UK Hydrological Outlook

Delivered in partnership by: UK Centre for Ecology & Hydrology

Period: From July 2021

Issued on 08.07.2021 using data to the end of June 2021

SUMMARY

The outlook for July and for the July–September period is for river flows to be normal to below normal for northern areas of the UK, and normal to above normal elsewhere. Groundwater levels in July, and for the next three months, are likely to be normal to above normal across most of the UK, the exception being the far south of England where normal to below normal levels are expected.

Rainfall:

June saw a reversal of the usual rainfall gradient: it was very dry across northern and western Britain, with less than a third of the typical rainfall in some areas, and very wet in south-east England, where some areas experienced twice the typical June rainfall.

The rainfall outlook for July (issued by the Met Office on 28.06.2021) suggests an increased chance of dry conditions compared to normal. Over the three month period to September, a similar picture is seen.

River flows:

River flows in June were below normal in parts of northern England, north Wales and Northern Ireland. Flows were above normal across much of southern England and parts of east Anglia.

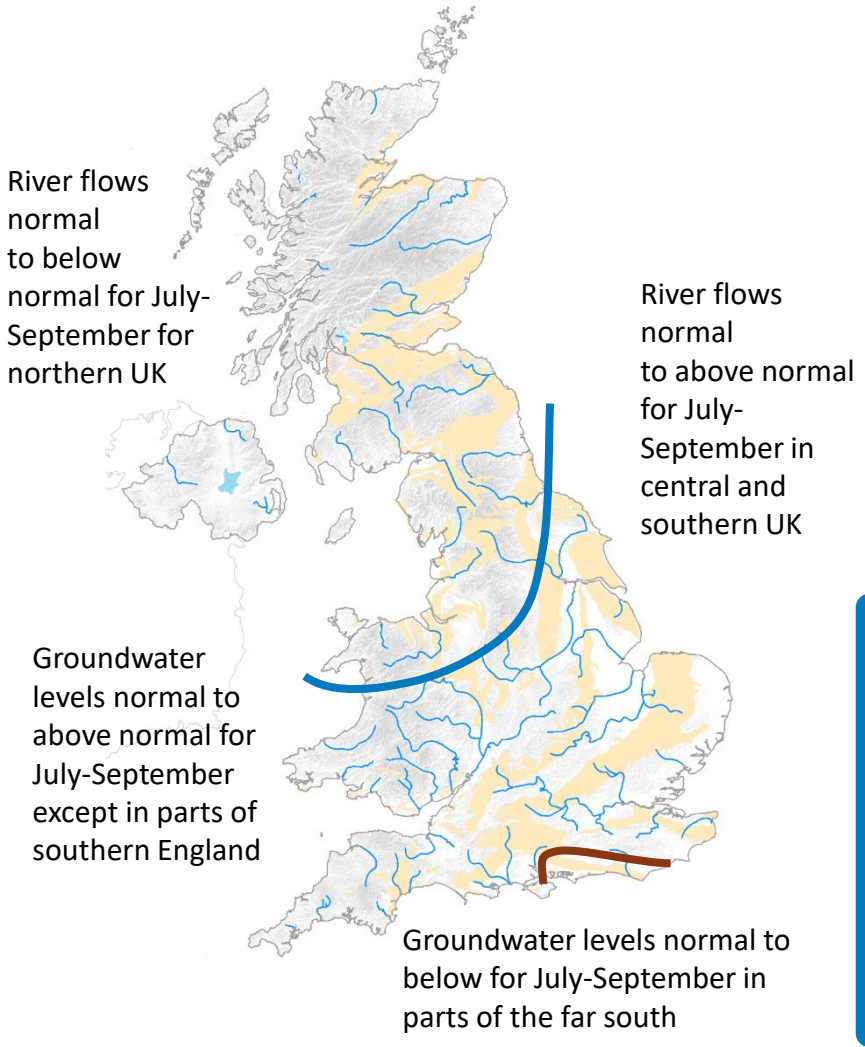
River flows in July are likely to show a similar spatial contrast to June. Normal to below normal flows are expected across northern areas, with below normal flows being most likely in parts of Scotland. Normal to above normal flows are expected elsewhere, with the highest likelihood of above normal flows being for the far south-east of England. A similar picture is seen for the June-September period, but with a higher likelihood of normal flows across the UK.

Groundwater:

Groundwater levels in June showed a mixed picture. Below normal levels in the Chalk of the far south contrasted with mostly normal to above normal levels in the Chalk further north. In most other aquifers, levels were normal to above normal.

The July outlook is broadly similar to the pattern for June. Normal to below normal levels are likely to persist in parts of the south, but elsewhere normal to above normal levels are expected. Over the three month timeframe the outlook is similar, but with levels at more locations tending towards normal.

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



Shaded areas show principal aquifers

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

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About the Hydrological Outlook:

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

Data and Models:

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

Climate forecasts are produced by the Met Office. Hydrological modelling is undertaken by UKCEH using the Grid-to-Grid, PDM and CLASSIC hydrological models and by the EA using CATCHMOD. Hydrogeological modelling uses the R-groundwater model run by BGS and CATCHMOD run by the EA. Supporting documentation is available from the Outlooks website:
http://www.hydoutuk.net/methods

Presentation:

The language used in the summary presented overleaf generally places flows and groundwater levels into just three classes, i.e. below normal, normal, and above normal. However, the underpinning methods use as many as seven classes as defined in the graphic to the right, i.e. the summary uses a simpler classification than some of the methods. On those occasions when it is appropriate to provide greater discrimination at the extremes the terminology and definitions of the seven class scheme will be adopted.

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

Disclaimer and liability:

The Hydrological Outlook partnership aims to ensure that all Content provided is accurate and consistent with its current scientific understanding. However, the science which underlies hydrological and hydrogeological forecasts and climate projections is constantly evolving. Therefore any element of the Content which involves a forecast or a prediction should not be relied upon as though it were a statement of fact. To the fullest extent permitted by applicable law, the Hydrological Outlook Partnership excludes all warranties or representations (express or implied) in respect of the Content.

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From April 2018 the Hydrological Outlook is supported by the Natural Environment Research Council funded UK-SCAPE and Hydro-JULES Programmes.

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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, April, UK Centre for Ecology and Hydrology, Oxfordshire UK, Online,
http://www.hydoutuk.net/latest-outlook/

Other Sources of Information:

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

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

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

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

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

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

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

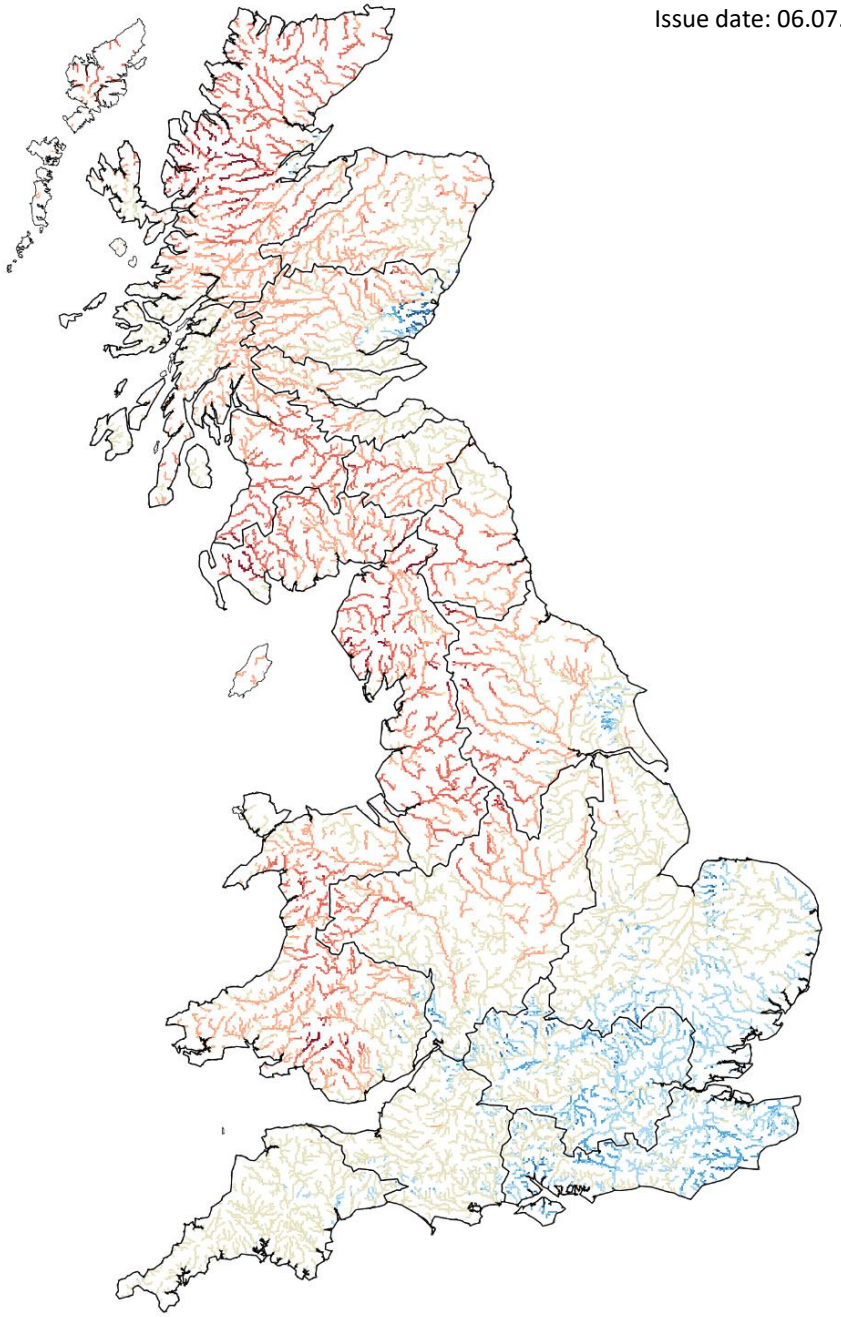
Period: June 2021

Issue date: 06.07.2021

The 1km resolution Grid-to-Grid (G2G) hydrological model is run up to the forecast origin with observed rainfall and potential evaporation to provide the hydrological initial condition for the HOUK seasonal river flow forecasts.

