Hydrological Outlook UK

Period: From March 2020

Issued on 10.03.2020 using data to the end of February 2020

SUMMARY

Following the exceptional rainfall and associated flooding in February, the outlook for March is for a continuation of above normal (and locally notably high) flows across large parts of southern and central England and Wales. Elsewhere, March flows are likely to be normal to above normal. Groundwater levels are likely to remain above normal across most of the UK, with normal levels most likely in East Anglia and the Chilterns. For the three month outlook, normal to above normal flows are most likely across the UK, with many more rivers entering the normal range. Groundwater levels are also likely to return to normal in many areas, with above normal levels persisting in parts of the southern Chalk and some northern areas.

Rainfall:

With a succession of severe storms bringing persistent heavy rainfall, February 2020 was the wettest on record, in a series dating back to 1862, with 237% of average rainfall for the UK as a whole, bringing to a close the 5th wettest winter on record.

The rainfall outlook for March (issued by the Met Office on 20th February) indicates below-average precipitation is slightly more likely than above-average precipitation. For March-April-May as a whole, above-average precipitation is slightly more likely than below-average precipitation. The probability that UK-average precipitation for March-April-May will fall into the driest of five equal categories is around 15% and the probability that it will he wettest category is 25% (the 1981-2010 probability for each of these categories is 20%).

River flows:

River flows for February were notably or exceptionally high across almost the entire country, with many rivers across Wales and northern England registering the highest February flows on record. Correspondingly, severe flooding was widespread and prolonged.

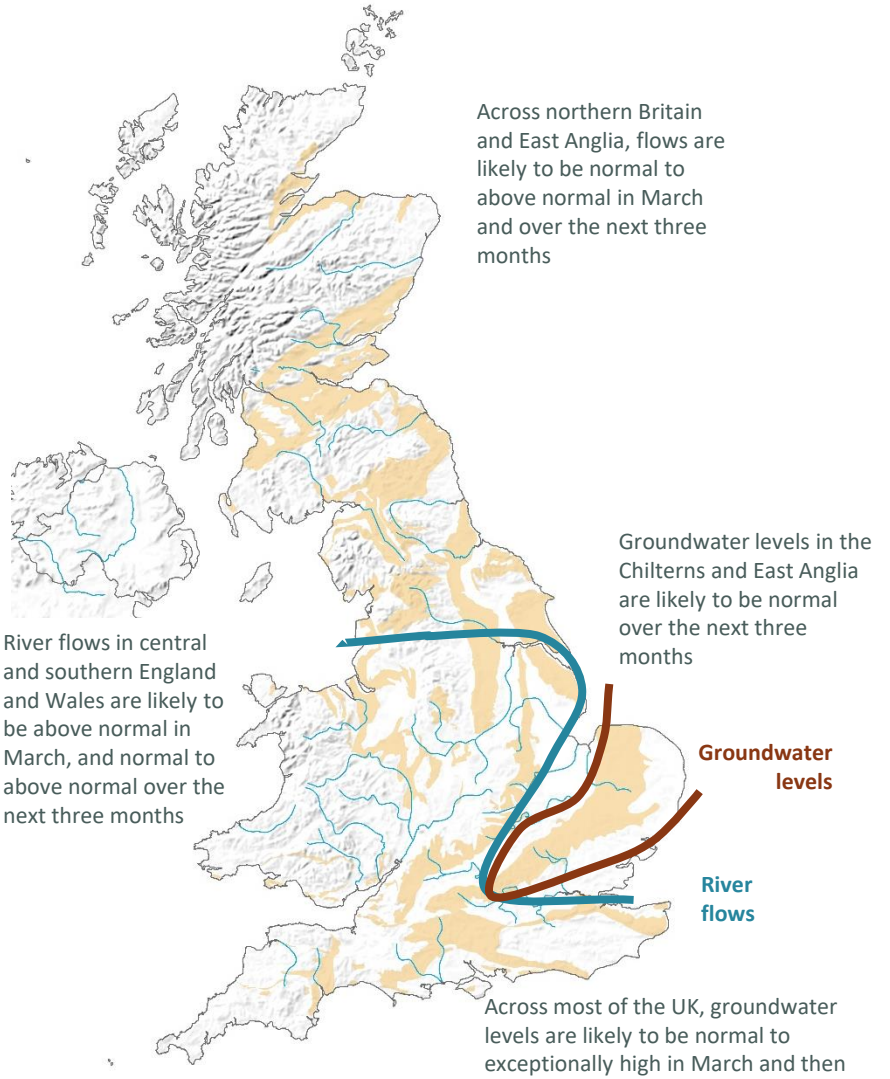
The outlook for March is for above normal flows to continue across much of central and southern England and Wales, with notably or exceptionally high flows possible in some catchments. For northern Britain and eastern England, the outlook is more mixed, indicating normal to above normal flows, with normal flows most likely in groundwater dominated catchments in the east. For the three month outlook, more catchments are likely to drop into the normal range and the outlook is for normal to above normal flows across the UK.

