UK Hydrological Outlook

Delivered in partnership by: UK Centre for Ecology & Hydrology

Period: From January 2024 Issued on 10.01.2024 using data to the end of December 2023

SUMMARY

The outlook for January is for above normal river flows in eastern Britain, and normal to above normal river flows in western Britain. The three-month outlook is for normal to above normal river flows for the whole of the UK. Groundwater levels are likely to be notably high to exceptionally high for January, and normal to notably high in January-March over the next three months.

Rainfall:

December 2023 rainfall was above average across the UK. Widespread areas, including central and northern England, eastern Scotland and south Wales, received more than 170% of the average rainfall.

The forecast (issued by the Met Office on 18.12.2023) shows the chances of a drier than average January are slightly higher than usual, and for the January–March period there is a moderate reduction in the chances of wet conditions. The start of January was very wet following Storm Henk, with some areas of England and Wales registering more than half of the average January rainfall in the first few days of the month.

River flows:

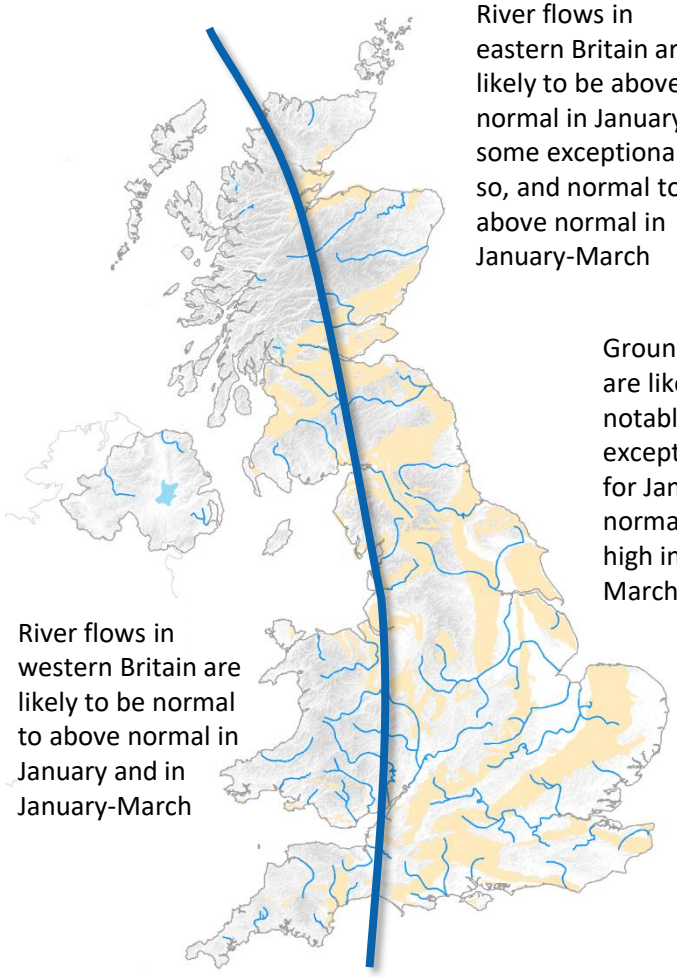
River flows in December were above normal across much of the country, apart from western Scotland where they were normal. Elsewhere, exceptionally high flows were registered across the country, with some rivers recording their highest December monthly flows on record in England and eastern Scotland.

The outlook for January is for above normal river flows in eastern Britain, and particularly in larger catchments, where we have already seen extensive flooding, some of these will be notably or exceptionally high. In western parts, flows are likely to be normal to above normal. The rainfall forecast suggests river flows will continue to recede through the remainder of January, though any intense rainfall is likely to prompt a rapid response. Over the three-month period (January to March), river flows are likely to be normal to above normal for the UK.

Groundwater:

Groundwater levels in December were mainly above normal, many exceptionally high, with record December levels recorded in some parts of the Jurassic Limestones.

The outlook for January is for notably high to exceptionally high levels across much of the UK, particularly so in the Wessex Chalk, Yorkshire Chalk, South Downs Chalk, and the Jurassic Limestones. In these areas there is potential for groundwater flooding. Over the three-month period (January to March), groundwater levels are likely to remain above normal to notably high, although more mixed, with some normal levels in southern England.



Shaded areas show principal aquifers

The UK Hydrological Outlook provides an outlook for the water situation for the United Kingdom 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 HYDROLOGICAL OUTLOOK

January 2024

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 UK 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 & 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 UK 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 and GR6J hydrological models. Hydrogeological modelling uses the AquiMod model run by BGS.
Supporting documentation is available from the Outlooks website:
https://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 UK 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 UK Hydrological Outlook Partnership excludes all warranties or representations (express or implied) in respect of the Content.

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From April 2018 the UK 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 UK Hydrological Outlook, and the derivation of the maps, plots and interpretation provided in this outlook, please visit the UK Hydrological Outlook 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. Dynamic access to many of the outputs of the UK Hydrological Portal are available on the UK Hydrological Outlooks Portal.

Contact:

UK Hydrological Outlooks, UK Centre for Ecology & Hydrology, Wallingford, Oxfordshire, OX10 8BB
t: 01491 838800 e: https://hydoutuk.net/contact

Reference for the UK Hydrological Outlook:

UK Hydrological Outlook, 10 January 2024, UK Centre for Ecology & Hydrology, Oxfordshire UK, Online, https://www.hydoutuk.net/latest-outlook/

Other Sources of Information:

The UK 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:
i. Environment Agency: https://flood-warning-information.service.gov.uk/map
ii. Natural Resources Wales: https://flood-warning.naturalresources.wales/
iii. 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/

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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UK Centre for Ecology & Hydrology

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

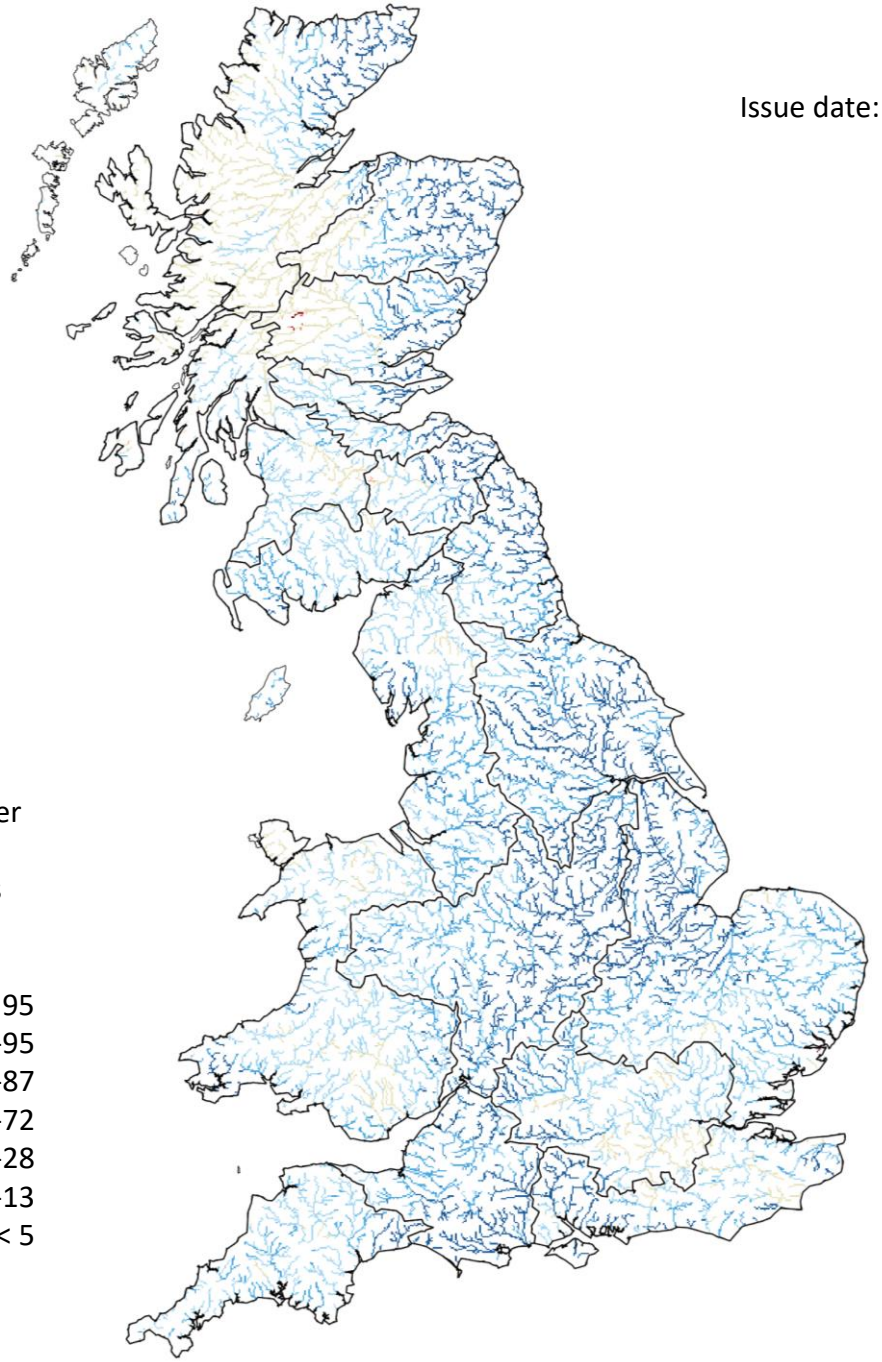
CURRENT CONDITIONS

Issue date: 03.01.2024

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.



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

January 2024

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UK Centre for Ecology & Hydrology

Current Daily Simulated Subsurface Water Storage Conditions

Based on subsurface water storage estimated for 31 December 2023

Issue date: 03.01.2024

These maps are based on Grid-to-Grid (G2G) hydrological model simulated subsurface water storage (water in the soil and groundwater), expressed as an anomaly from the historical monthly mean. To highlight areas that are particularly wet or dry, the storage anomaly is presented relative to historical extremes. Rainfall in WET areas with high positive relative wetness could result in flooding in the coming days/weeks. Areas of negative relative wetness indicate locations which are particularly DRY, and little or no rain in these areas could potentially lead to (or prolong) a drought. Maps of soil moisture only are available on the next page.

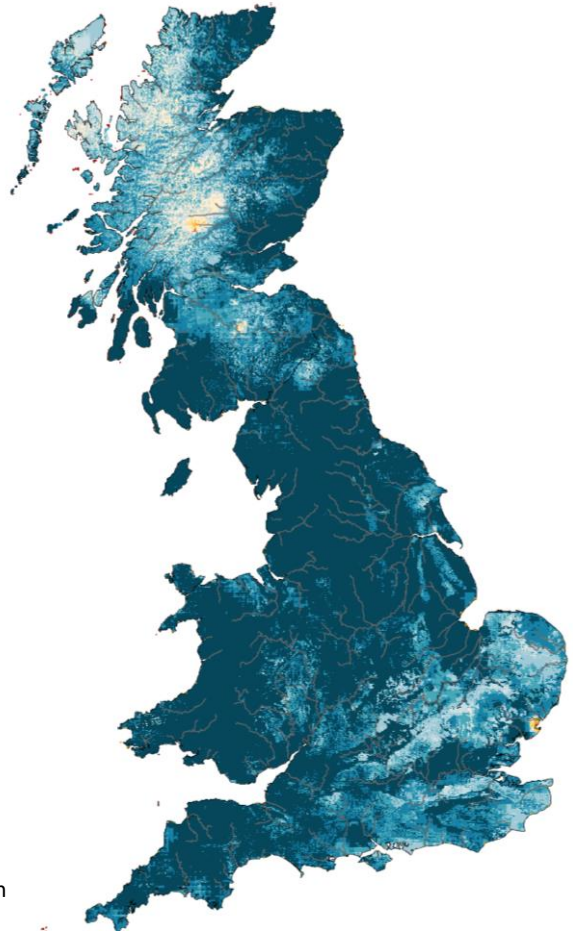
SUMMARY: Subsurface water stores have risen over December and are now very high (wet) across large parts of Great Britain. In a small number of upland areas subsurface water stores remain typical for the time of year.

