UK Hydrological Outlook

Delivered in partnership by: **UK Centre for Ecology & Hydrology**

Period: From August 2023

Issued on 08.08.2023 using data to the end of July 2023

SUMMARY Following an exceptionally wet July, river flows across the UK are expected to be normal to above normal for August, and over the next three months. Groundwater levels are likely to be within the normal range across the majority of the UK, though above normal levels are expected in southern England in August, and normal to below normal groundwater levels are likely in Wales over the next three months.

Rainfall:

Rainfall in July was exceptionally high across the UK, with national rainfall being 180% of average. Parts of central and south-western England, and Northern Ireland saw over 200% of average rainfall for July.

The forecast (issued by the Met Office on 31.07.2023) shows that the chances of August, and the three month period August to October, being dry or wet are similar to normal. There is an increased chance of August and August to October being warmer than average, but near average temperatures remain the most likely outcome.

River flows:

River flows in July were normal to above normal, with above normal, notably high, and some exceptionally high flows seen across the western parts of the UK. Record breaking high flows were recorded in the Mourne catchment in Northern Ireland. A few localised below normal flows were recorded in East Anglia and north-eastern England.
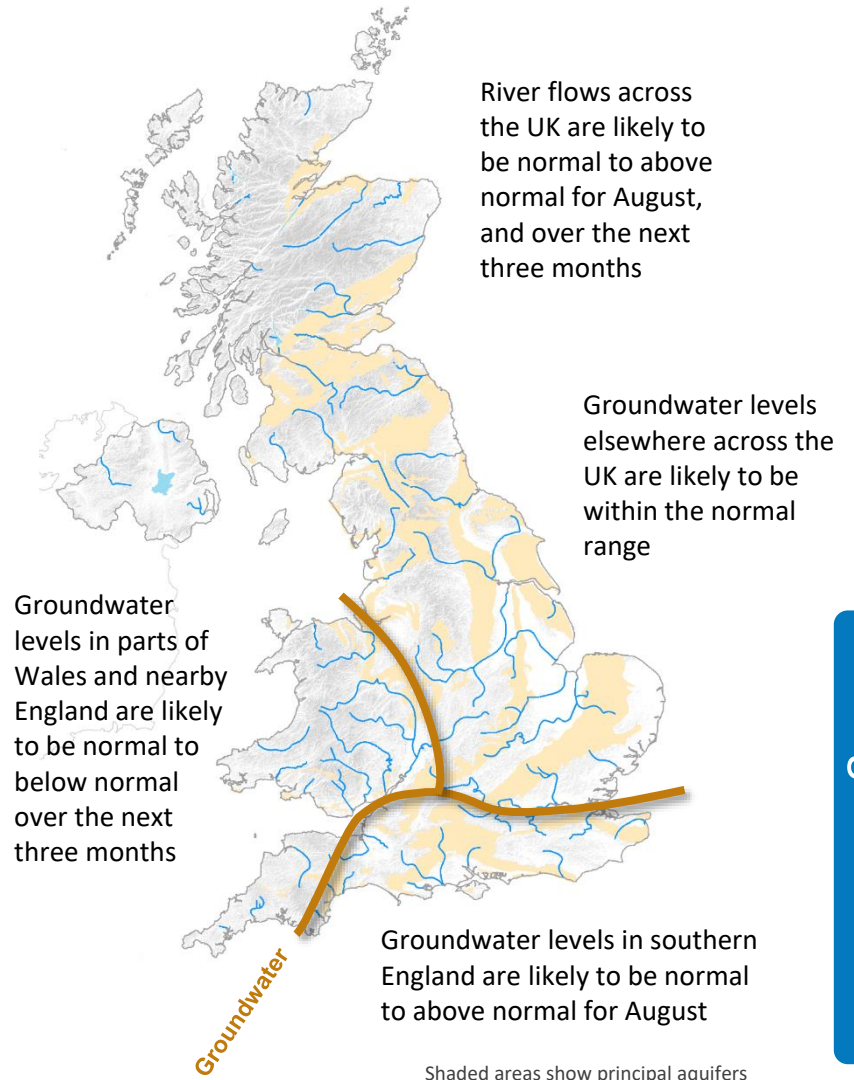
The outlook for August, and for the August to October period is for normal to above normal flows to persist across the UK. Normal flows are more likely along the eastern coastline, with a chance of some below normal flows in north-eastern Scotland.

Groundwater:

Groundwater levels in July were predominantly within the normal range or above. Above normal groundwater levels were recorded across large parts of southern England and record breaking high levels were seen in Northern Ireland. As with river flows, a few localised below normal levels were recorded in East Anglia, north-eastern England and northern Scotland.

Groundwater levels are expected to be within the normal range for the majority of the UK for August and the next three months. Levels in southern England are likely to remain above normal for August, whilst levels in Wales and the nearby English Jurassic limestone are likely to be normal to below normal over the next three months.

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

River flows across the UK are likely to be normal to above normal for August, and over the next three months

Groundwater levels elsewhere across the UK are likely to be within the normal range

Groundwater levels in parts of Wales and nearby England are likely to be normal to below normal over the next three months

Groundwater levels in southern England are likely to be normal to above normal for August

Shaded areas show principal aquifers

August 2023

UK Centre for Ecology & Hydrology

British Geological Survey

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

Environment Agency

Met Office

Cyfoeth Naturiol Cymru Natural Resources Wales

SEPA Scottish Environment Protection Agency

UK Hydrological Outlook

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About the 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 GR4J hydrological models. Hydrogeological modelling uses the AquiMod model run by BGS.

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.

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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.

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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.

Contact:

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

Reference for the UK Hydrological Outlook:

UK Hydrological Outlook, 08 August 2023, UK Centre for Ecology and 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:
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
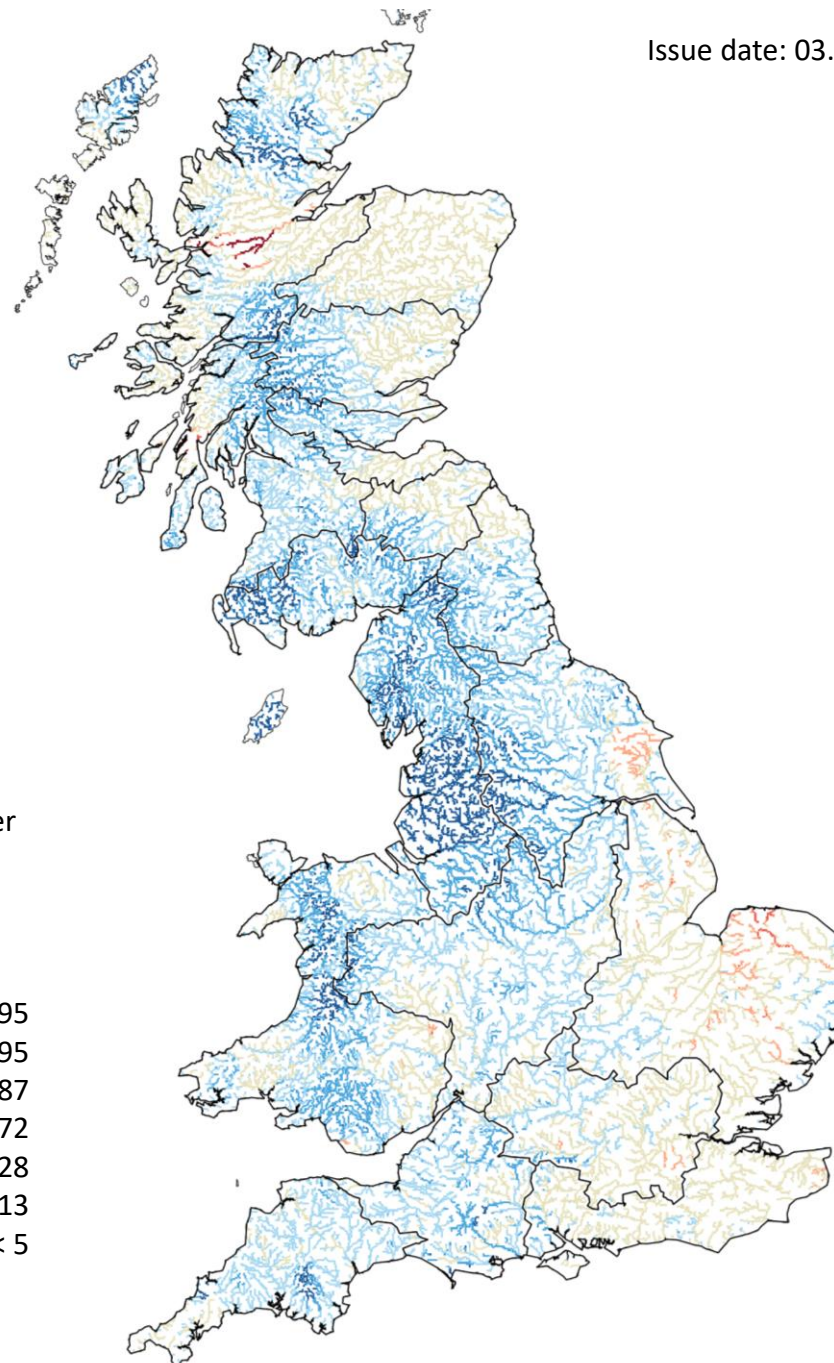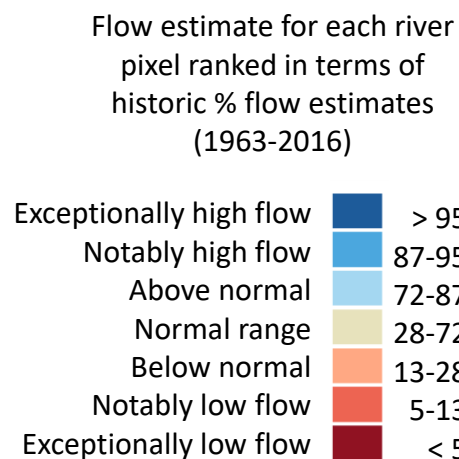
UK Water Resources Portal: monitor the UK hydrological situation in near real-time including rainfall, river flow, groundwater and soil moisture from COSMOS-UK:
https://eip.ceh.ac.uk/hydrology/water-resources/

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

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

UK Centre for Ecology & Hydrology

Issue date: 03.08.2023

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.

