UK Hydrological Outlook

Delivered in partnership by: UK Centre for Ecology & Hydrology

Period: From September 2021 Issued on 09.09.2021 using data to the end of August 2021

SUMMARY

River flows in northern and western areas are likely to be normal to below normal in both September and September-November, whereas river flows in the south-east are likely to be normal to above normal over both timeframes. Groundwater levels in most boreholes of the UK are likely to be normal to above normal in September, but normal to below normal during September-November.

Rainfall:

Rainfall in August was below average across the vast majority of the UK, notably so in parts of central and eastern England, and the Scottish Highlands. Above average rainfall was generally limited to parts of Northern Ireland and eastern Scotland.

The rainfall outlook for the UK for September (issued by the Met Office on 23.08.2021) is that near-average rainfall is the most likely outcome. For September-October-November as a whole, it is more likely to be dry than wet.

River flows:

River flows in August were generally below average across Northern Ireland, Wales, and most of England (except for the south-east). Flows were notably low in catchments draining the northern Pennines and in western Wales.

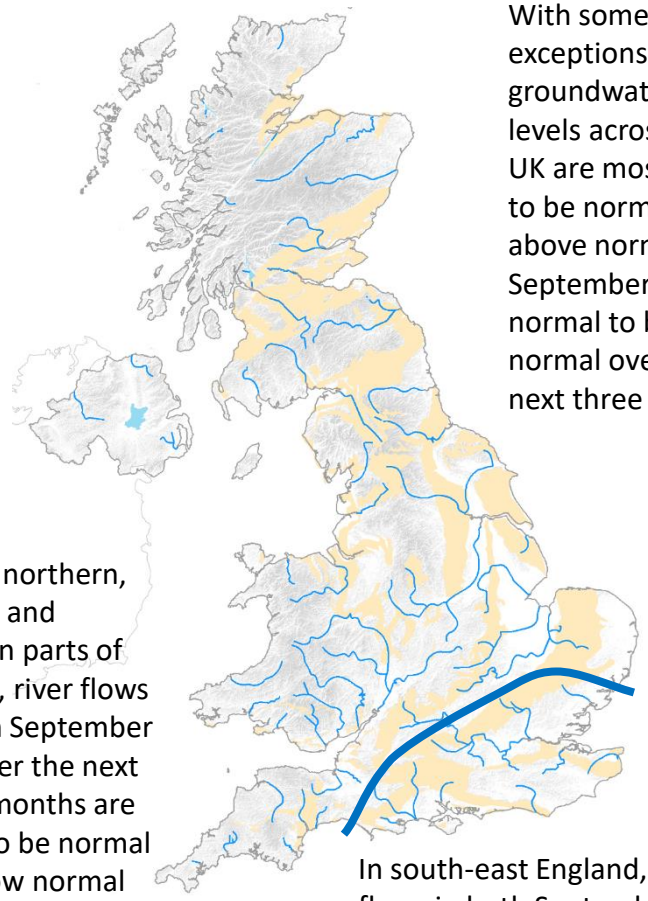
The outlook for September is for normal to above normal river flows in the south-east and for normal to below normal river flows further north and west. Although the signal is dampened, this pattern is also suggested for the September-November timeframe.

Groundwater:

Groundwater levels in August were normal to above normal across most of the UK, and exceptionally high in some localised boreholes along the south coast and in parts of northern Britain. Conversely, levels were low in Northern Ireland and south Wales.

The outlook for September is for normal to above normal groundwater levels across most of the UK. Conversely, levels are likely to be below normal in south Wales. Over the September-November timeframe, the outlook is for normal to below normal groundwater levels, though some boreholes in southern England remain likely to be above normal.

Note that due to continuing issues with data access, no data are available for Scotland.



With some exceptions, groundwater levels across the UK are most likely to be normal to above normal in September and normal to below normal over the next three months

Across northern, central and western parts of the UK, river flows in both September and over the next three months are likely to be normal to below normal

In south-east England, river flows in both September and over the next three months are likely to be normal to above normal

Shaded areas show principal aquifers

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UK Hydrological Outlook

Delivered in partnership by: UK Centre for Ecology & Hydrology

About the Hydrological Outlook:

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

Data and Models:

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

Climate forecasts are produced by the Met Office. Hydrological modelling is undertaken by UKCEH using the Grid-to-Grid, PDM and CLASSIC hydrological models and by the EA using CATCHMOD. Hydrogeological modelling uses the R-groundwater model run by BGS and CATCHMOD run by the EA. Supporting documentation is available from the Outlooks website:
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 Hydrological Outlook is supported by the Natural Environment Research Council funded UK-SCAPE and Hydro-JULES Programmes.

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Further information:

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

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

Contact:

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

Reference for the Hydrological Outlook:

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

Other Sources of Information:

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

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

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

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

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

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

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UK Centre for Ecology & Hydrology

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

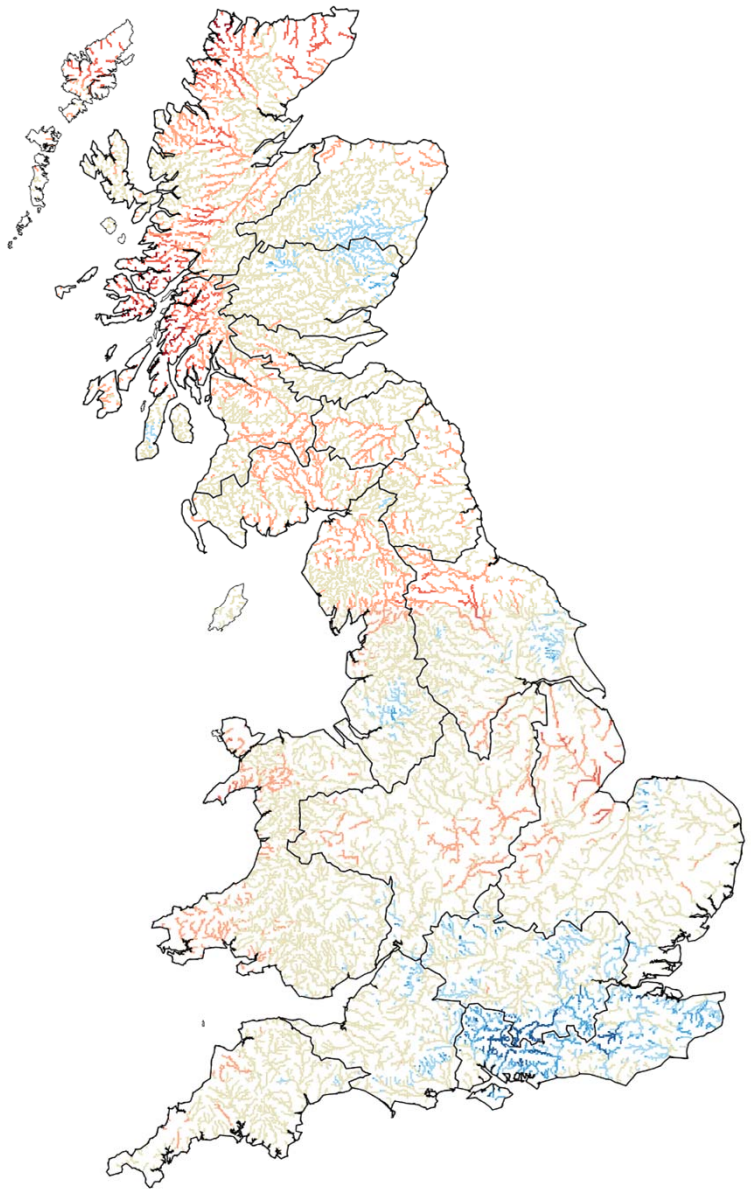
Period: August 2021

Issue date: 02.09.2021

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

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OUTLOOK BASED ON CURRENT CONDITIONS