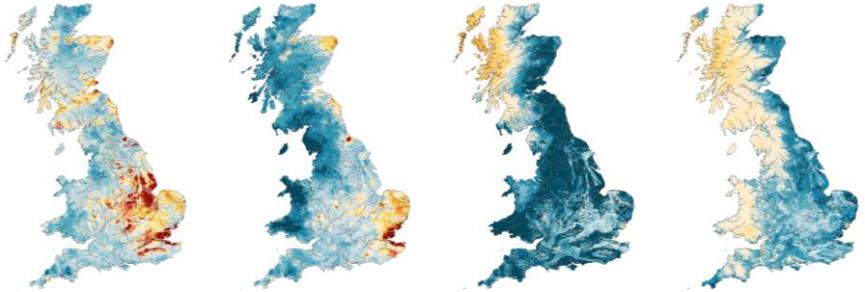
Relative wetness

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

High (very wet)	>80
	60-80
Medium wetness	40-60
	20-40
Low wetness	0.01-20
Average conditions	-0.01-0.01
Low dryness	-20--0.01
	-40--20
Medium dryness	-60--40
	-80--60
High (very dry)	<-80
Major rivers	

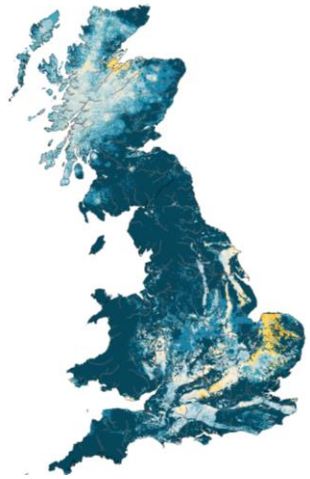
Labels refer to estimated storage on final day of named month





August September October November

December 2022



October 2000*

*Example month displaying extreme positive wetness

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UK Centre for Ecology & Hydrology

Current Daily Simulated Soil Moisture Conditions

Based on soil moisture estimated for 31 December 2023

Issue date: 03.01.2024

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 relative to historical extremes. These maps are not a forecast; rather an indication of current conditions. 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.

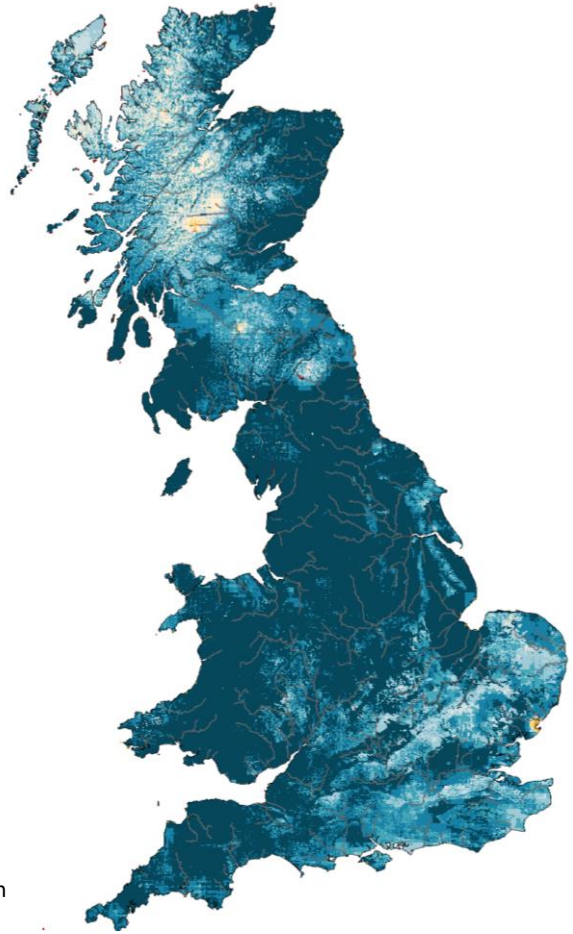
SUMMARY: Soil moisture stores have risen over December and are now very high (wet) across large parts of Great Britain. In a small number of upland areas soil moisture stores remain typical for the time of year.

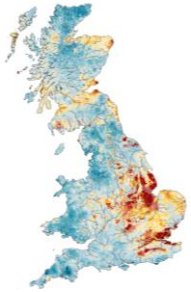
Relative wetness

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

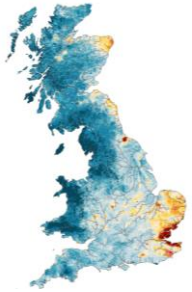
High (very wet)	>80
	60-80
Medium wetness	40-60
	20-40
Low wetness	0.01-20
Average conditions	-0.01-0.01
Low dryness	-20--0.01
	-40--20
Medium dryness	-60--40
	-80--60
High (very dry)	<-80
Major rivers	

Labels refer to estimated storage on final day of named month



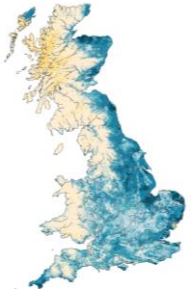


August



September

October



November

December 2022

October 2000*

*Example month displaying extreme positive wetness

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UK Centre for Ecology & Hydrology

Estimate of Additional Rainfall Required to Overcome Dry Conditions

Based on subsurface water storage estimated for 31 December 2023

Issue date: 03.01.2024

CURRENT CONDITIONS

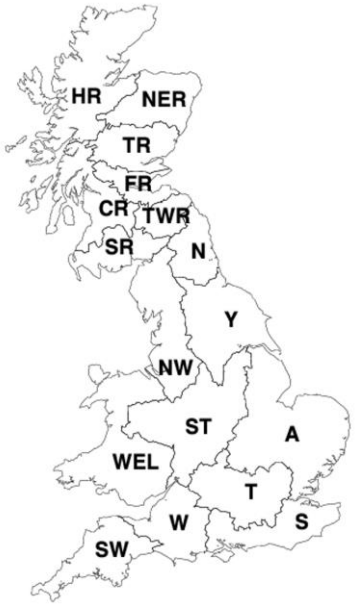
January 2024

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 in red/pink.

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
0	NER	North East Region
0	TR	Tay Region
0	FR	Forth Region
0	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

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UK Centre for Ecology & Hydrology

Return Period of Rainfall Required to Overcome Dry Conditions

Period: January 2024 - June 2024

Issue date: 03.01.2024

CURRENT CONDITIONS

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 one to six months (areas with no storage deficit will always be white). These maps do not provide a drought forecast; instead they indicate whether particularly heavy rainfall would be required to return to normal conditions for the time of year.

SUMMARY: There are no regions of Great Britain with water storage deficits at the start of January.

Jan

Feb

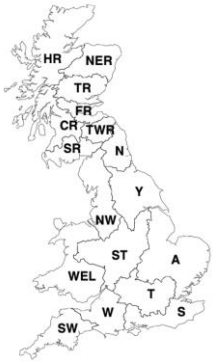
Mar

Apr

May

Jun

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



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

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January 2024

UK Centre for Ecology & Hydrology

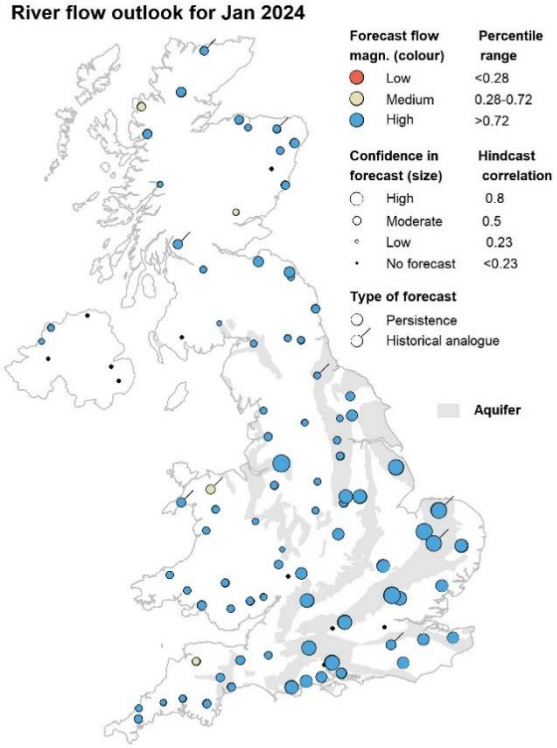
Outlook based on hydrological persistence and analogy

Overview

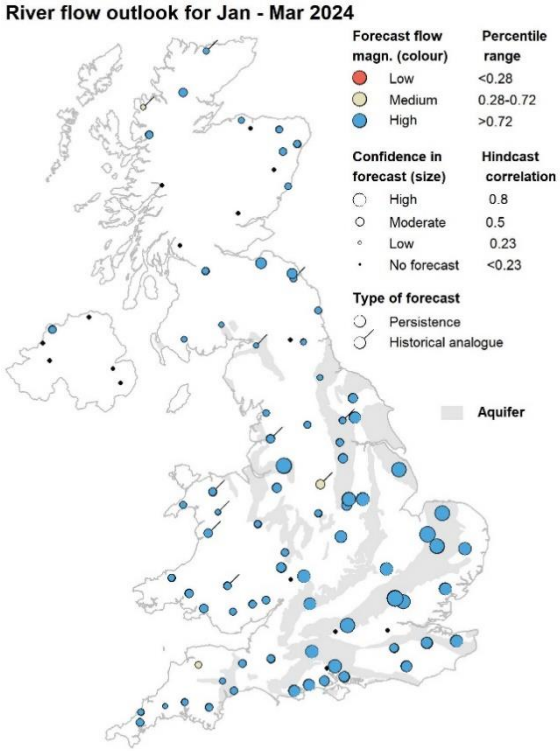
Period: January 2024 – March 2024

Issued on 09.01.2024 using data to the end of December 2023

SUMMARY:
The January and January - March outlook indicate river flows across the country are going to be above normal. Note that the confidence of the forecasts in north-western areas is low.



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.