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

Note that the G2G 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

OUTLOOK BASED ON CURRENT CONDITIONS

July 2021

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UK Centre for Ecology & Hydrology

Current Daily Simulated Subsurface Water Storage Conditions

Based on subsurface water storage estimated for 30th June 2021

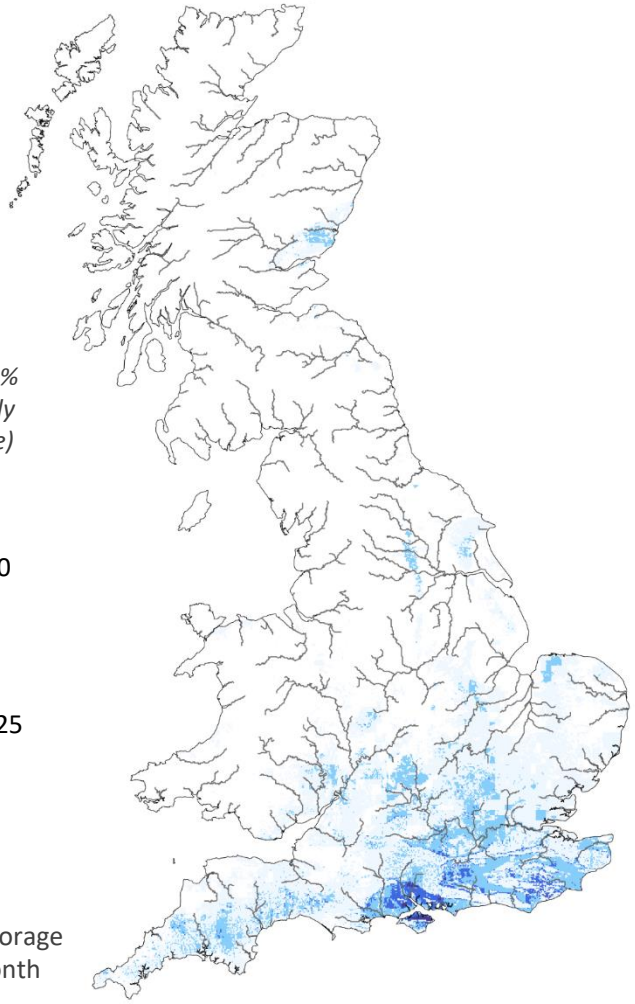
Issue date: 06.07.2021

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

These maps do not provide a flood forecast and are not maps of soil moisture. Instead they indicate areas where subsurface water storage approaches or exceeds its historical maximum. Rainfall in the high 'relative wetness' areas could result in flooding.

SUMMARY: At the end of June, subsurface water levels were higher than average for this time of year across southern England with low to medium relative wetness.

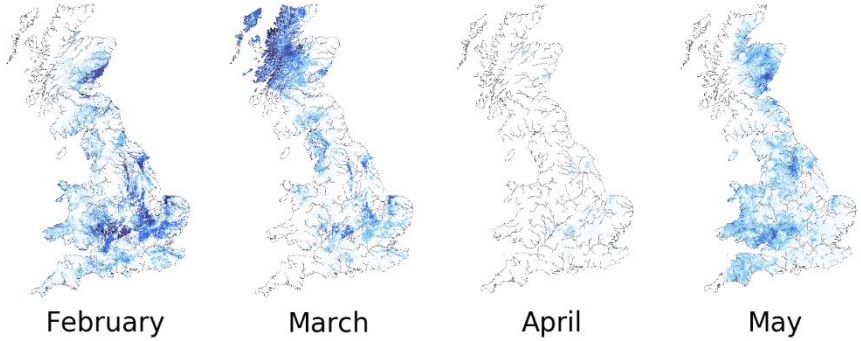
Relative Wetness

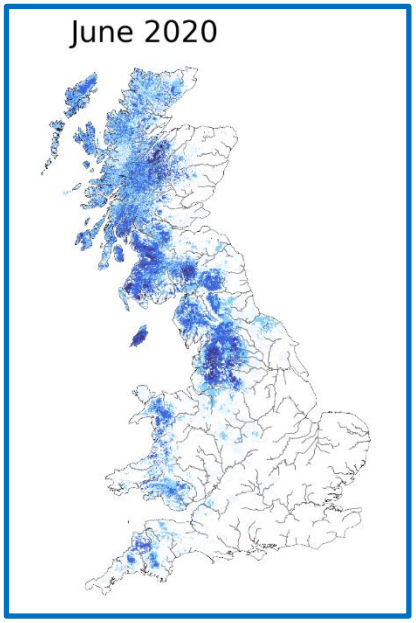


Water storage anomaly as a % of maximum storage anomaly (zero indicates average value)

High (very wet)	>100
	75-100
Medium	50-75
	25-50
Low	0.01-25
(No wetness)	<0
Main rivers	

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





*Example month displaying extreme relative wetness

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July 2021

UK Centre for Ecology & Hydrology

Current Daily Simulated Subsurface Water Storage Conditions

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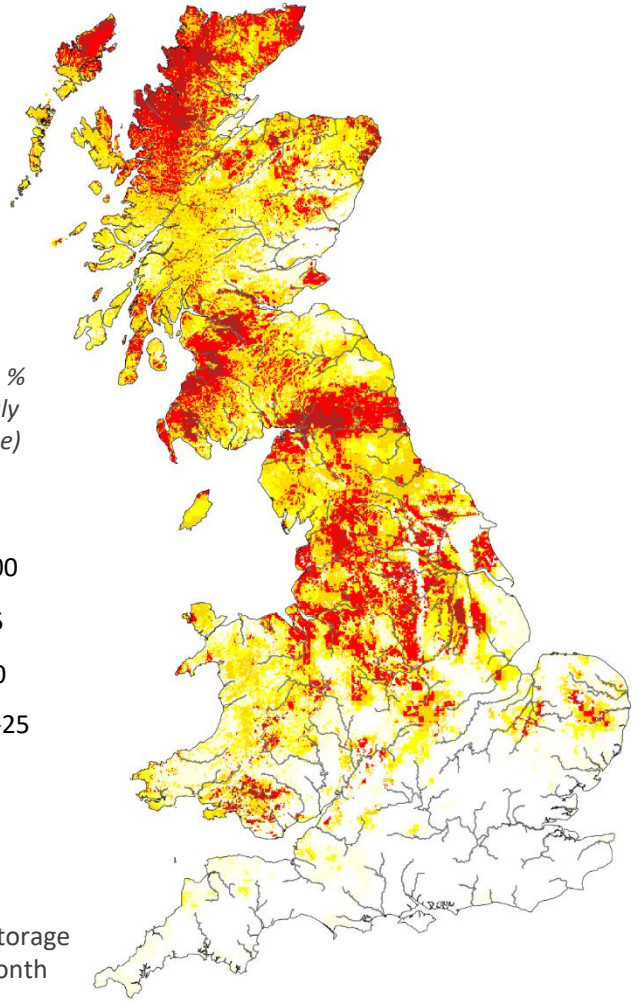
These maps do not provide a drought forecast and are not maps of soil moisture. Instead they indicate areas where subsurface water storage approaches or exceeds its historical minimum. A lack of rainfall in the high 'relative dryness' areas could lead to (or prolong) a drought.

SUMMARY: At the end of June, subsurface water levels were drier than normal for this time of year in much of Wales and Scotland, northern England and some areas across central England.