September 2021

UK Centre for Ecology & Hydrology

Current Daily Simulated Subsurface Water Storage Conditions

Prototype

Based on subsurface water storage estimated for 31st August 2021

Issue date: 02.09.2021

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

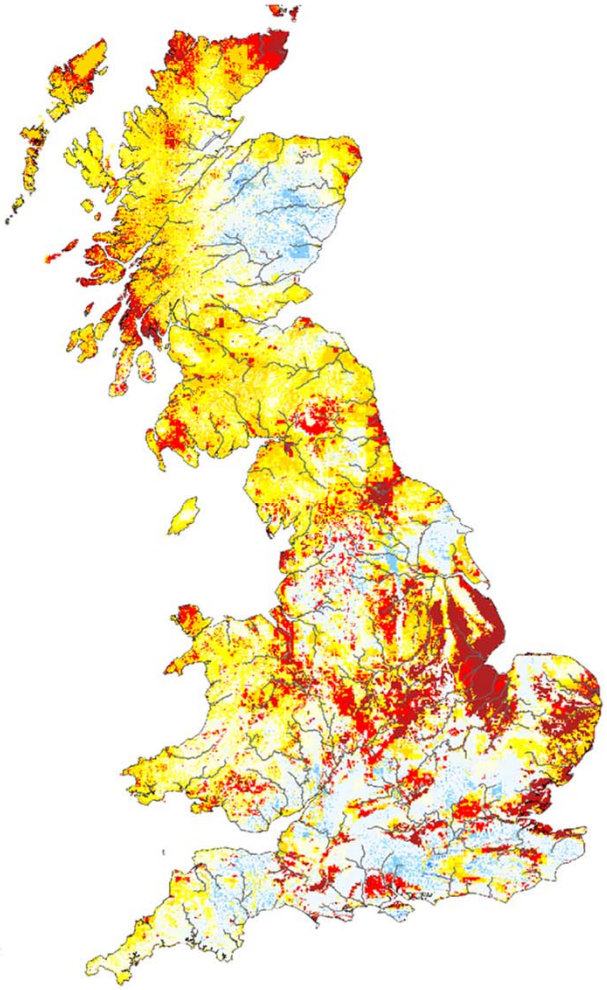
SUMMARY: At the end of August, subsurface levels were normal or lower (drier) than normal across most of the country, especially in east England (very dry). Subsurface water levels were higher (wetter) for areas of southern England, the midlands and east Scotland.

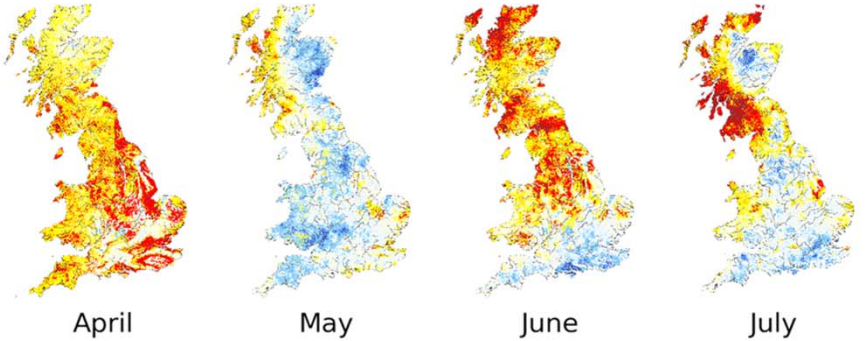
Relative wetness

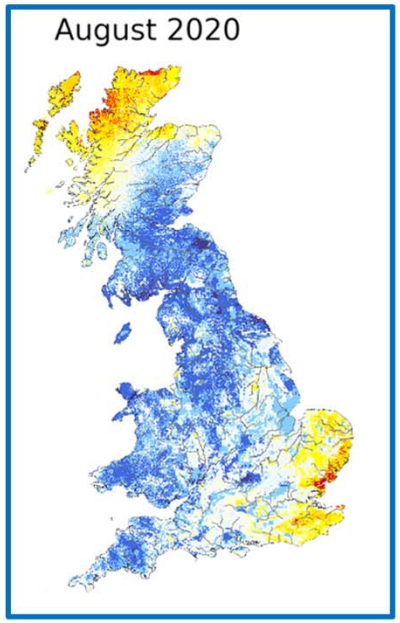
Water storage anomaly as a % of maximum (positive wetness) or minimum (negative wetness) storage anomaly (zero indicates average value)

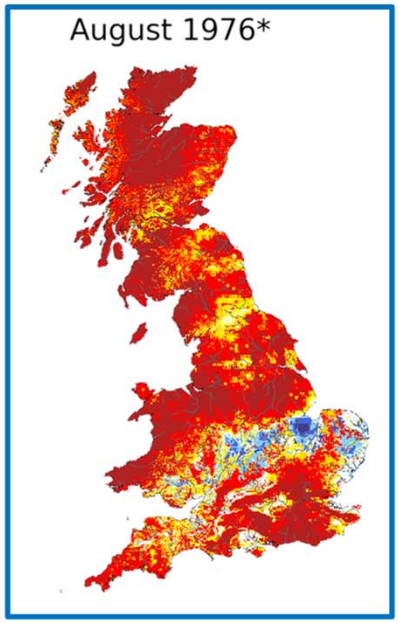
High (very wet)	>100
	75 - 100
Medium wetness	50 - 75
	25 - 50
Low wetness	0.01 - 25
Average conditions	-0.01 - 0.01
Low dryness	-25 - - 0.01
	-50 - -25
Medium dryness	-75 - -50
	-100 - -75
High (very dry)	< -100
Main rivers	

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









*Example month displaying extreme negative wetness

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OUTLOOK BASED ON CURRENT CONDITIONS

September 2021

Current Daily Simulated Subsurface Water Storage Conditions

Relative wetness

- Each month, to highlight areas that are particularly wet or dry, the total daily mean subsurface water storage (S, mm) is presented using a colour scale showing water storage anomaly relative to the historical maximum or minimum anomaly. The "relative wetness" map combines maps previously shown separately as the "relative wetness" and "relative dryness".
- The relative wetness in the sub-surface, R_w (%), is expressed as an anomaly from the monthly mean (1981 – 2010) wetness at that location:

for $S \leq S_{average}$

$$R_w\,(\%) = \frac{(S - S_{average})}{(S_{max} - S_{average})} \times 100$$

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

for $S > S_{average}$

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

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

- A value of $\mathbf{R_w = 0}$ indicates that the sub-surface water storage in the region matches the monthly average value.
- Places where $\mathbf{R_w > 0}$ and $\mathbf{R_w < 0}$ are wetter or drier, respectively, than is average for that month.
- Values where $\mathbf{|\,R_w\,| > 100}$ indicate the subsurface water storage is higher/lower than the previous maximum/minimum monthly mean storage estimated by the G2G over the period 1971 to 2010 (over all months), and is thus an unusually extreme value.

- These maps **do not provide a forecast**, but the relative wetness can provide an indication of locations which are particularly wet or dry. Rainfall in areas with high positive relative wetness areas **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.

UK Centre for Ecology & Hydrology

Return Period of Rainfall Required to Overcome Dry Conditions

Period: September 2021 – February 2022

Issue date: 02.09.2021

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

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

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

Sep

Oct

Nov

Dec

Jan

Feb

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

SCOTLAND

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

ENGLAND

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

WALES

WEL	Welsh

NORTHERN IRELAND

This method cannot currently be used in Northern Ireland

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OUTLOOK BASED ON CURRENT CONDITIONS

September 2021

Return Period of Rainfall Required to Overcome the Dry Conditions

Method

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

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

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

- For each of the next 6 months, we estimate the rainfall total (including what is normally expected for each month) required to overcome the dry conditions.
  - To overcome the dry conditions by the end of month 1:
    rainfall required (mm) = regional monthly average rainfall for month 1 + regional average storage deficit
  - To overcome the dry conditions by the end of month 2 (more likely):
    rainfall required (mm) = regional monthly average rainfall for months 1 and 2 + regional average storage deficit
  - To overcome the dry conditions by the end of month *n* (likely):
    rainfall required (mm) = regional monthly average rainfall for months 1 to *n* + regional average storage deficit