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Outlook based on hydrological persistence and analogy

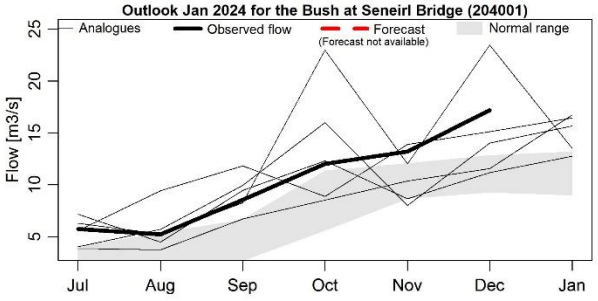
Site-based: 1 month outlook

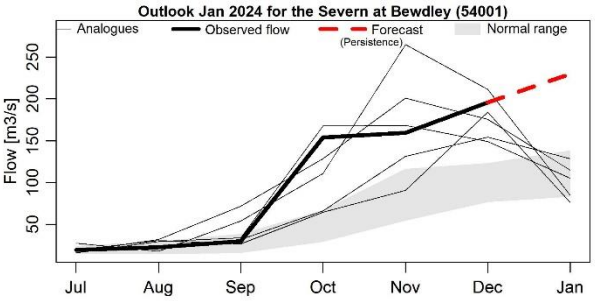
Period: January 2024

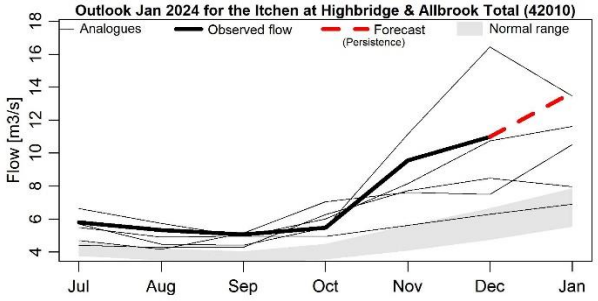
Issued on 09.01.2024 using data to the end of December 2023

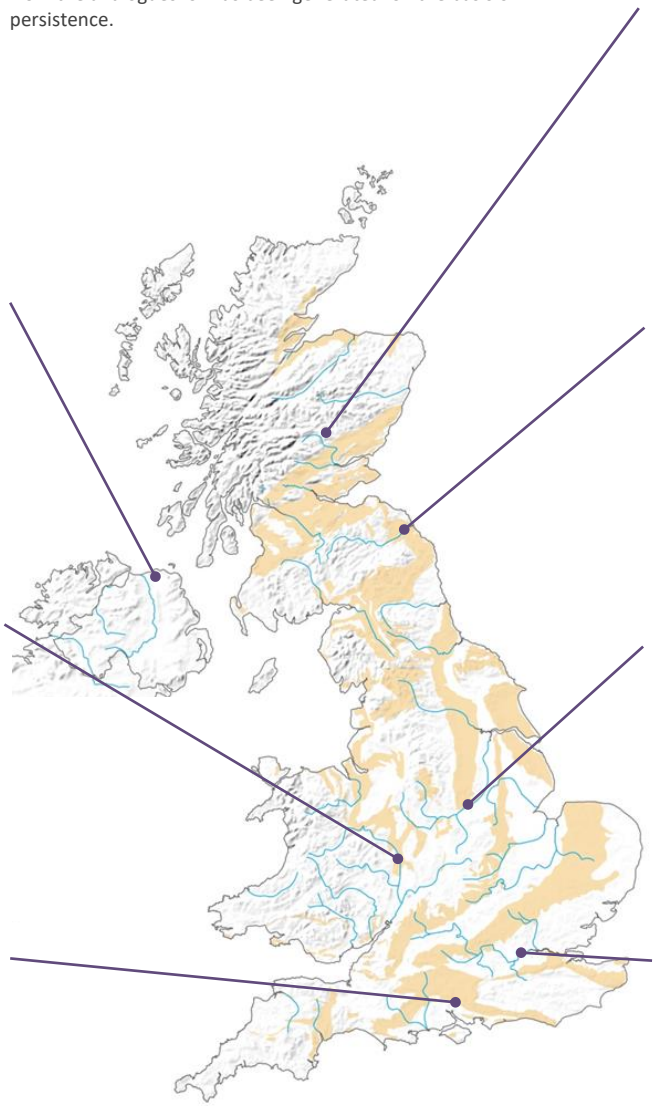
These figures provide insight into the hydrological analogue methodology for a set of sites from across the UK.

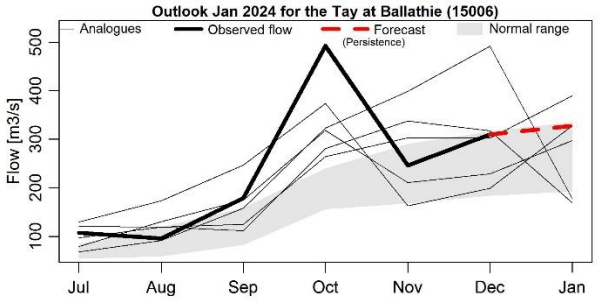
In each of the time series graphs the bold black line represents the observed flow during the past six months. The grey band indicates the normal flow range (the normal band includes 44% of observed flows in each month). The selected analogues are shown as thin lines and the trajectories that flows took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

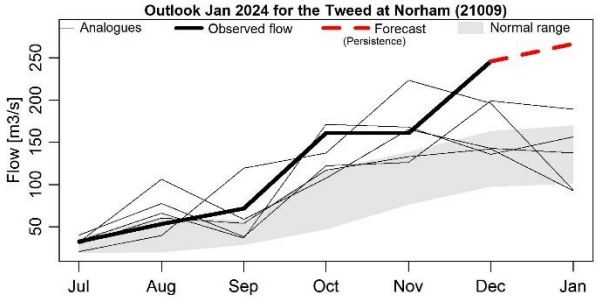


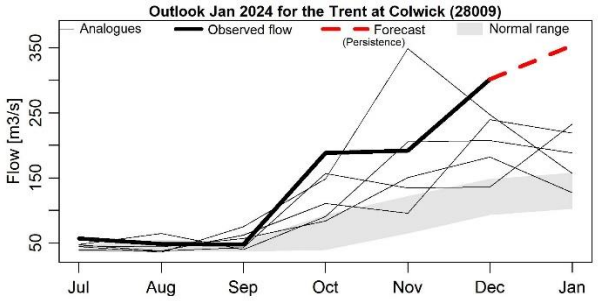


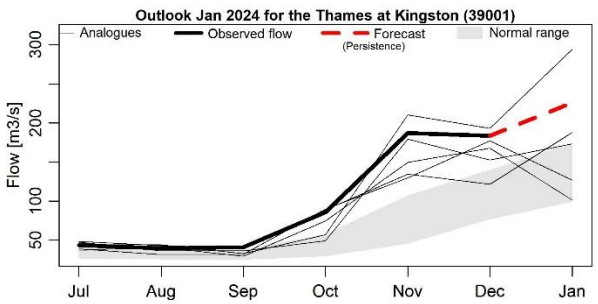












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RIVER FLOW ANALOGY

January 2024

UK Centre for Ecology & Hydrology

Outlook based on hydrological persistence and analogy

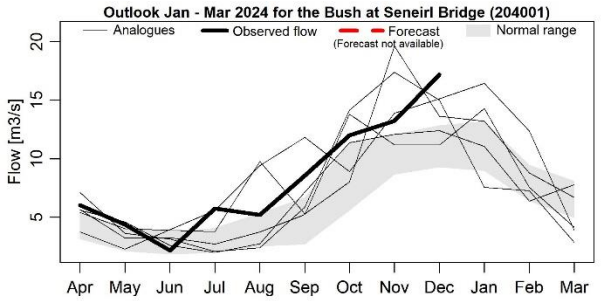
Site-based: 3 month outlook

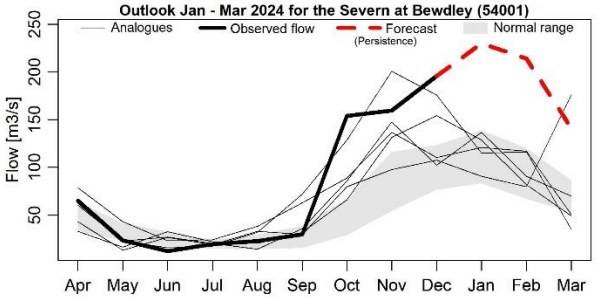
Period: January 2024 – March 2024

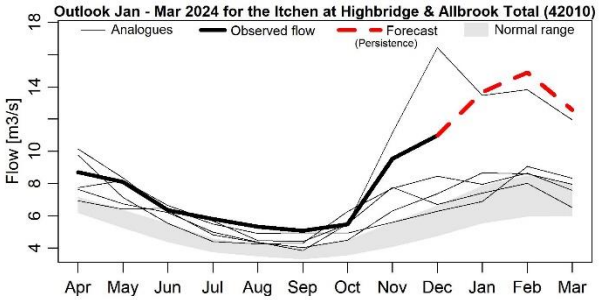
Issued on 09.01.2024 using data to the end of December 2023

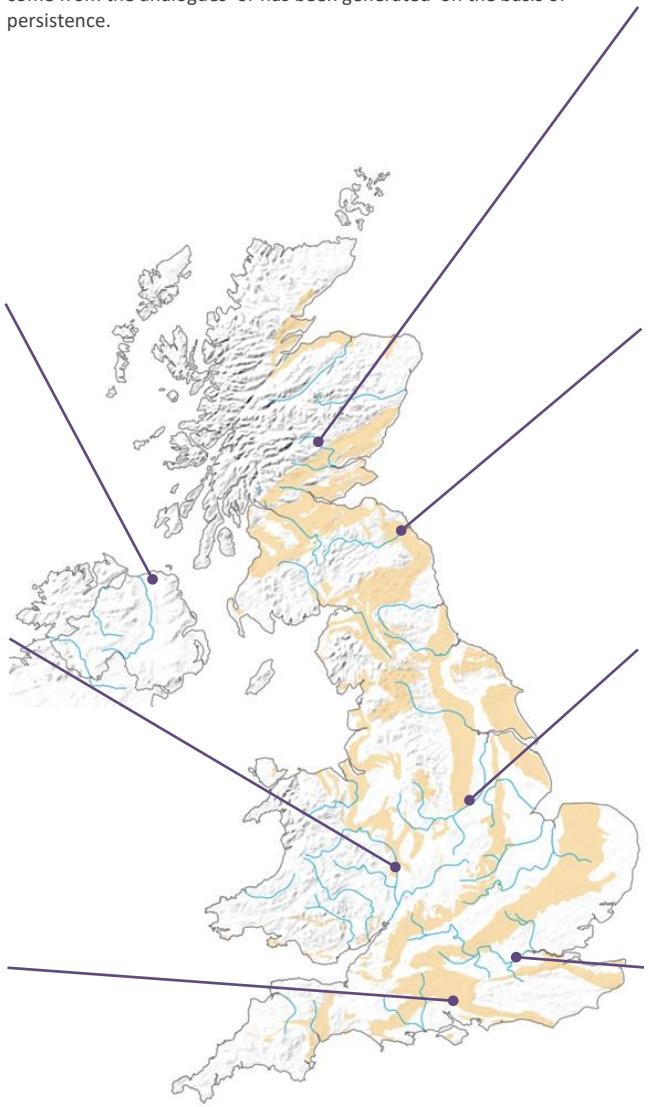
These figures provide insight into the hydrological analogue methodology for a set of sites from across the UK.