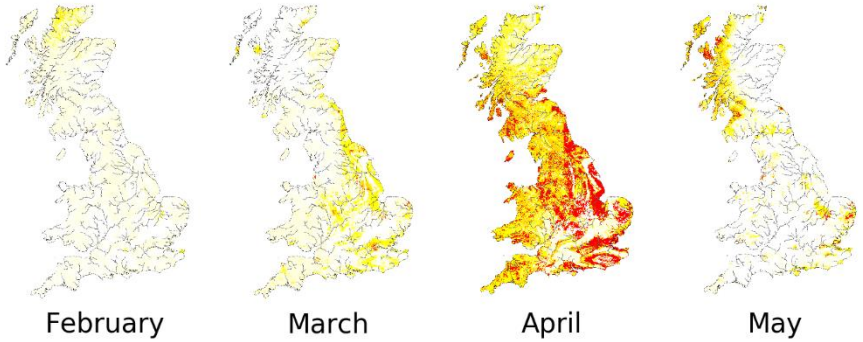
Relative Dryness

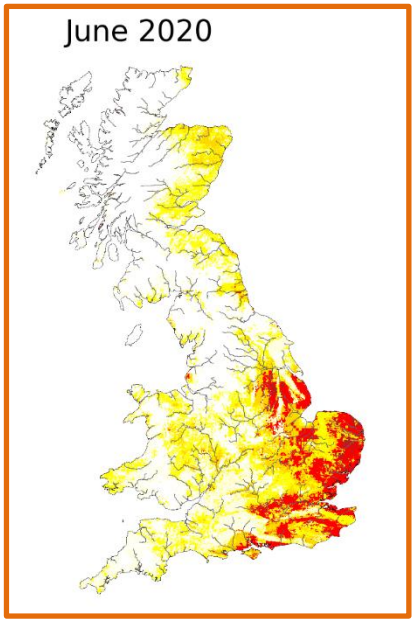


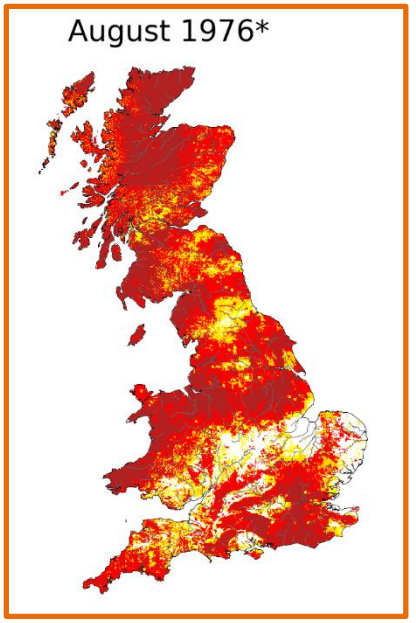
Water storage anomaly as a % of minimum storage anomaly (zero indicates average value)

High (very dry)	>100
	75-100
Medium	50-75
	25-50
Low	0.01-25
(No dryness)	<0
Main rivers	

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







*Example month displaying extreme relative dryness

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OUTLOOK BASED ON CURRENT CONDITIONS

July 2021

UK Centre for Ecology & Hydrology

Current Daily Simulated Subsurface Water Storage Conditions

OUTLOOK BASED ON CURRENT CONDITIONS

Relative Dryness

- The relative dryness map highlights areas where current estimates of **subsurface water storage** (from the G2G hydrological model, calculated for the last day of last month) are particularly ***low***.
- The map indicates areas where the ground is dry compared to the monthly **average** storage (for the period 1981 to 2010), and shows this relative to the historical **minimum** storage level (for 1971 to 2010).
- Relative dryness calculation: $R_d\,(\%) = \frac{(S_{average} - S)}{(S_{average} - S_{min})} \times 100$

  $= \frac{\text{(average storage for this month - storage at end of last month)}}{\text{(average storage for this month - historical minimum storage)}} \times 100$
- A value of $\boldsymbol{R_d = 100}$ shows that a region is very dry, and indicates that the storage is as low as the minimum value ever estimated by the model for this month.
- A value of $\boldsymbol{R_d = 0}$ indicates that the storage in the region matches the monthly average value. *Negative relative dryness values will show up as part of the relative wetness map.*
- The map **does not provide a drought forecast**. A lack of rainfall in the high 'relative dryness' areas **could** lead to (or prolong) a drought.

Relative Wetness

- The relative wetness map highlights areas where current estimates of **subsurface water storage** (from the G2G hydrological model, calculated for the last day of last month) are particularly ***high***.
- The map indicates areas where the ground is wet compared to the monthly **average** storage (for the period 1981 to 2010), and shows this relative to the historical **maximum** storage level (for 1971 to 2010).
- Relative wetness calculation: $R_w\,(\%) = \frac{(S - S_{average})}{(S_{max} - S_{average})} \times 100$

  $= \frac{\text{(storage at end of last month - average storage for this month)}}{\text{(historical maximum storage - average storage for this month)}} \times 100$
- A value of $\boldsymbol{R_w = 100}$ shows that a region is very wet, and indicates that the storage is as high as the maximum value ever estimated by the model for this month.
- A value of $\boldsymbol{R_w = 0}$ indicates that the storage in the region matches the monthly average value. *Negative relative wetness values will show up as part of the relative dryness map.*
- The map **does not provide a flood forecast**. Rainfall in the high 'relative wetness' areas **could** result in flooding.

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Return Period of Rainfall Required to Overcome Dry Conditions

Period: July 2021 – December 2021

Issue date: 06.07.2021

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 July to December, Great Britain will not require particularly unusual rainfall (<5 year return periods) to return to average conditions for the time of year.

Jul

Aug

Sep

Oct

Nov

Dec

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

July 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.

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Estimate of Additional Rainfall Required to Overcome Dry Conditions

Based on subsurface water storage estimated for 30th June 2021

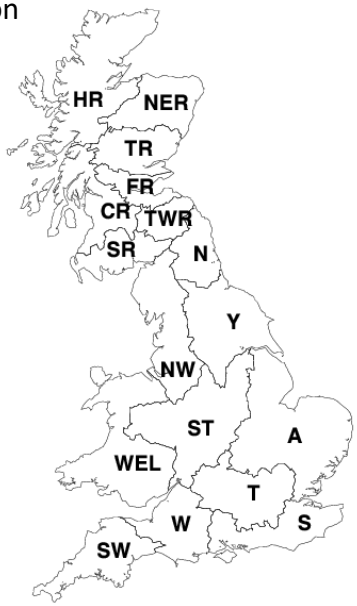
Issue date: 06.07.2021

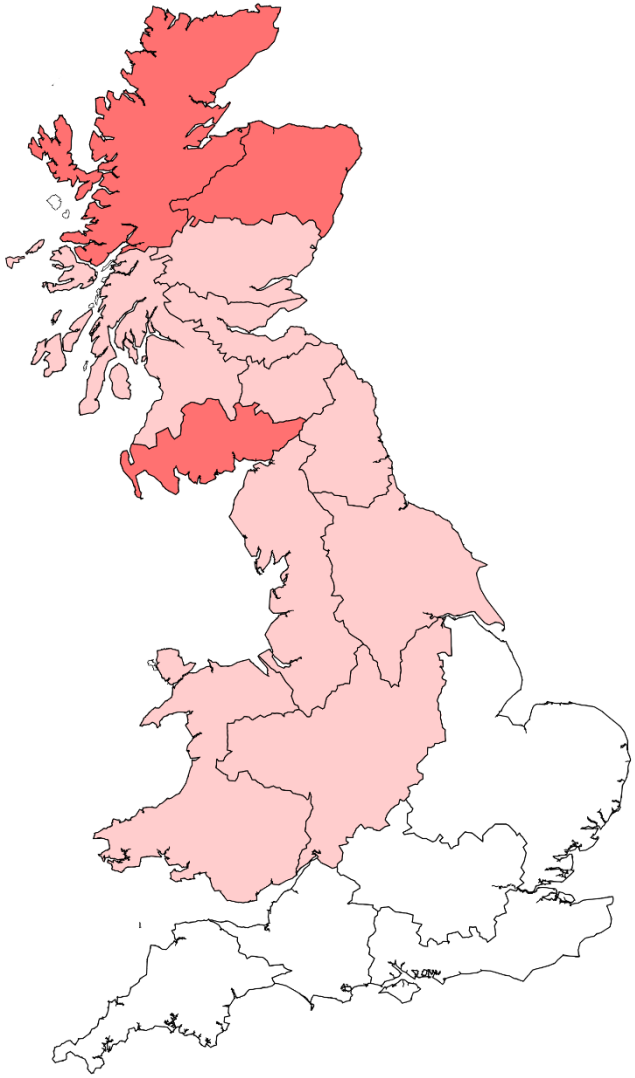
These maps show the Grid-to-Grid (G2G) hydrological model simulated subsurface water storage, expressed as an anomaly from the historical monthly mean (1981-2010), presented on a 1km grid and as regional means.
Subsurface storage deficits, i.e. where the subsurface water storage anomaly is less than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