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

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

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

UK Centre for Ecology & Hydrology

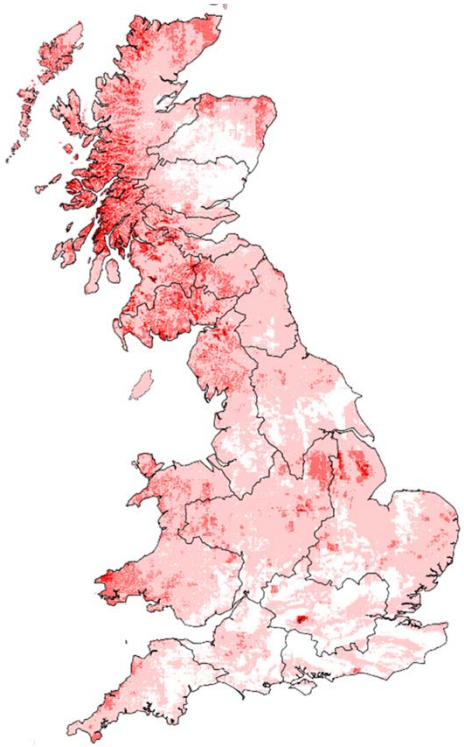
Estimate of Additional Rainfall Required to Overcome Dry Conditions

Based on subsurface water storage estimated for 31st August 2021

Issue date: 02.09.2021

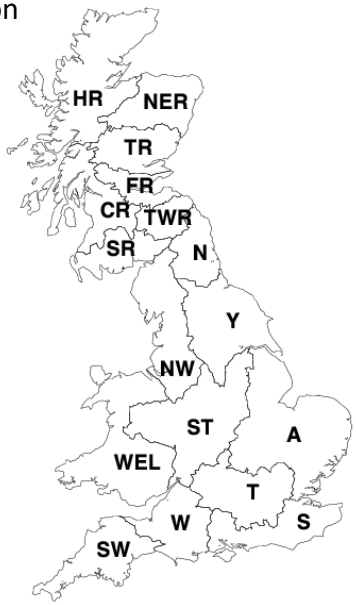
These maps show the Grid-to-Grid (G2G) hydrological model simulated subsurface water storage, expressed as an anomaly from the historical monthly mean (1981-2010), presented on a 1km grid and as regional means.
Subsurface storage deficits, i.e. where the subsurface water storage anomaly is less than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

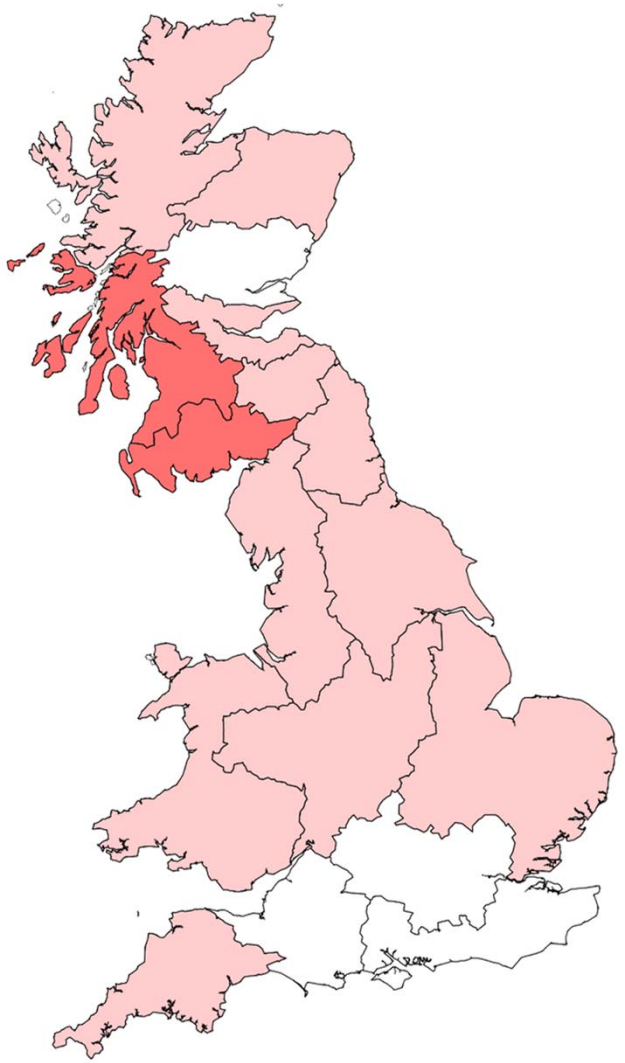
The **subsurface storage deficit (mm)** can be interpreted as an estimate of additional rainfall that would be required in future months to overcome dry conditions (i.e. rainfall in addition to what is expected on average). Regional mean values of additional rainfall required are provided in the table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



Regional estimate of additional rainfall required (mm)

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





Water storage deficit (anomaly, mm)

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

OUTLOOK BASED ON CURRENT CONDITIONS

September 2021

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UK Centre for Ecology & Hydrology

Outlook based on hydrological persistence and analogy

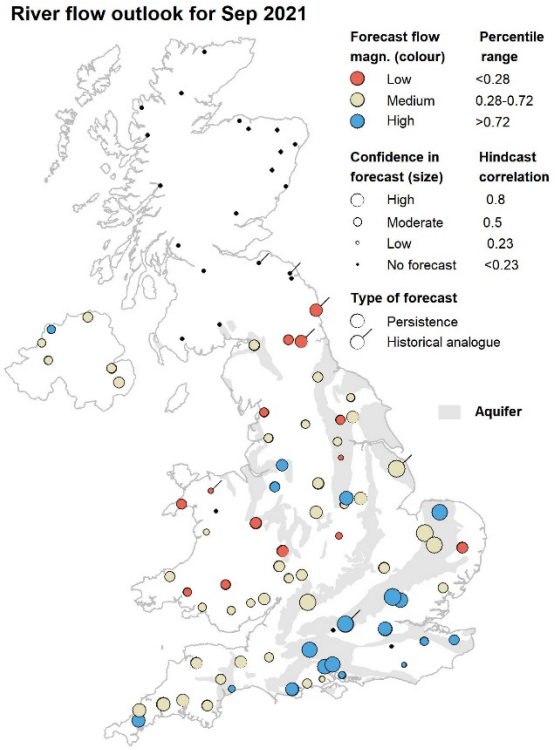
Overview

Period: September – November 2021

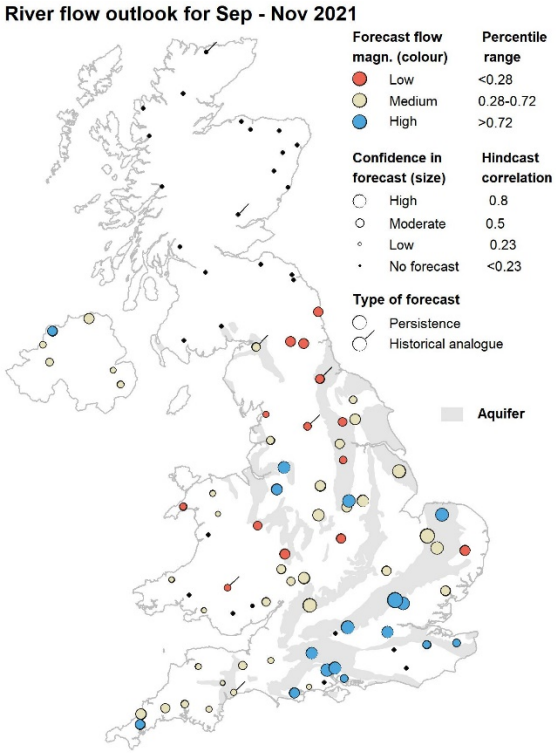
Issued on 07.09.2021 using data to the end of August 2021

SUMMARY

The outlooks for September and for September-November are for normal to above normal flows in south-east England. Elsewhere flows are likely to be normal to below normal, although there is some localised variability. Note there are no forecasts available for Scotland.



1-month flow outlook



3-month flow outlook

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

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

Both methods are considered at each site and the forecast from the method with the higher confidence is presented. A simple classification of flows is used (high, medium and low) as indicated by the colours of the dots, with the confidence of the forecast being represented by the size of the dot. A tag on the dot indicates which method has been used in each instance.