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

August 2023

Current Daily Simulated Subsurface Water Storage Conditions

UK Centre for Ecology & Hydrology

Based on subsurface water storage estimated for 31 July 2023
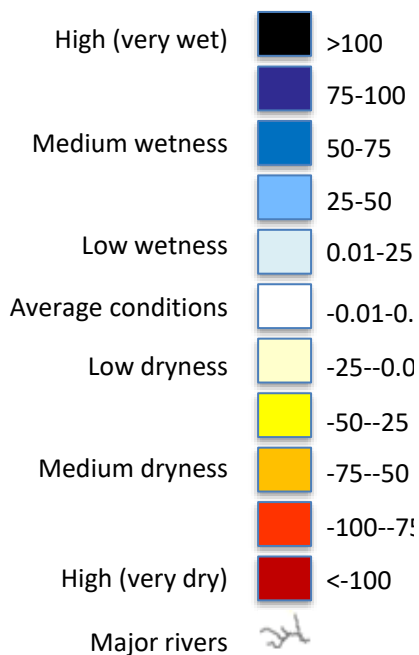
Issue date: 03.08.2023

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.
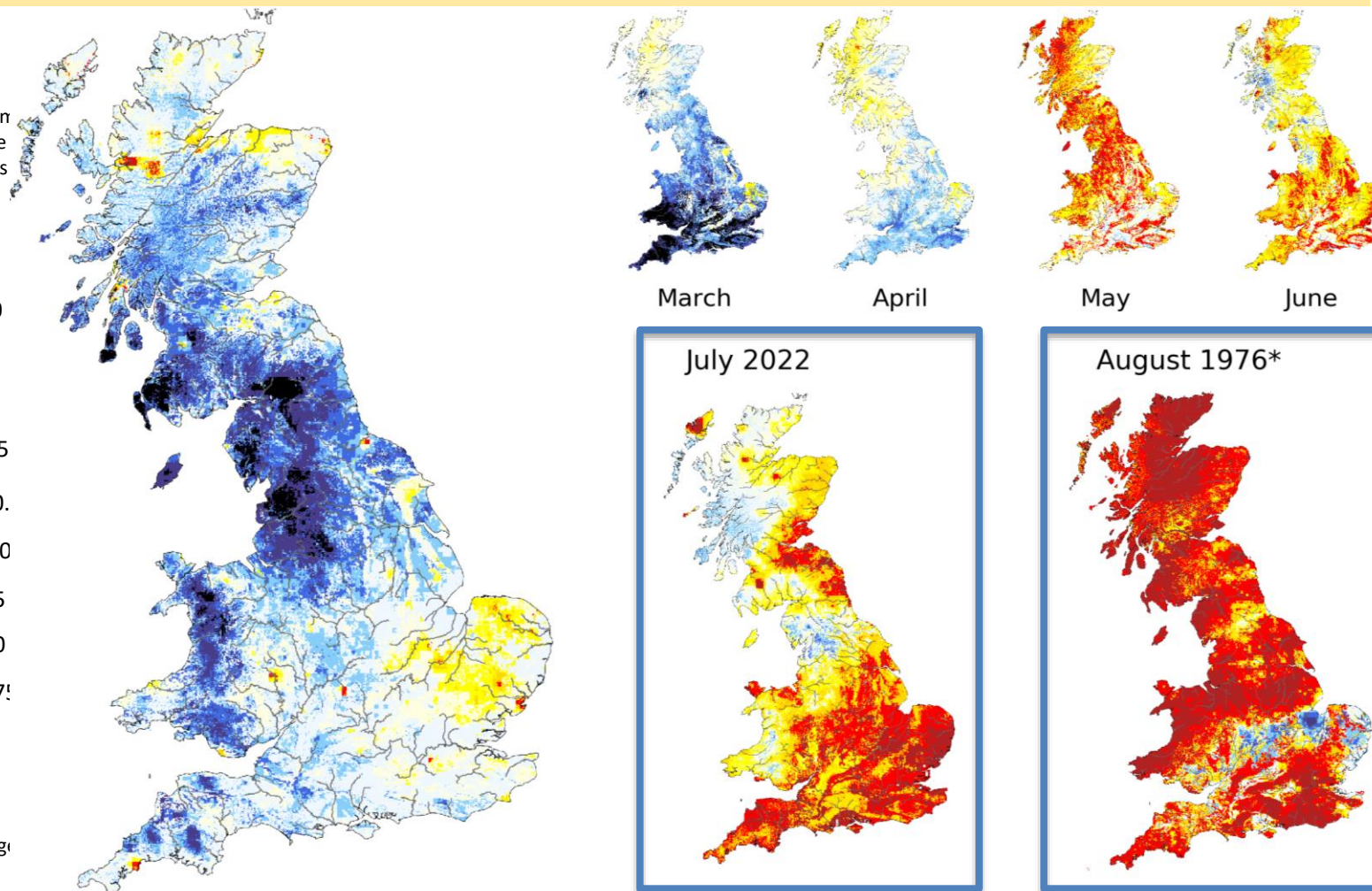
SUMMARY: At the end of July, subsurface water levels were higher (wetter) than is typical for this time of year across most of Great Britain, apart from some areas of dry conditions in East Anglia and northern Scotland. There were some areas which were very wet in southwest Scotland, northern England and western Wales.

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.
Low dryness	■	-25--0.0
	■	-50--25
Medium dryness	■	-75--50
	■	-100--7!
High (very dry)	■	<-100
Major rivers	～	

Labels refer to estimated storage final day of named month

March   April   May   June

July 2022

August 1976*

*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

Current Daily Simulated SOIL MOISTURE Conditions

PROTOTYPE

Based on soil moisture estimated for 31 July 2023

Issue date: 03.08.2023

UK Centre for Ecology & Hydrology

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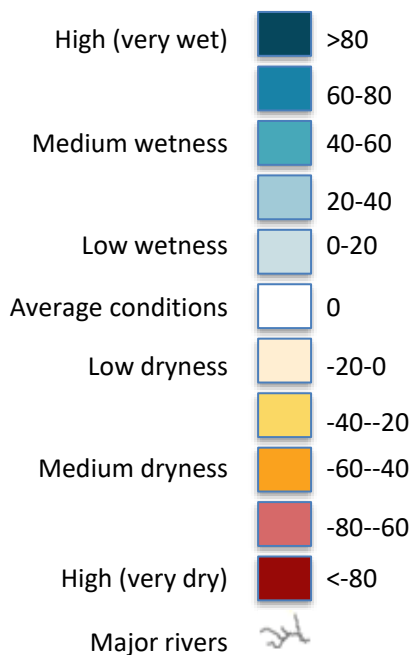
These maps do not provide a forecast. These maps are prototype representations of model estimates of soil moisture, which are currently under development.

