Hydrological Outlook UK

Period: From January 2020

Issued on 09.01.2020 using data to the end of December 2019

SUMMARY

The outlook for January is for river flows to be within the normal range across the majority of northern and western parts of the UK, as well as in the groundwater fed catchments of East Anglia and the Chilterns. River flows in the East Midlands, central-southern and south-eastern England are likely to be normal to above normal for January. Over the next three months, river flows in northern and western parts of the UK are likely to be normal to above normal. Groundwater levels are expected to follow a similar pattern with normal levels being likely in East Anglia and the Chilterns over the next one to three months. Normal to exceptionally high groundwater levels, with a variable spatial pattern, are likely to extend across the remainder of the UK for the next three months.

Rainfall:

Rainfall in December was above average in south-eastern England and western Scotland. Particularly high volumes of rain fell around the Thames estuary. North-eastern parts of the UK and northern Wales saw below average rainfall.

The rainfall outlook (issued by the Met Office on 12th December 2019) is that for January and January-February-March as a whole, above-average precipitation is more likely than below-average precipitation. The probability that UK-average precipitation for January-February-March will fall into the driest of five equal categories is between 15% and 20%, and the probability that it will fall into the wettest of the five categories is around 30% (the 1981-2010 probability for each of the categories is 20%).

River flows:

River flows in December remained above normal to exceptionally high across the majority of England and Wales, though average flows for the month were generally lower than they were in November. Flows in northern England, Scotland and Northern Ireland were mostly within the normal range.

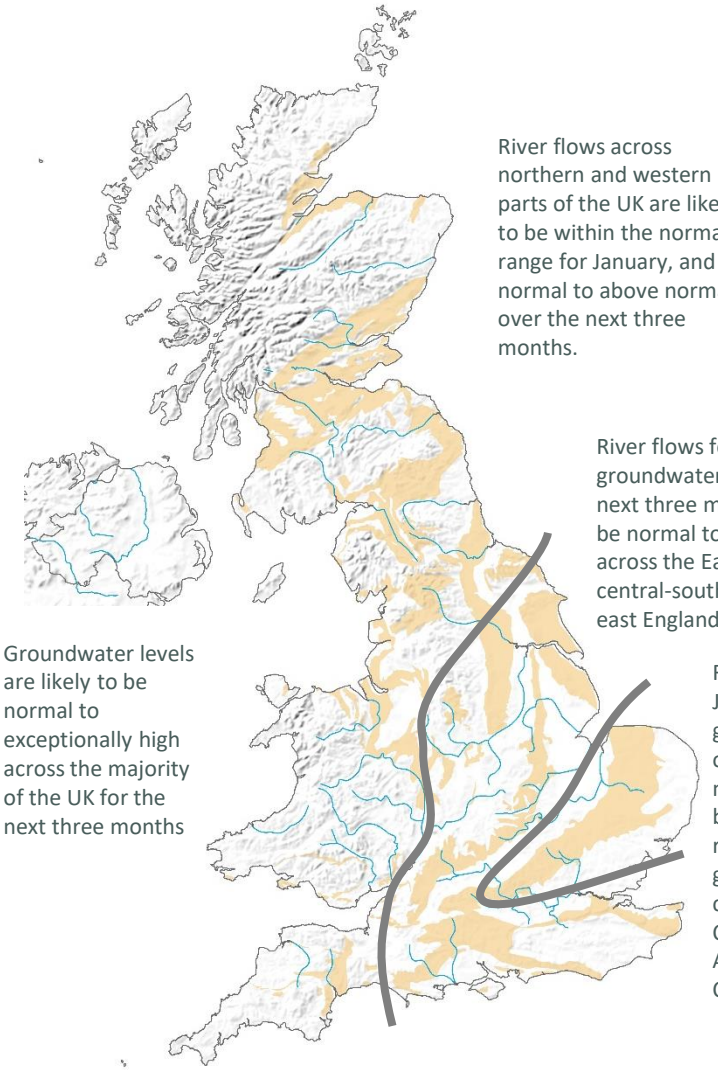
Following a dry end to December and start of January, the outlook for January is for flows to be within the normal range across the majority of the UK. The exception is across the East Midlands, central southern England and south-east England where river flows are likely to continue to be above normal, though some catchments may return to being within the normal range. River flows over the next three months are less certain at this time of year, though the influence of a positive North Atlantic Oscillation may bring some above normal flows to north-western parts of the UK.

Groundwater:

Groundwater levels were exceptionally high across large parts of the UK in December, particularly in the East Midlands and central southern England where several boreholes saw record breaking high figures. Elsewhere, levels were generally above normal, with the exception of the Chalk aquifer of East Anglia and the Chilterns where they were below normal.

Groundwater levels across the majority of the UK over the next three months are expected to start falling from their current high levels, but are likely to remain above normal to exceptionally high with a variable spatial pattern. Some localised areas are expected to return to being within their normal range. The previously below normal groundwater levels in the Chalk of East Anglia and the Chilterns have begun to rise, and are expected to be within the normal range for the three month period January to March.

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



Shaded areas show principal aquifers

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Hydrological Outlook UK

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.

Copyright:

Further information:

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

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

Contact:

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

Reference for the Hydrological Outlook:

Hydrological Outlook UK, 2020, January, 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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Met Office 3-month Outlook

Period: January – March 2020 Issue date: 12.12.19

The forecast presented here is for January and the average of the January-February-March period for the United Kingdom as a whole. The forecast for January will be superseded by the long-range information on the public weather forecast web page (www.metoffice.gov.uk/public/weather/forecast/#?tab=regionalForecast), starting from 2nd January 2020.

This forecast is based on information from observations, several numerical prediction systems and expert judgement.

SUMMARY – PRECIPITATION:

For January and January-February-March as a whole, above-average precipitation is more likely than below-average precipitation.

The probability that UK-average precipitation for January-February-March will fall into the driest of our five categories is between 15% and 20% and the probability that it will fall into the wettest of our five categories is around 30% (the 1981-2010 probability for each of these categories is 20%).

CONTEXT:

The influence of global drivers on UK weather patterns is strongest during winter and predictability is higher than at other times of year. For both January and January-February-March, there is a greater-than-usual likelihood of a positive phase of the North Atlantic Oscillation (NAO), with westerly winds bringing excess moisture from the Atlantic to the UK (see temperature Outlook). The chances of above-average precipitation are therefore greater than the chances of below-average precipitation (see graphs of figure P2). The Outlook implies an increase in the risks from high winds and heavy rainfall compared to what is normally expected at this time of year.

The increased probability of our wettest category does not imply extreme precipitation or storminess throughout the 3-month period. Indeed, the Outlook does not identify weather for a particular day or week. In addition, despite increased chances of the Outlook period being wetter than average, a drier-than-average outcome remains possible, although less likely.

Fig P1

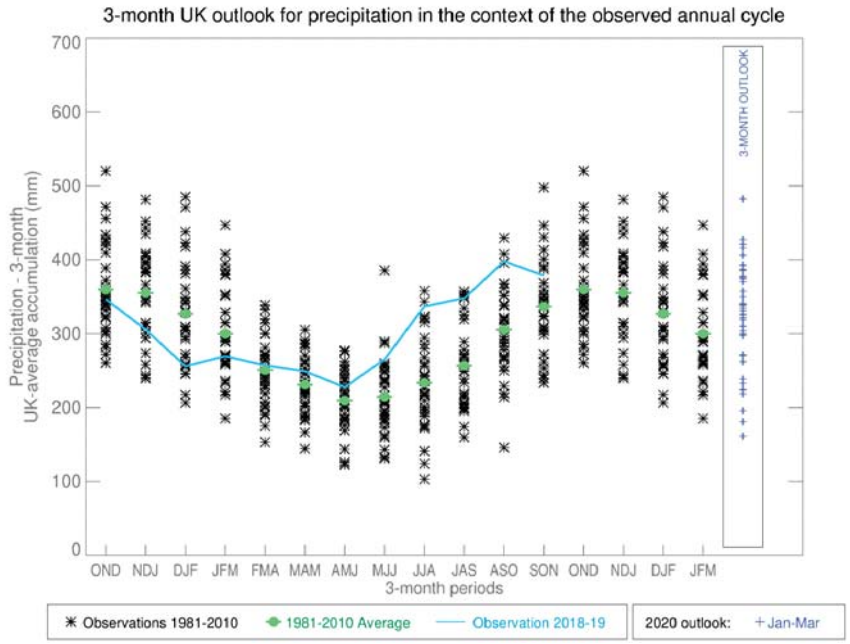


Fig P2

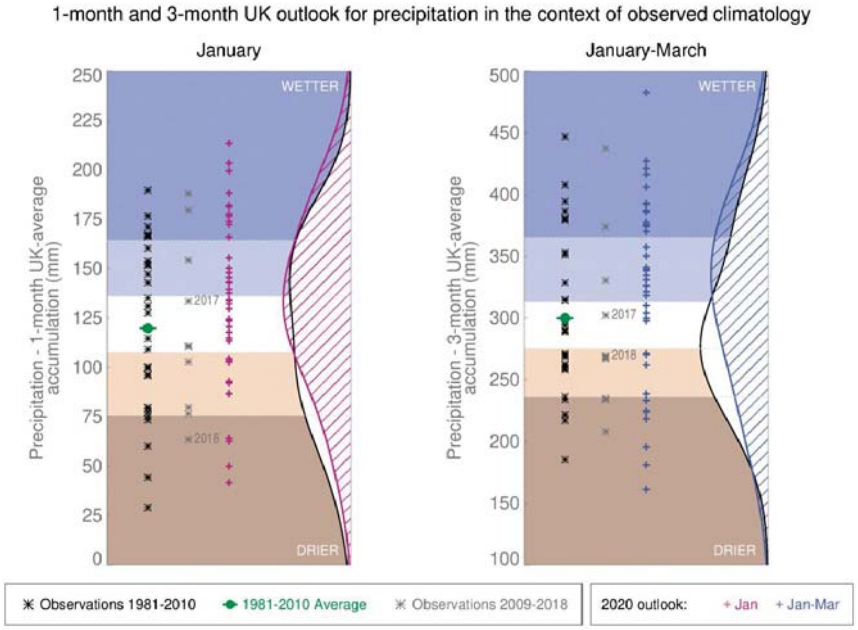
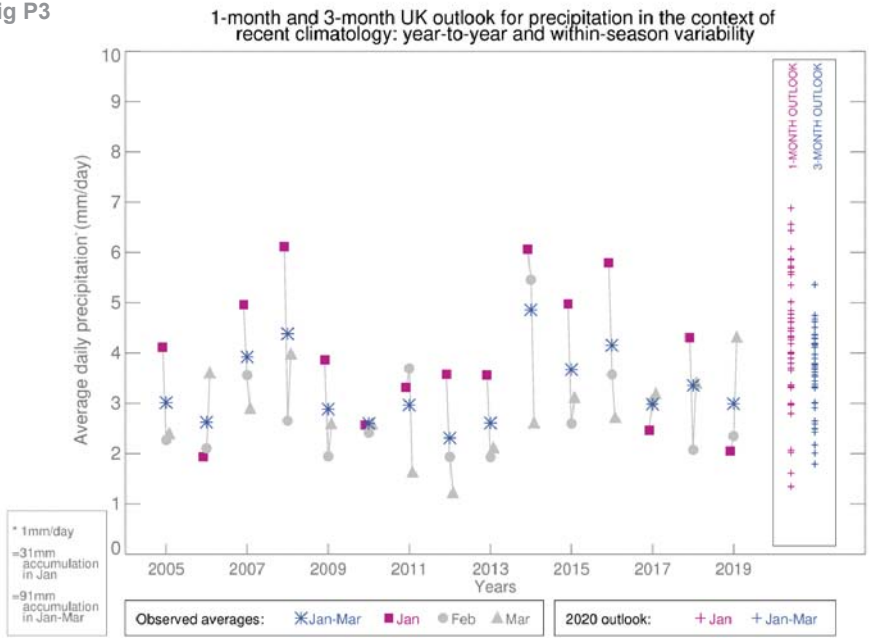