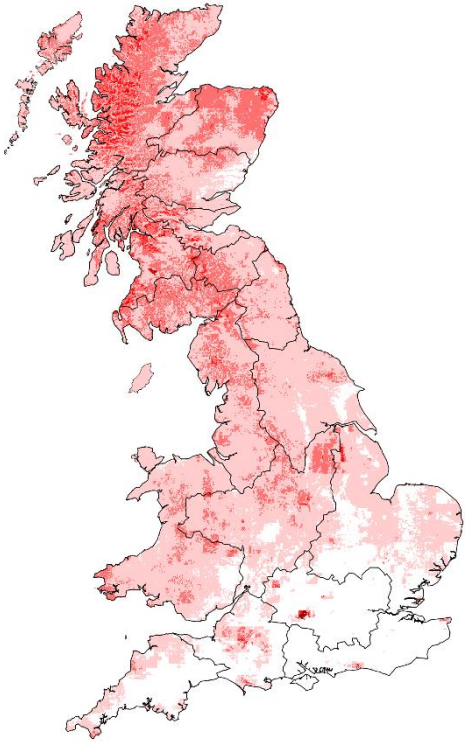
The **subsurface storage deficit (mm)** can be interpreted as an estimate of additional rainfall that would be required in future months to overcome dry conditions (i.e. rainfall in addition to what is expected on average). Regional mean values of additional rainfall required are provided in the table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

Regional estimate of additional rainfall required (mm)

	SCOTLAND	
29	HR	Highlands Region
25	NER	North East Region
12	TR	Tay Region
20	FR	Forth Region
25	CR	Clyde Region
23	TWR	Tweed Region
26	SR	Solway Region
	ENGLAND	
14	N	Northumbria
20	NW	North West
9	Y	Yorkshire
10	ST	Severn Trent
0	A	Anglian
0	T	Thames
0	W	Wessex
0	S	Southern
0	SW	South West
	WALES	
12	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

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Outlook based on hydrological persistence and analogy

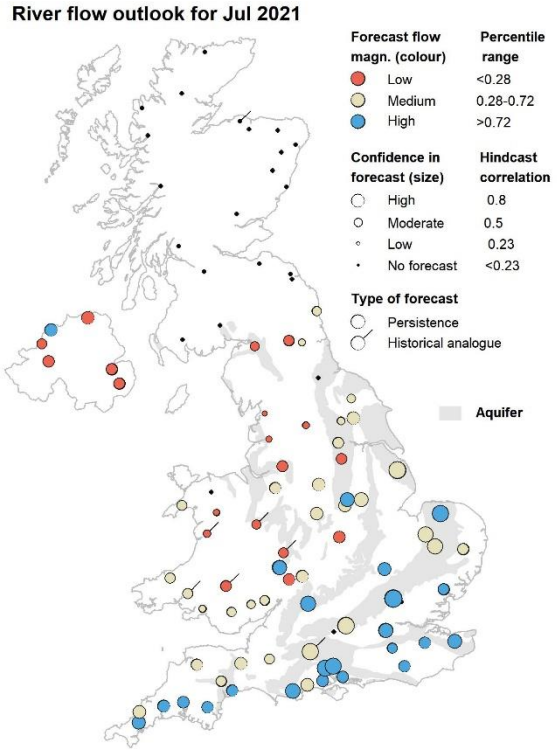
Overview

Period: July – September 2021

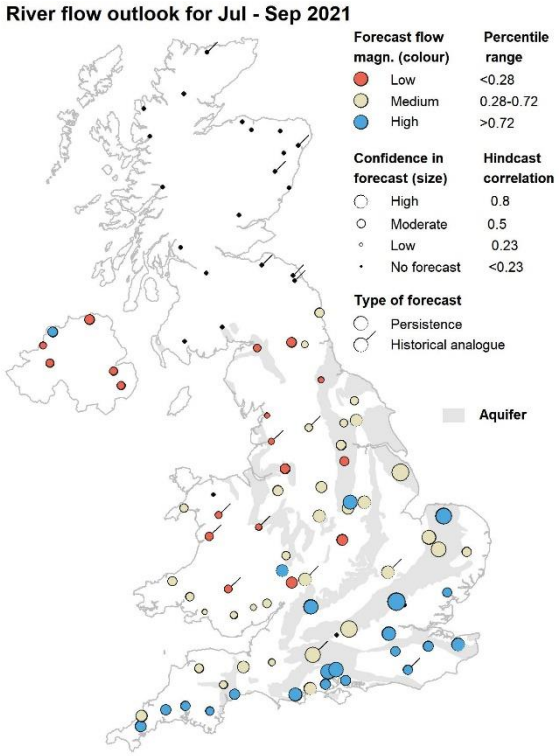
Issued on 06.07.2021 using data to the end of June 2021

SUMMARY

The outlooks for July and for July-September are for normal to above normal flows in south and south-east England. Elsewhere flows are likely to be normal to below normal. 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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Outlook based on hydrological persistence and analogy

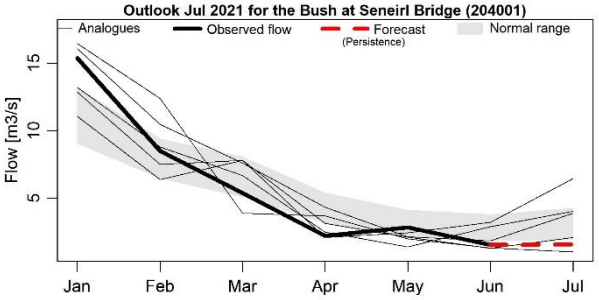
Site-based: 1 month outlook

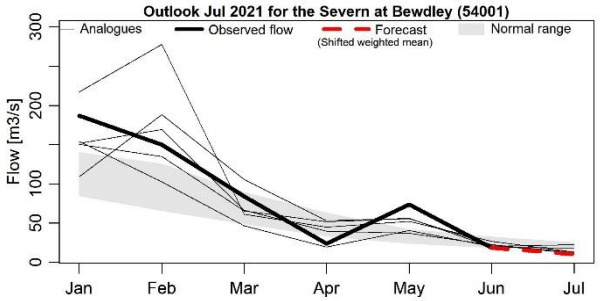
Period: July 2021

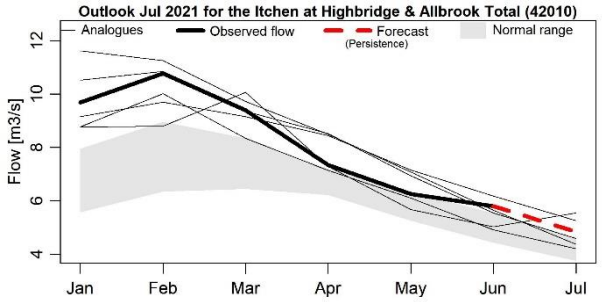
Issued on 06.07.2021 using data to the end of June 2021

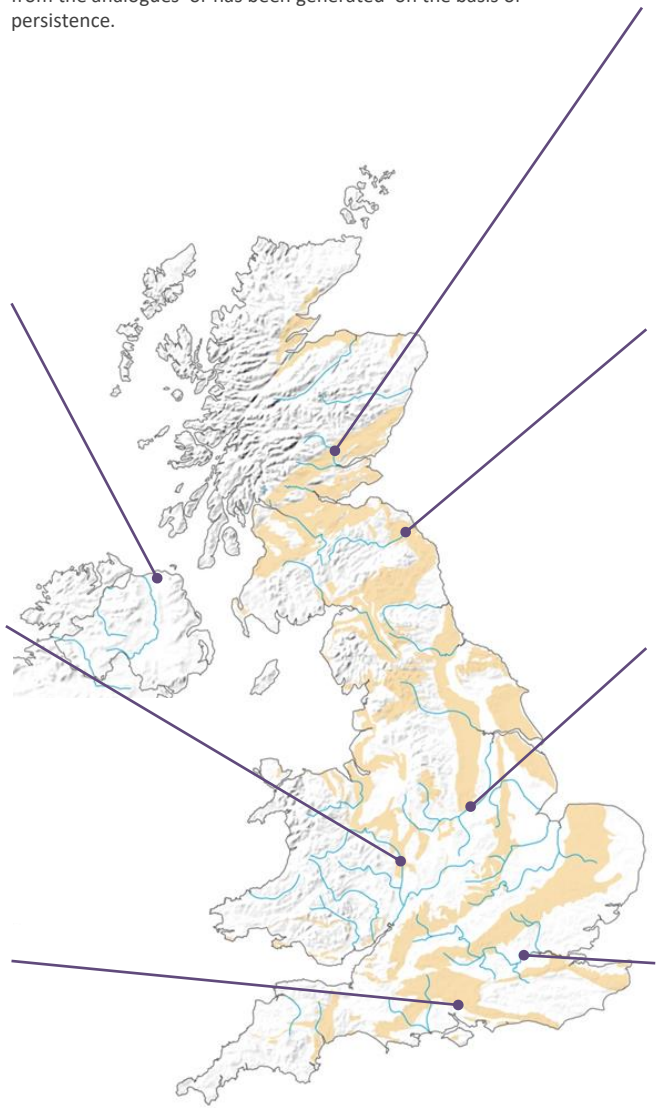
These figures provide insight into the hydrological analogue methodology for a set of sites from across the UK.

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.