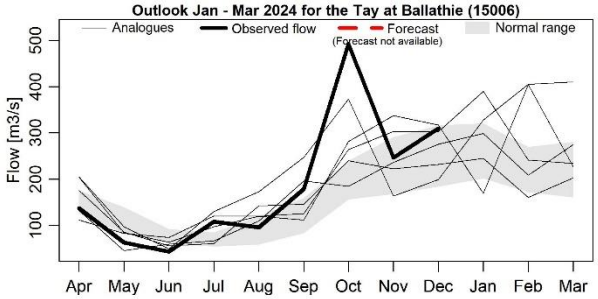
In each of the time series graphs the bold black line represents the observed flow during the past nine months. The grey band indicates the normal flow range (the normal band includes 44% of observed flows in each month). The selected analogues are shown as thin lines and the trajectories that flows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

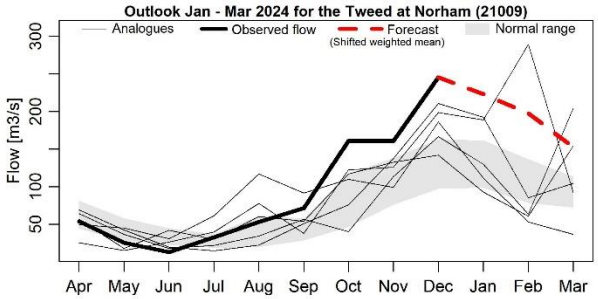


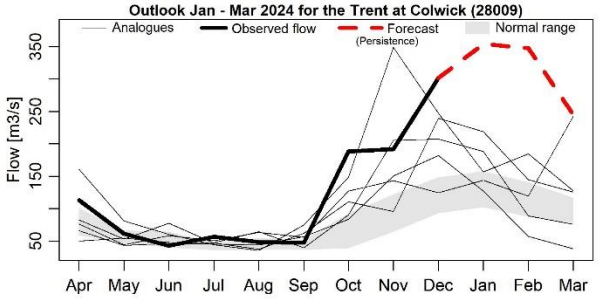


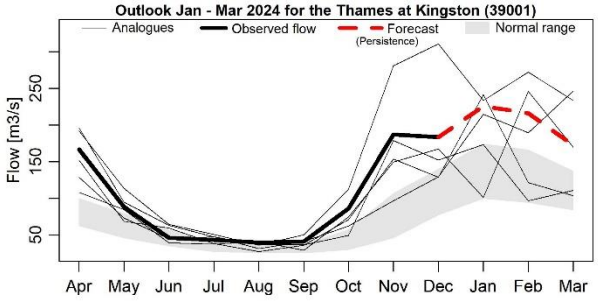












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RIVER FLOW ANALOGY

January 2024

UK Centre for Ecology & Hydrology

British Geological Survey

Environment Agency

Outlook based on modelled flow from historical climate

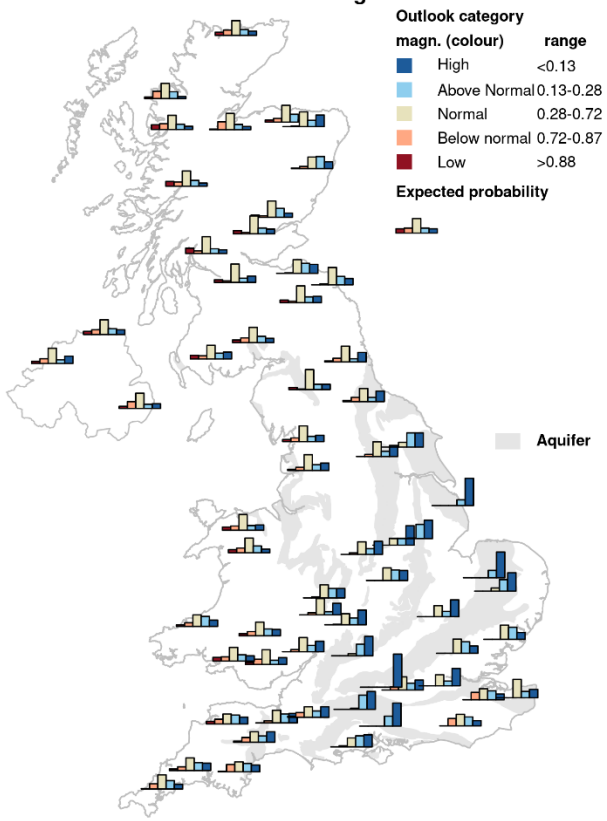
Overview

Period: January 2024 – June 2024

Issued on 03.01.2024 using data to the end of December 2023

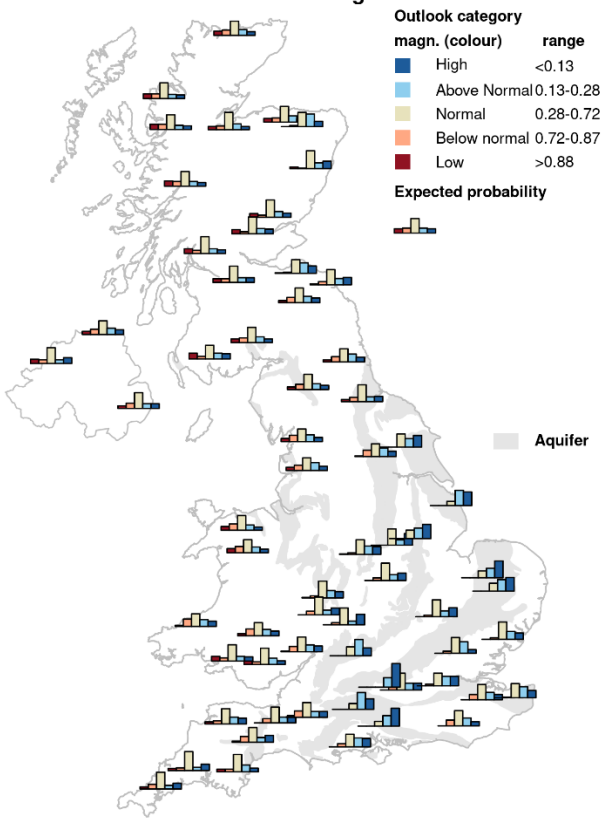
The outlook for January indicates that flows are likely to be within the normal range for western Scotland, Northern Ireland, north western England and northern Wales. Elsewhere in the UK flows are likely to be above normal, with some catchments in southern and eastern England likely to be high. The January-March outlook shows that this pattern is likely to persist over the coming few months.

1-month river flow outlook starting Jan 2024



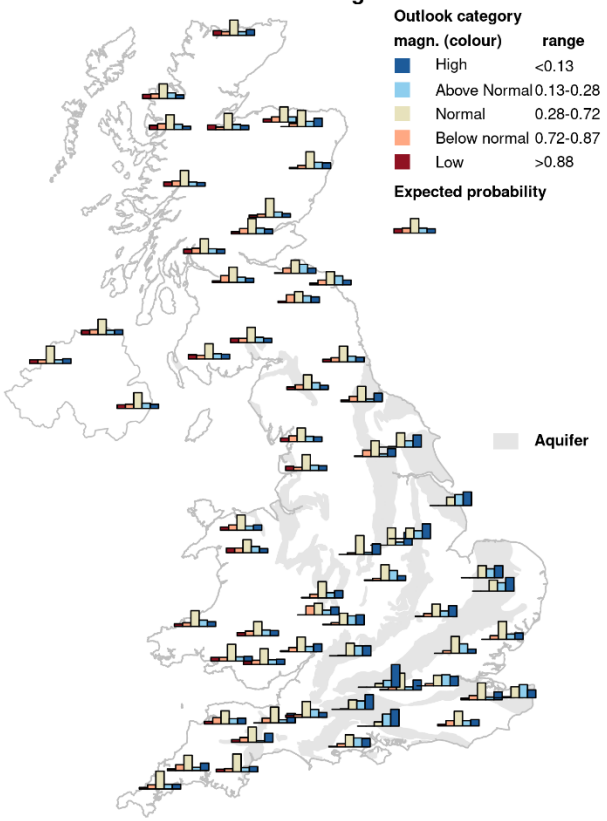
This outlook is based on monthly ensembles of historical sequences of observed climate (rainfall and potential evapotranspiration) that form input to a hydrological model. The outputs are probabilistic simulations of the average river flow over the forecast period (1 to 12 months ahead), at each location. 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 Jan 2024



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 Jan 2024



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

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RIVER FLOW FROM HISTORICAL CLIMATE

January 2024

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.

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RIVER FLOW FROM HISTORICAL CLIMATE

January 2024

UK Centre for Ecology & Hydrology

Met Office

Outlook based on modelled flow using historical weather analogues

Period: January 2024 – March 2024

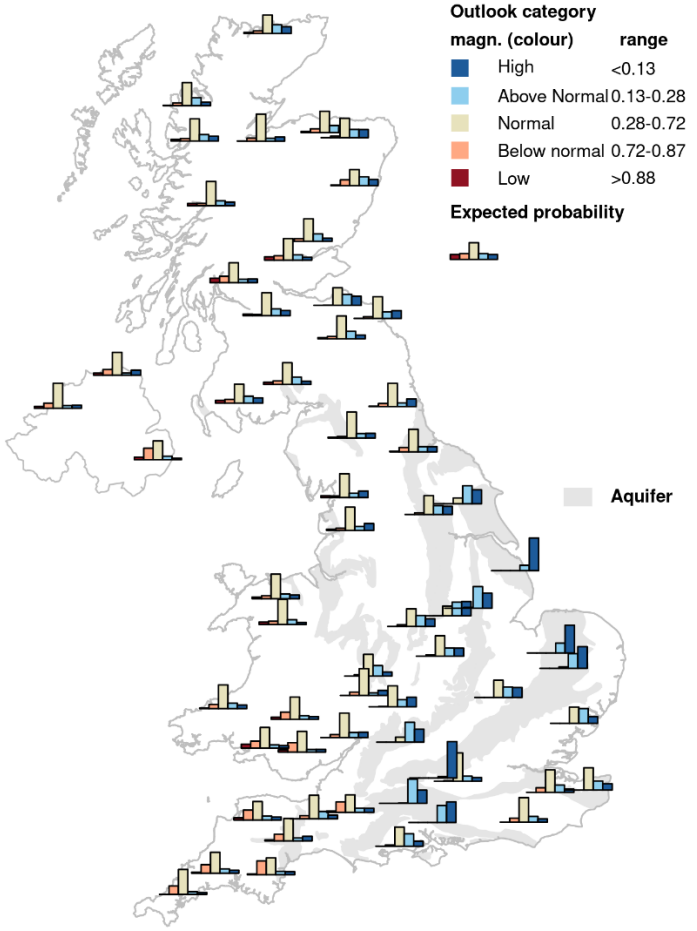
Issued on 03.01.2024 using data to the end of December

The start of January has already seen widespread flooding in many areas. The outlooks are ensemble forecasts, and current conditions indicate that the highest ensemble members are now most likely for January. As such, we expect flows in the majority of England to be above normal to high for January, and are likely to persist in some catchments over the next three months. Elsewhere in northern parts of the UK flows are expected to be within the normal range for the January-March period.

The historical weather analogues method uses Met Office predictions of average weather 1 and 3 months ahead to provide inputs to a hydrological model. Like the ESP method, observed rainfall and temperature data from past years are used to drive the predictions, however, the analogue method constrains the selection of past rainfall using the weather conditions in the meteorological forecasts (which are summarised for this forecast in the Met Office likelihood of impacts blocks underneath the maps). For each member of the Met Office forecast ensemble, the 10 analogues that best match the predicted average weather pattern (surface pressure map) over the forecast period are selected. Precipitation and temperature sequences constructed from the selected analogue scenarios are corrected to account for historic trends and used as inputs to hydrological models. Here, the GR6J model is run using these inputs, creating an ensemble of hydrological forecasts.