Fig P3



This Outlook provides an indication of possible temperature and rainfall conditions over the next 3 months. It is part of a suite of forecasts designed for contingency planners.

The Outlook should not be used in isolation but should be used with shorter-range and more detailed (30-day, 15-day and 1-to-7-day) forecasts and warnings available to the contingency planning community from the Met Office.

Met Office 3-month Outlook

Period: January – March 2020 Issue date: 12.12.19

The forecast presented here is for January and the average of the January-February-March period for the United Kingdom as a whole. The forecast for January will be superseded by the long-range information on the public weather forecast web page (www.metoffice.gov.uk/public/weather/forecast/#?tab=regionalForecast), starting from 2nd January 2020.

This forecast is based on information from observations, several numerical prediction systems and expert judgement.

SUMMARY – TEMPERATURE:

For January and January-February-March as a whole, above-average temperatures are more likely than below-average temperatures. Impacts from cold weather remain possible, but they are less likely than normal.

Overall, the probability that the UK-average temperature for January-February-March will fall into the coldest of our five categories is 5% and the probability that it will fall into the warmest of our five categories is around 50% (the 1981-2010 probability for each of these categories is 20%).

CONTEXT:

The El Niño-Southern Oscillation (ENSO) is currently in a neutral phase, with little likelihood of a significant El Niño or La Niña event developing during the Outlook period. It is therefore not expected to influence UK weather patterns.

The Indian Ocean Dipole (IOD) remains in a positive phase, with warmer-than-average sea surface temperatures (SSTs) in the western part of the Tropical Indian Ocean and cooler-than-average temperatures in the east. The IOD is expected to continue disrupting rainfall patterns in the Tropics in the first part of the 3-month period. These changes have an influence on the European region, increasing the chances of mild, westerly winds.

Sea surface temperatures in the North Atlantic continue to show a pattern that increases the likelihood of the positive phase of the North Atlantic Oscillation (NAO). Positive NAO in winter is associated with milder-than-average conditions. Patterns of predicted rainfall in the tropical Atlantic Ocean, however, increase the chances of a negative phase of the NAO.

The Stratospheric Polar Vortex (SPV) – the circulation of winds in the stratosphere above the Arctic – is currently strengthening and has an increased likelihood of remaining stronger than average in the first part of the Outlook period. A strong SPV favours a more active jet stream across the Atlantic, increasing the likelihood of milder-than-average conditions. On the other hand, the sun is close to a minimum in its 11-year cycle of activity, which increases the chances of weakening of the SPV in late winter.

For January and January-February-March as a whole, the Met Office long-range prediction system and systems from other centres around the world are in good agreement in showing an increased chance of the positive phase of the NAO. This is consistent, on balance, with the influences outlined above. Along with the warming of climate, it contributes to an increase in the probability of above-average temperatures (see graphs of figure T2). Note that below-average temperatures remain possible, although less likely.

Fig T1

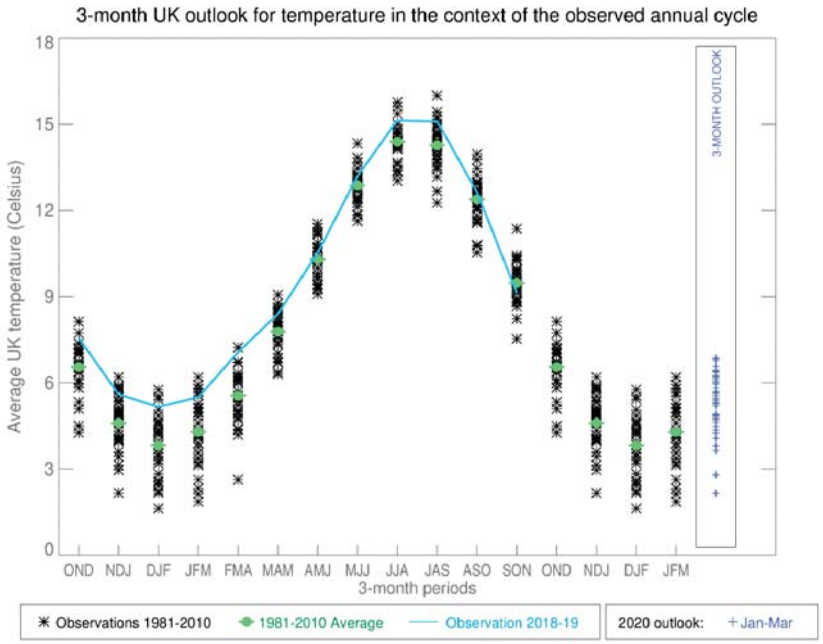


Fig T2

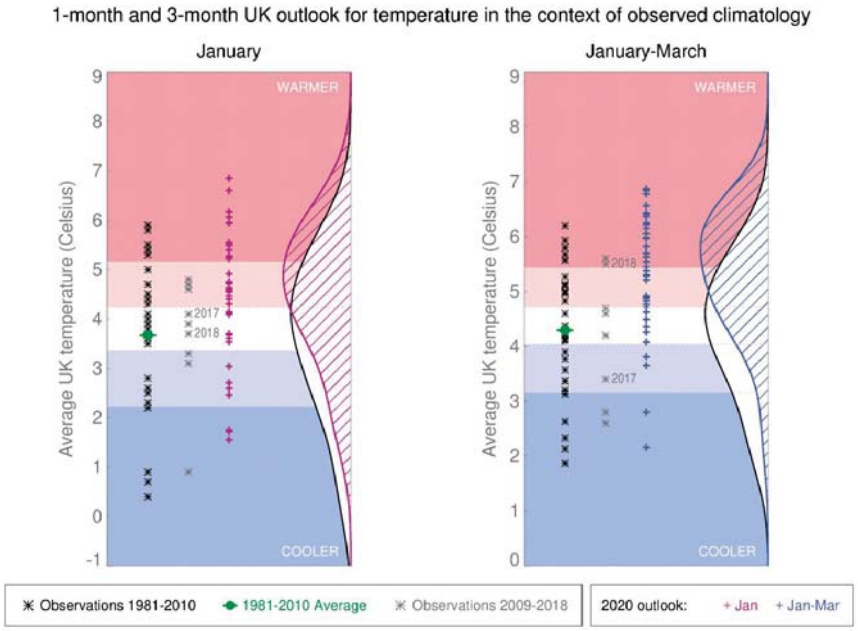
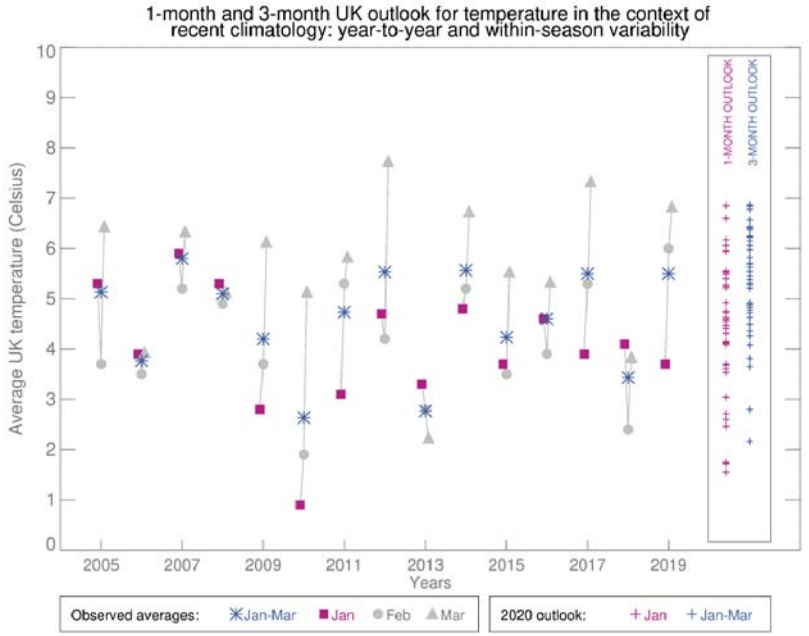


Fig T3



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UK Centre for Ecology & Hydrology