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.
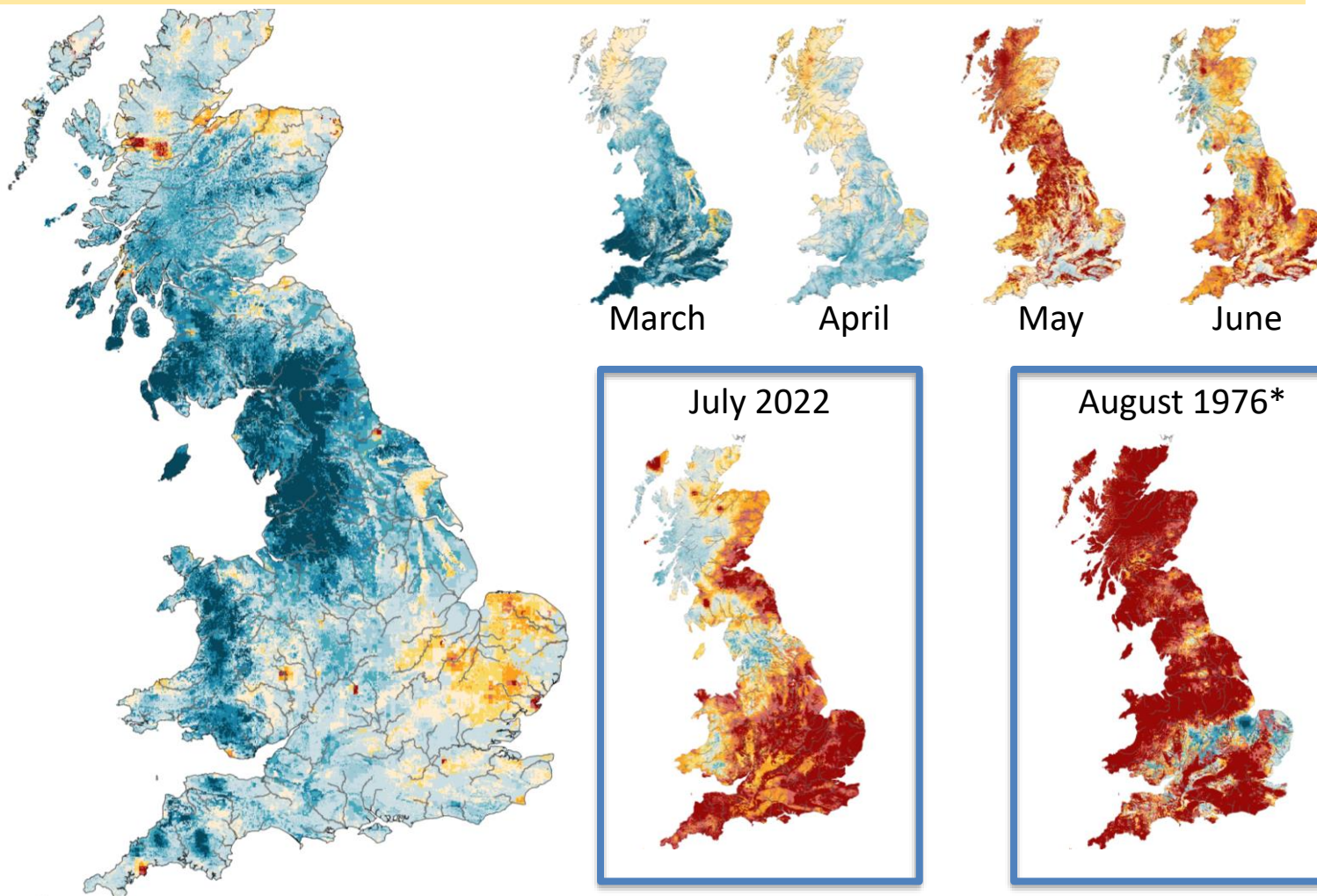
SUMMARY: At the end of July, soil wetness was higher (wetter) than is typical for this time of year across most of Great Britain, apart from some areas of dry conditions in East Anglia and northern Scotland. There were some areas where soil wetness was high (very wet) in southwest Scotland, northern England and western Wales.

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

March April May June

July 2022 August 1976*

*Example month displaying extreme negative wetness

August 2023

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Return Period of Rainfall Required to Overcome Dry Conditions

Period: August 2023 - January 2024

Issue date: 03.08.2023

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: No areas of Great Britain will require particularly unusual (>5 years return period) rainfall over the next six months to replenish current storage deficits.
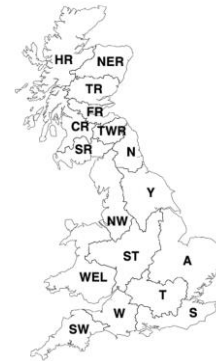
SCOTLAND

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

Aug

Sep

Oct

Nov

Dec

Jan

Rainfall amount (Probability)   Return period (years)

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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![UK Centre for Ecology & Hydrology]
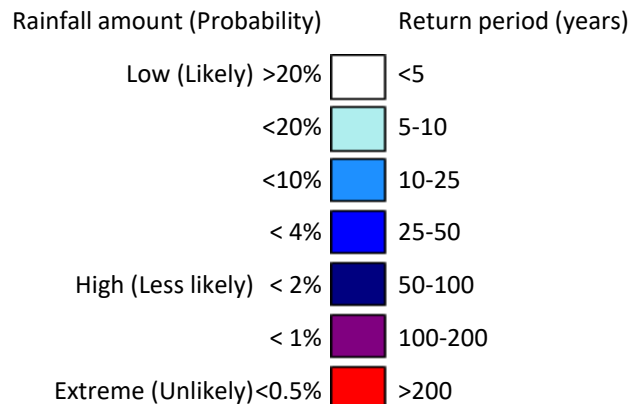
Estimate of Additional Rainfall Required to Overcome Dry Conditions

Based on subsurface water storage estimated for 31 July 2023

Issue date: 03.08.2023

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.

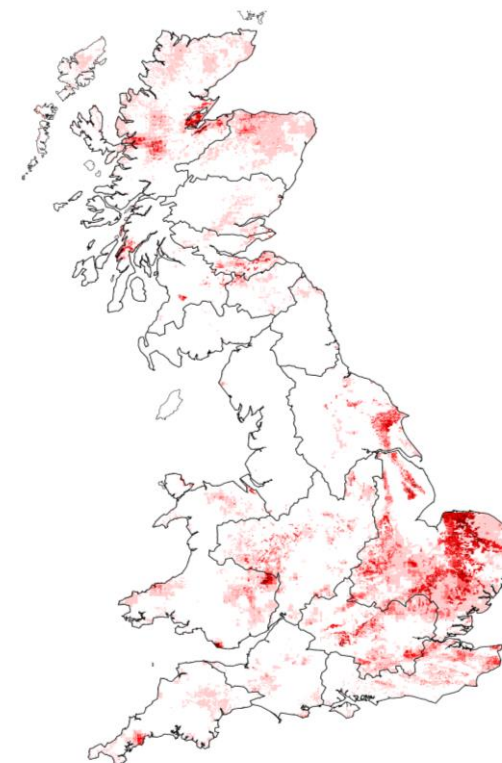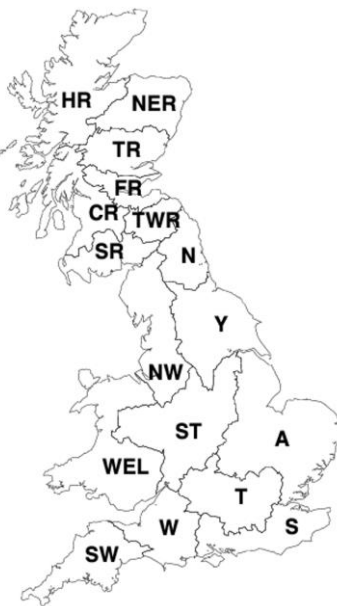## Regional estimate of additional rainfall required (mm)

SCOTLAND

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
13	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

August 2023

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![UK Centre for Ecology & Hydrology]

Outlook based on hydrological persistence and analogy

Overview

Period: August 2023 – October 2023

Issued on 07.08.2023 using data to the end of July 2023

SUMMARY:

The August and August – October outlook is mainly for normal to above normal flows across the country. Along the eastern coast of Britain, and in south-west England flows tend more towards normal, or in isolated cases below normal (e.g. in East Anglia and eastern Scotland). Please note that not many forecasts are available in western Scotland for the August – October outlook.
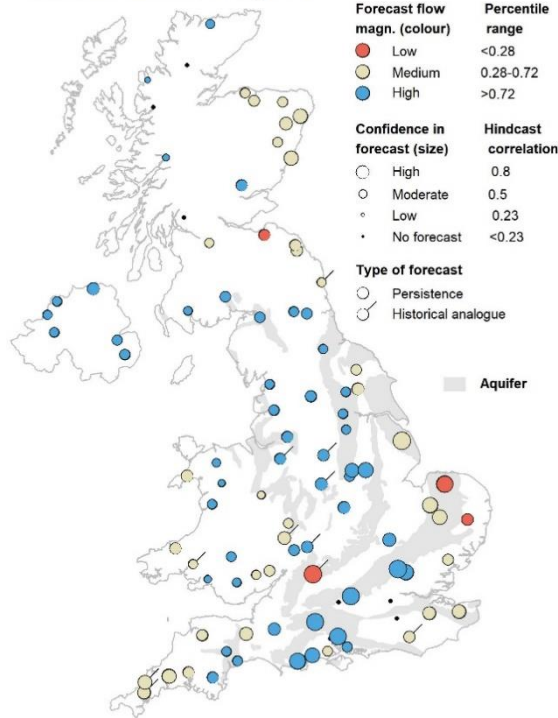
1-month flow outlook

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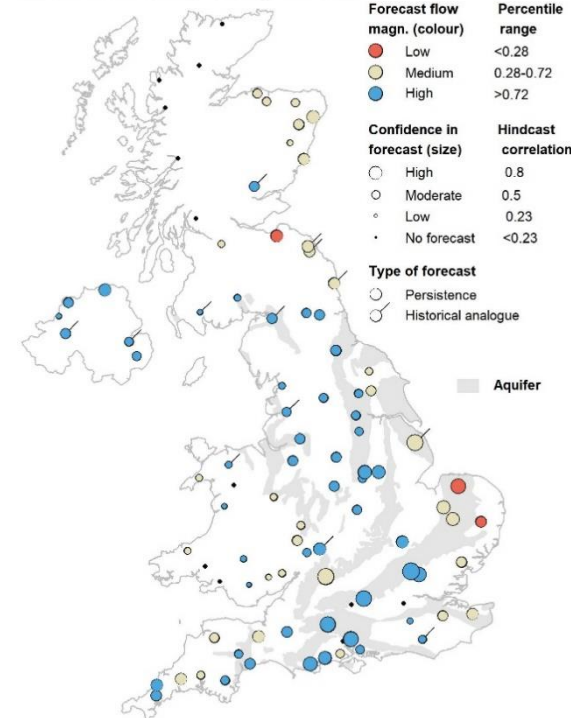
It is, however, often the case that a simpler forecast based on the persistence of river flow provides a better forecast than provided by analogy. This is particularly true for slowly responding catchments associated with aquifer outcrops.