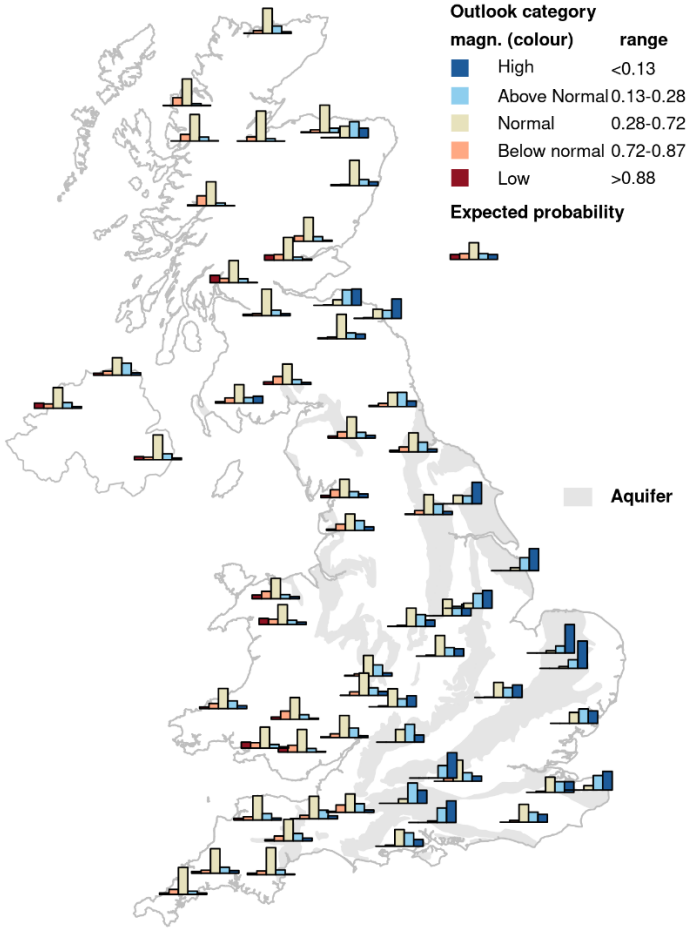
The outputs shown in the maps are the likelihoods of different outcomes for the average river flow over the one-month and three-month forecast periods at each location. The outlooks maps show the distribution for 64 catchments across the United Kingdom. Each bar plot represents the likelihood of the 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. The expected climatological probability of ensemble members in each of these categories is shown under the legend.

1-month river flow outlook starting Jan 2024



Met Office 1-month likelihood of precipitation impact

3-month river flow outlook starting Jan 2024



Met Office 3-month likelihood of precipitation impact

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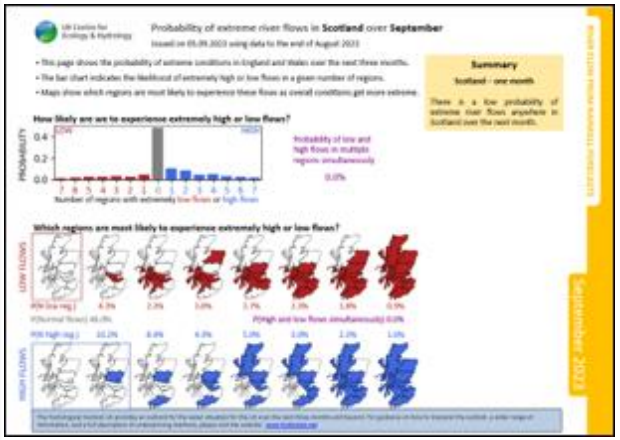
UK Centre for Ecology & Hydrology

Forecasts of river flows using Met Office rainfall forecasts

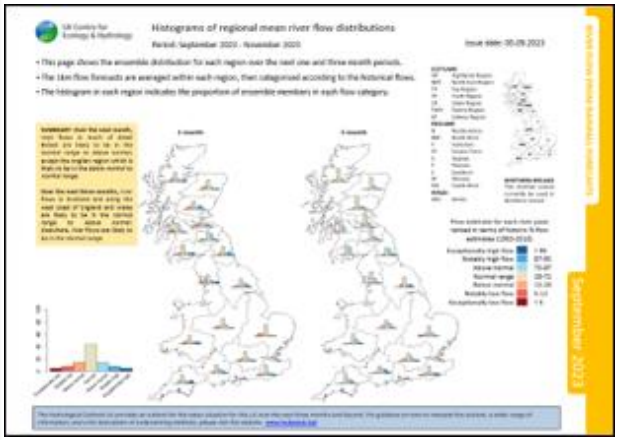
- These (yellow edged) pages summarise river flow forecasts produced by the UKCEH Water Balance Model.
- This model uses an ensemble of rainfall forecasts provided by the Met Office and a hydrological model to forecast river flows for the next one- and three-months ahead.
- A detailed description of these forecast products can be found on the final page, and a full technical description is given in the documentation available via the Hydrological Outlook website.
- Additional forecast products are available on the Hydrological Outlook Portal, via the website.

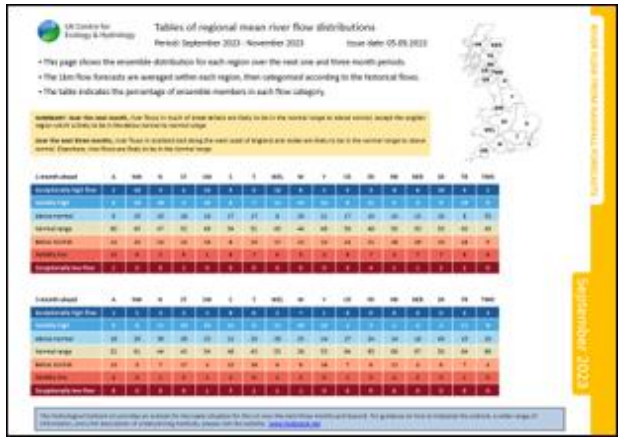
Probability of extreme river flows



- **Use these pages if you are interested in extreme conditions across multiple regions.**
- These pages summarise the risk of extremely high or low flows being observed across GB.
- The four pages show the risk for **Scotland** and for **England & Wales** over the next one and three months.
- The slides indicate the **probability of widespread extreme conditions** and which regions are most likely to experience extremely high or low flows.

Regional mean river flow distributions





- **Use these pages if you are interested in the ensemble distribution in a single region.**
- The first page shows the ensemble distribution as a histogram for each region.
- The second page shows the percentage of ensemble members in each band for each region.

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RIVER FLOW FROM RAINFALL FORECASTS

January 2024

UK Centre for Ecology & Hydrology

Probability of extreme river flows in **Scotland** over **January**

Issued on 03.01.24 using data to the end of December 2023

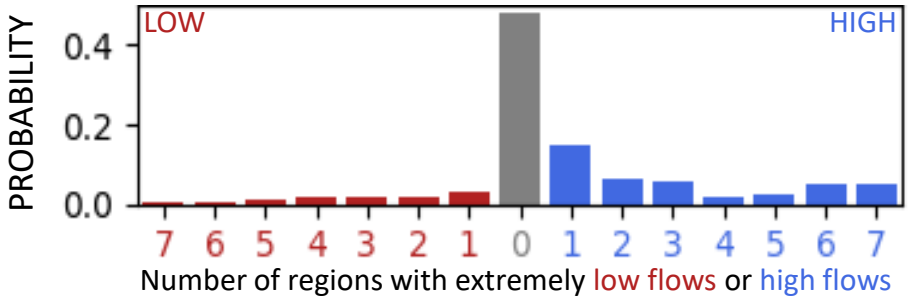
This page shows the **probability of extreme conditions in Scotland** over the next month. The bar chart indicates the likelihood of extremely high or low flows in a given number of regions. Maps show which regions are most likely to experience these flows as overall conditions get more extreme.

Summary

Scotland – one month

Extremely high and low flows are not likely to be experienced in Scotland across January. Extremely high flows are more probable than low flows and are more likely to be experienced along the east coast.

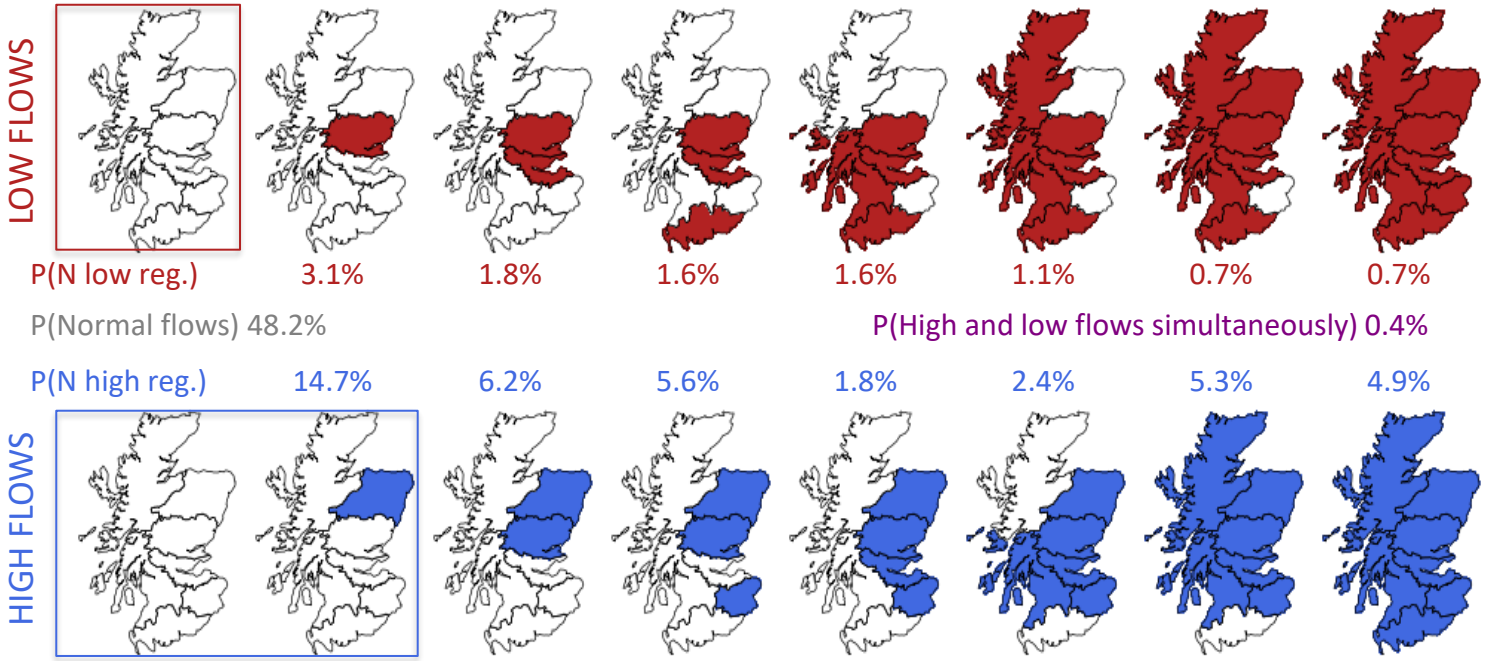
How likely are we to experience extremely low or high flows?



Probability of low and high flows in multiple regions simultaneously

0.4%

Which regions are most likely to experience extremely low or high flows?



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RIVER FLOW FROM RAINFALL FORECASTS

January 2024

UK Centre for Ecology & Hydrology

Probability of extreme river flows in **Scotland** over **January to March**

Issued on 03.01.24 using data to the end of December 2023

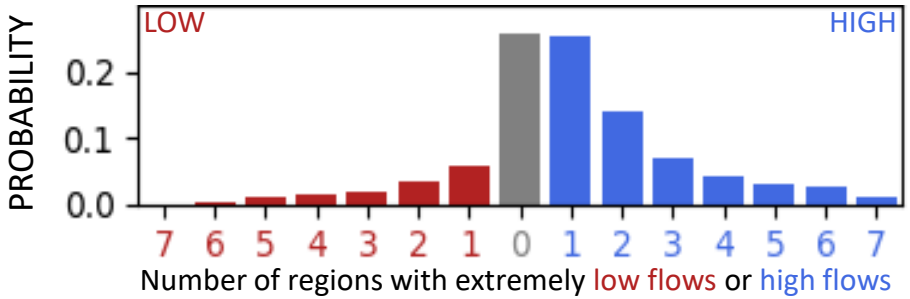
This page shows the **probability of extreme conditions in Scotland** over the next three months. The bar chart indicates the likelihood of extremely high or low flows in a given number of regions. Maps show which regions are most likely to experience these flows as overall conditions get more extreme.

Summary

Scotland – three months

Extremely high flows are likely to be experienced in Scotland over the next three months, but only in a small number of regions. They are more probable along the east coast.