Outlook based on hydrological persistence and analogy

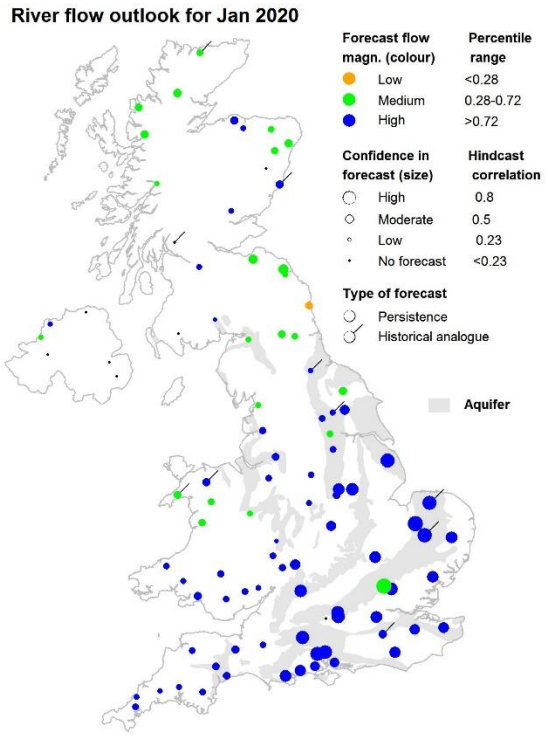
Overview

Period: January 2020 – March 2020

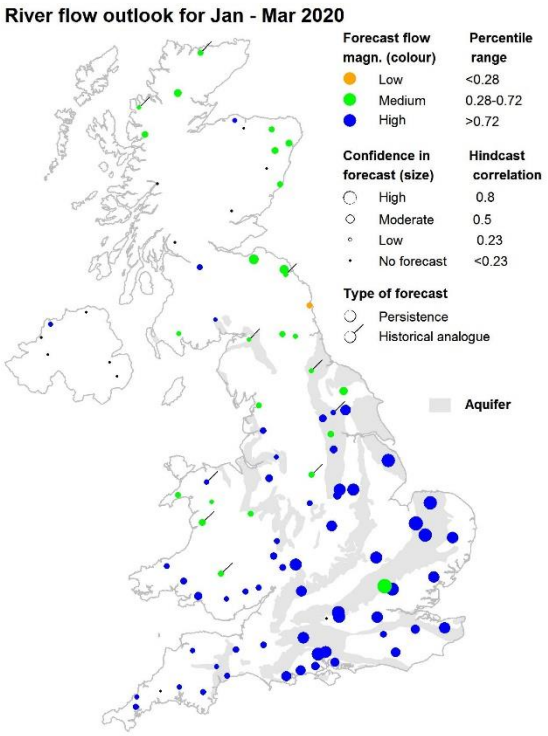
Issued on 07.01.2020 using data to the end of December 2019

SUMMARY

The outlooks for January and for January to March are for above normal river flows in southern England, and normal to above normal river flows for the rest of the UK, with a few local exceptions. Note that not many forecasts are available for the north-west.



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

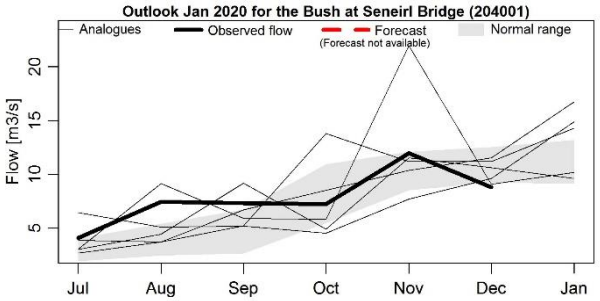
Site-based: 1 month outlook

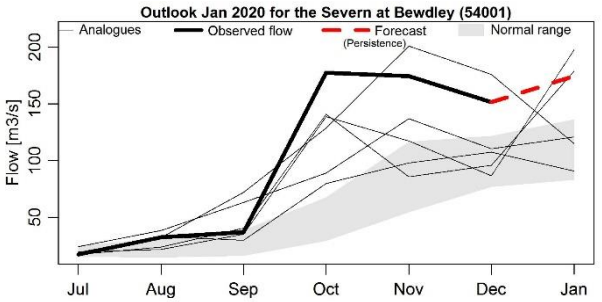
Period: January 2020

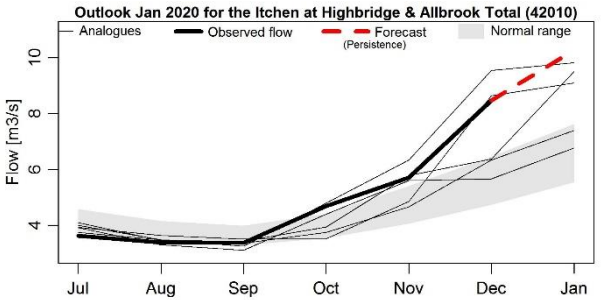
Issued on 07.01.2020 using data to the end of December 2019

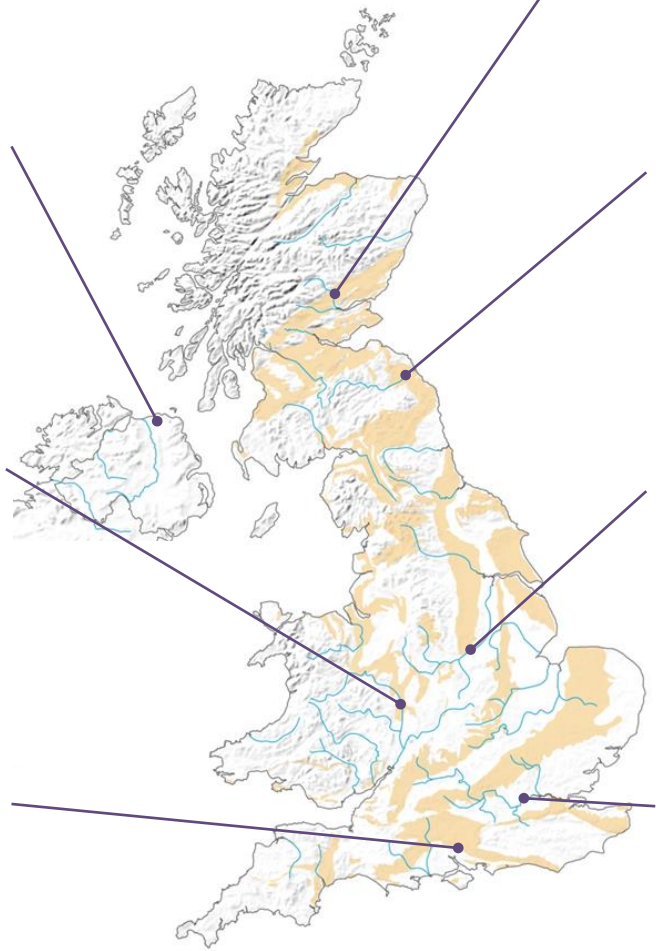
These figures provide insight into the hydrological analogue methodology for a set of sites from across the UK.

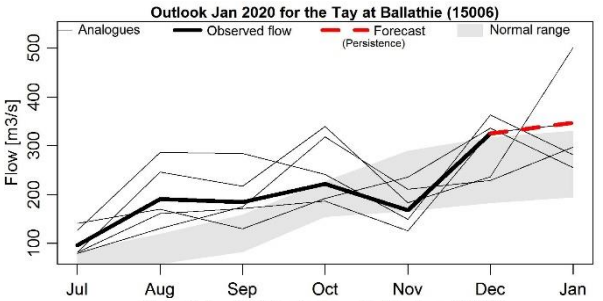
In each of the time series graphs the bold black line represents the observed flow during the past six months. The grey band indicates the normal flow range (the normal band includes 44% of observed flows in each month). The selected analogues are shown as thin lines and the trajectories that flows took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

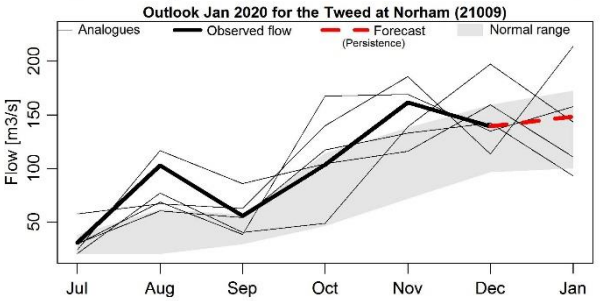


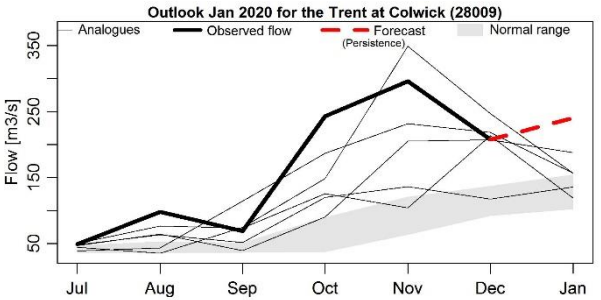


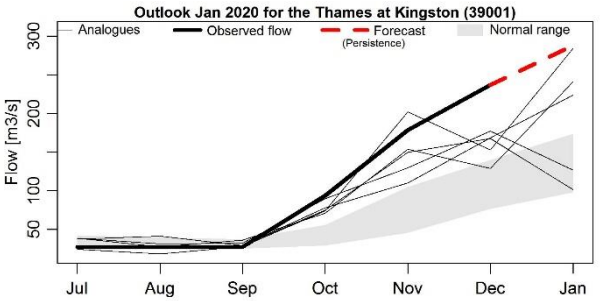












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RIVER FLOW ANALOGY

January 2020

UK Centre for Ecology & Hydrology

Outlook based on hydrological persistence and analogy

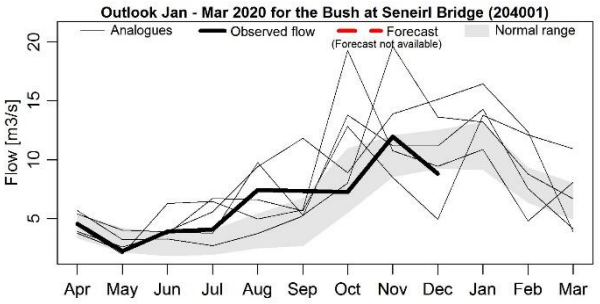
Site-based: 3 month outlook

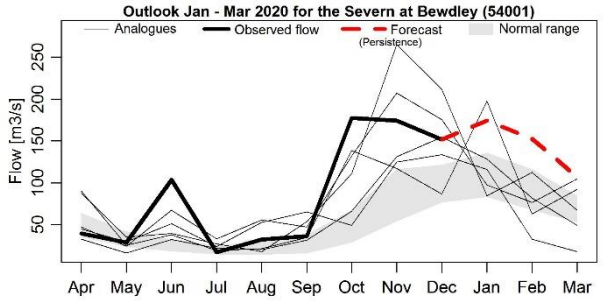
Period: January 2020 – March 2020

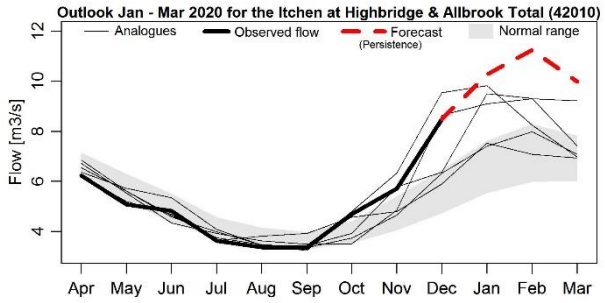
Issued on 07.01.2020 using data to the end of December 2019