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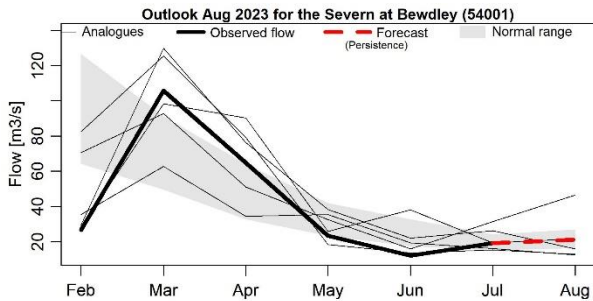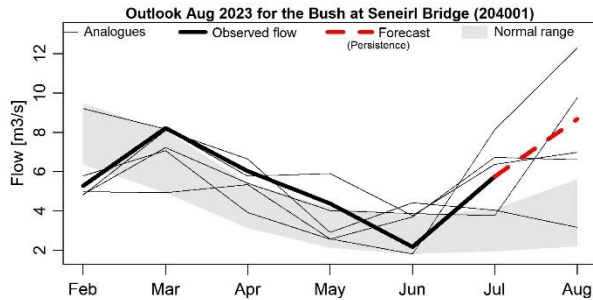
of the forecast being represented by the size of the dot. A tag on the dot indicates which method has been used in each instance.

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Outlook based on hydrological persistence and analogy

Site-based: 1 month outlook

Period: August 2023

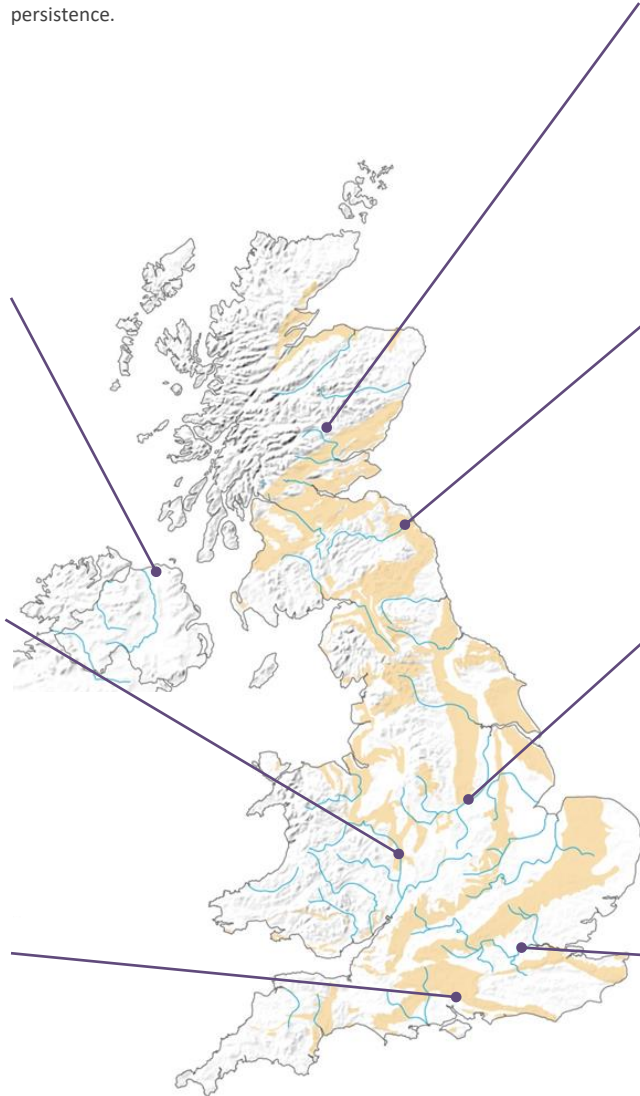Issued on 07.08.2023 using data to the end of July 2023

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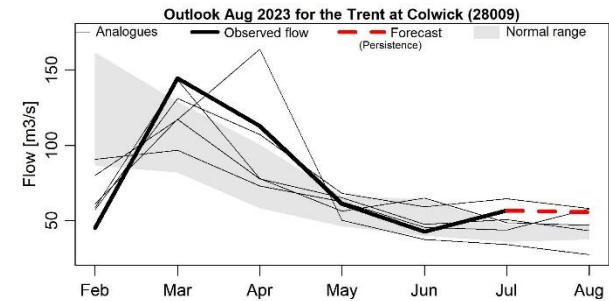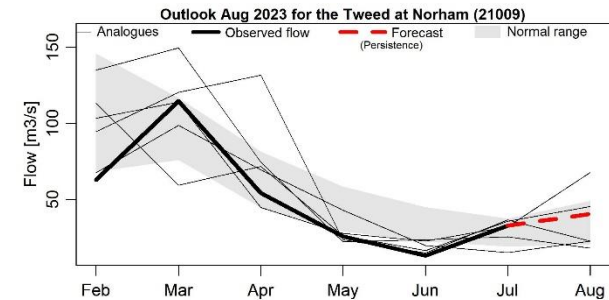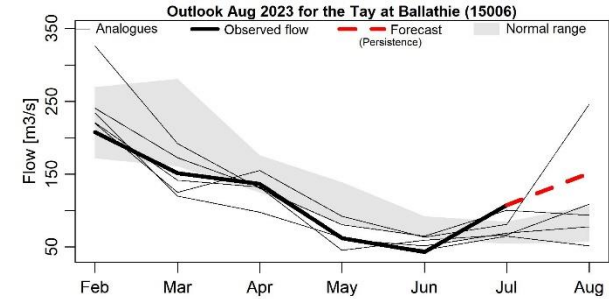
of observed flows in each month). The selected analogues are shown as thin lines and the trajectories that flows took in the following month are also shown. The forecast is shown as the dashed red line, and in each plot it states whether this has come from the analogues or has been generated on the basis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

Outlook Aug 2023 for the Tay at Ballathie (15006)

Outlook Aug 2023 for the Bush at Seneirl Bridge (204001)

Outlook Aug 2023 for the Tweed at Norham (21009)

Outlook Aug 2023 for the Severn at Bewdley (54001)

Outlook Aug 2023 for the Trent at Colwick (28009)

No observation data available

No observation data available

August 2023

Outlook based on hydrological persistence and analogy

Site-based: 3 month outlook

Period: August 2023 – October 2023

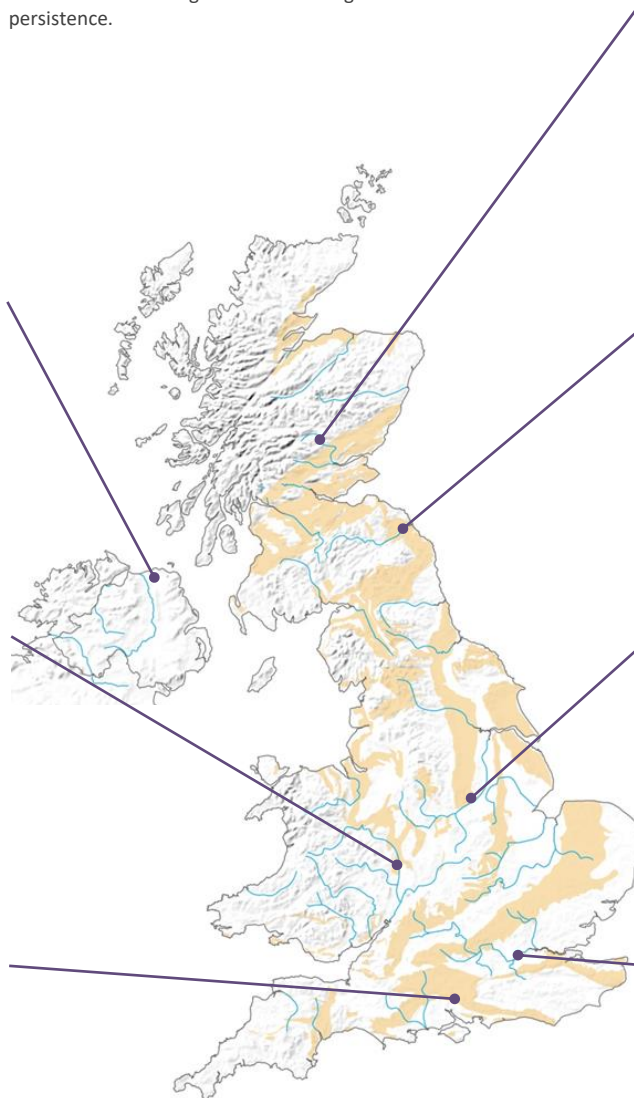Issued on 07.08.2023 using data to the end of July 2023

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 norma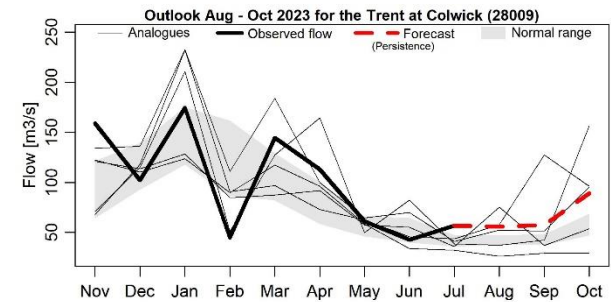l flow range (the normal band includes 44% of observed flows in each month). The selected analogues are shown as thin lines and the trajectories that flows took in the following three months are also shown. The forecast is shown as the dashed red line, and in each plot it states whether this has come from the analogues or has been generated on the basis of persistence.