Groundwater:

Groundwater levels for February were mostly above normal, with widespread exceptionally high levels and the highest February levels on record in some boreholes in central and northern England. However, for the Chalk of the Chilterns and East Anglia, levels were normal or below.

The outlook for March is for a continuation of the current situation, with above normal to exceptionally high levels across a range of aquifers, but particularly in the southern Chalk. For the Chilterns and East Anglia, normal levels are most likely. The three month outlook is for normal to above normal levels. Normal levels are likely to be more prevalent, but above normal levels are likely to persist in parts of the southern Chalk and the sandstone aquifers of northern England and southern Scotland.

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



HYDROLOGICAL OUTLOOK UK

March 2020

UK Centre for Ecology & Hydrology

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Environment Agency

Met Office

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Scottish Environment Protection Agency

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, March, 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: March – May 2020 Issue date: 20.02.20

The forecast presented here is for March and the average of the March-April-May period for the United Kingdom as a whole. The forecast for March 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 1st March 2020.

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

SUMMARY – PRECIPITATION:

For March, below-average precipitation is slightly more likely than above-average precipitation. For March-April-May as a whole, above-average precipitation is slightly more likely than below-average precipitation.

The probability that UK-average precipitation for March-April-May will fall into the driest of our five categories is around 15% and the probability that it will fall into the wettest of our five categories is 25% (the 1981-2010 probability for each of these categories is 20%).

CONTEXT:

During the Outlook period there is a greater-than-usual likelihood of a positive phase of the North Atlantic Oscillation (NAO) (see Temperature Outlook). This implies increased chances of moist westerly winds from the Atlantic Ocean and wetter-than-usual conditions. Long-range prediction systems additionally show a greater-than-usual chance of high pressure impinging on the UK from the south. This moderates the chances of above-average precipitation.
For March, the chances of below-average precipitation are slightly greater than the chances of above-average precipitation. For the March-April-May period overall, above-average precipitation is slightly more likely than below-average precipitation. Nevertheless, the shifts in probability are slight, reflecting uncertainty in the relative influence of the two competing features described above on UK-average precipitation (see graphs of figure P2). Given the increase in the likelihood of these weather patterns, however, the chances of above-average precipitation are higher in the north and northwest of the UK than in the south and southeast. The chances of impacts from high winds are also increased compared to normal, particularly during March.