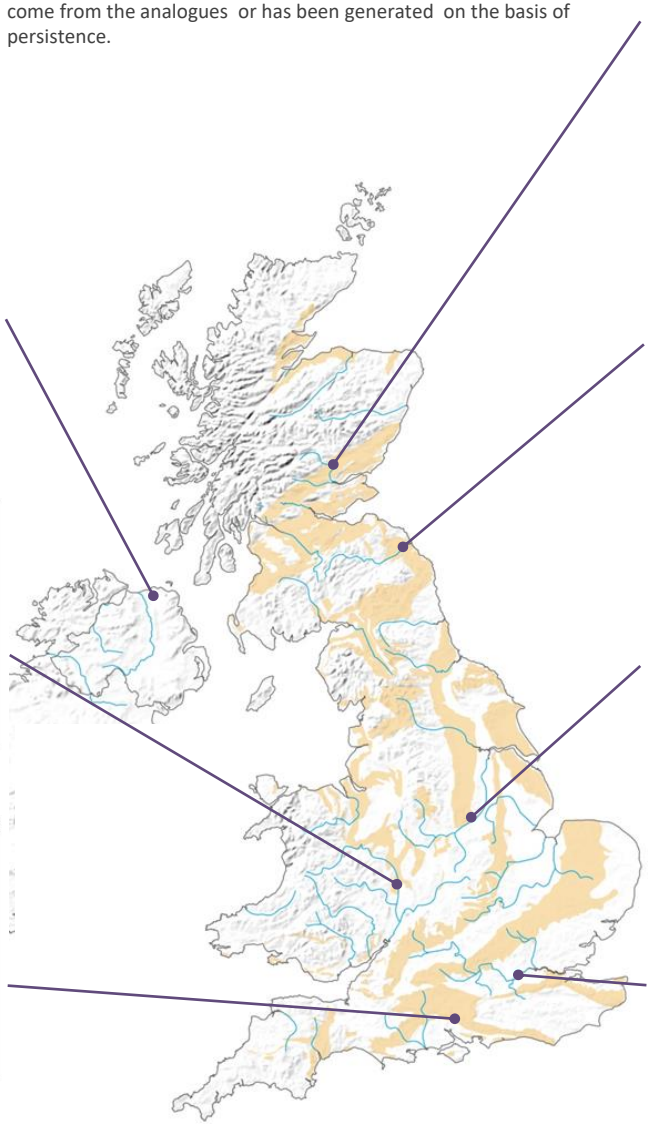
These figures provide insight into the hydrological analogue methodology for a set of sites from across the UK.

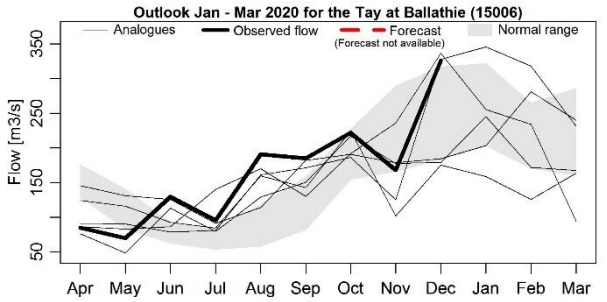
In each of the time series graphs the bold black line represents the observed flow during the past nine months. The grey band indicates the normal flow range (the normal band includes 44% of observed flows in each month). The selected analogues are shown as thin lines and the trajectories that flows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

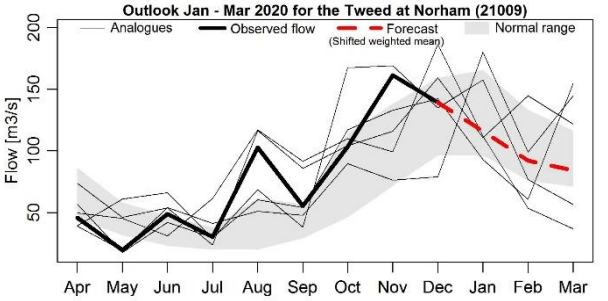


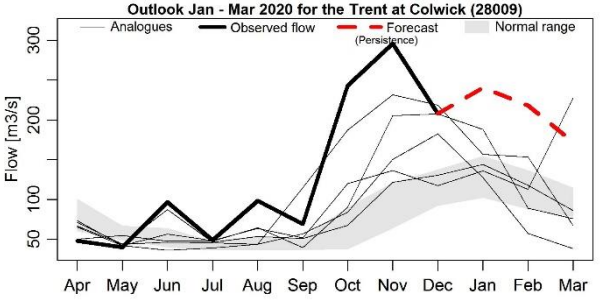


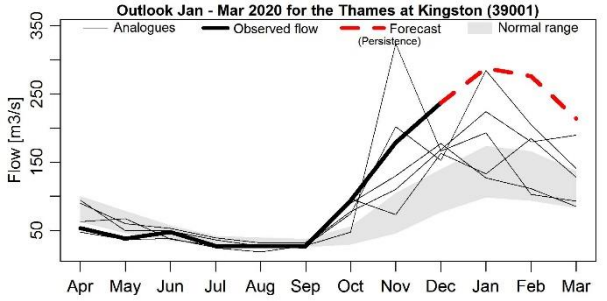












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RIVER FLOW ANALOGY

January 2020

UK Centre for Ecology & Hydrology

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Environment Agency

Outlook based on modelled flow from historical climate

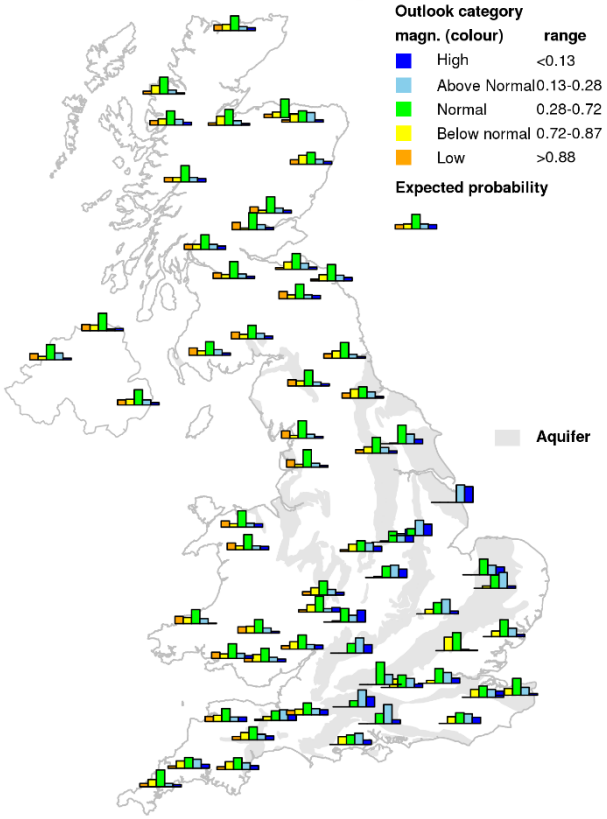
Overview

Period: January 2020 – June 2020

Issued on 07.01.2020 using data to the end of December

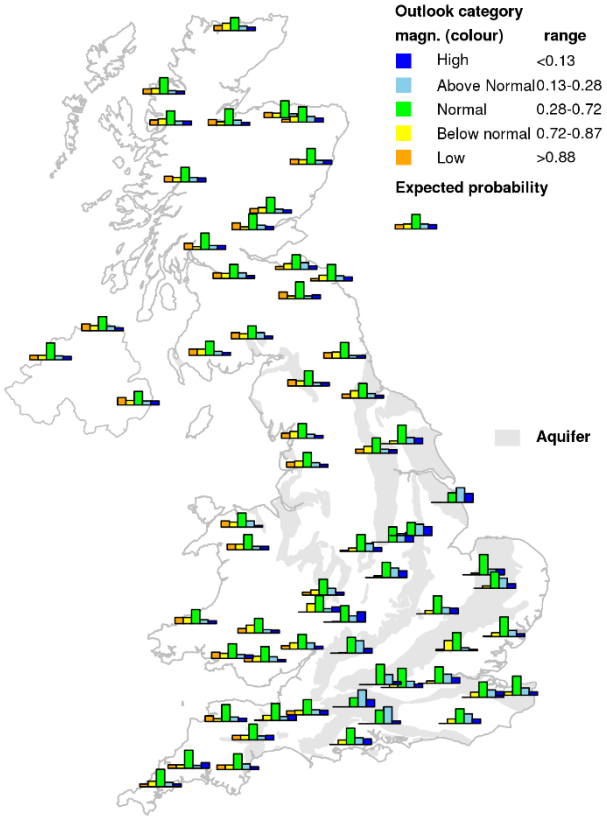
River flows across the East Midlands and central southern England are likely to be above normal in January, and normal to above normal over the next three months. Elsewhere across the UK, flows are expected to be within the normal range for the next one to three months.

1-month river flow outlook starting Jan 2020



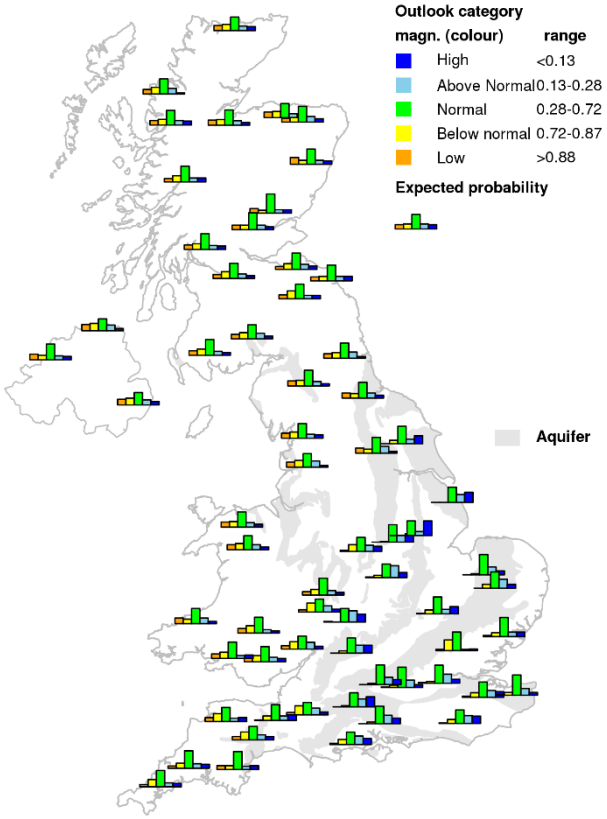
This outlook is based on monthly ensembles of historical sequences of observed climate (rainfall and potential evapotranspiration) that form input to a hydrological model. The outputs are probabilistic simulations of the average river flow over the forecast period (1 to 12 months ahead), at each location. 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 Jan 2020



The bar plot maps show the outlook distribution for 3, 6 and 12-month period for 64 catchments across England and Wales. Each bar plot represents the probabilistic distribution of the simulated river flow compared to the historical river flow, for the same n-month period. The probabilities fall within five categories, classified as: low, below normal, normal, above normal and high.