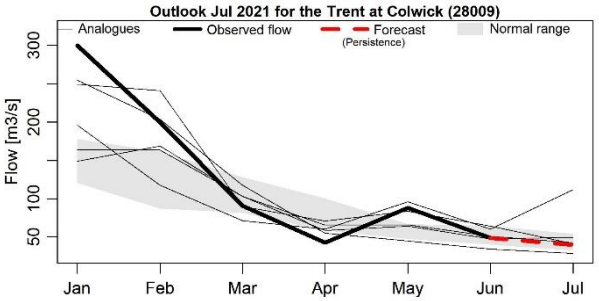


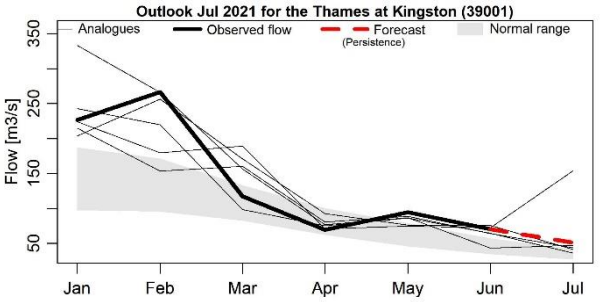




No forecast available

No forecast available





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RIVER FLOW ANALOGY

July 2021

UK Centre for Ecology & Hydrology

Outlook based on hydrological persistence and analogy

Site-based: 3 month outlook

Period: July – September 2021

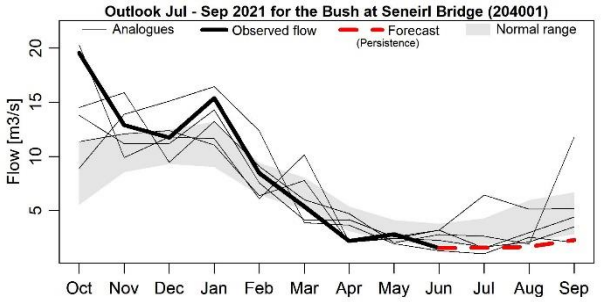
Issued on 06.07.2021 using data to the end of June 2021

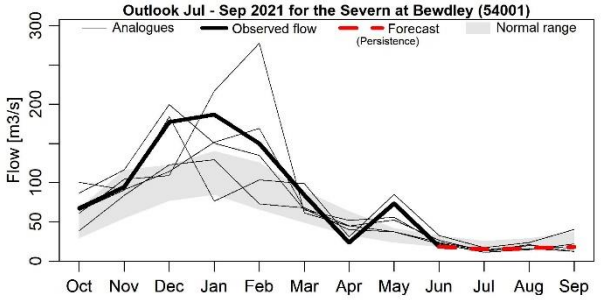
RIVER FLOW ANALOGY

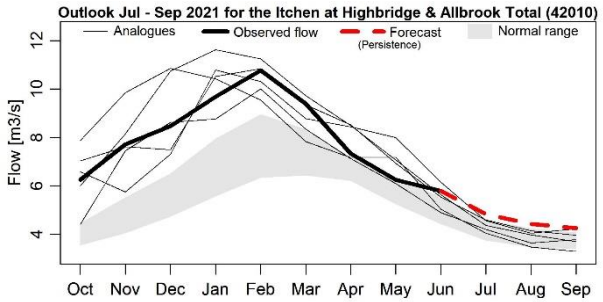
July 2021

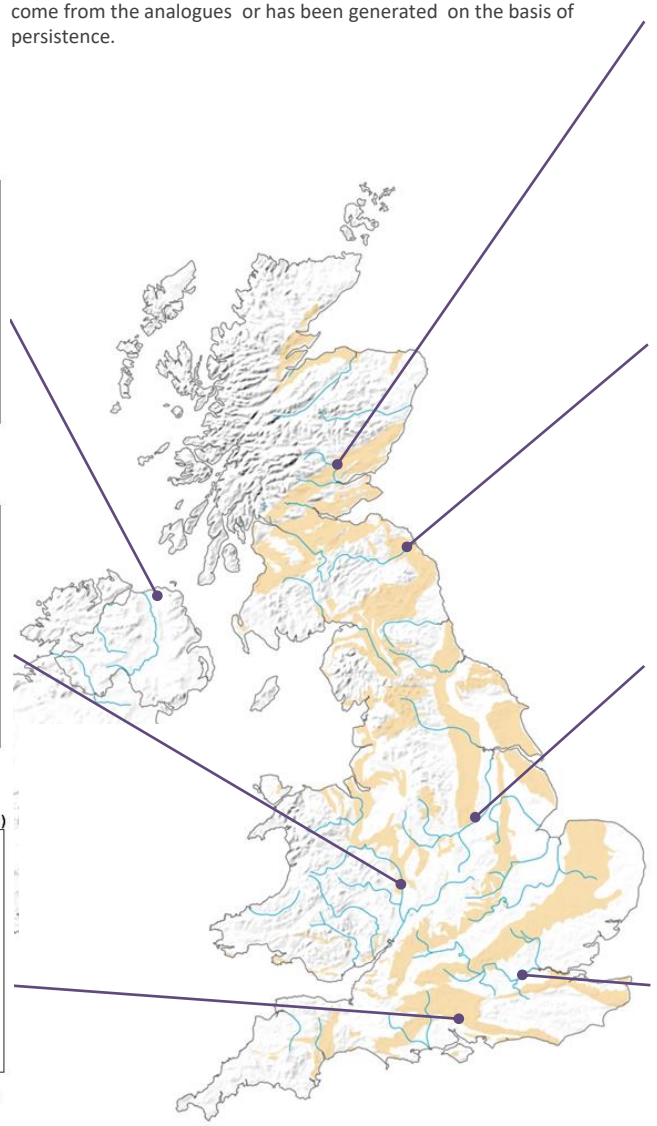
These figures provide insight into the hydrological analogue methodology for a set of sites from across the UK.

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









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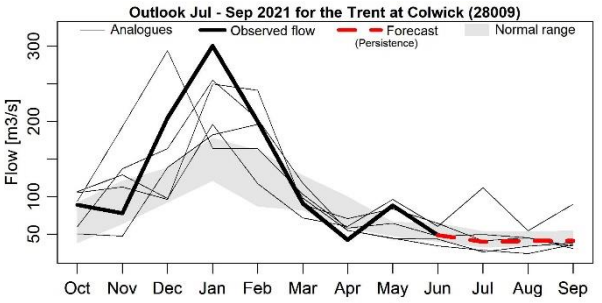

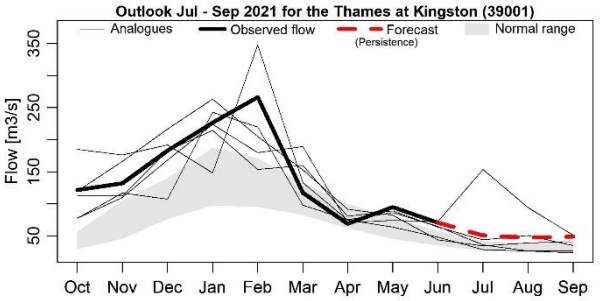

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UK Centre for Ecology & Hydrology