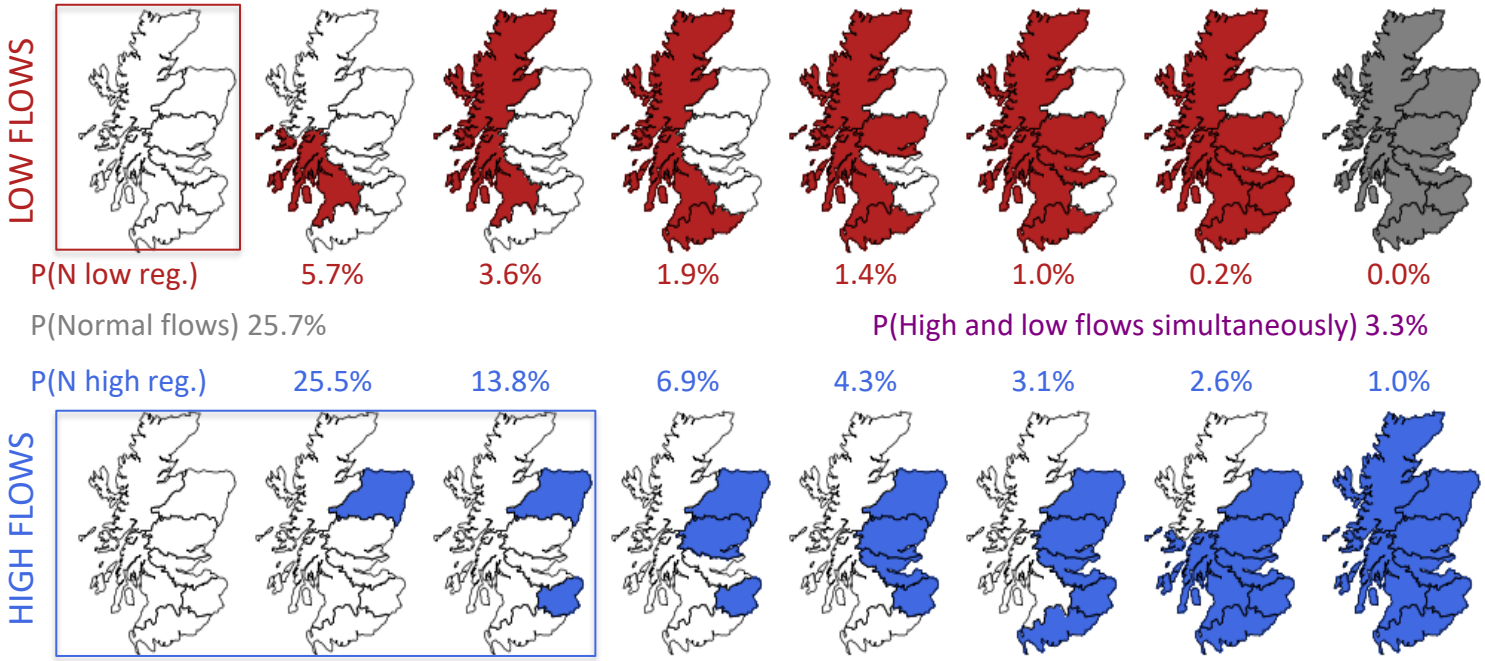
How likely are we to experience extremely low or high flows?



Probability of low and high flows in multiple regions simultaneously

3.3%

Which regions are most likely to experience extremely low or high flows?



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RIVER FLOW FROM RAINFALL FORECASTS

January 2024

UK Centre for Ecology & Hydrology

Probability of extreme river flows in **England and Wales** over **January**

Issued on 03.01.24 using data to the end of December 2023

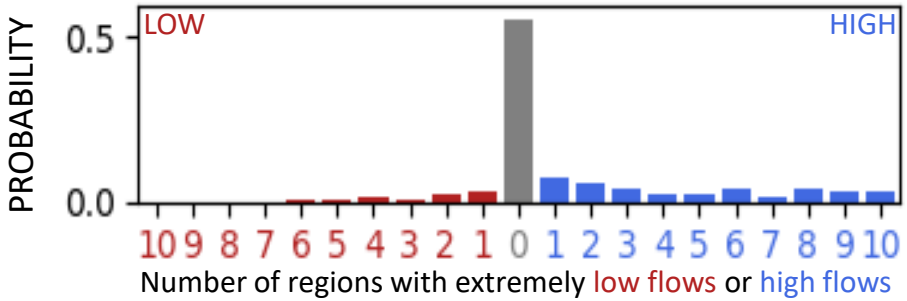
This page shows the **probability of extreme conditions in England and Wales** over the next month. The bar chart indicates the likelihood of extremely high or low flows in a given number of regions. Maps show which regions are most likely to experience these flows as overall conditions get more extreme.

Summary

England and Wales – one month

Extremely high or low flows are not likely to be experienced in England and Wales over the next month.

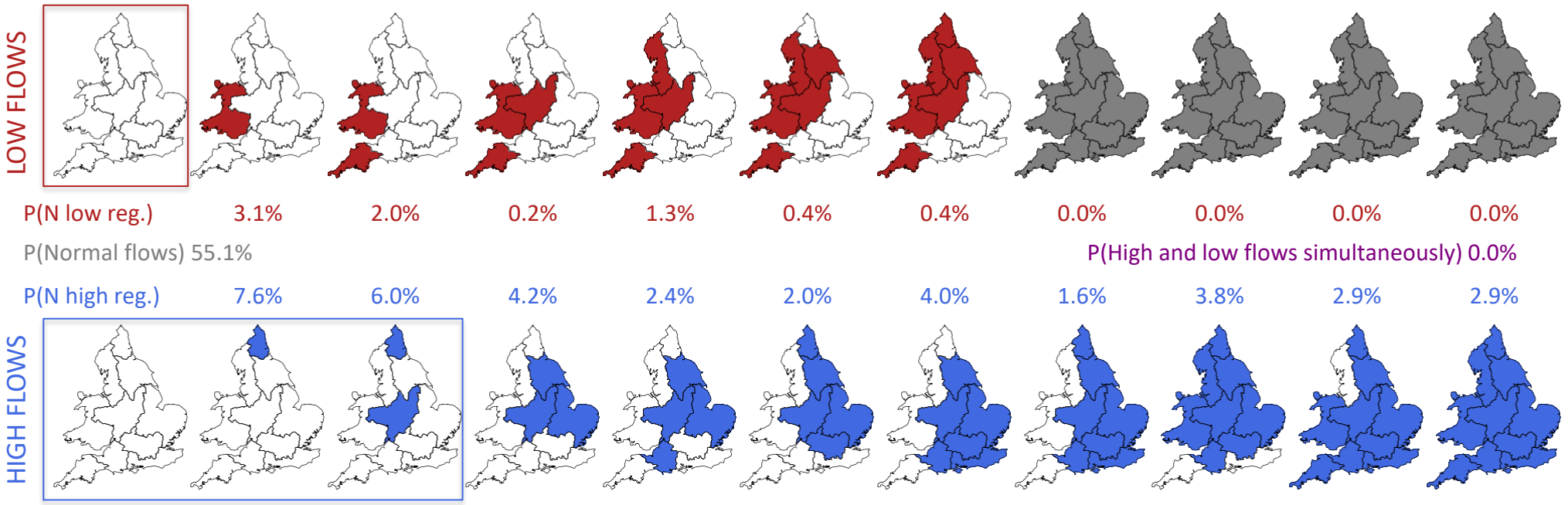
How likely are we to experience extremely low or high flows?



Probability of low and high flows in multiple regions simultaneously

0.0%

Which regions are most likely to experience extremely low or high flows?



P(N low reg.)	3.1%	2.0%	0.2%	1.3%	0.4%	0.4%	0.0%	0.0%	0.0%	0.0%
P(N high reg.)	7.6%	6.0%	4.2%	2.4%	2.0%	4.0%	1.6%	3.8%	2.9%	2.9%

P(Normal flows) 55.1%

P(High and low flows simultaneously) 0.0%

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RIVER FLOW FROM RAINFALL FORECASTS

January 2024

UK Centre for Ecology & Hydrology

Probability of extreme river flows in **England and Wales** over **January to March**

Issued on 03.01.24 using data to the end of December 2023

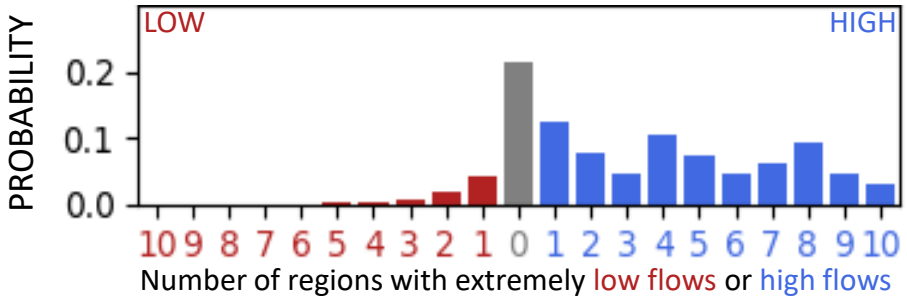
This page shows the **probability of extreme conditions in England and Wales** over the next three months. The bar chart indicates the likelihood of extremely high or low flows in a given number of regions. Maps show which regions are most likely to experience these flows as overall conditions get more extreme.

Summary

England and Wales – three months

Extremely high flows are likely in England and Wales over the next three months. They are most probable in eastern and southern areas.

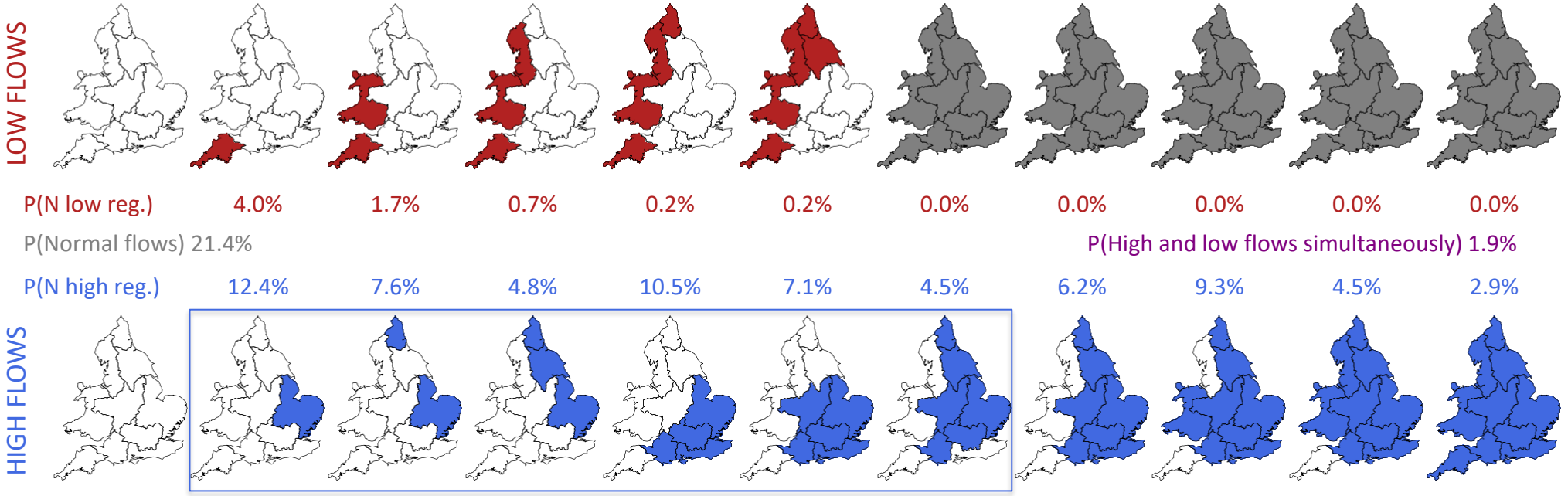
How likely are we to experience extremely low or high flows?