6-month river flow outlook starting Jan 2020



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

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Environment Agency

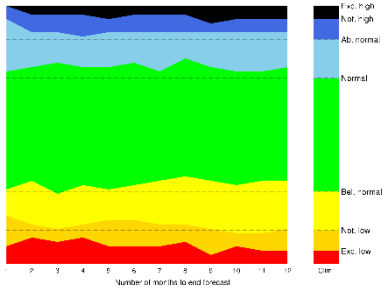
Outlook based on modelled flow from historical climate

Overview

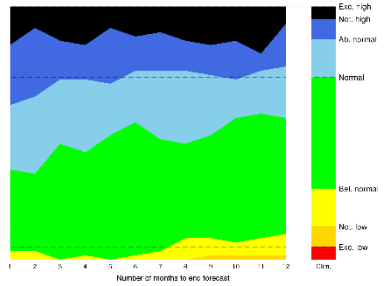
RIVER FLOW FROM HISTORICAL CLIMATE

January 2020

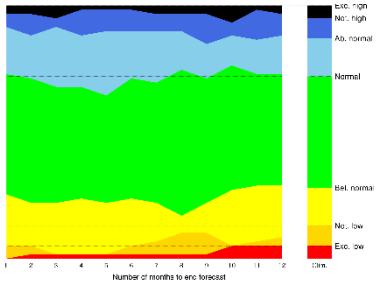
Mourne 201010

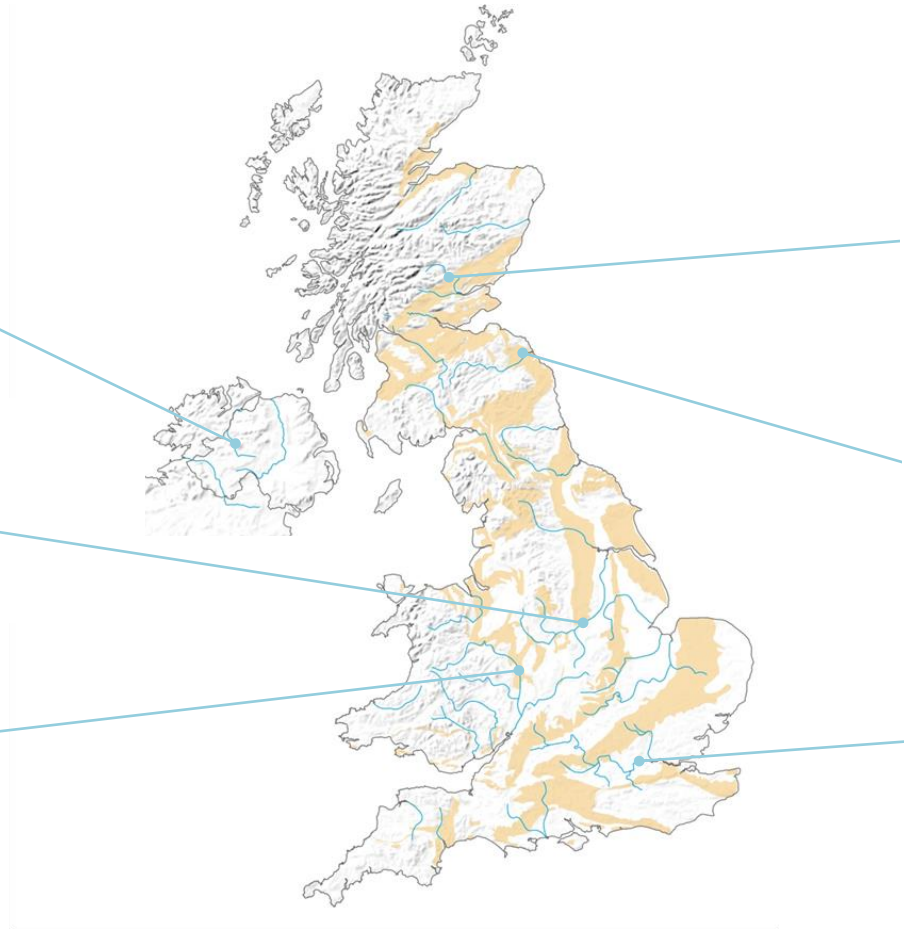


Trent 28009

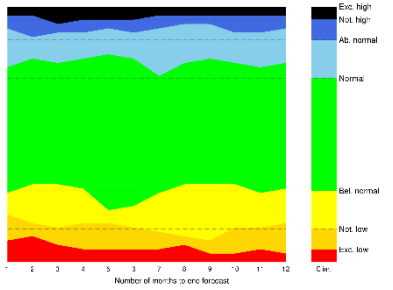


Severn 54032

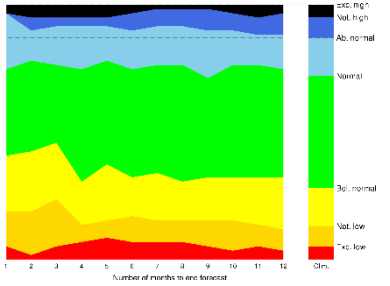




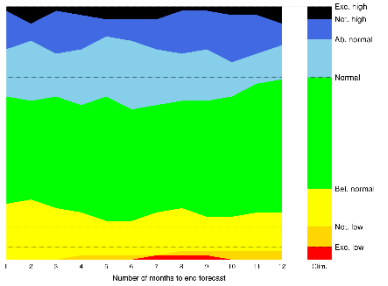
Tay 15006



Tweed 21009



Thames 39001



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

Current Daily Simulated Subsurface Water Storage Conditions

Based on subsurface water storage estimated for **31st December 2019**

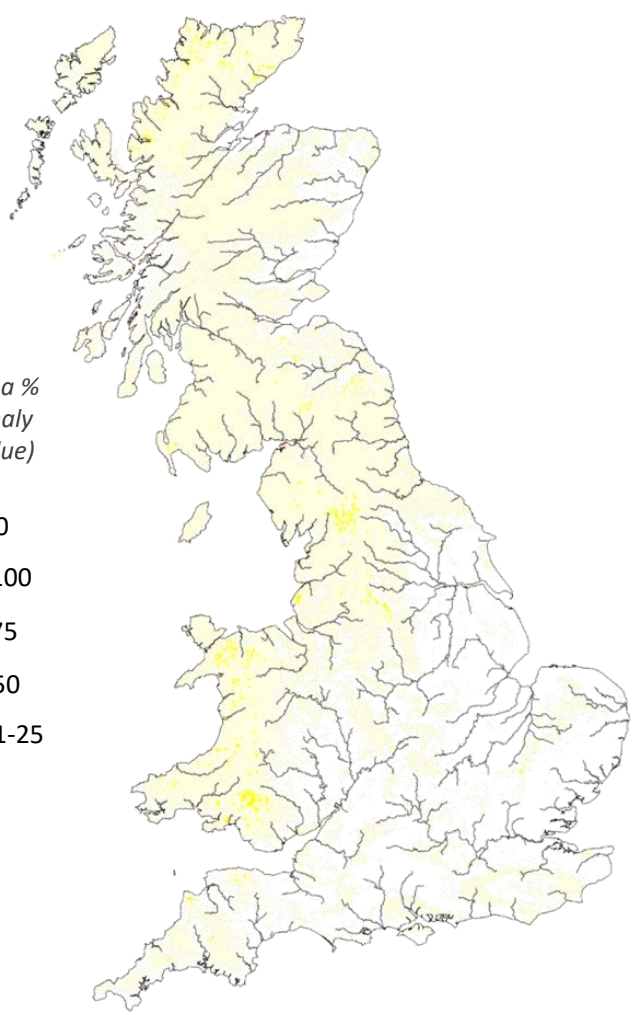
Issue date: 07.01.2020

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 dryness.

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.

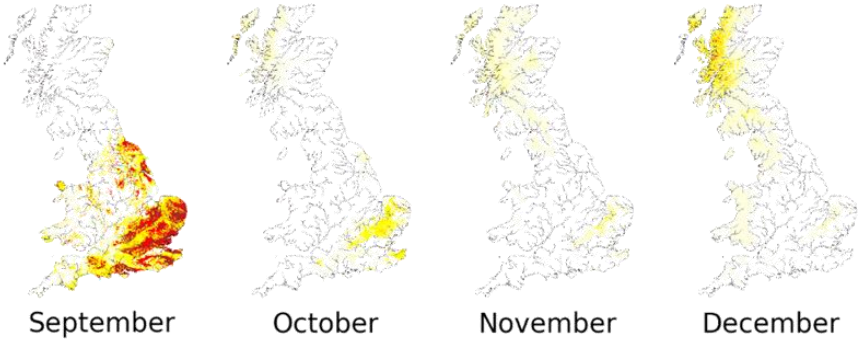
SUMMARY: At the end of December, most of the country is not experiencing relative dryness levels that are higher than the average for this time of year.