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UK Centre for Ecology & Hydrology

Outlook based on hydrological persistence and analogy

Site-based: 1 month outlook

Period: September 2021

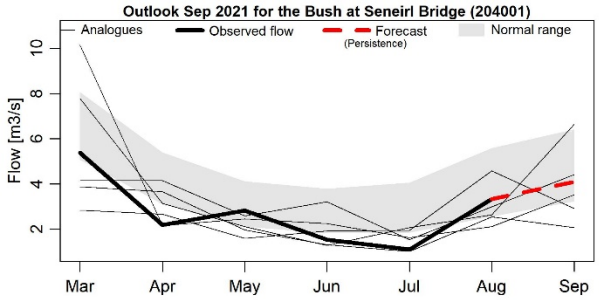
Issued on 07.09.2021 using data to the end of August 2021

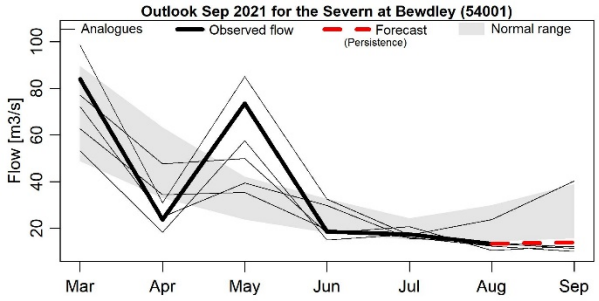
RIVER FLOW ANALOGY

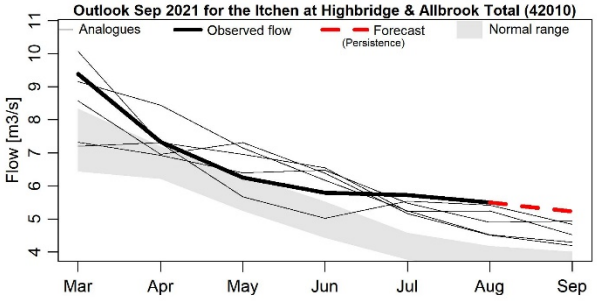
September 2021

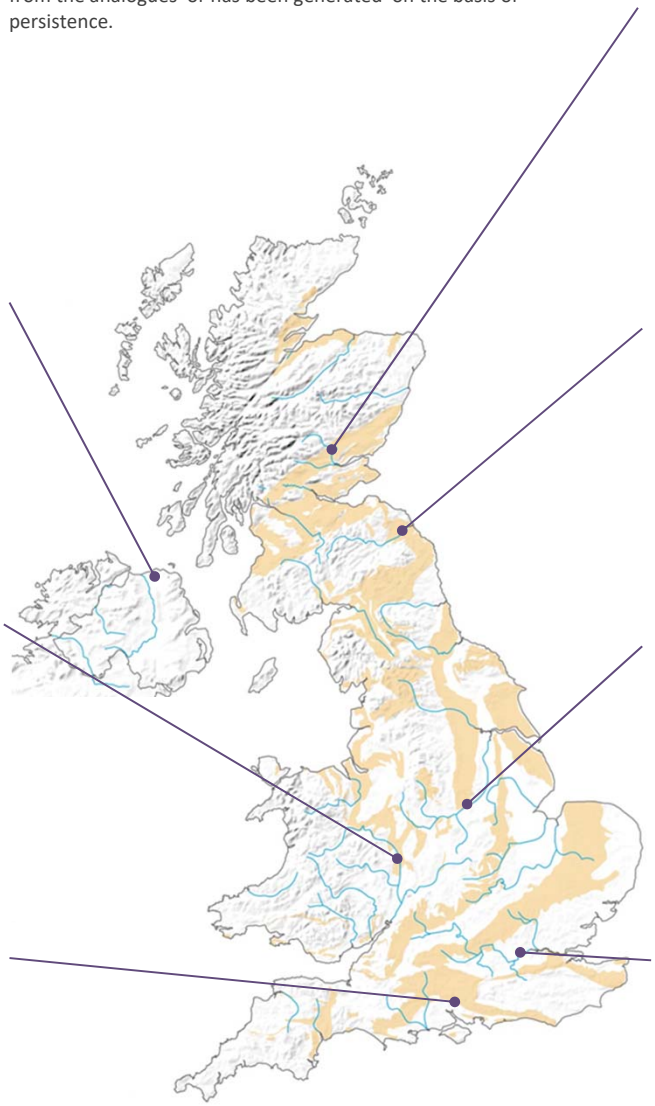
These figures provide insight into the hydrological analogue methodology for a set of sites from across the UK.

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



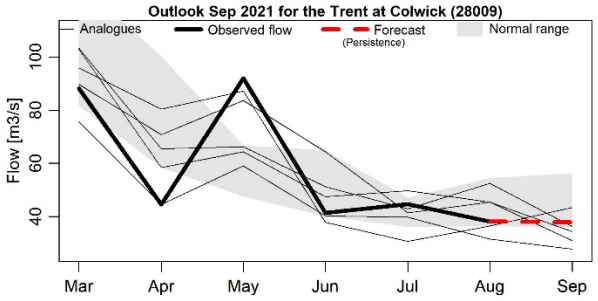


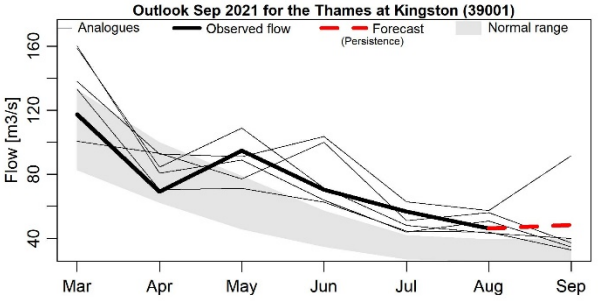




No forecast available

No forecast available





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UK Centre for Ecology & Hydrology

Outlook based on hydrological persistence and analogy

Site-based: 3 month outlook

Period: September – November 2021

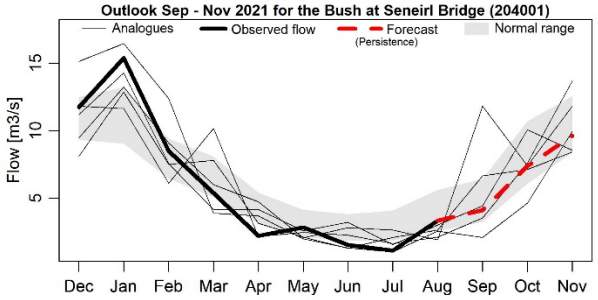
Issued on 07.09.2021 using data to the end of August 2021