Probability of low and high flows in multiple regions simultaneously

1.9%

Which regions are most likely to experience extremely low or high flows?



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RIVER FLOW FROM RAINFALL FORECASTS

January 2024

UK Centre for Ecology & Hydrology

Histograms of GB regional mean river flow distributions

Period: January 2024 - March 2024

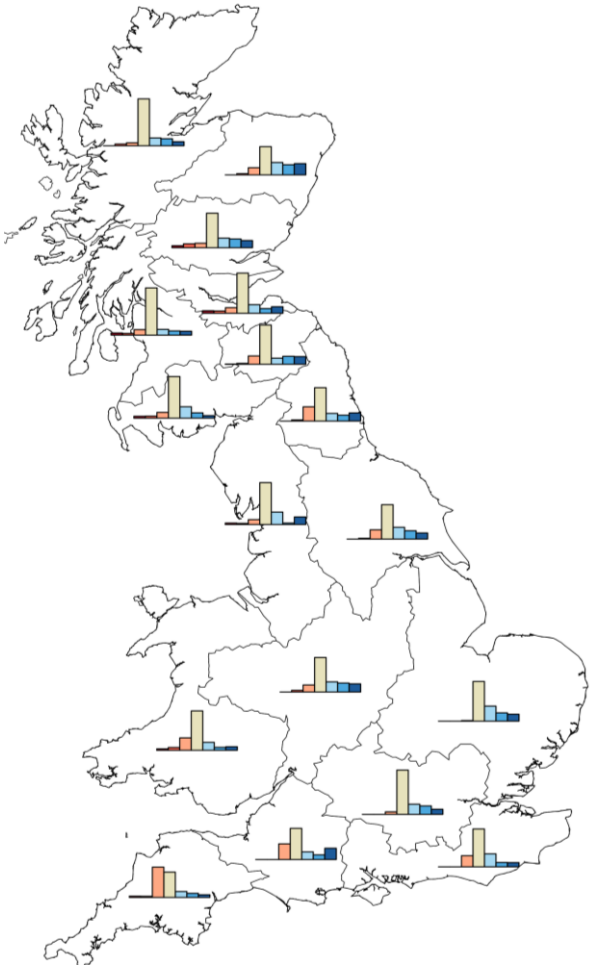
Issue date: 03.01.2024

- This page shows **the ensemble flow distribution for each region** over the next 1- and 3-month periods.
- The 1km flow forecasts are averaged within each region, then categorised according to the historical flows.
- The histogram in each region indicates the proportion of ensemble members in each flow category.

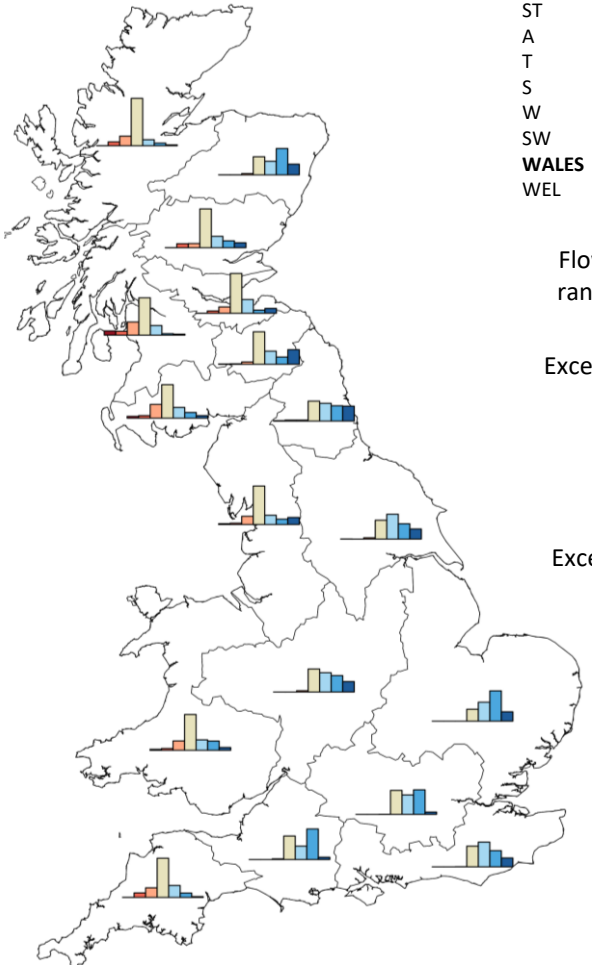
SUMMARY: Over the next month, river flows across most of Great Britain are likely to be in the *normal range* to *above normal*. The South West region may experience flows in the *below normal* to *normal range.*

Over the next three months, flows across eastern parts of Great Britain are likely to be in the *normal range* to *notably high*. Western parts are likely to experience flows in the *normal range.*

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

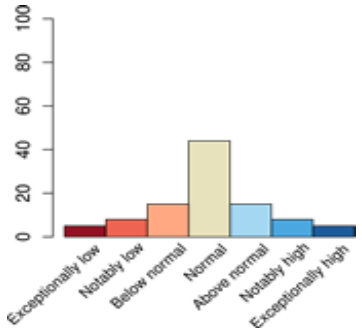
N	Northumbria
NW	North West
Y	Yorkshire
ST	Severn Trent
A	Anglian
T	Thames
S	Southern
W	Wessex
SW	South West

WALES

WEL	Welsh

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

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



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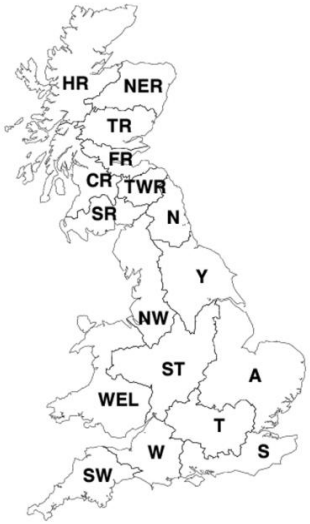
RIVER FLOW FROM RAINFALL FORECASTS

January 2024

UK Centre for Ecology & Hydrology

Tables of GB regional mean river flow distributions

Period: January 2024 - March 2024 Issue date: 03.01.2024



- This page shows **the ensemble flow distribution for each region** over the next 1- and 3-month periods.
- The 1km flow forecasts are averaged within each region, then categorised according to the historical flows.
- The table indicates the percentage of ensemble members in each flow category.

SUMMARY: Over the next month, river flows across most of Great Britain are likely to be in the *normal range* to *above normal*. The South West region may experience flows in the *below normal* to *normal range.*

Over the next three months, flows across eastern parts of Great Britain are likely to be in the *normal range* to *notably high*. Western parts are likely to experience flows in the *normal range.*

1-month ahead	A	NW	N	ST	SW	S	T	WEL	W	Y	CR	FR	HR	NER	SR	TR	TWR
Exceptionally high flow	10	11	12	12	4	6	7	5	16	9	6	9	6	16	4	10	11
Notably high	12	2	8	13	6	6	12	4	7	12	6	7	10	14	8	12	11
Above normal	21	18	11	14	8	18	14	11	11	17	8	12	11	18	16	14	9
Normal range	56	59	47	49	36	54	63	56	44	49	67	57	66	40	59	49	56
Below normal	1	7	20	10	43	16	4	18	22	13	8	8	4	10	8	6	12
Notably low	0	2	2	2	2	0	0	4	0	1	2	3	2	2	3	6	1
Exceptionally low flow	0	2	0	0	2	0	0	2	0	0	3	4	0	0	3	3	0

3-month ahead	A	NW	N	ST	SW	S	T	WEL	W	Y	CR	FR	HR	NER	SR	TR	TWR
Exceptionally high flow	13	10	21	15	1	13	3	4	3	14	1	7	1	15	4	7	21
Notably high	43	8	22	23	6	23	35	13	43	22	2	4	4	37	8	10	10
Above normal	27	13	25	27	17	35	28	15	19	35	14	20	9	19	15	16	19
Normal range	17	54	28	33	56	29	34	51	33	27	53	56	67	26	47	55	46
Below normal	0	12	1	2	14	0	0	13	1	2	19	9	14	2	20	6	3
Notably low	0	2	1	0	6	0	0	3	0	0	6	3	6	0	4	6	1
Exceptionally low flow	0	1	1	0	0	0	0	1	0	0	6	0	0	0	3	0	0

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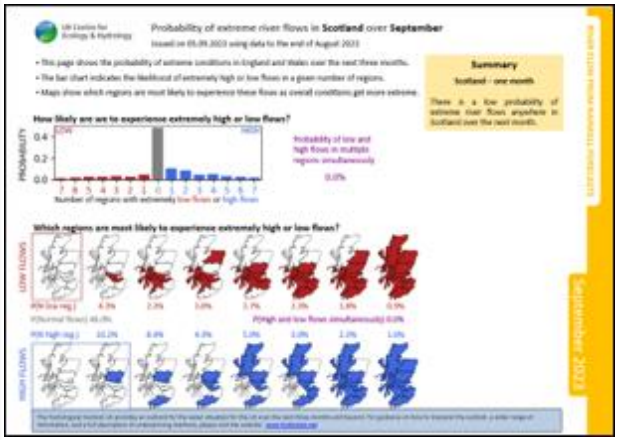
UK Centre for Ecology & Hydrology

Forecasts of river flows using Met Office rainfall forecasts

- The data on these (yellow-bordered) pages are based on approximately 400 rainfall scenarios provided by the Met Office, which are used as inputs to a water balance hydrological model.
- River flow forecasts for every 1km grid cell are ranked according to the historical flow estimates and aggregated within each region.
- A full description of this method and these summary products is given in the technical documentation available via the Hydrological Outlook website.

Probability of extreme river flows



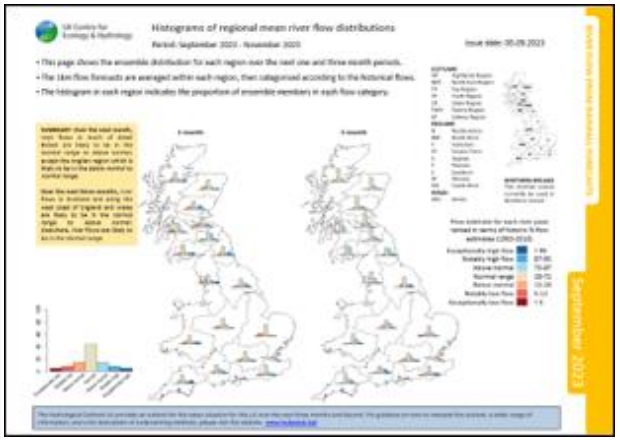
Extreme river flows are defined as those which rank in the lowest or highest 13% of historical flow estimates (1963 - 2016). This definition encompasses the 'Notably' and 'Exceptionally' high/low flow bands used elsewhere in the Outlook.