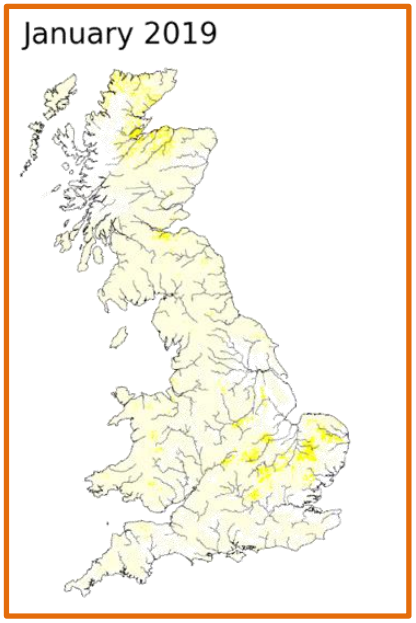
Relative Dryness

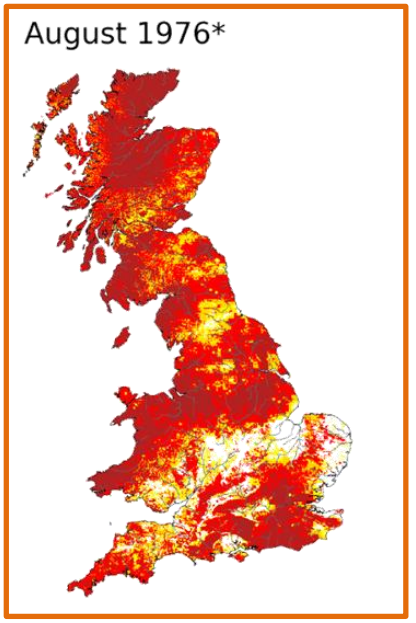


Water storage anomaly as a % of minimum storage anomaly (zero indicates average value)

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







*Example month displaying extreme relative dryness

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OUTLOOK BASED ON CURRENT CONDITIONS

January 2020

UK Centre for Ecology & Hydrology

Current Daily Simulated Subsurface Water Storage Conditions

Based on subsurface water storage estimated for **31st December 2019**

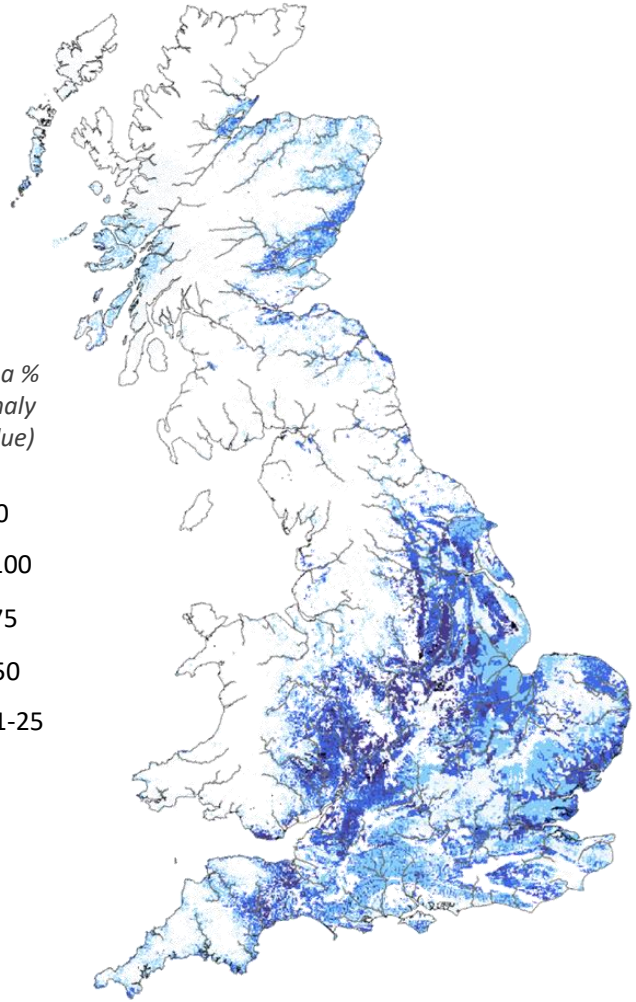
Issue date: 07.01.2020

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.

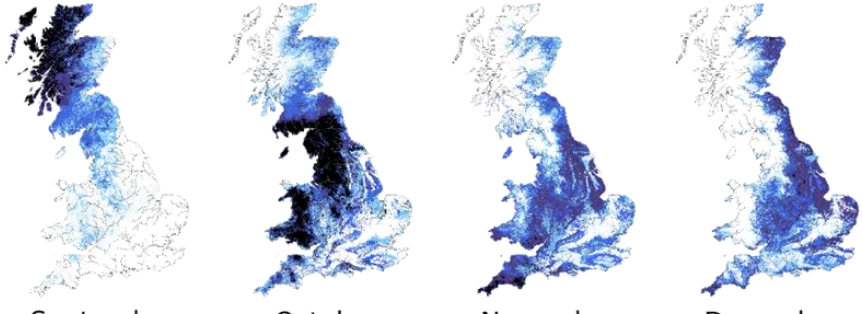
SUMMARY: At the end of December, regions in central, eastern and southern England are experiencing relative wetness levels that are higher than average for this time of year. The majority of Scotland and Wales are not experiencing particularly high levels of relative wetness.

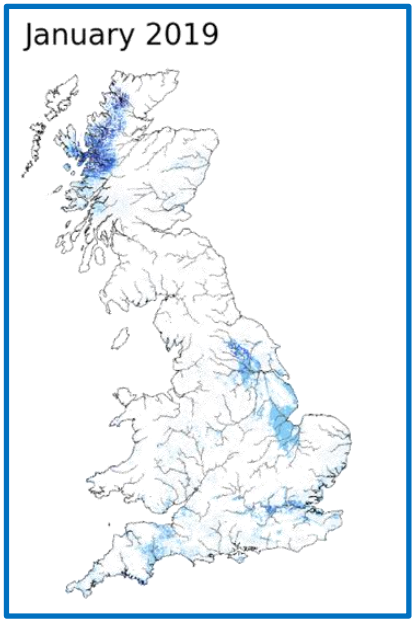
Relative Wetness



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		





*Example month displaying extreme relative wetness

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OUTLOOK BASED ON CURRENT CONDITIONS

January 2020

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.

UK Centre for Ecology & Hydrology

Return Period of Rainfall Required to Overcome the Dry Conditions

Period: January 2020 – June 2020

Issue date: 07.01.2020

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 January to June, Britain will not require particularly unusual rainfall (0 to 5 year return periods) to return to average conditions for the time of year.

Jan

Feb

Mar

Apr

May

Jun

Rainfall amount / Probability			*Return period (years)*
Low (this rain is likely to occur)	> 20%		0 - 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

January 2020

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 December 2020**

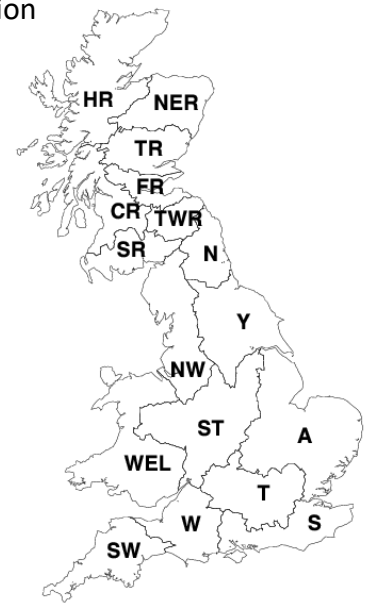
Issue date: 07.01.2020

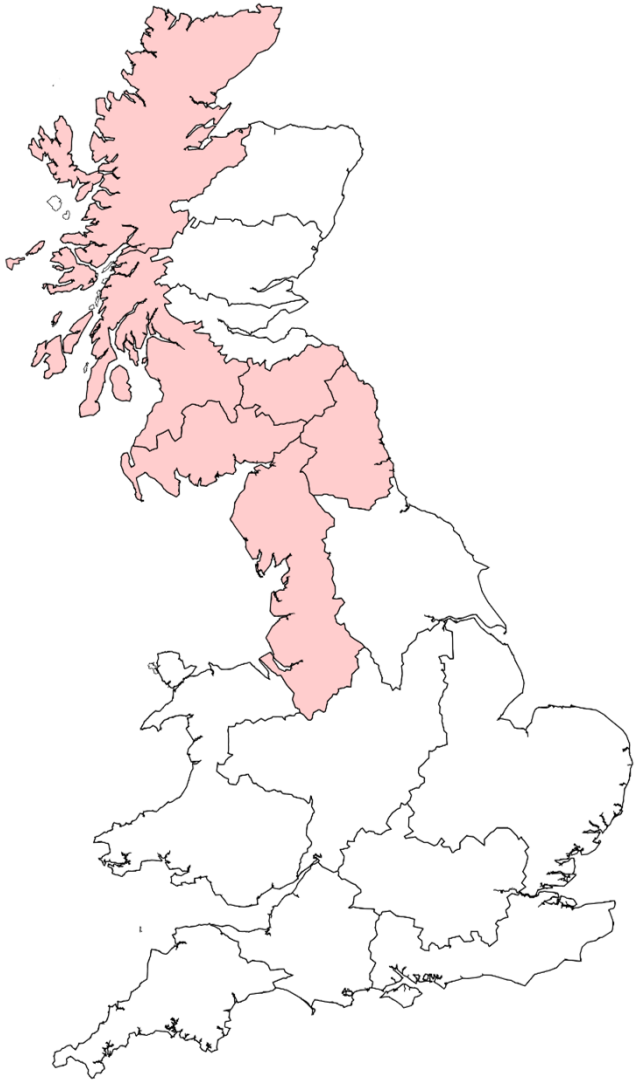
These maps show the Grid-to-Grid (G2G) hydrological model simulated subsurface water storage, expressed as an anomaly from the historical monthly mean (1981-2010), presented on a 1km grid and as regional means.
Subsurface storage deficits, i.e. where the subsurface water storage anomaly is less than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

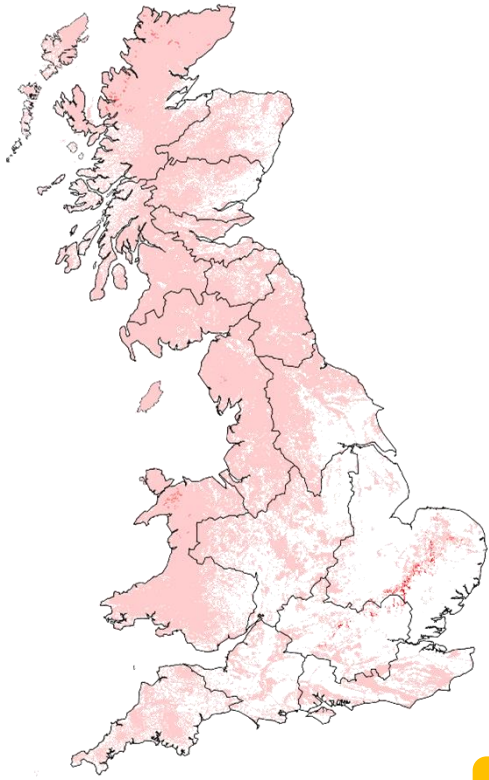
The **subsurface storage deficit (mm)** can be interpreted as an estimate of additional rainfall that would be required in future months to overcome dry conditions (i.e. rainfall in addition to what is expected on average). Regional mean values of additional rainfall required are provided in the table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

Regional estimate of additional rainfall required (mm)

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







Water storage deficit (anomaly, mm)

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

OUTLOOK BASED ON CURRENT CONDITIONS

January 2020

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UK Centre for Ecology & Hydrology