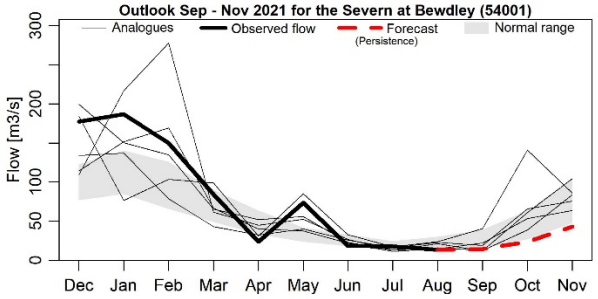
RIVER FLOW ANALOGY

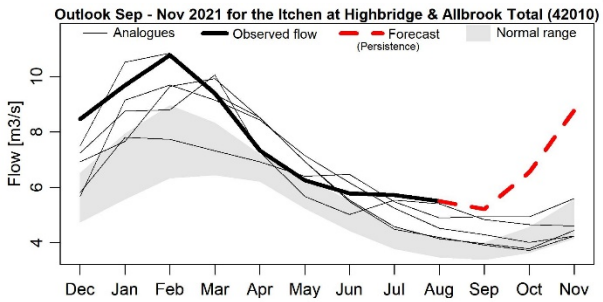
September 2021

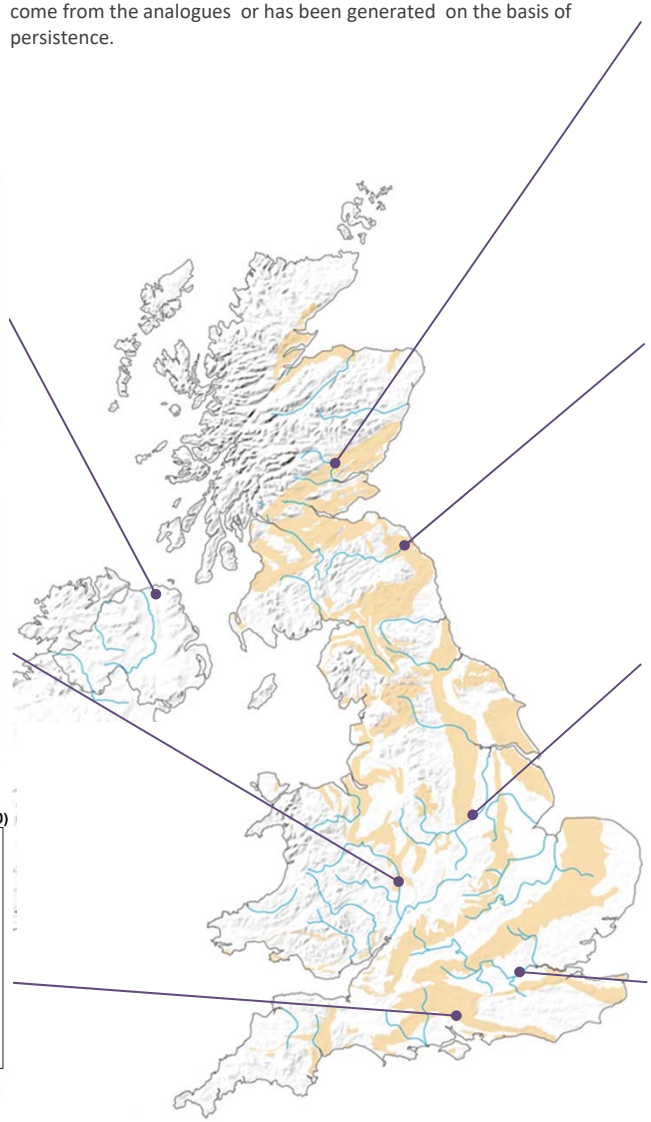
These figures provide insight into the hydrological analogue methodology for a set of sites from across the UK.

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



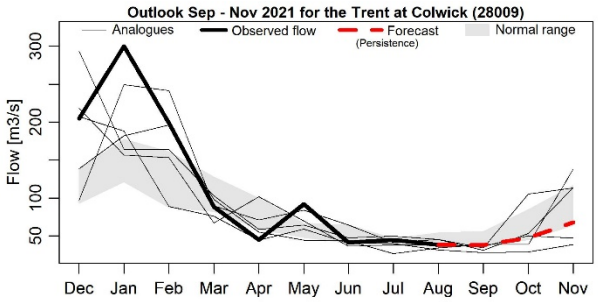


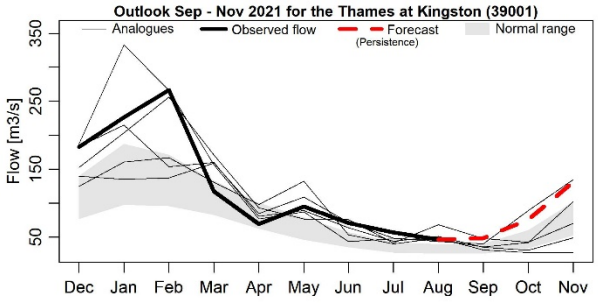




No forecast available

No forecast available





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UK Centre for Ecology & Hydrology

British Geological Survey

Environment Agency

Outlook based on modelled flow from historical climate

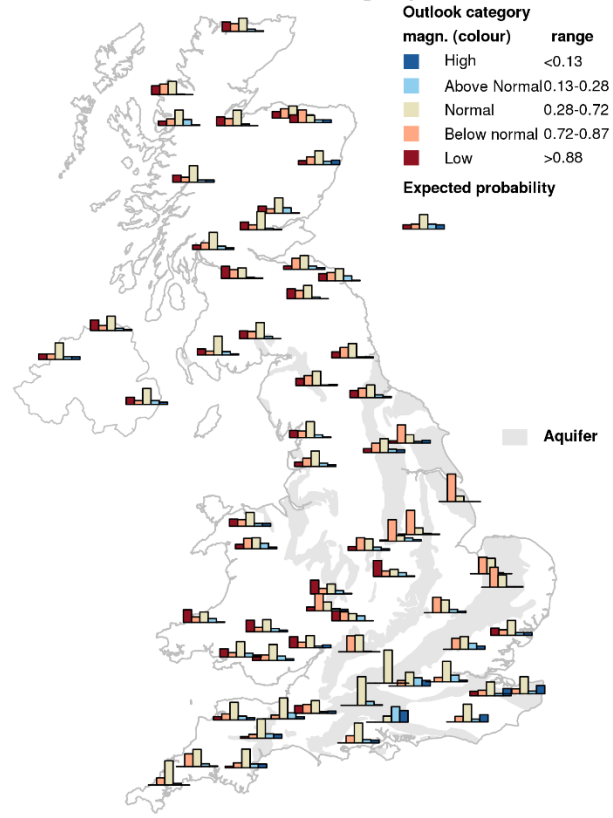
Overview

Period: September 2021 – February 2022

Issued on 02.09.2021 using data to the end of August 2021

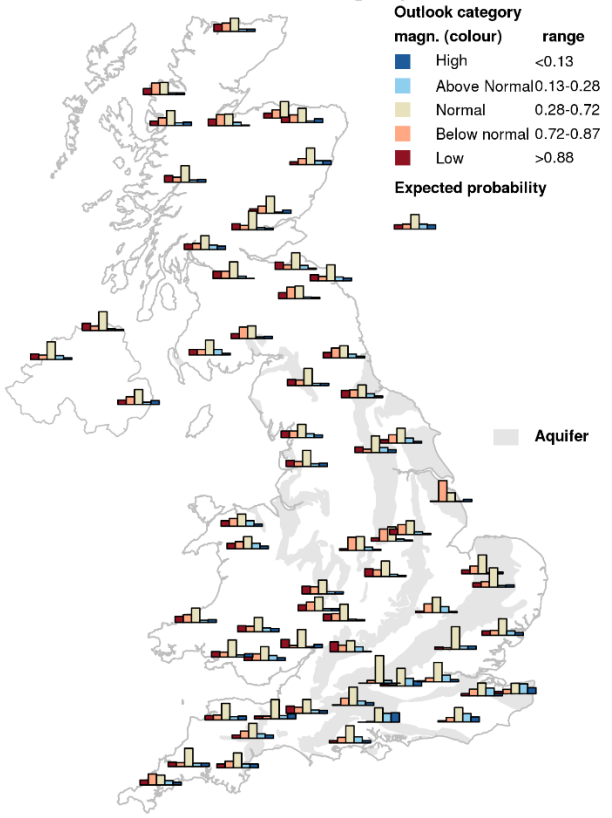
The outlook for September indicates below normal to low flows are likely across much of the UK, with the exception of normal flows expected across southern England, and above normal flows expected in some catchments of the south-east. This pattern is likely to persist over the next three months, though the magnitude of both above- and below-normal flows is likely to be dampened over the longer term, with flows in the normal range becoming more likely.