British Geological Survey

Environment Agency

Outlook based on modelled flow from historical climate

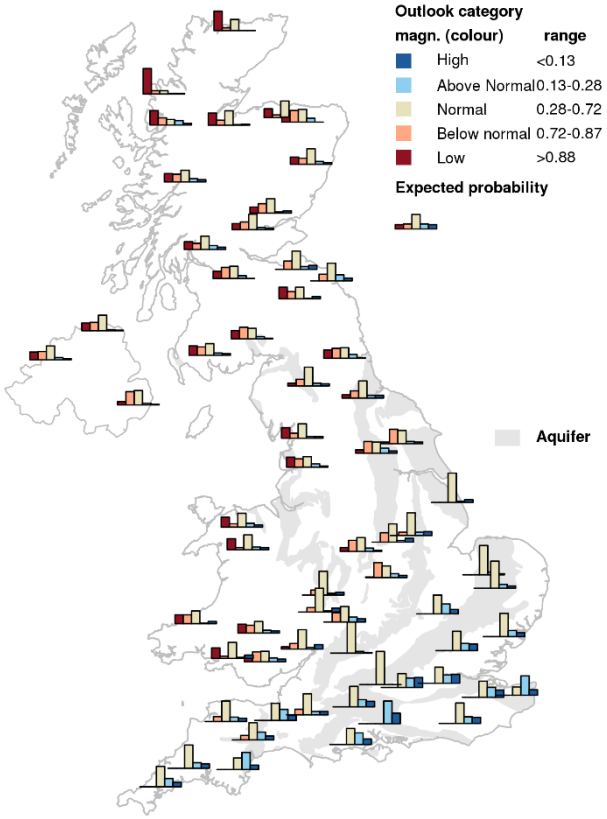
Overview

Period: July 2021 – December 2021

Issued on 05.07.2021 using data to the end of June 2021

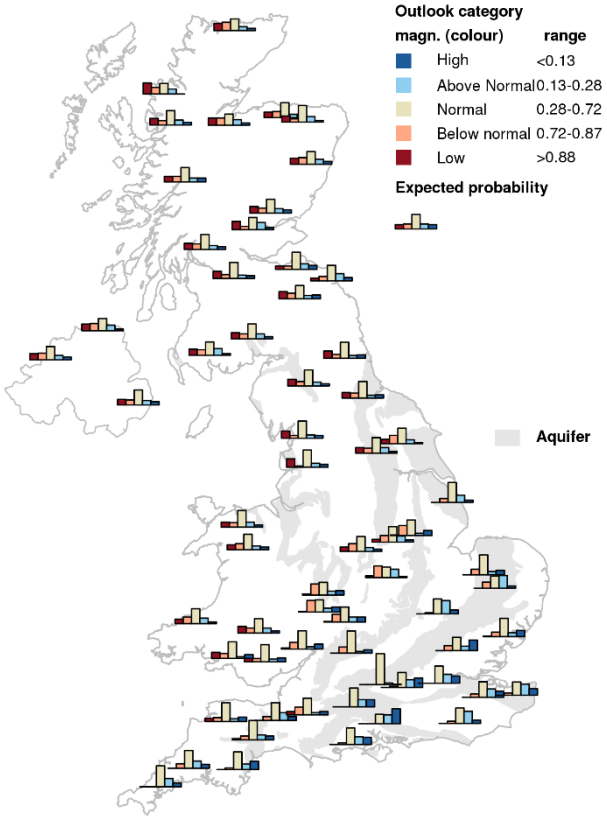
The outlook for July presents a polarised picture. In the south and southeast of England flows are expected to be normal to above normal in the 1 month outlook. For the rest of the UK, flows are expected to be normal to below normal and flows in northern Scotland expected to be below normal to low. This pattern is expected to persist in the 3-month outlook, although flows are gradually returning to within the normal range.

1-month river flow outlook starting Jul 2021



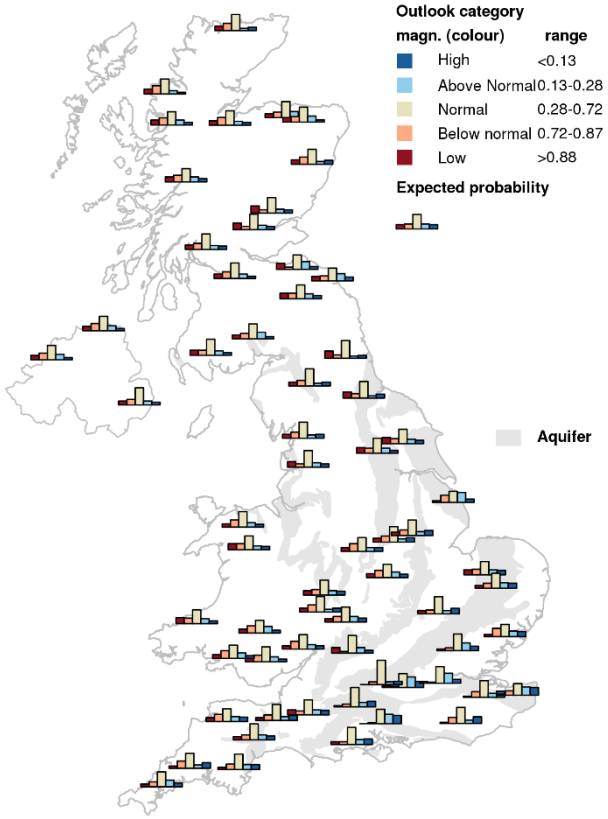
This outlook is based on monthly ensembles of historical sequences of observed climate (rainfall and potential evapotranspiration) that form input to a hydrological model. The outputs are probabilistic simulations of the average river flow over the forecast period (1 to 12 months ahead), at each location.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

July 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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UK Centre for Ecology & Hydrology

Outlook Based on Modelled Flow from Rainfall Forecasts

Overview

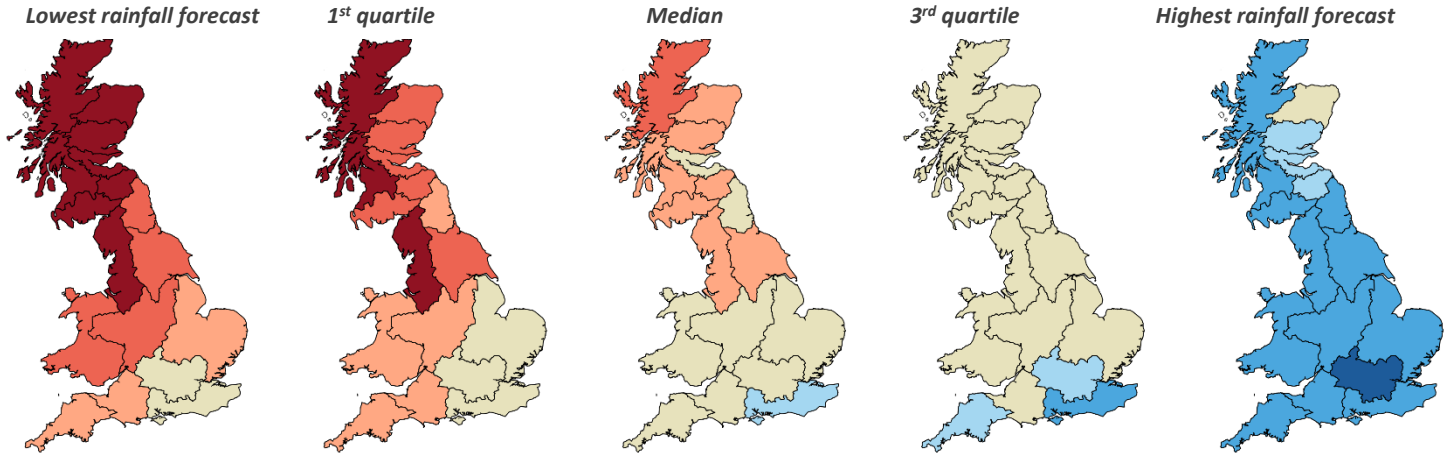
Period: July 2021 – September 2021

Issued on 06.07.2021 using data to the end of June

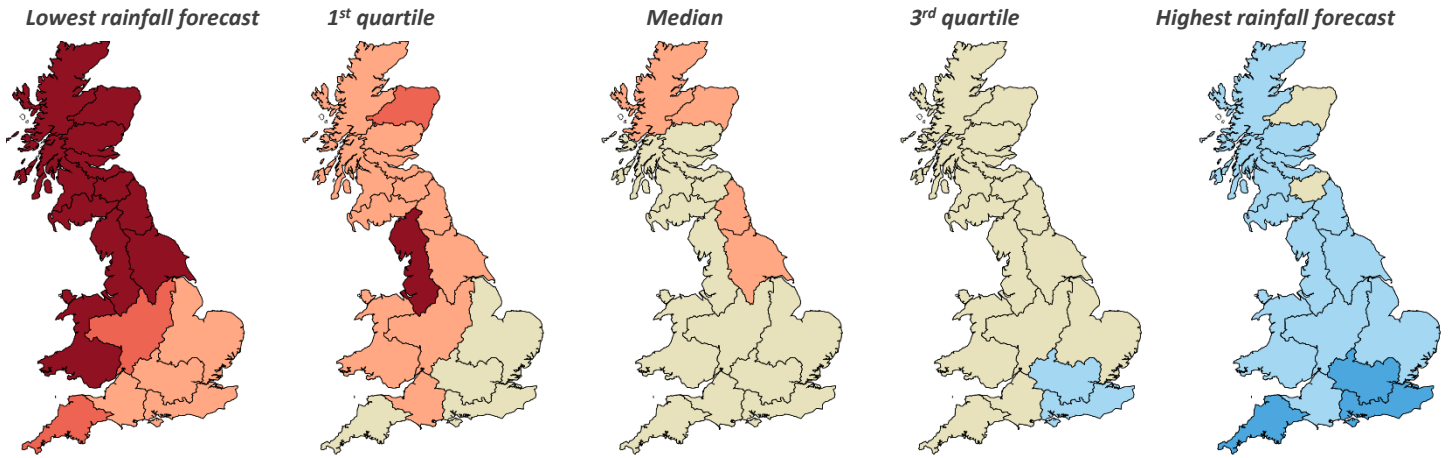
SUMMARY: During July river flows in Scotland and in the North West region are most likely to be in the *Normal range* or below. For the Highlands and Clyde Regions there is a high chance of exceptionally low flows. River flows for the rest of England are likely to be in the *Normal range* with the exception of the Thames and Southern regions which are most likely to be in the *Normal range* or above.

Over the next 3 months river flows across the north and west are most likely to be in the *Normal range* or below, whilst river flows in the south and east are more likely to be in the *Normal range* or above.