Outlook Aug - Oct 2023 for the Tay at Ballathie (15006)

Outlook Aug - Oct 2023 for the Bush at Seneirl Bridge (204001)

Outlook Aug - Oct 2023 for the Tweed at Norham (21009)

Outlook Aug - Oct 2023 for the Severn at Bewdley (54001)

Outlook Aug - Oct 2023 for the Trent at Colwick (28009)

No observation data available

No observation data available

August 2023

Outlook based on modelled flow from historical climate

Overview
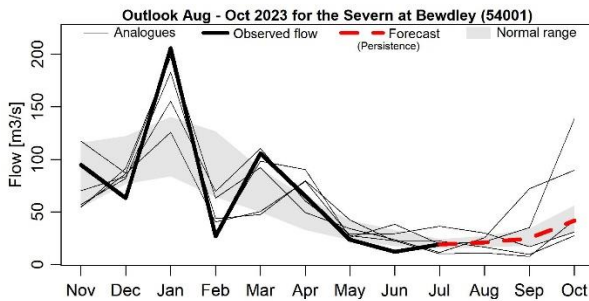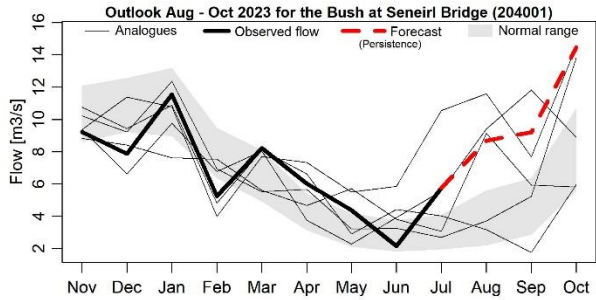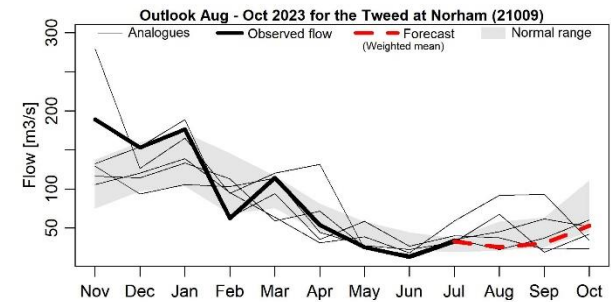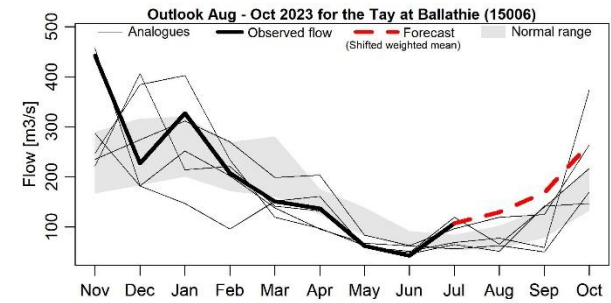
Period: August 2023 – January 2024

Issued on **07.08.2023** using data to the end of July 2023

The outlook for August indicates that flows in Northern Ireland, Wales, and northern and south-western England are likely to be normal to above normal, with normal flows expected else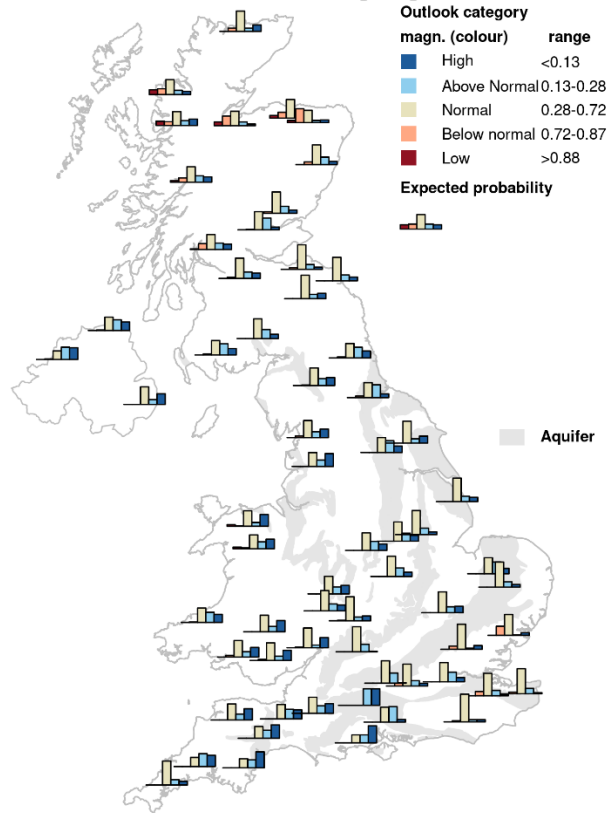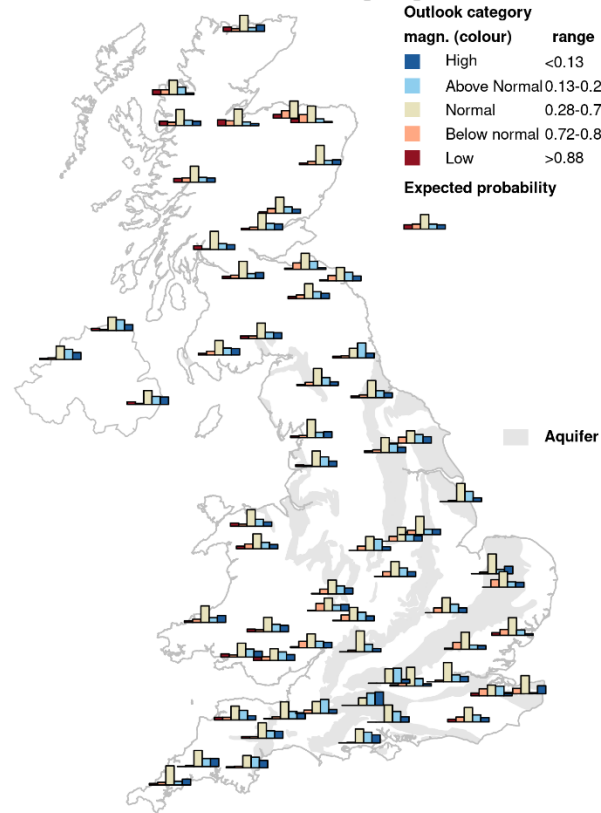where. The July-August-September outlook indicates normal to above normal flows are likely for southern England, and a shift towards normal conditions for the rest of the UK, though confidence over this period is lower than the 1-month forecast.
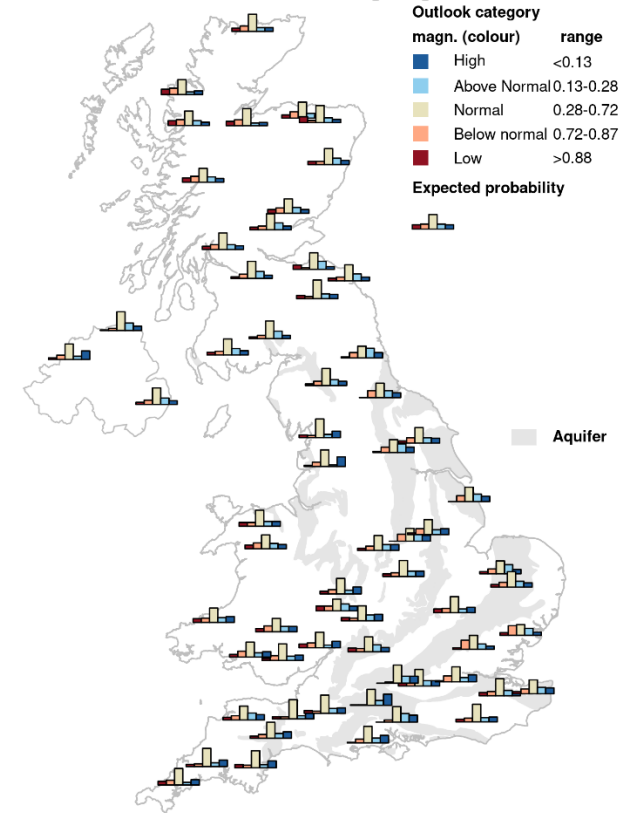
1-month river flow outlook starting Aug 2023