1-month river flow outlook starting Sep 2021



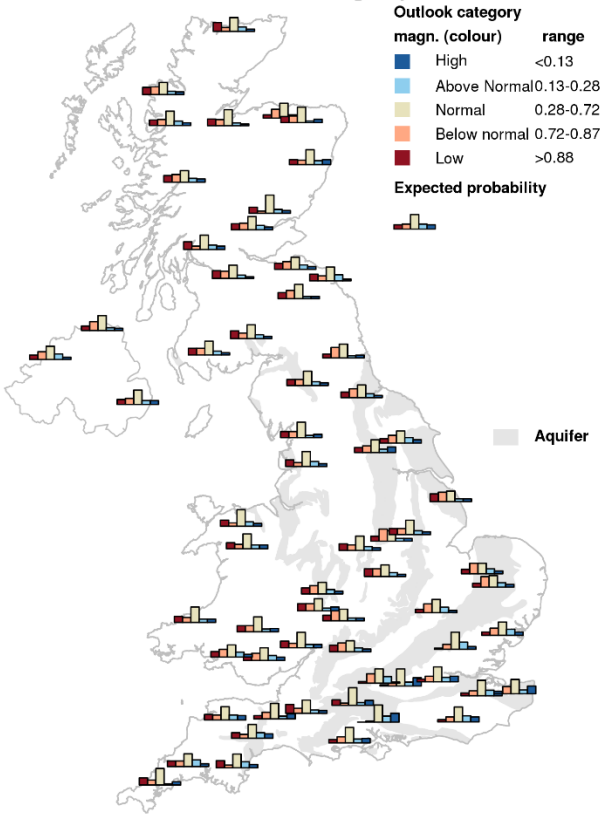
This outlook is based on monthly ensembles of historical sequences of observed climate (rainfall and potential evapotranspiration) that form input to a hydrological model. The outputs are probabilistic simulations of the average river flow over the forecast period (1 to 12 months ahead), at each location.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

3-month river flow outlook starting Sep 2021



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

6-month river flow outlook starting Sep 2021



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

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RIVER FLOW FROM HISTORICAL CLIMATE

September 2021

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

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

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

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RIVER FLOW FROM HISTORICAL CLIMATE

September 2021

UK Centre for Ecology & Hydrology

Outlook Based on Modelled Flow from Rainfall Forecasts

Overview

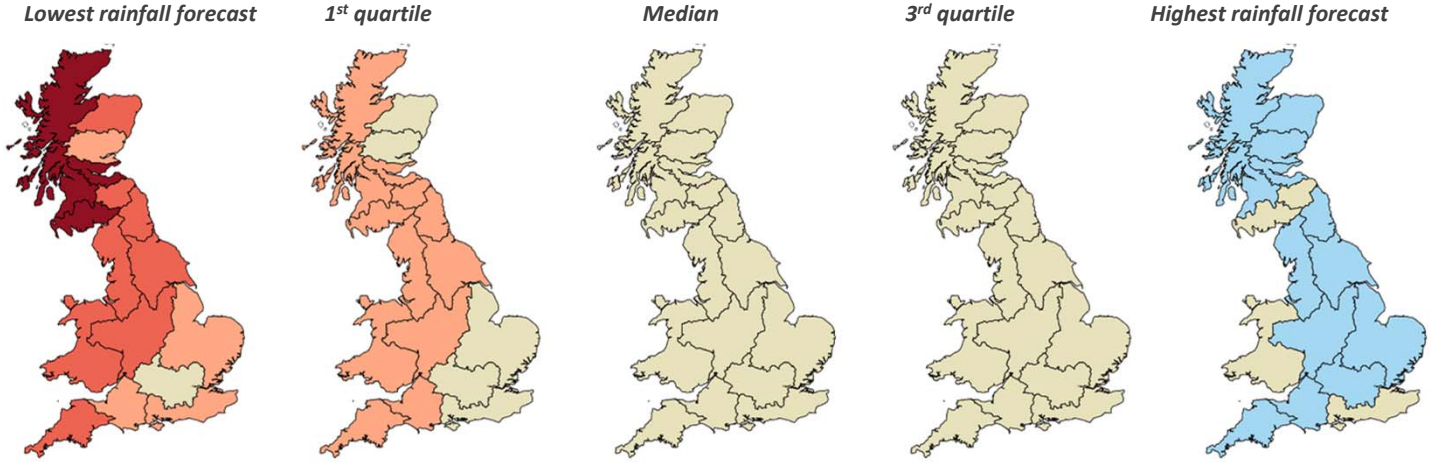
Period: September 2021 – November 2021

Issued on 02.09.2021 using data to the end of August

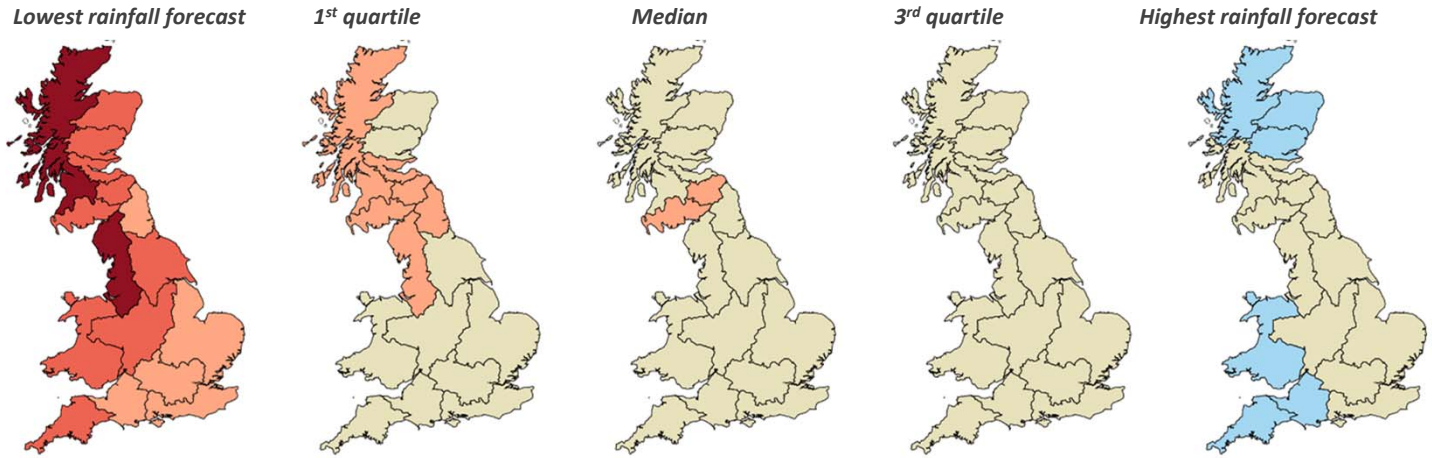
SUMMARY: During September river flows in southeast England and east Scotland are most likely to be in the *Normal range*, elsewhere flows are most likely to be in the *Normal range* or below.

Over the next 3 months river flows are likely to be in the *Normal range* across most of Great Britain, but flows in northern England and southern Scotland are more likely to be in the *Normal range* or below.

1-month flow outlook



3-month flow outlook



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

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

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

Key

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

SCOTLAND

HR Highlands Region
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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RIVER FLOW FROM RAINFALL FORECASTS