Outlook Based on Modelled Flow from Rainfall Forecasts

Overview

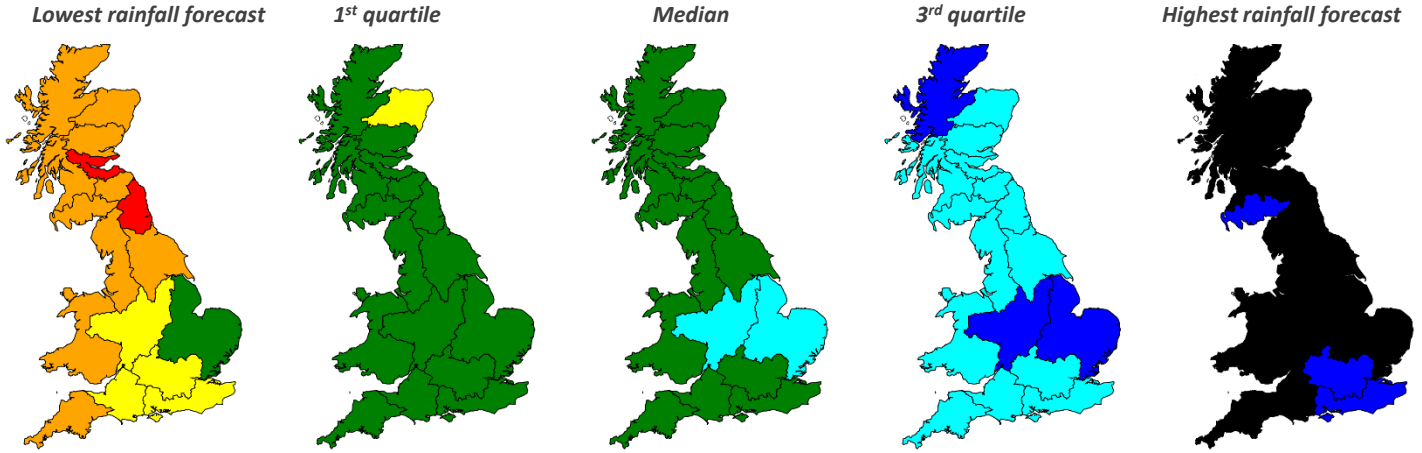
Period: January 2020 – March 2020

Issued on 07.01.2019 using data to the end of December

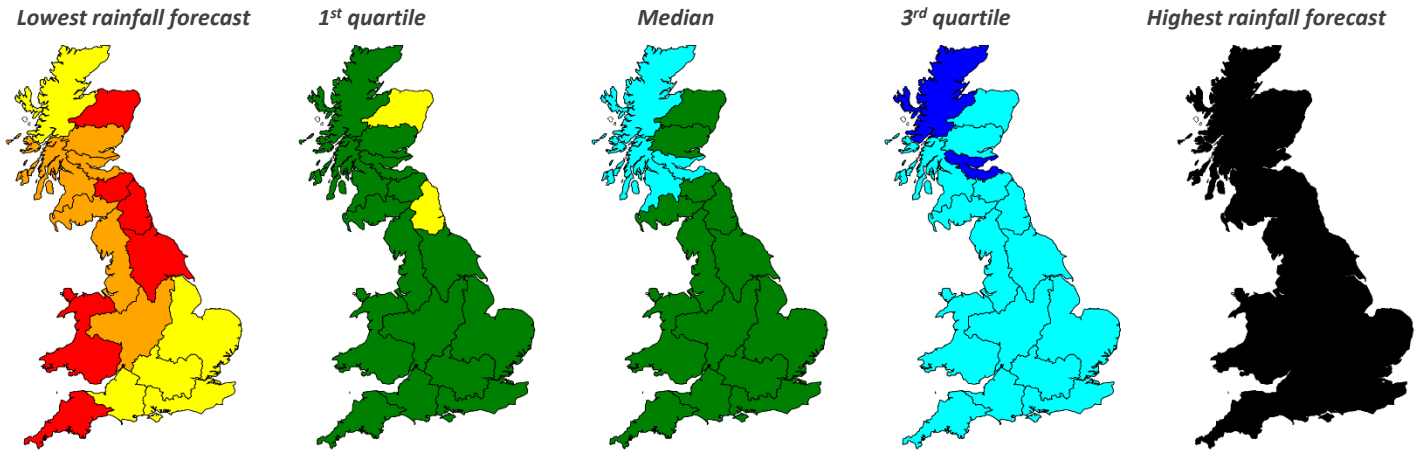
SUMMARY: During January, river flows across the majority of the country are most likely to be in the *Normal range* or above. River flows in central and eastern England may be *Above normal.*

Over the next 3 months river flows across England and Wales are most likely to be in the in the *Normal range* or above. Some Scottish regions may experience *Above normal* flows.

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

January 2020

UK Centre for Ecology & Hydrology

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

Period: January 2020 – March 2020

Issue date: 07.01.2020

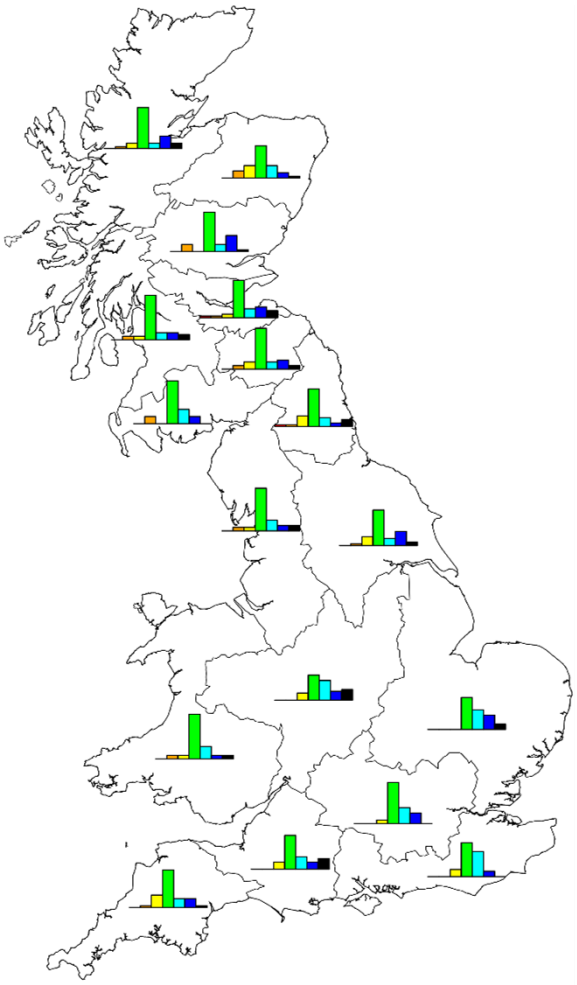
The regional maps illustrating the regional river flows for five members of the Met Office ensemble of rainfall forecasts give some indication of the range of possible river flows in the coming months. As noted previously, the actual flows could be more extreme than the flows generated by either the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

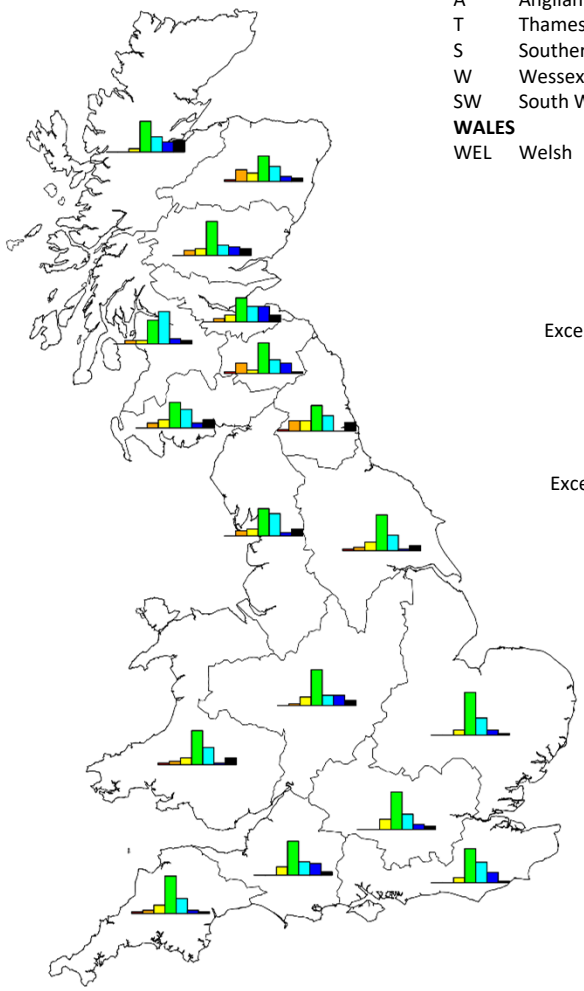
SUMMARY: During January, river flows across the majority of the country are most likely to be in the *Normal range* or above. River flows in central and eastern England may be *Above normal.*

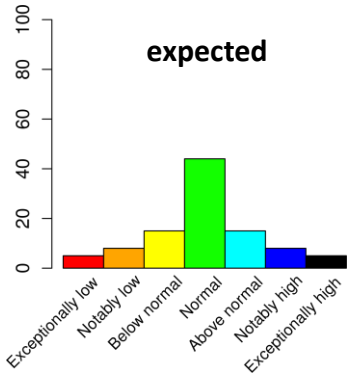
Over the next 3 months river flows across England and Wales are most likely to be in the in the *Normal range* or above. Some Scottish regions may experience *Above normal* flows.

1-month



3-month





SCOTLAND

HR	Highlands Region
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ENGLAND

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WALES

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NORTHERN IRELAND

This method cannot currently be used in Northern Ireland

Percentile range of historic values for relevant month

Exceptionally high flow	> 95
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Above normal	72-87
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UK Centre for Ecology & Hydrology

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

Period: January 2020 – March 2020

Issue date: 07.01.2020

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 January, river flows across the majority of the country are most likely to be in the *Normal range* or above. River flows in central and eastern England may be *Above normal.*

Over the next 3 months river flows across England and Wales are most likely to be in the in the *Normal range* or above. Some Scottish regions may experience *Above normal* flows.