Fig P1

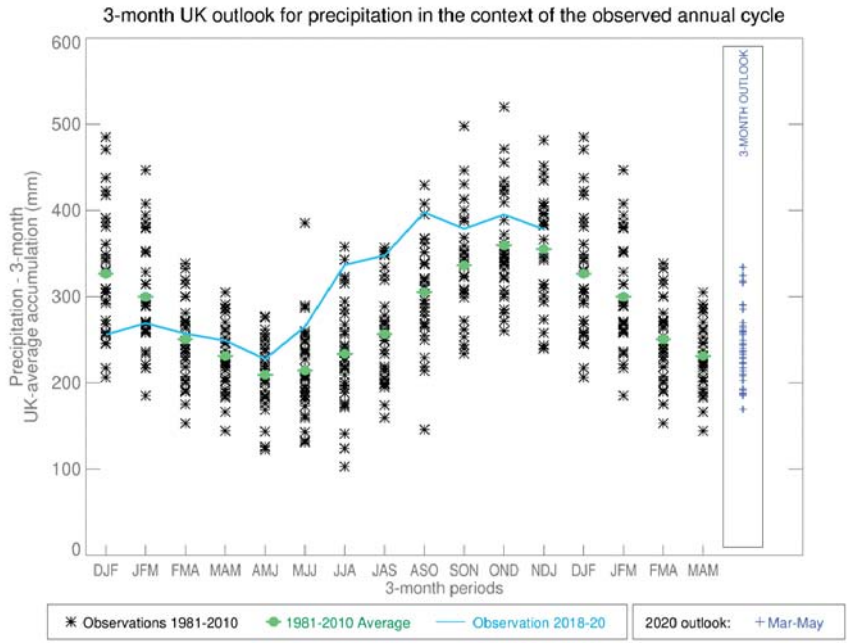


Fig P2

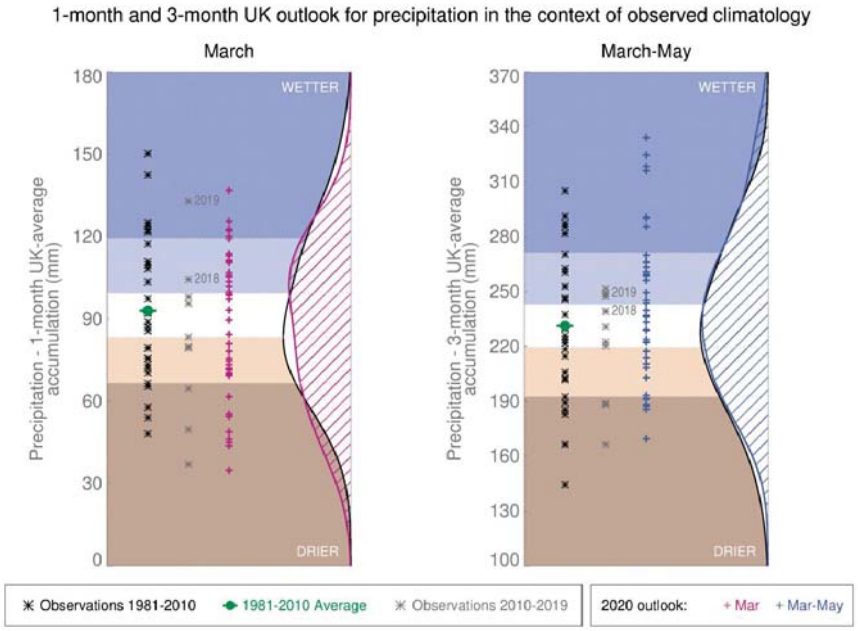
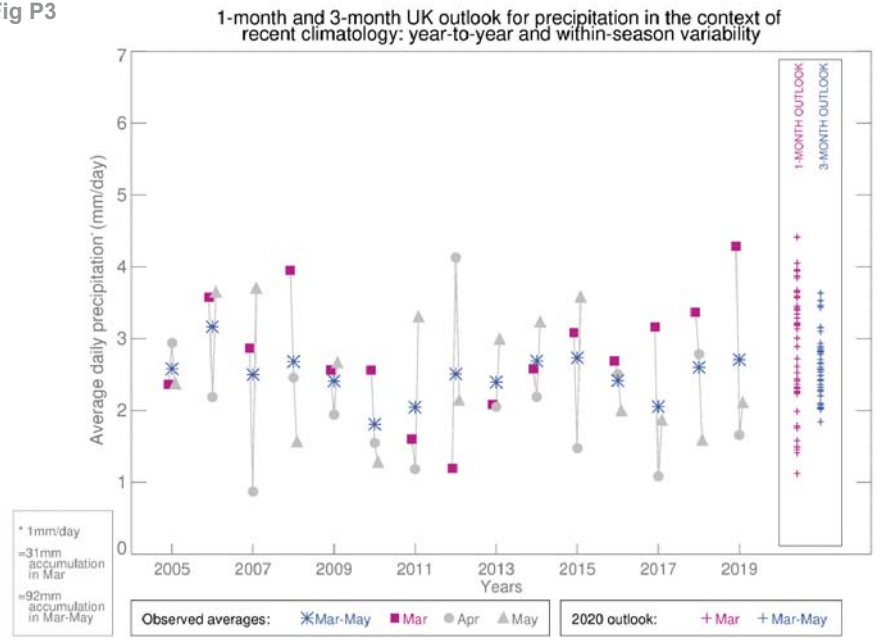