September 2021

UK Centre for Ecology & Hydrology

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

Period: September 2021 – November 2021 Issue date: 02.09.2021

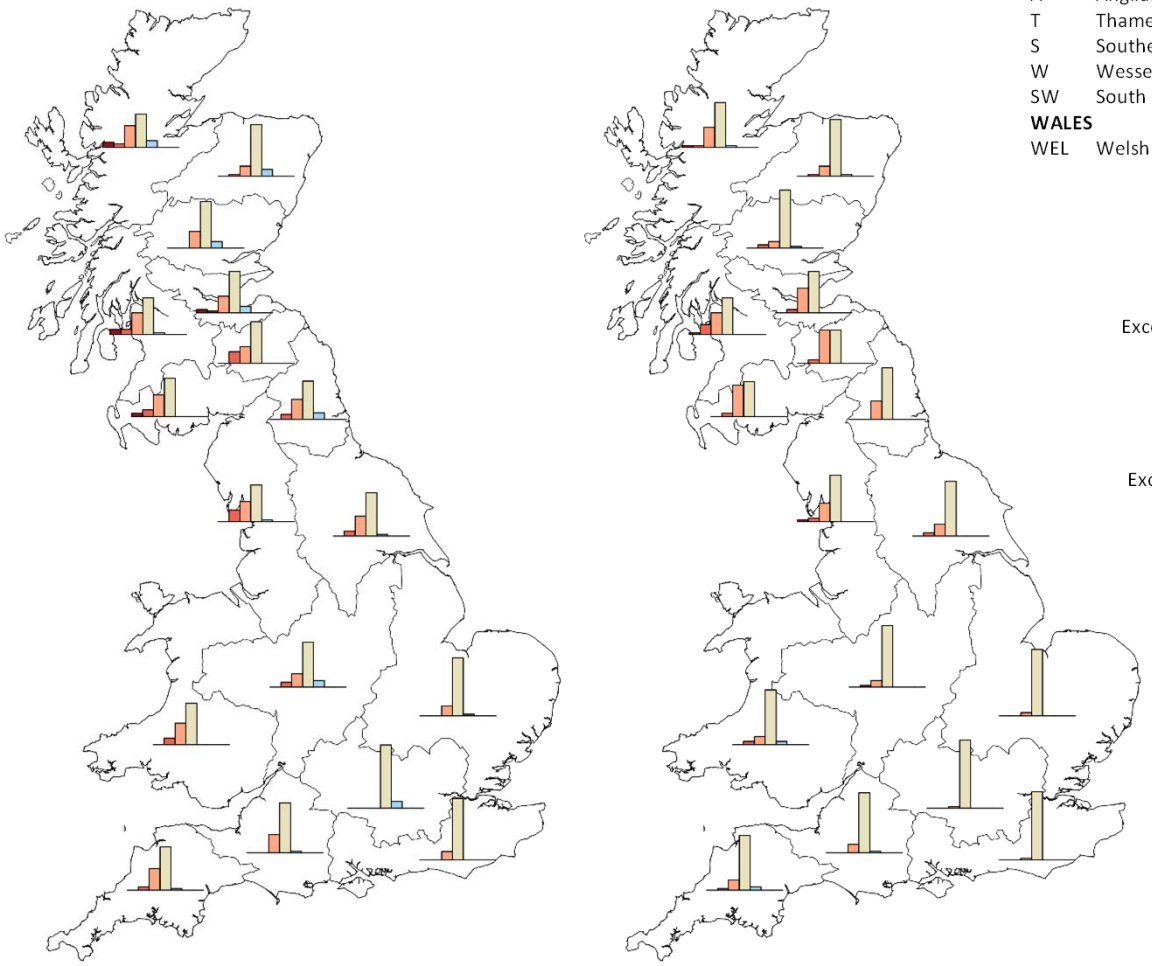
The regional maps illustrating the regional river flows for five members of the Met Office ensemble of rainfall forecasts give some indication of the range of possible river flows in the coming months. As noted previously, the actual flows could be more extreme than the flows generated by either the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

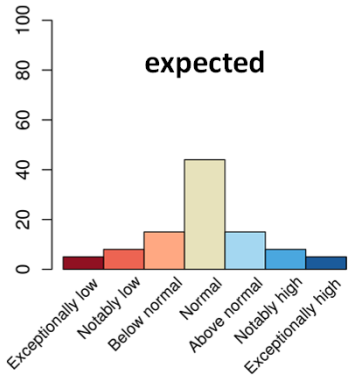
The bar charts (below) give further insight into the range of river flow forecasts by considering all members of the forecast rainfall ensemble. The regional bar charts show the percentage of ensemble forecasts falling in each of the flow categories as generated by the monthly-resolution water-balance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

SUMMARY: During September river flows in southeast England and east Scotland are most likely to be in the *Normal range*, elsewhere flows are most likely to be in the *Normal range* or below.

Over the next 3 months river flows are likely to be in the *Normal range* across most of Great Britain, but flows in northern England and southern Scotland are more likely to be in the *Normal range* or below.

1-month *3-month*





SCOTLAND

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

ENGLAND

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

WALES

WEL	Welsh

NORTHERN IRELAND
This method cannot currently be used in Northern Ireland

Percentile range of historic values for relevant month

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

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RIVER FLOW FROM RAINFALL FORECASTS

September 2021

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Period: September 2021 – November 2021 Issue date: 02.09.2021

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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 September river flows in southeast England and east Scotland are most likely to be in the *Normal range*, elsewhere flows are most likely to be in the *Normal range* or below.

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

NORTHERN IRELAND
This method cannot currently be used in Northern Ireland

1-month ahead	A	NW	N	ST	SW	S	T	Welsh	W	Y	CR	FR	HR	NER	SR	TR	TWR
Exceptionally high flow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Notably high flow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Above normal	2	2	10	10	2	0	10	0	2	2	2	10	10	10	0	10	0
Normal range	83	52	55	64	62	88	90	60	71	62	52	60	48	74	55	67	60
Below normal	14	29	29	19	31	12	0	31	26	29	31	24	31	14	31	24	24
Notably low flow	0	17	7	7	5	0	0	10	0	7	7	2	5	2	10	0	17
Exceptionally low flow	0	0	0	0	0	0	0	0	0	0	7	5	7	0	5	0	0

3-months ahead	A	NW	N	ST	SW	S	T	Welsh	W	Y	CR	FR	HR	NER	SR	TR	TWR
Exceptionally high flow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Notably high flow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Above normal	0	0	0	0	5	0	0	5	2	0	0	0	2	2	0	2	0
Normal range	95	67	74	88	79	98	98	79	86	79	52	60	64	81	50	83	48
Below normal	5	26	26	10	14	2	2	12	12	17	31	36	29	14	45	10	48
Notably low flow	0	5	0	2	2	0	0	5	0	5	14	5	2	2	5	5	5
Exceptionally low flow	0	2	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0

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Outlook based on modelled groundwater level & climate forecast

