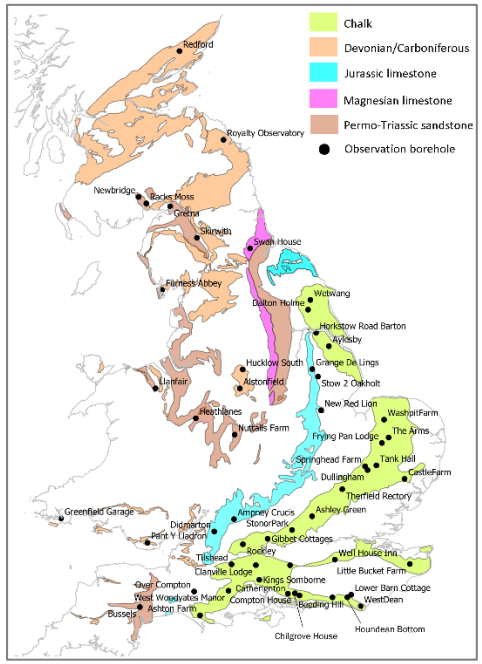


3-month outlook

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



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 FROM CLIMATE FORECASTS

November 2023

UK Centre for Ecology & Hydrology

British Geological Survey

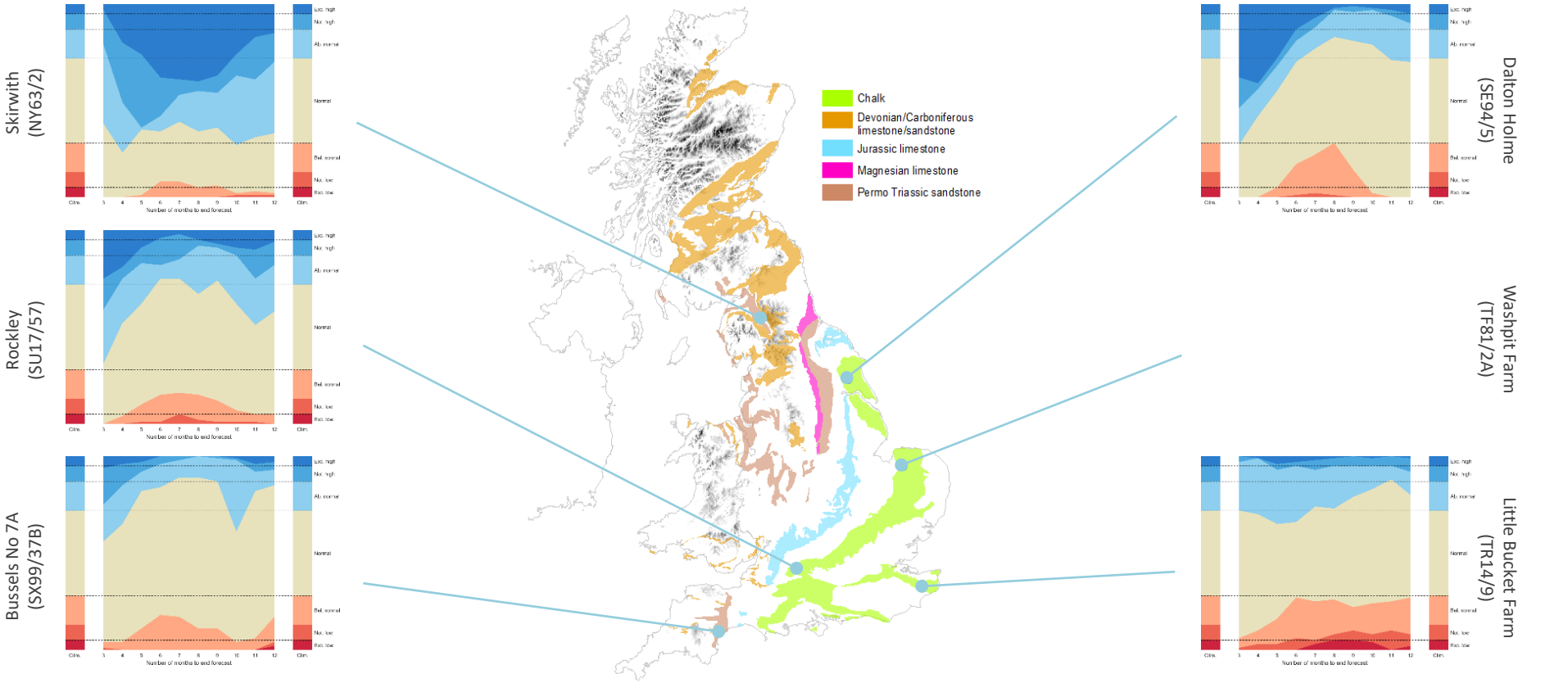
Environment Agency

Outlook based on modelled groundwater from historical climate

Period: November 2023 – October 2024

Issued on 07.11.2023 using data to the end of October

Groundwater levels at Skirwith in the Permo-Triassic Sandstones are forecast to be above normal to exceptionally high over the next 12 months. In the Chalk at Rockley and the Permo-Triassic Sandstones at Bussels No 7A, normal to above normal conditions in next 3 to 4 months give way to more normal conditions over the spring/summer period. At Dalton Holme, above normal to exceptionally high levels are forecast in the next 3 to 5 months, with levels returning to more normal conditions in the summer months of 2024. At Little Bucket Farm, predominantly normal levels are anticipated, with a possibility of lower than normal and above normal levels at times in the next year. Data from Washpit Farm appear anomalous and have not been included.



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.

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