Fig P3



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: March – May 2020 Issue date: 20.02.20

The forecast presented here is for March and the average of the March-April-May period for the United Kingdom as a whole. The forecast for March 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 1st March 2020.

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

SUMMARY – TEMPERATURE:

For March and March-April-May as a whole, above-average temperatures are more likely than below-average temperatures.

Overall, the probability that the UK-average temperature for March-April-May will fall into the coldest of our five categories is less than 5% and the probability that it will fall into the warmest of our five categories is around 55% (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. Consequently, it is not expected to influence UK weather patterns.

The Stratospheric Polar Vortex (SPV) – the circulation of winds in the stratosphere above the Arctic – is currently much stronger than usual and is likely to remain so through much of the outlook period. A strong SPV favours a positive phase of the North Atlantic Oscillation (NAO) and milder-than-normal conditions.

For March and March-April-May as a whole, there is good agreement between the Met Office long-range prediction system and systems from other centres around the world. These show an increased chance of a positive phase of the NAO with more frequent westerly or south-westerly winds. Along with the warming of climate, this contributes to an increase in the probability of above-average temperatures (see graphs of figure T2). Nevertheless, there remains a chance of colder-than-average conditions, even though it is less than usual.

The relatively high probability of our warmest category does not imply extreme or unseasonal weather throughout the 3-month period. Indeed, the Outlook does not identify weather for a particular day or week. The increased likelihood of this category could mean more days with temperatures that are above average to a more modest degree. Above-average temperatures can also arise from a range of types of weather, not just sunny and dry conditions.