Outlook category

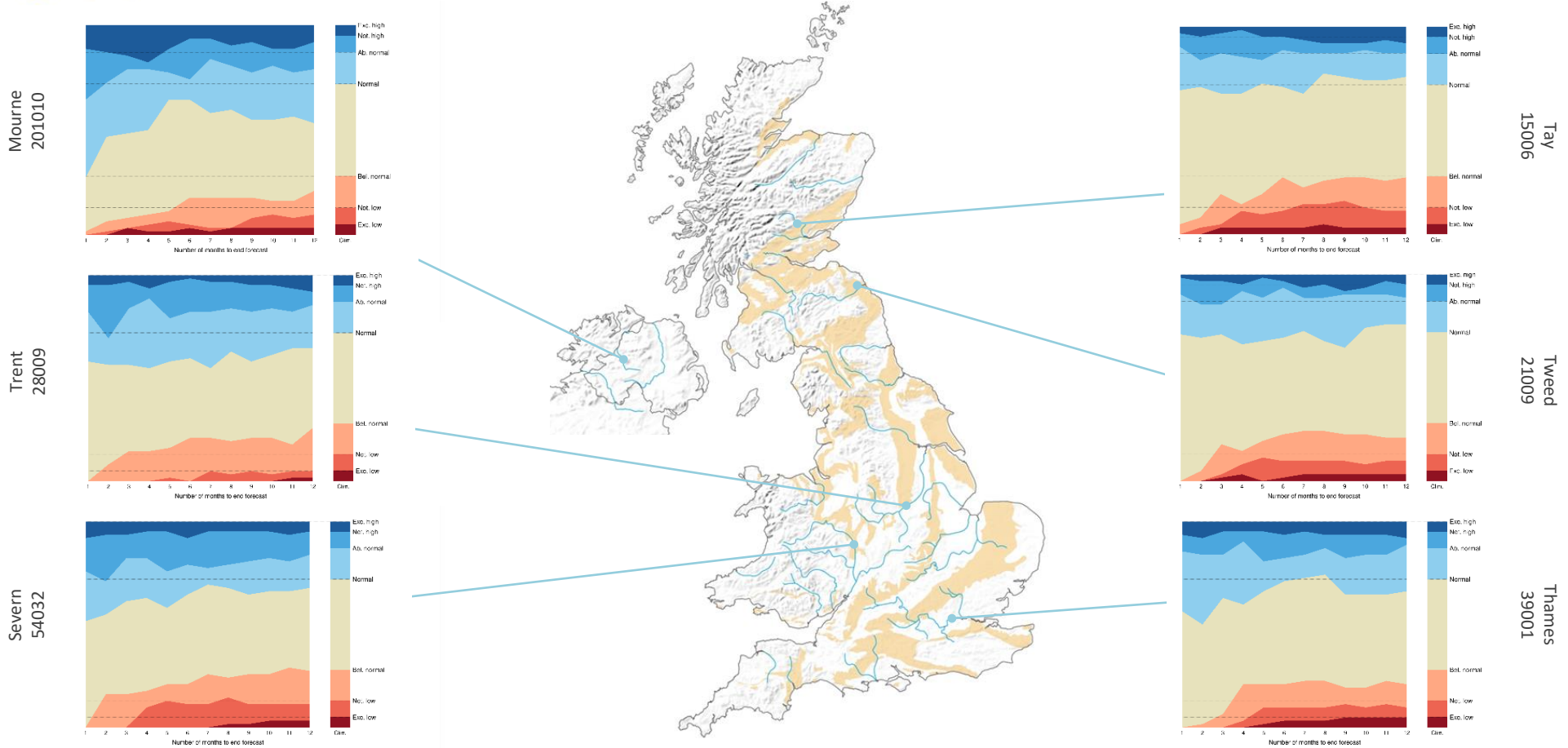| magn. (colour)		range
■	High	<0.13
■	Above Normal	0.13-0.28
■	Normal	0.28-0.72
■	Below normal	0.72-0.87
■	Low	>0.88

Expected probability

Aquifer

3-month river flow outlook starting Aug 2023

Outlook category

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

Expected probability

Aquifer

6-month river flow outlook starting Aug 2023

Outlook category

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

Expected probability

Aquifer

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

The bar plot maps show the outlook distribution for 1, 3 and 6-month period for 64 catchments across England and Wales. Each bar plot represents the probabilistic distribution of the simulated river flow compared to the historical river flow, for the same n-month period. The probabilities fall within five categories, classified as: low, below normal, normal, above normal and high.

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

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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 GR4J conceptual rainfall-runoff model from IRSTEA (France) calibrated on observed or naturalised flows.

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

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

August 2023

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Outlook based on Modelled Flow from Rainfall Forecasts

UK Centre for Ecology & Hydrology

Period: August 2023 – October 2023

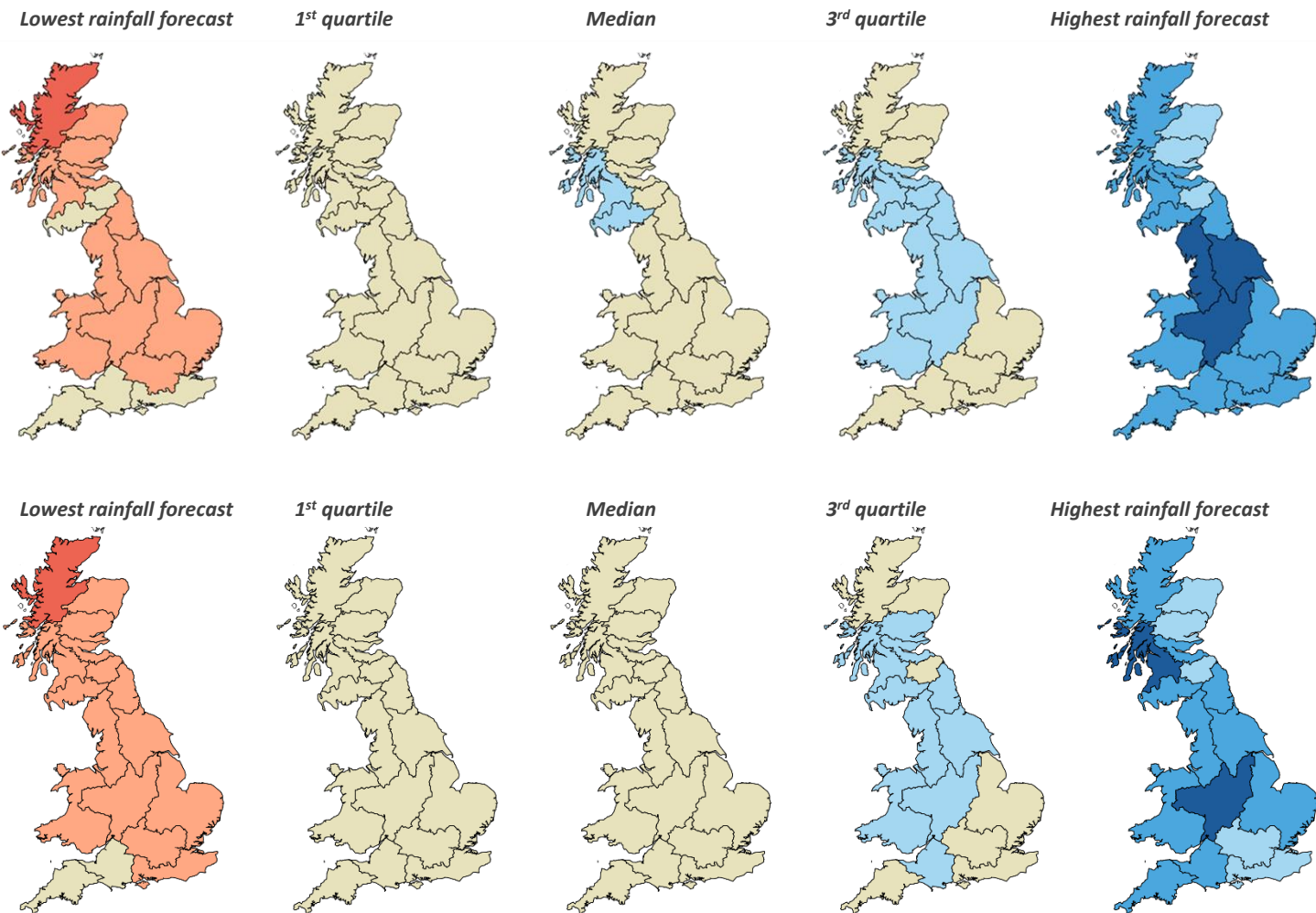Issued on 03.08.2023 using data to the end of July.

SUMMARY: During August, river flows are likely to be in the *normal range* or *above normal* across southwest Scotland, northern England and Wales. Elsewhere, river flows are likely to be in the *normal range*.