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

July 2021

UK Centre for Ecology & Hydrology

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

Period: July 2021 – September 2021

Issue date: 06.07.2021

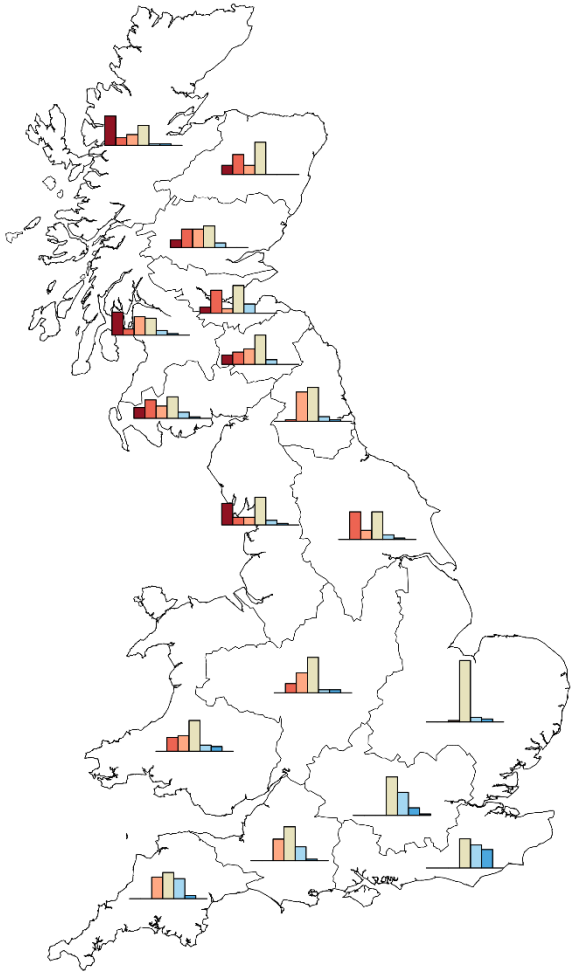
The regional maps illustrating the regional river flows for five members of the Met Office ensemble of rainfall forecasts give some indication of the range of possible river flows in the coming months. As noted previously, the actual flows could be more extreme than the flows generated by either the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

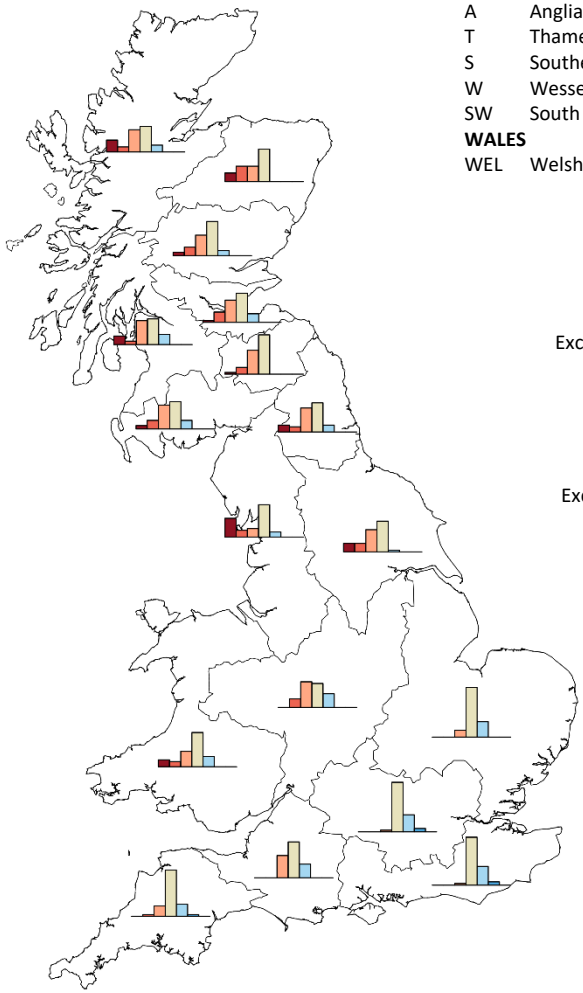
SUMMARY: During July river flows in Scotland and in the North West region are most likely to be in the *Normal range* or below. For the Highlands and Clyde Regions there is a high chance of exceptionally low flows. River flows for the rest of England are likely to be in the *Normal range* with the exception of the Thames and Southern regions which are most likely to be in the *Normal range* or above.

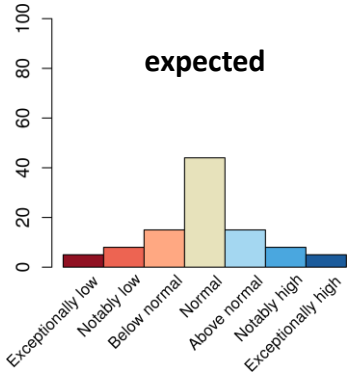
Over the next 3 months river flows across the north and west are most likely to be in the *Normal range* or below, whilst river flows in the south and east are more likely to be in the *Normal range* or above.

1-month



3-month





SCOTLAND

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ENGLAND

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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
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Notably low flow	5-13
Exceptionally low flow	< 5

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RIVER FLOW FROM RAINFALL FORECASTS

July 2021

UK Centre for Ecology & Hydrology

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

Period: July 2021 – September 2021

Issue date: 06.07.2021

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

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

SUMMARY: During July river flows in Scotland and in the North West region are most likely to be in the *Normal range* or below. For the Highlands and Clyde Regions there is a high chance of exceptionally low flows. River flows for the rest of England are likely to be in the *Normal range* with the exception of the Thames and Southern regions which are most likely to be in the *Normal range* or above.

Over the next 3 months river flows across the north and west are most likely to be in the *Normal range* or below, whilst river flows in the south and east are more likely to be in the *Normal range* or above.

SCOTLAND

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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	2	0	0	0	0	0	0	0	0	0	0
Notably high flow	4	2	2	4	4	26	11	7	2	2	2	0	2	0	2	0	0
Above normal	7	7	7	4	28	33	33	9	20	7	7	13	2	0	9	7	7
Normal range	87	39	48	50	37	41	54	43	48	39	24	39	28	46	30	30	41
Below normal	2	11	41	28	30	0	0	22	30	13	26	7	15	13	17	26	22
Notably low flow	0	11	2	13	0	0	0	20	0	39	9	33	11	28	26	26	17
Exceptionally low flow	0	30	0	0	0	0	0	0	0	0	33	9	41	13	15	11	13

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	2	5	5	0	0	0	0	0	0	0	0	0	0
Above normal	21	7	10	19	17	26	24	14	19	2	14	12	10	0	12	7	0
Normal range	69	45	40	33	64	67	69	48	50	43	36	40	36	45	38	48	55
Below normal	10	12	33	36	14	2	2	21	31	31	33	31	31	21	33	29	33
Notably low flow	0	10	7	12	2	0	0	7	0	12	5	14	7	21	12	12	10
Exceptionally low flow	0	26	10	0	0	0	0	10	0	12	12	2	17	12	5	5	2

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Outlook based on modelled groundwater level & climate forecast