SCOTLAND

HR	Highlands Region
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TWR	Tweed Region
SR	Solway Region

ENGLAND

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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	8	8	10	15	3	0	0	5	15	5	8	10	8	3	0	3	5
Notably high flow	20	8	5	13	13	8	15	5	10	20	10	15	18	8	10	23	13
Above normal	28	15	13	28	13	35	23	18	18	10	10	13	8	18	20	10	10
Normal range	45	60	52	35	52	48	58	63	48	50	63	52	58	45	60	55	58
Below normal	0	5	15	10	18	10	5	5	10	13	5	5	8	18	0	0	10
Notably low flow	0	5	3	0	3	0	0	5	0	3	5	3	3	10	10	10	5
Exceptionally low flow	0	0	3	0	0	0	0	0	0	0	0	3	0	0	0	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	2	10	12	7	2	2	5	10	5	7	5	10	17	5	12	10	2
Notably high flow	7	5	0	14	5	14	7	2	17	2	7	21	14	7	7	12	14
Above normal	24	31	21	14	21	29	21	24	19	21	45	21	21	21	26	14	19
Normal range	60	38	36	50	52	48	52	48	48	50	33	33	43	36	36	48	43
Below normal	7	10	14	12	12	7	14	10	12	12	5	10	5	12	12	10	5
Notably low flow	0	7	14	2	5	0	0	5	0	5	5	5	0	17	7	7	14
Exceptionally low flow	0	0	2	0	2	0	0	2	0	2	0	0	0	2	0	0	2

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

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Outlook based on modelled groundwater level & climate forecast

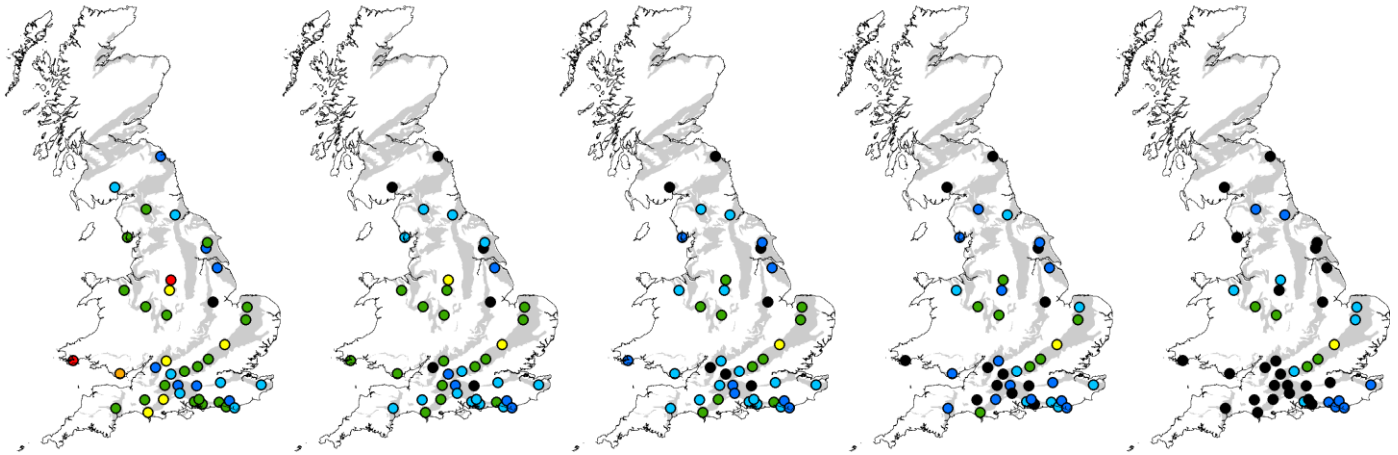
Overview

Period: January 2020 – March 2020

Issued on 08.01.2020 using data to the end of December

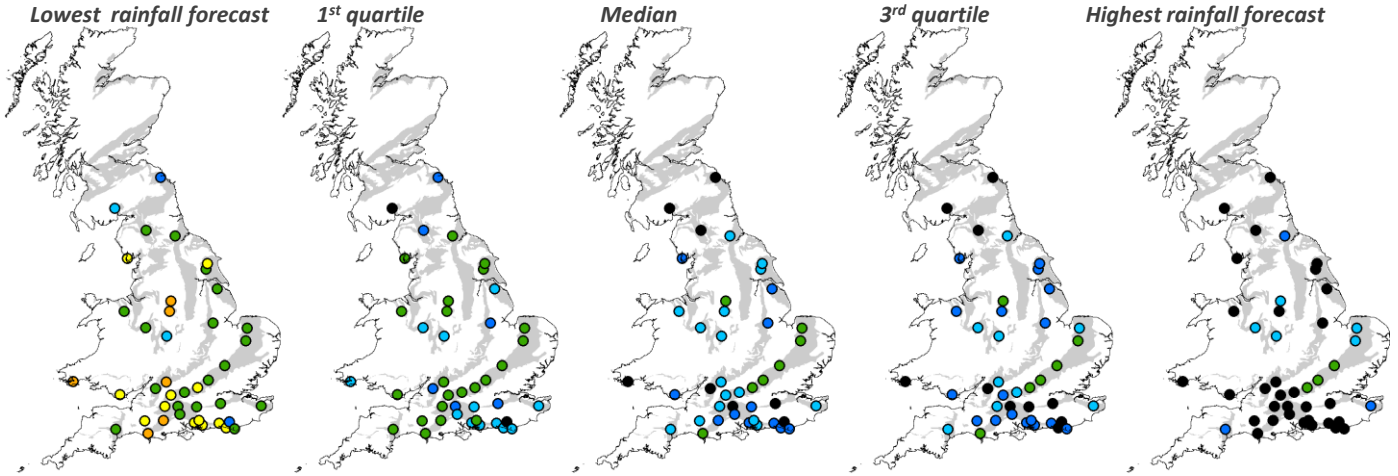
Groundwater levels are expected to be normal to above normal across most of the UK over both the one and three month forecasts. Notably or exceptionally high groundwater levels are forecast under median scenarios in parts of the Chalk, Jurassic limestone and Permo-Triassic Sandstones. Although this is not a flood forecasting service, note that prolonged exceptionally high groundwater levels, particularly in the Chalk, may be associated with local groundwater flooding. Levels in the Chilterns Chalk are likely to have recovered to the normal range in a month.

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*

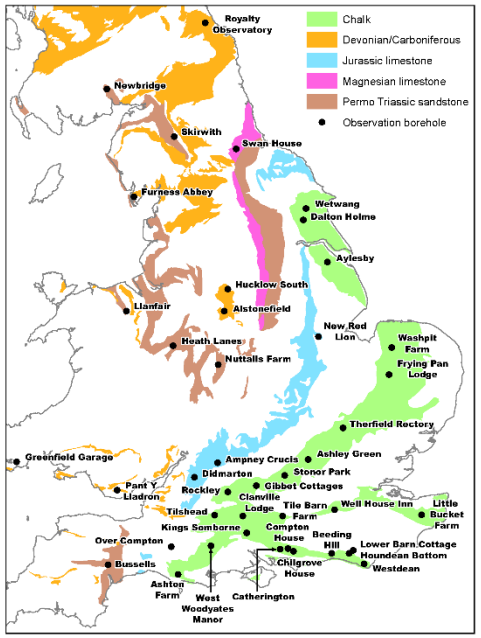


3-month outlook

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	13-28
Notably low levels	5-13
Exceptionally low levels	< 5



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GROUNDWATER FROM CLIMATE FORECASTS

January 2020

UK Centre for Ecology & Hydrology

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

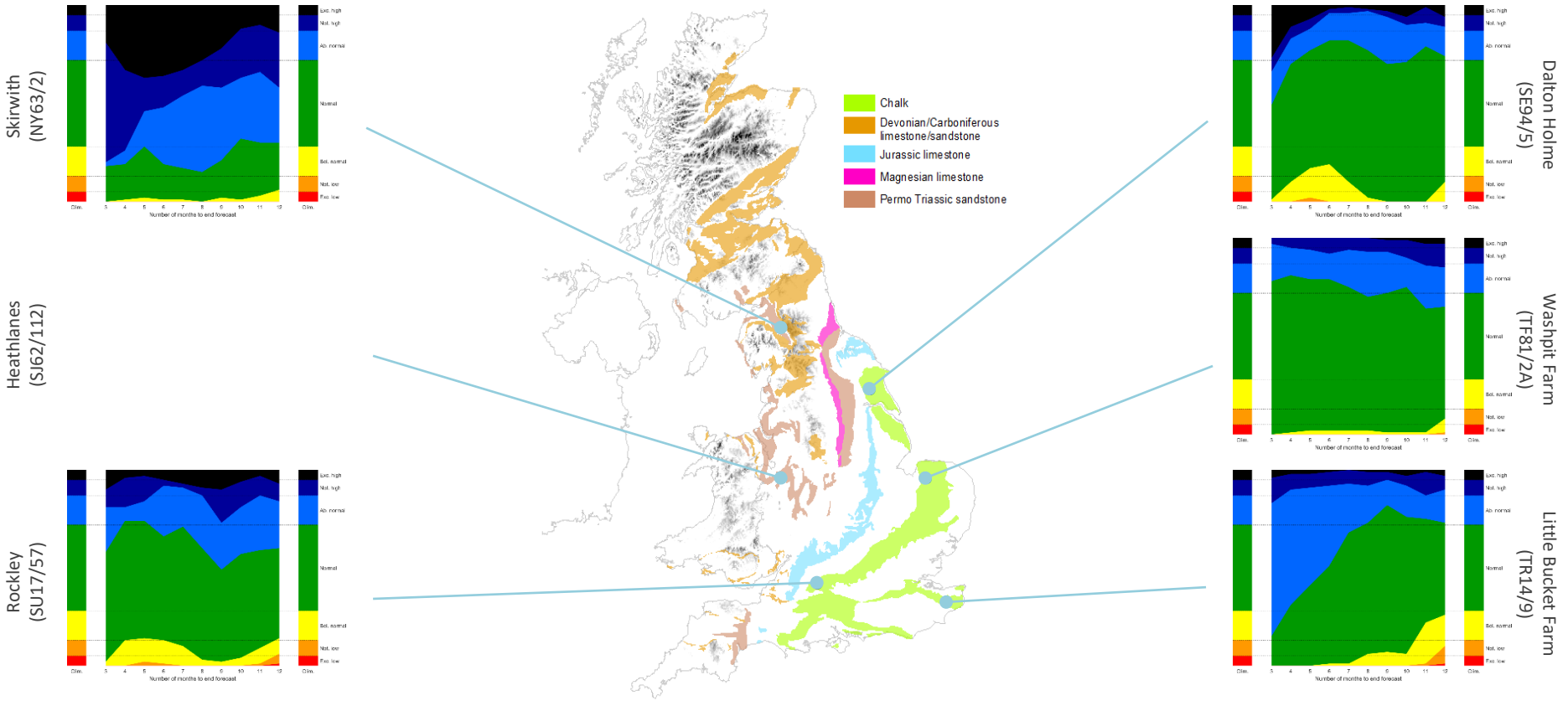
Environment Agency

Outlook based on modelled groundwater from historical climate

Period: January 2020 – December 2020

Issued on 08.01.2020 using data to the end of December

Normal to above-normal conditions are expected across the UK over the next 12 months, with the outlook trending towards normal over this timescale. Note that Heathlanes has been abandoned with no levels since March and has been omitted.



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

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

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

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