Over the next 3 months river flows are likely to be in the *normal range* across northern Scotland and Southern England, and in the *normal range* or *above normal* elsewhere.

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.

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

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

Key

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

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

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

WALES
WEL Welsh

NORTHERN IRELAND
This method cannot currently be used in Northern Ireland

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![UK Centre for Ecology & Hydrology]

Outlook based on Modelled Flow from Rainfall Forecasts

Period: August 2023 - October 2023

Issue date: 03.08.2023

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 August, river flows are likely to be in the *normal range* or *above normal* across southwest Scotland, northern England and Wales. Elsewhere, river flows are likely to be in the *normal range*.

Over the next 3 months river flows are likely to be in the *normal range* across northern Scotland and Southern England, and in the *normal range* or *above normal* elsewhere.
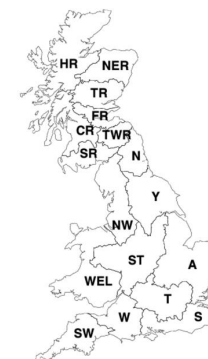
SCOTLAND
HR — Highlands Region
NER — North East Region
TR — Tay Region
FR — Forth Region
CR — Clyde Region
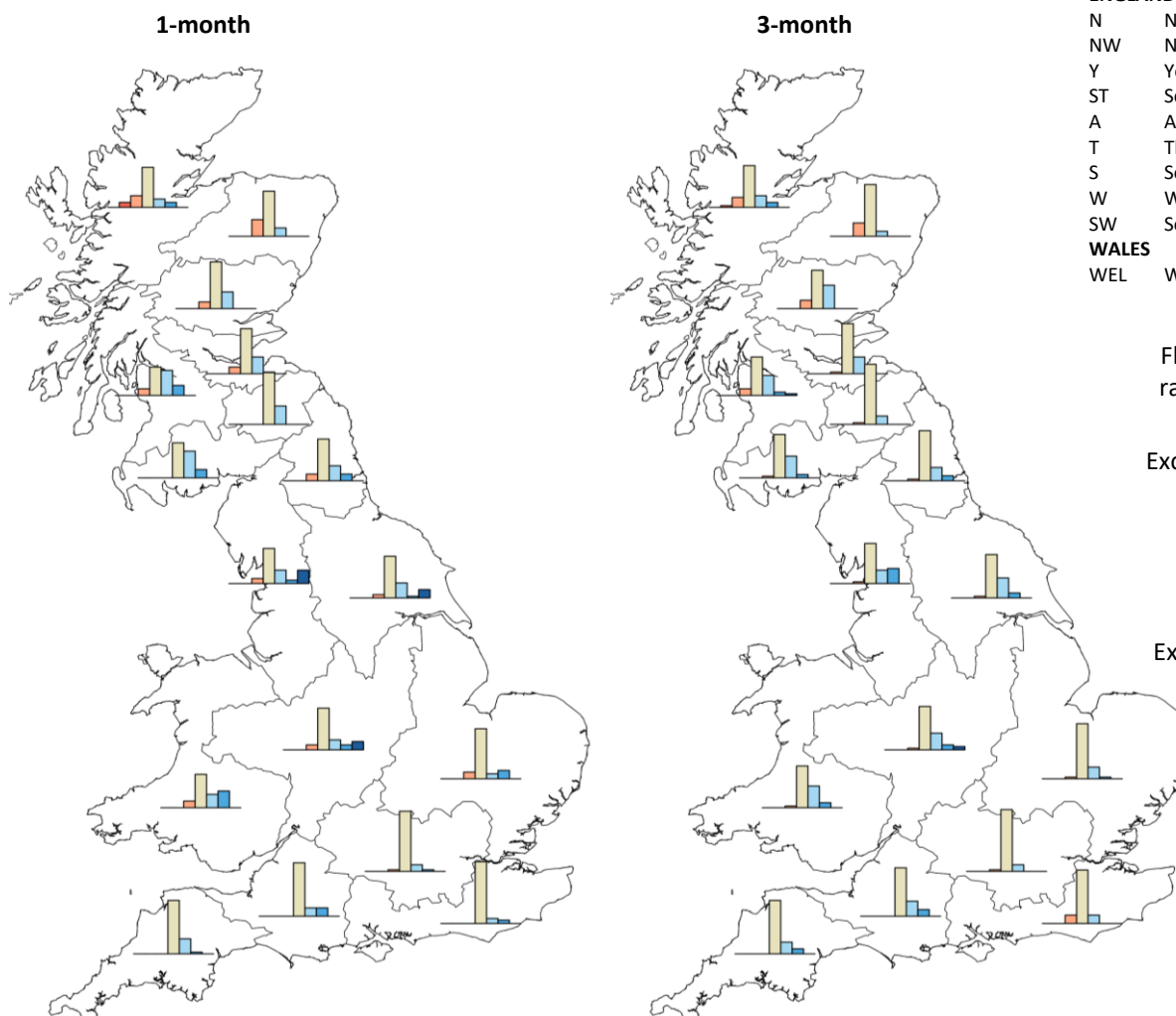TWR — Tweed Region
SR — Solway Region

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

3-month

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

August 2023

Outlook based on Modelled Flow from Rainfall Forecasts

UK Centre for Ecology & Hydrology

Period: August 2023 - October 2023   Issue date: 03.08.2023

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 August, river flows are likely to be in the *normal range* or *above normal* across southwest Scotland, northern England and Wales. Elsewhere, river flows are likely to be in the *normal range*.
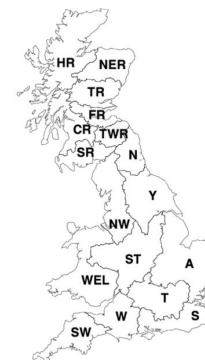>
> **Over the next 3 months** river flows are likely to be in the *normal range* across northern Scotland and Southern England, and in the *normal range* or *above normal* elsewhere.

SCOTLAND
HR — Highlands Region
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NORTHERN IRELAND
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1-month ahead	A	NW	N	ST	SW	S	T	WEL	W	Y	CR	FR	HR	NER	SR	TR	TWR
Exceptionally high flow	0	19	0	12	0	0	0	0	0	12	0	0	0	0	0	0	0
Notably high	12	5	10	7	2	5	2	24	12	2	14	2	7	0	12	0	0
Above normal	7	19	21	14	21	7	10	19	12	21	36	24	12	12	38	24	26
Normal range	71	50	60	60	76	88	86	48	76	60	40	64	57	64	50	67	74
Below normal	10	7	10	7	0	0	2	10	0	5	10	10	17	24	0	10	0
Notably low	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0
Exceptionally low flow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

3-month ahead	A	NW	N	ST	SW	S	T	WEL	W	Y	CR	FR	HR	NER	SR	TR	TWR
Exceptionally high flow	0	0	0	5	0	0	0	0	0	0	2	0	0	0	0	0	0
Notably high	2	21	7	7	7	0	0	7	10	7	5	2	7	0	5	0	0
Above normal	17	19	19	24	17	12	10	31	21	29	29	24	17	7	31	33	12
Normal range	79	57	71	62	76	76	88	60	69	62	55	71	60	74	62	55	86
Below normal	2	2	2	2	0	12	2	2	0	2	10	2	14	19	2	12	2
Notably low	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Exceptionally low flow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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Outlook based on modelled groundwater level & climate forecast
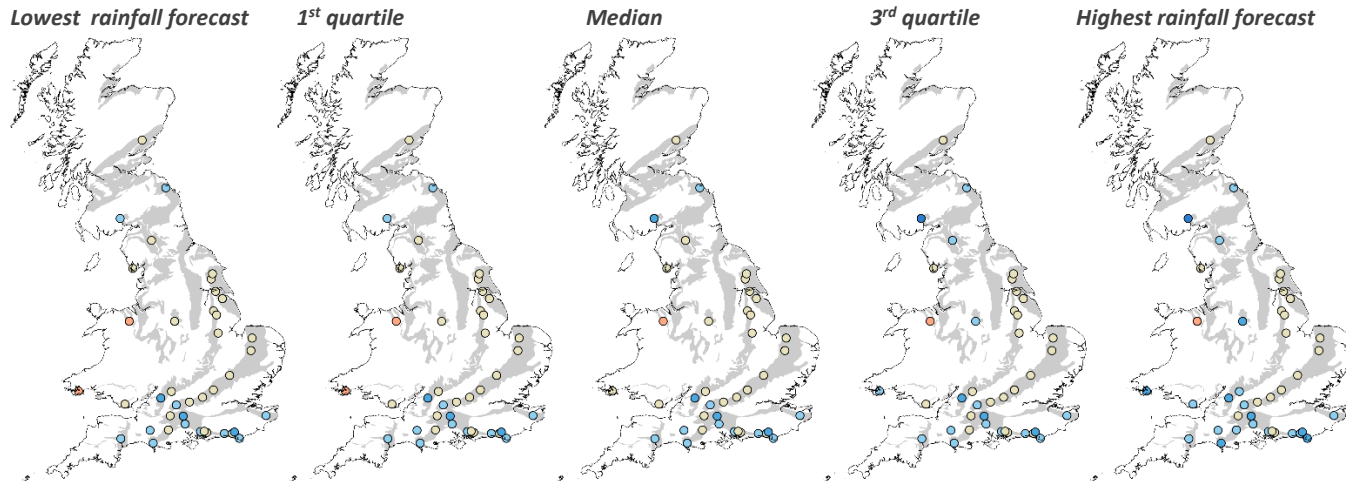
Overview