Fig T1

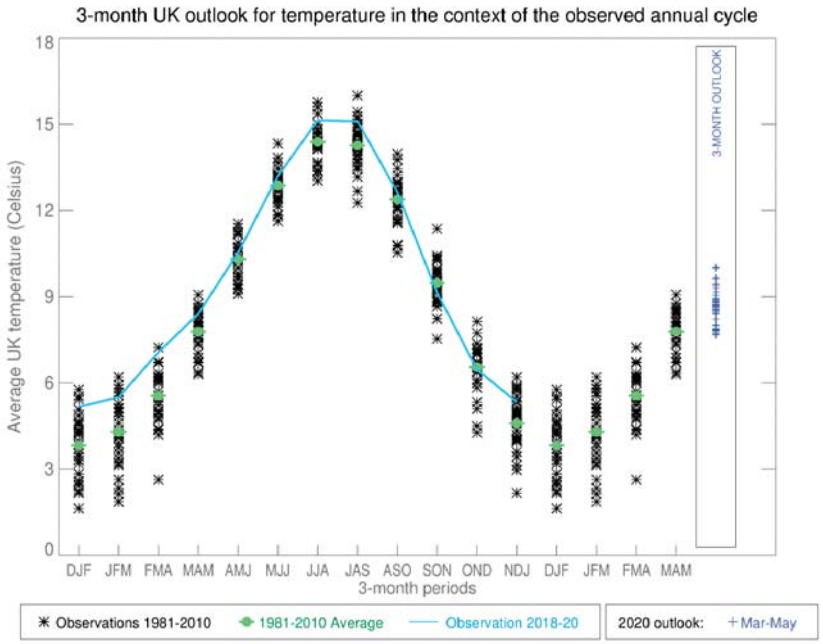


Fig T2

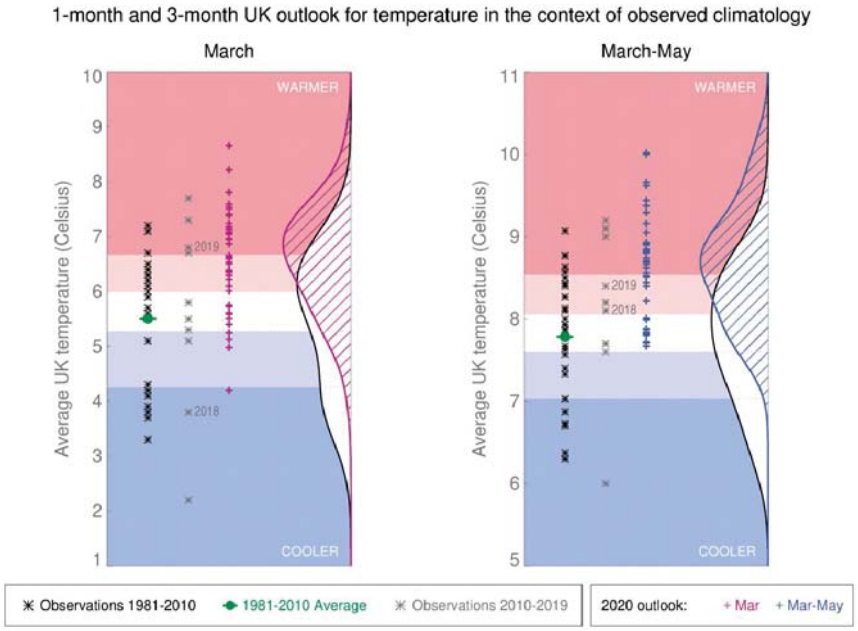
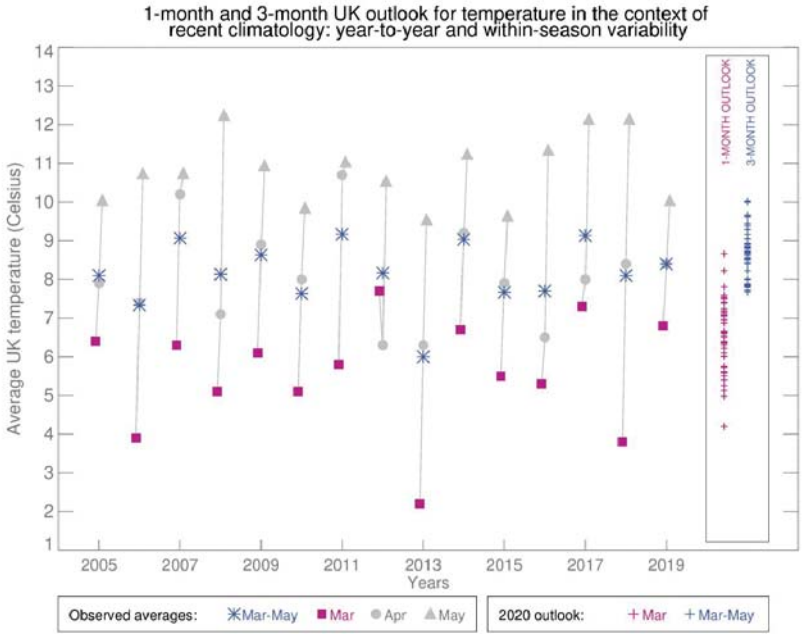


Fig T3



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UK Centre for Ecology & Hydrology