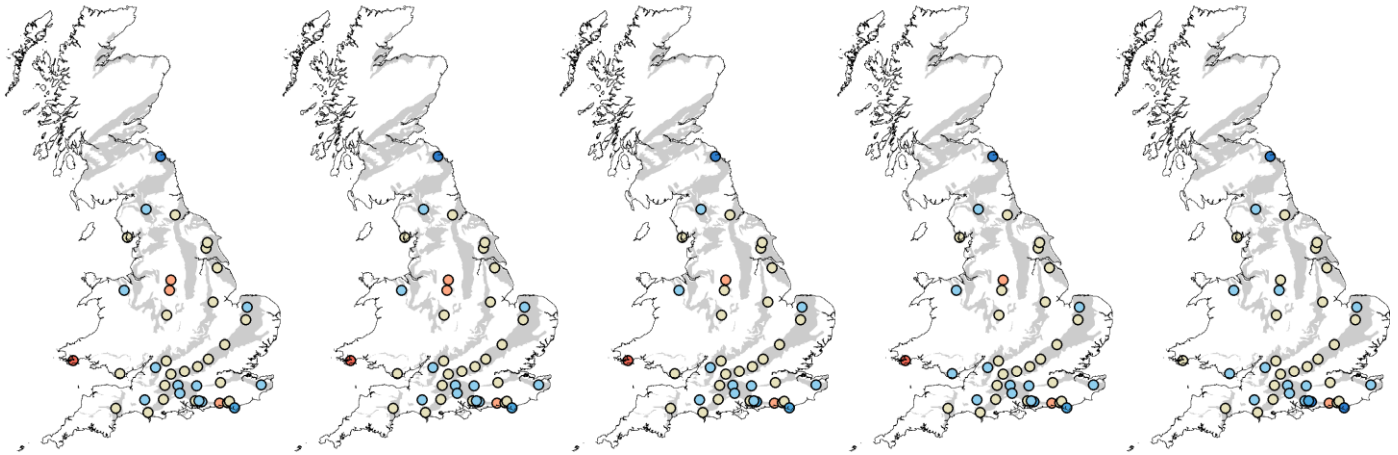
Overview

Period: September 2021 – November 2021

Issued on 08.09.2021 using data to the end of August

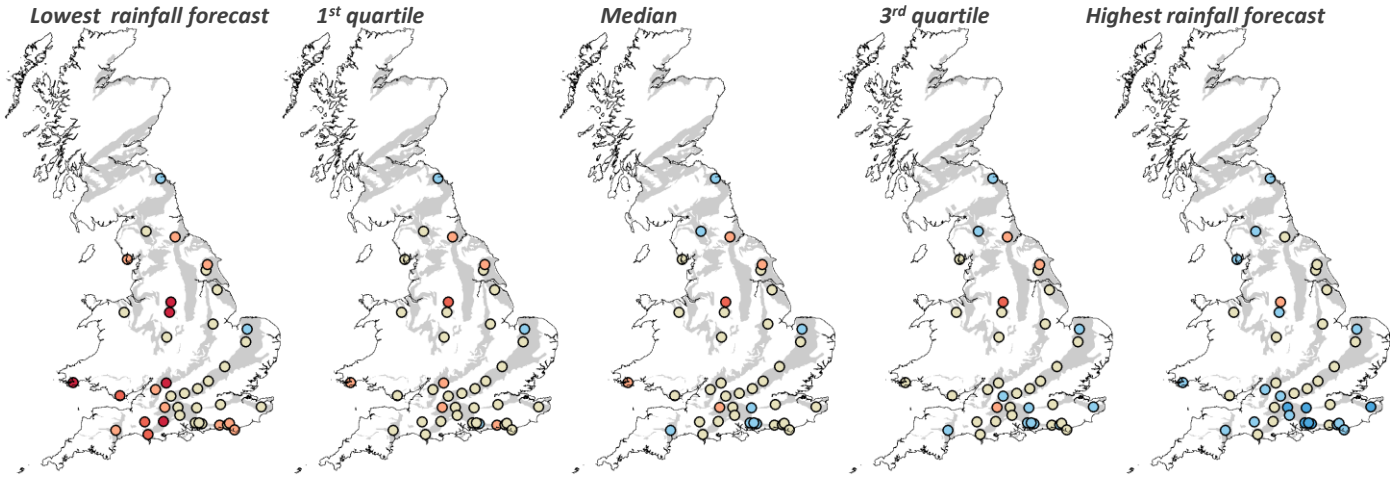
In the 1-month forecast normal to above normal groundwater levels are predicted across the Chalk of England. Elsewhere, levels are generally in this range with a few exceptions. At Greenfield Garage in south Wales notably low levels are predicted in most rainfall scenarios. Conversely, notably high levels are predicted at Royalty Observatory under all rainfall scenarios. In the 3-month forecast, the patterns remain similar, but with levels predicted to be lower across the UK. Note there are a reduced number of modelled sites. This is due to Covid-19 restrictions on access to sites in England and IT issues in Scotland.

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



1-month outlook

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

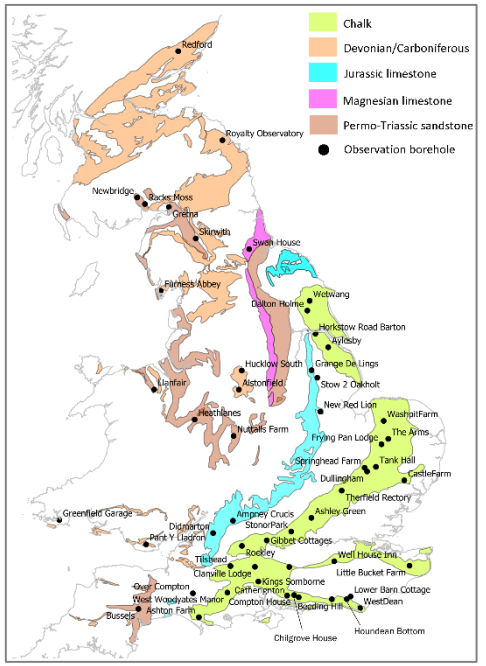


3-month outlook

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

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

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



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GROUNDWATER FROM CLIMATE FORECASTS

September 2021

UK Centre for Ecology & Hydrology

British Geological Survey

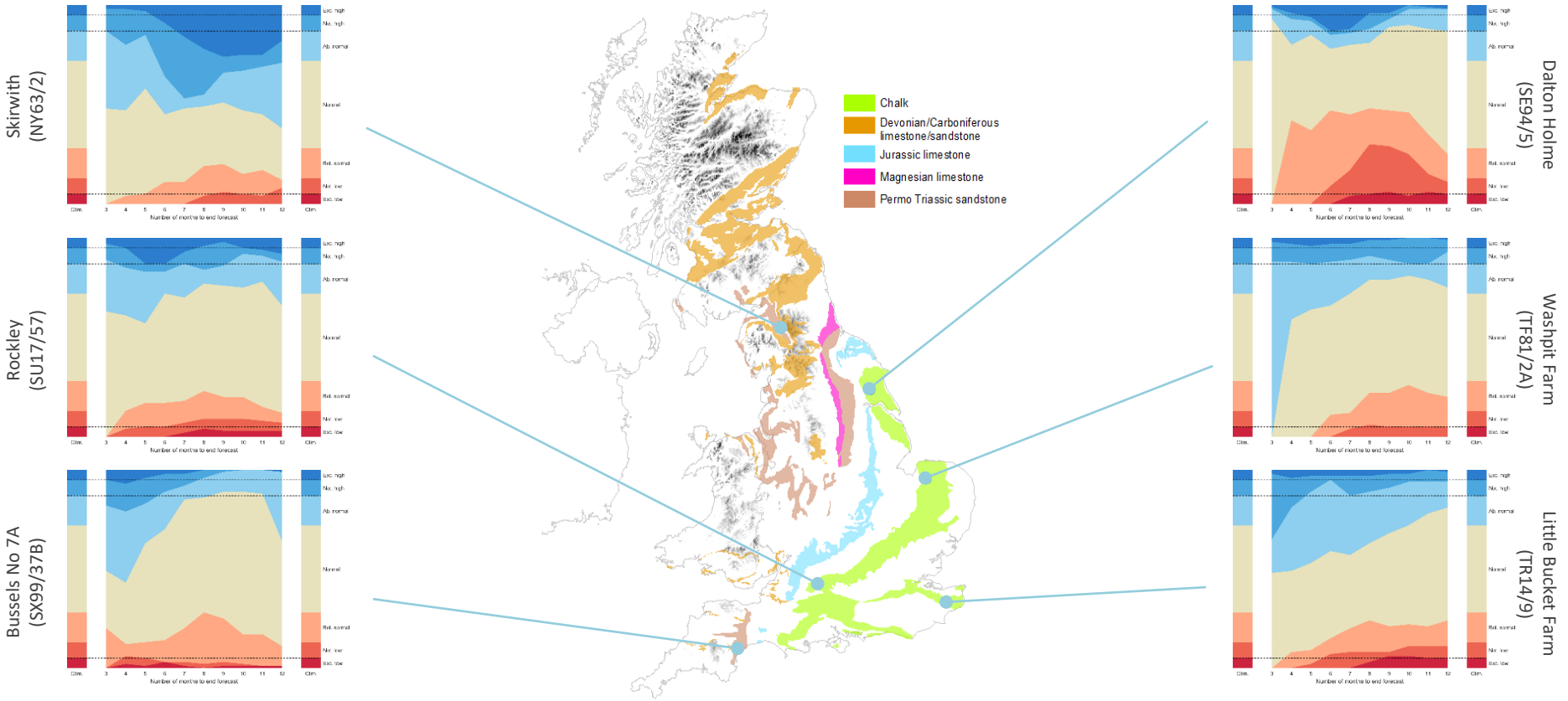
Environment Agency

Outlook based on modelled groundwater from historical climate

Period: September 2021 – August 2021

Issued on 08.09.2021 using data to the end of August

In the Chalk sites at Rockley, Washpit Farm and Little Bucket Farm the groundwater levels are predicted to be normal to above in the next 3 months, before becoming normal to below normal from 3-12 months. At Dalton Holme, normal levels are predicted in the first 3 months, then below normal levels are likely to prevail between 3-12 months. At Bussels, groundwater levels remain above normal for 5 months before returning to normal levels in 6-12 months. In the Permo-Triassic sandstone at Skirwith levels are predicted to remain normal to above normal throughout the 12-month 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.

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