Overview

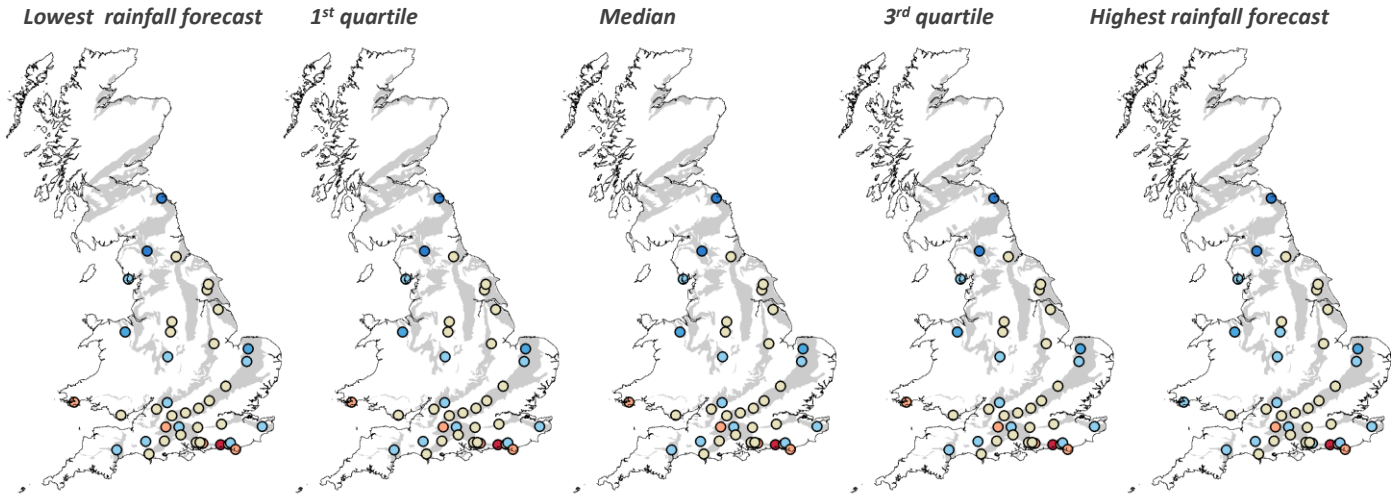
Period: July 2021 – September 2021

Issued on 07.07.2021 using data to the end of June

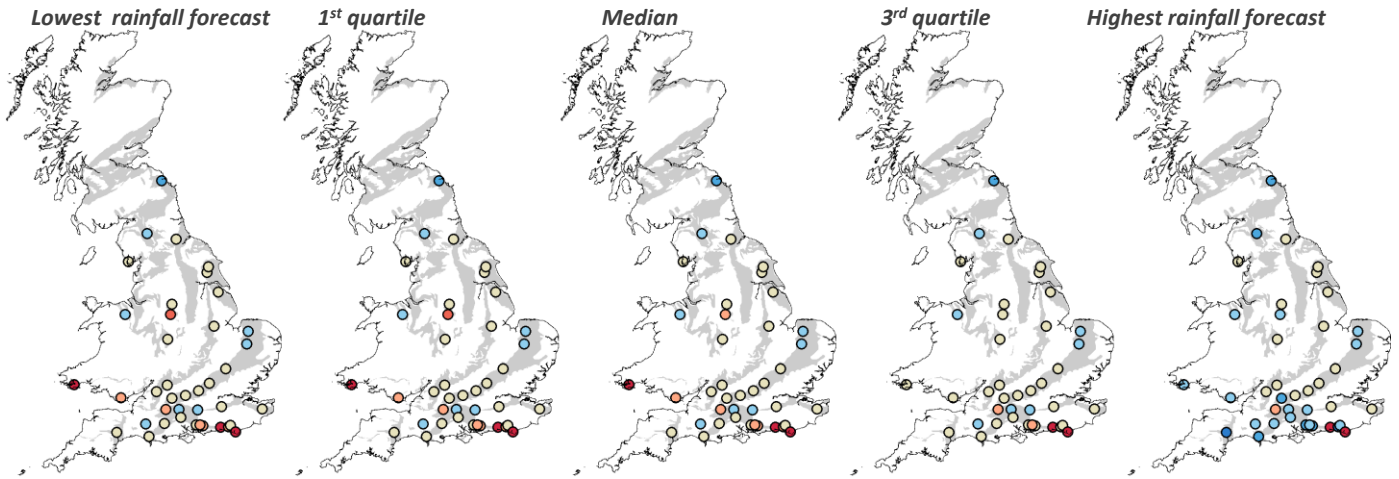
In the 1-month forecast, normal to above normal levels are predicted at most sites in central England and the Chalk of the South-West, with more normal levels predicted at many sites over three months. At some Chalk sites in the south of England, below normal to exceptionally low levels are predicted across all rainfall scenarios in both the 1- and 3-month forecasts. Over the next month, levels at Chalk sites in East Anglia are predicted to be above normal to notably high, and remain above normal over three months. In the Permo-Triassic and Devonian/Carboniferous aquifers in the north of England and northern Wales, above normal to exceptionally high levels prevail over one month, with normal to notably high levels over three months. 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.

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.

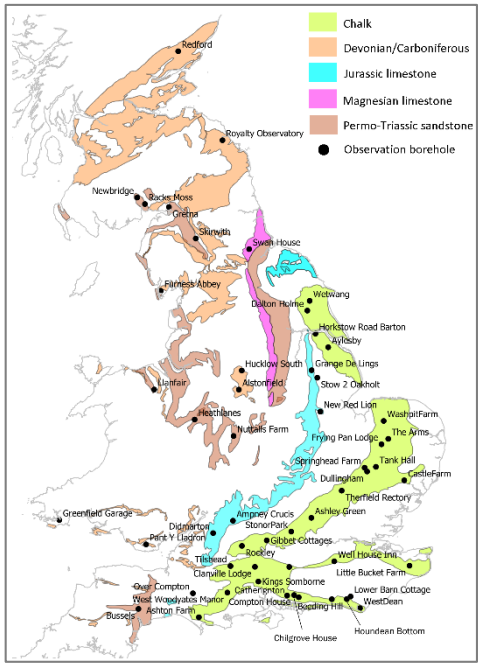


1-month outlook



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
Below normal	12-28
Notably low levels	5-13
Exceptionally low levels	< 5



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GROUNDWATER FROM CLIMATE FORECASTS

July 2021

UK Centre for Ecology & Hydrology

British Geological Survey

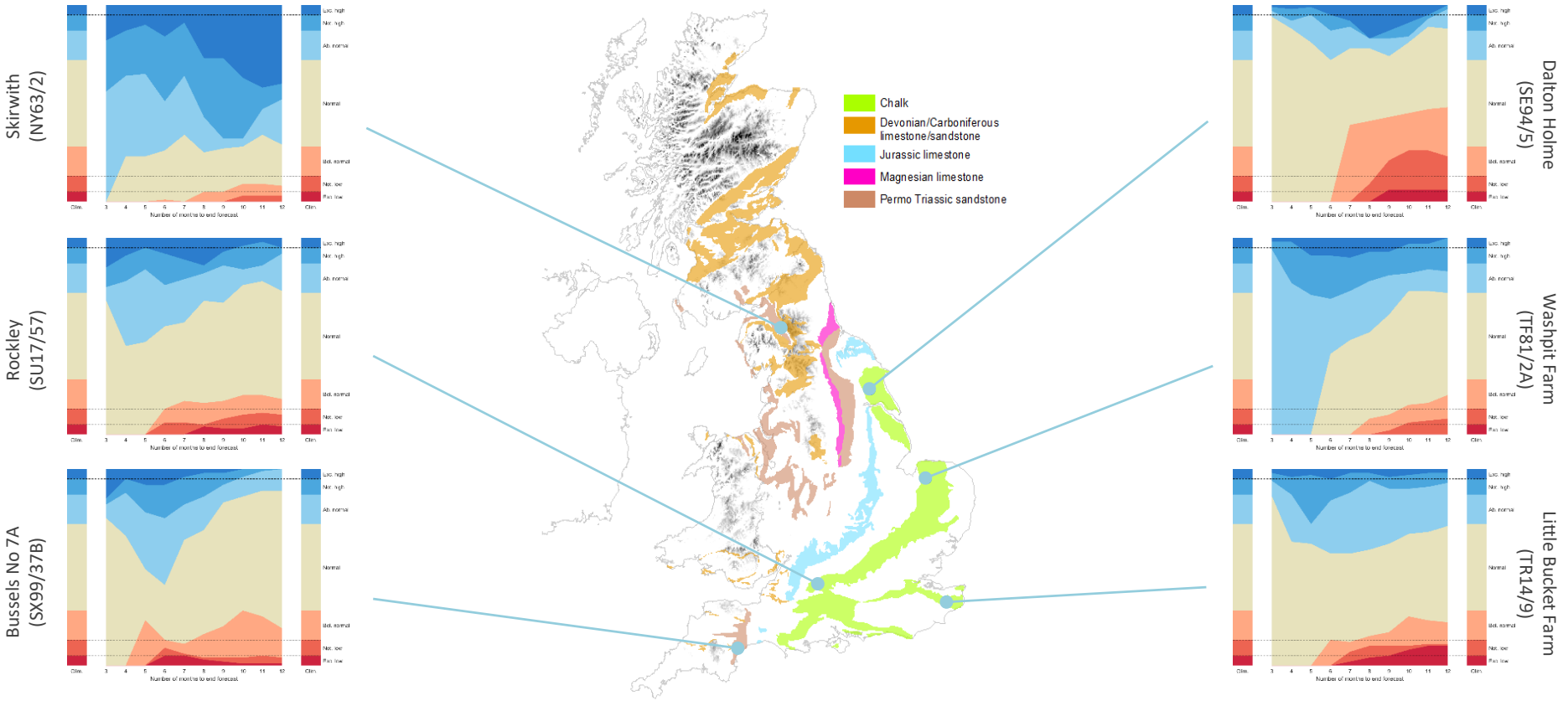
Environment Agency

Outlook based on modelled groundwater from historical climate

Period: July 2021 – June 2021

Issued on 07.07.2021 using data to the end of June

Groundwater levels at the Rockley, Dalton Holme and Little Bucket Farm in the Chalk and at Bussels in the Permo-Triassic sandstone are predicted to return to normal over the next 6 months. At Dalton Holme, levels are predicted to be normal to below normal over 6 to 12 months. In the Permo-Triassic sandstone at Skirwith and in the Chalk at Washpit Farm levels are predicted to remain above normal to exceptionally high for at least 6 months before tending towards normal from 6 to 12 months.



This outlook is based on monthly ensembles of historical sequences of observed climate (rainfall and potential evpotranspiration) that form input to hydrological models. The outputs are probabilistic simulations of the average groundwater level over the forecast horizon (3 to 12 months ahead), at each location.

The graphs show variation over time of the number of simulated groundwater levels in each monthly ensemble, that fall within each the seven categories: exceptionally low, notably low, below normal, normal, above normal, notably high and exceptionally high. The monthly variations can be compared to the long-term average distribution of levels, which are shown as columns on the left and right of each graph.

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

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