Period: August 2023 – October 2023

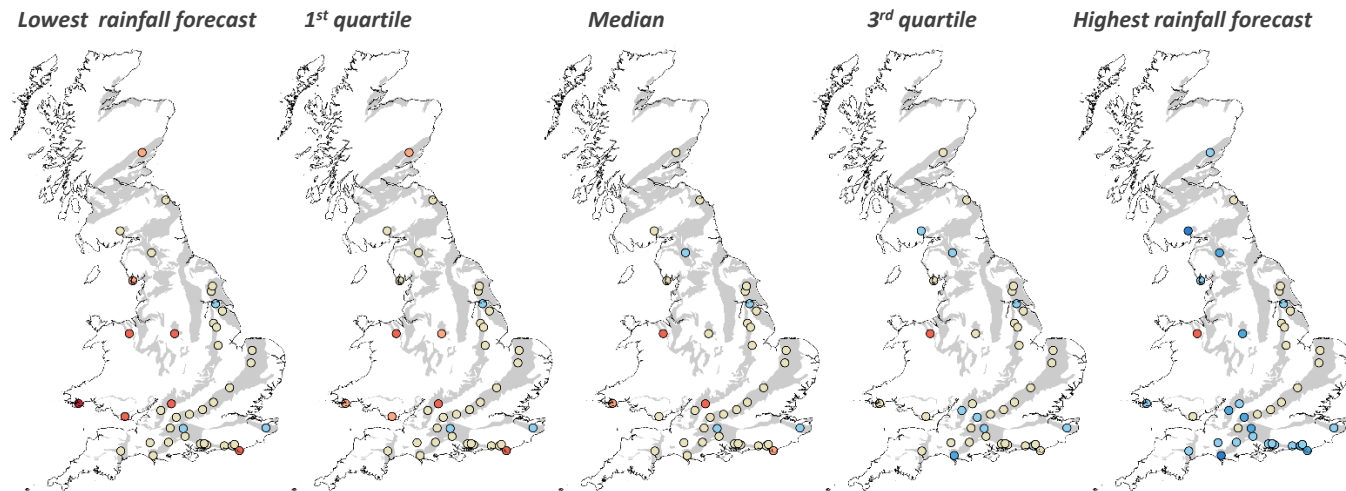Issued on 08.08.2023 using data to the end of July

Under median rainfall conditions, levels are expected to be normal to above normal at most sites in the next month with the exception for one site in north Wales that will be below normal. Above normal levels for the time of year continue to be forecast in the southern Chalk and the sandstones of Scotland and north-east England. The 3 month forecasts are similar to the 1 month forecast but with a tendency for levels in the southern Chalk to generally return to the normal range under all but the highest rainfall scenario.

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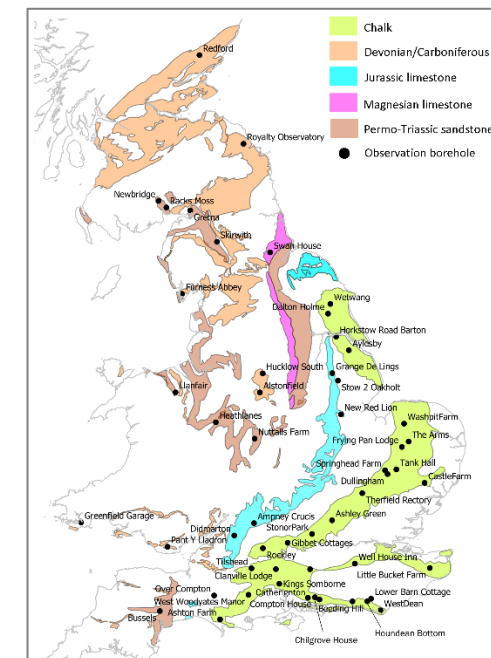
Lowest rainfall forecast | 1st quartile | Median | 3rd quartile | Highest rainfall forecast

1-month outlook

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

3-month outlook

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
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Notably low levels	5-13
Exceptionally low levels	< 5

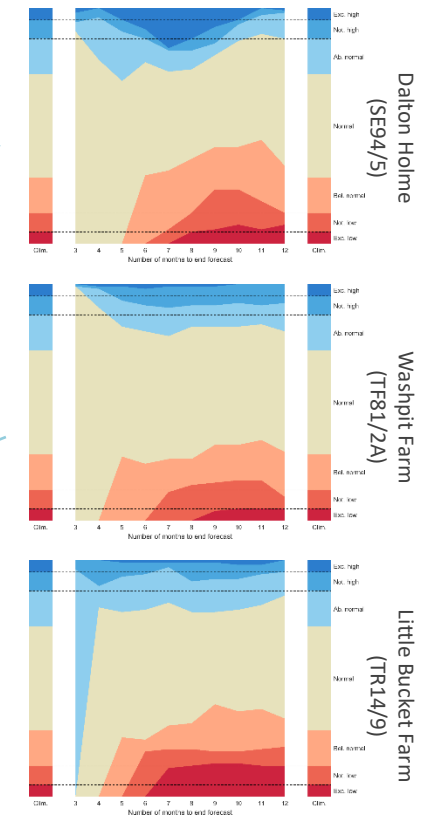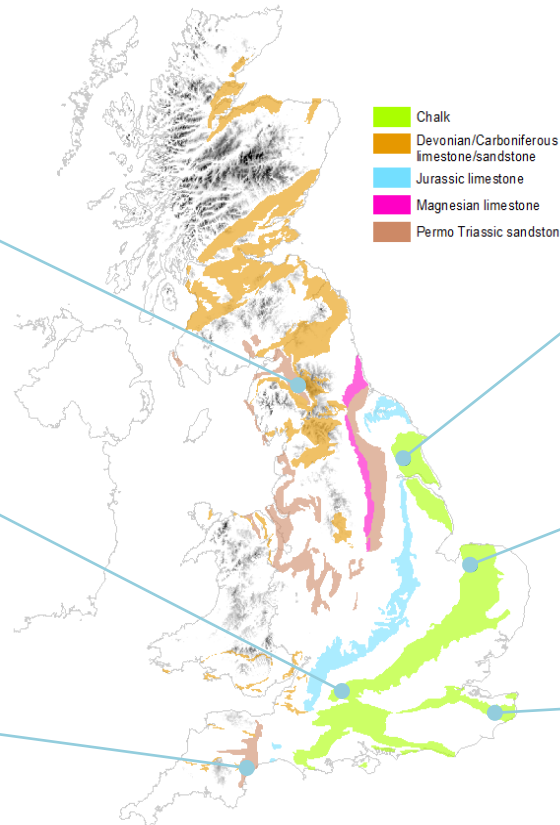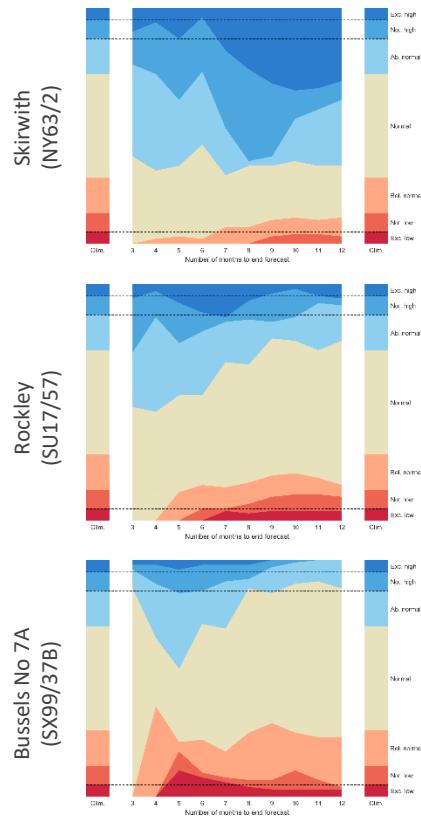| Legend	
Chalk	
Devonian/Carboniferous	
Jurassic limestone	
Magnesian limestone	
Permo-Triassic sandstone	
● Observation borehole	

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August 2023

UK Centre for Ecology & Hydrology

BGS British Geological Survey

Environment Agency

Outlook based on modelled groundwater from historical climate

Period: August 2023 – July 2024

Issued on 08.08.2023 using data to the end of July

Groundwater levels at Washpit Farm and Dalton Holme are expected to remain normal to below normal for much of the next year. At Bussels No 7A and Rockley, predominantly normal levels are forecast to return within the next 6 months. Levels at Skirwith are likely to be above over the next 12 months, while at Little Bucket Farm levels are expected to transition from below to normal within 2 months.

Skirwith (NY63/2)

Rockley (SU17/57)

Bussels No 7A (SX99/37B)

Dalton Holme (SE94/5)

Washpit Farm (TF81/2A)

Little Bucket Farm (TR14/9)

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

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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August 2023