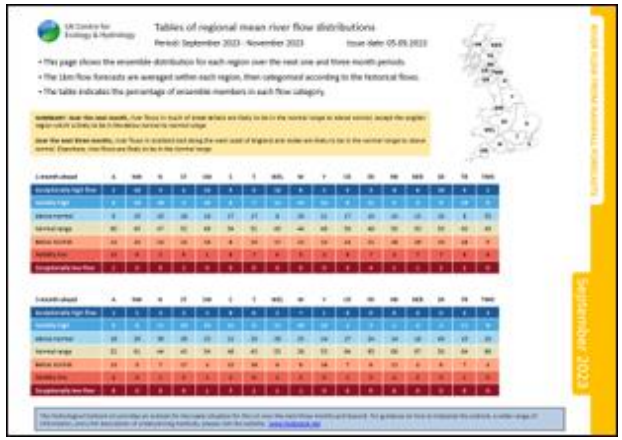
The bar chart shows the probability of a given number of regions experiencing extremely high/low flows, where scenarios showing both extremely high and extremely low flows in different regions simultaneously excluded. These probabilities are also shown beneath the maps.

Shaded regions on each map are those most likely to experience extreme flows from the set of scenarios with at least a given number of regions experiencing such flows. If shown, grey maps indicate scenarios not observed in the ensemble.

The box drawn around some maps spans the central 50% probability interval, excluding scenarios where extremely high/low flows are observed simultaneously. If these excluded cases constitute a significant probability, details are given in the yellow summary box.

Regional mean river flow distributions





The maps illustrate the ensemble distribution of regional mean river flows. The historical distribution is shown at bottom-left, and allows deviations from the normal distribution to be determined by comparing the forecast distribution to the historical distribution. A summary is given in the yellow box.

The table gives access to the data shown in the histograms. The numbers in the tables are the percentage of ensemble forecasts falling in each of the flow categories. As before results are averaged by region then ranked in terms of 54 years of historical regional flow estimates (1963 – 2016).

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

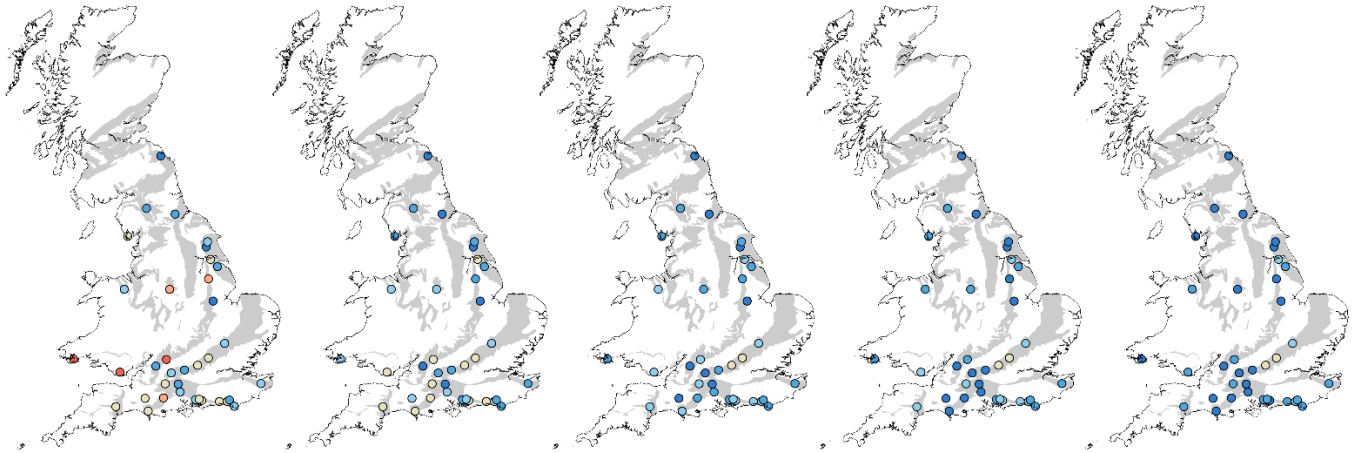
Overview

Period: January 2024 – March 2024

Issued on 09.01.2024 using data to the end of December

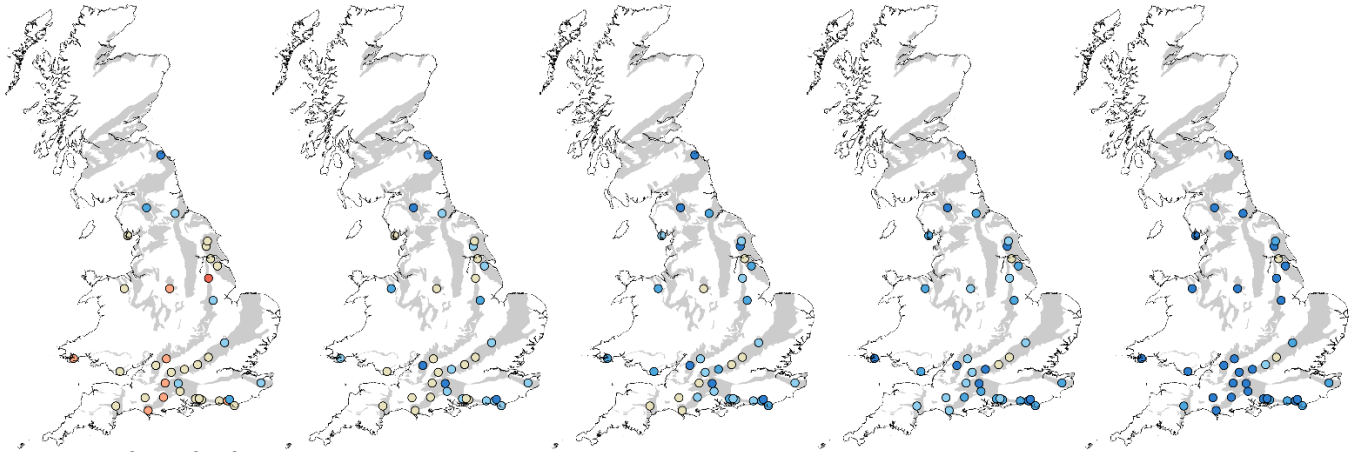
Under median rainfall conditions, groundwater levels are forecast to be notably high to exceptionally high at most sites over the next month, particularly in the Wessex Chalk, Yorkshire Chalk, South Downs Chalk, and the Jurassic Limestones. Given the notably to exceptionally high levels in these areas, there is potential for groundwater flooding. The three month forecasts are similar, with groundwater levels remaining at above normal to notably high or exceptionally high levels at most sites, particularly in the South Downs Chalk, Wessex Chalk and Jurassic Limestones. In parts of the Chilterns and Wessex Chalk, the forecast is more mixed, with levels likely to range from normal to notably high across this region over the next three months.

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*

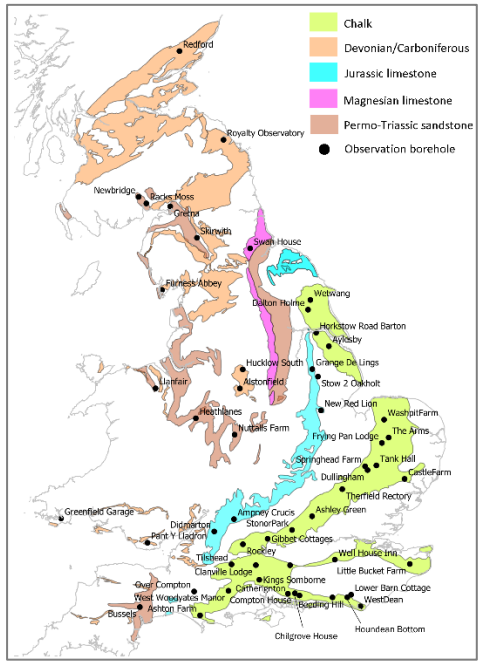


3-month outlook

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

January 2024

UK Centre for Ecology & Hydrology

British Geological Survey

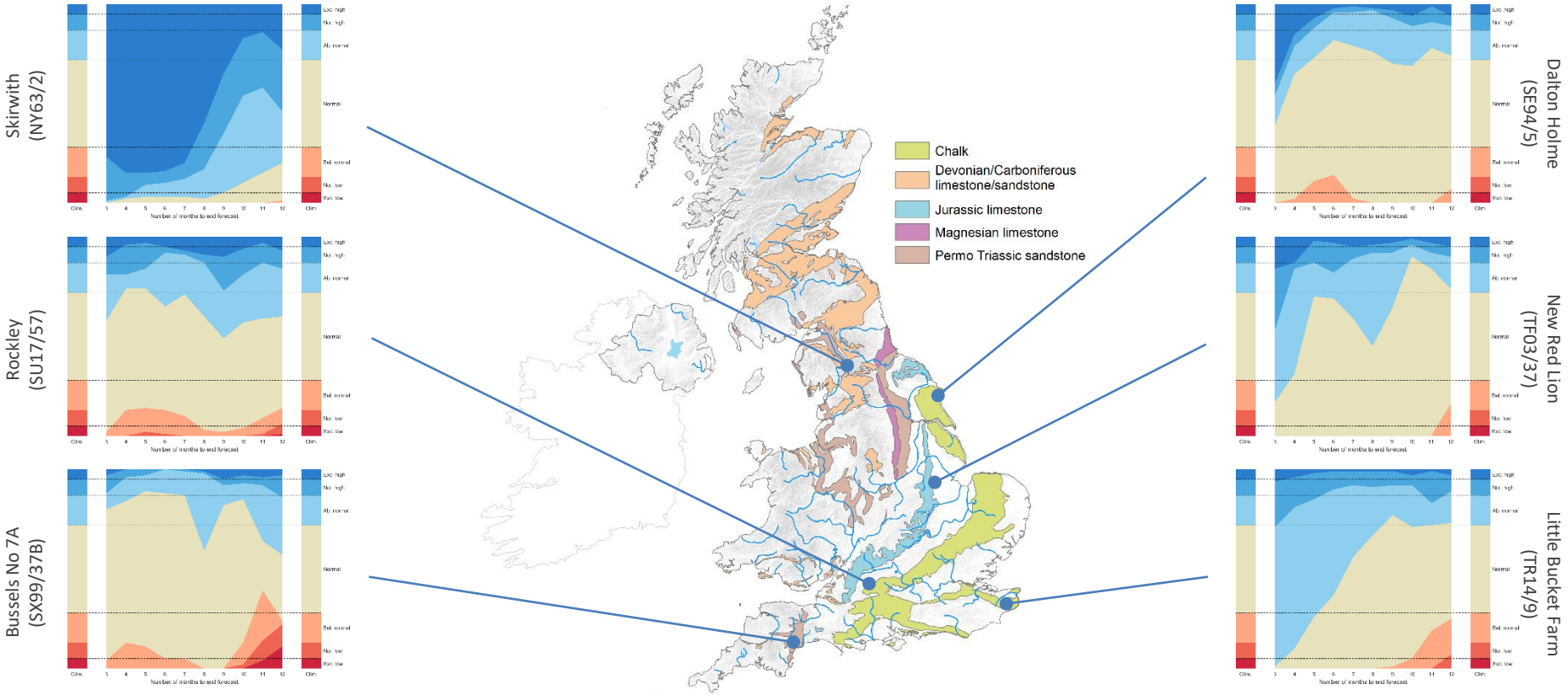
Environment Agency

Outlook based on modelled groundwater from historical climate

Period: December 2023 – November 2024

Issued on 09.01.2024 using data to the end of December

Groundwater levels at Skirwith in the Permo-Triassic Sandstones are forecast to be exceptionally high over the next 9 months, returning to notably high levels in the last quarter of 2024. In the Chalk at Rockley and the Permo-Triassic Sandstones at Bussels No 7A, normal conditions are expected over the next year. At Dalton Holme and New Red Lion, above normal to exceptionally high levels are forecast in the next 3, which are likely to give way to more normal conditions by the spring and summer of 2024. At Little Bucket Farm, above normal levels are anticipated for the next 3 to 6 months, with normal levels likely to return after this period.



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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