Outlook based on hydrological persistence and analogy

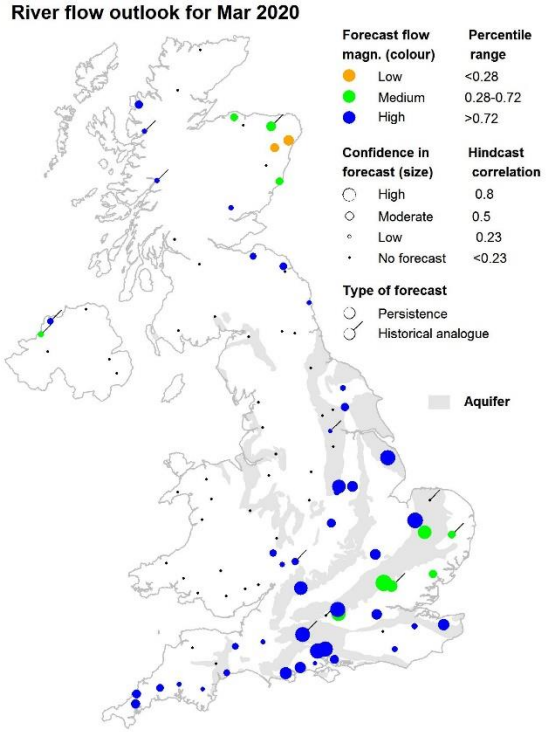
Overview

Period: March 2020 – May 2020

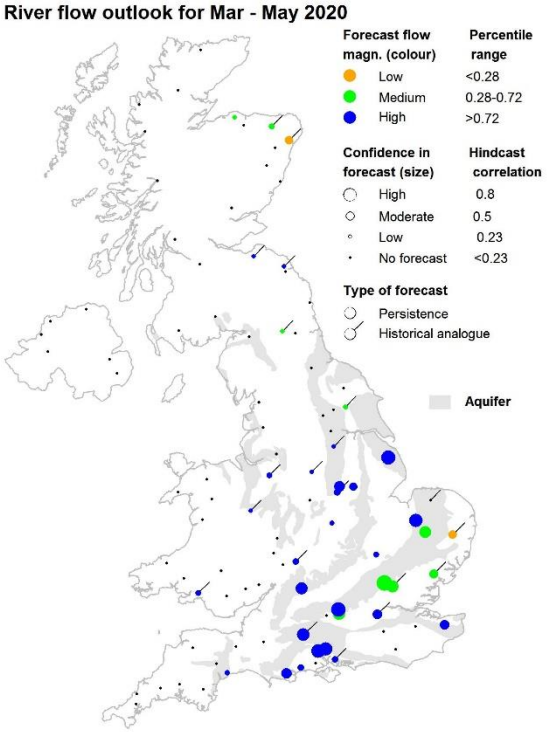
Issued on 05.03.2020 using data to the end of February 2020

SUMMARY

The outlooks for March and for March-May are for above normal river flows across most of the UK, with normal flows mainly occurring in the groundwater dominated catchments in south-east England and also in north-east Scotland. Please note that not many forecasts are available for the west of the country.



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

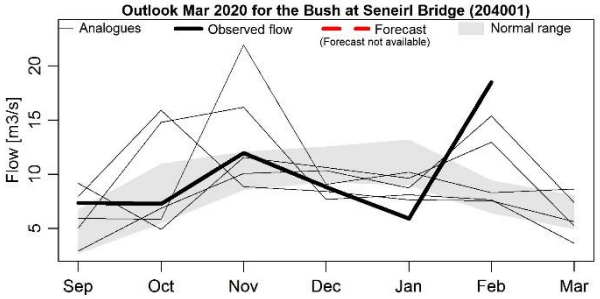
Site-based: 1 month outlook

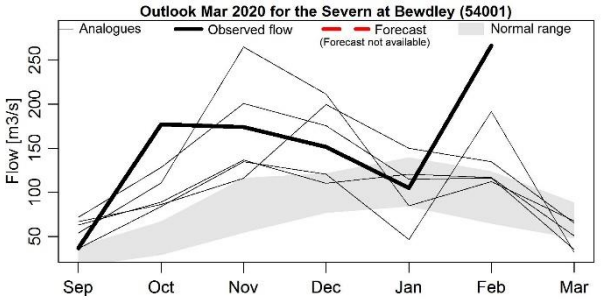
Period: March 2020

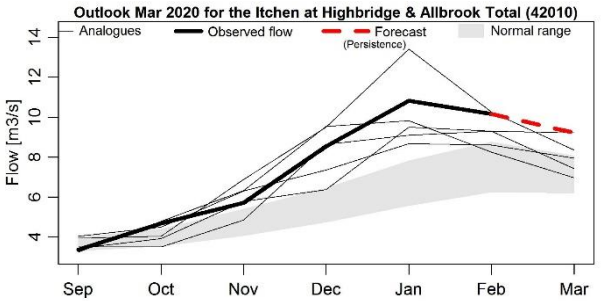
Issued on 05.03.2020 using data to the end of February 2020

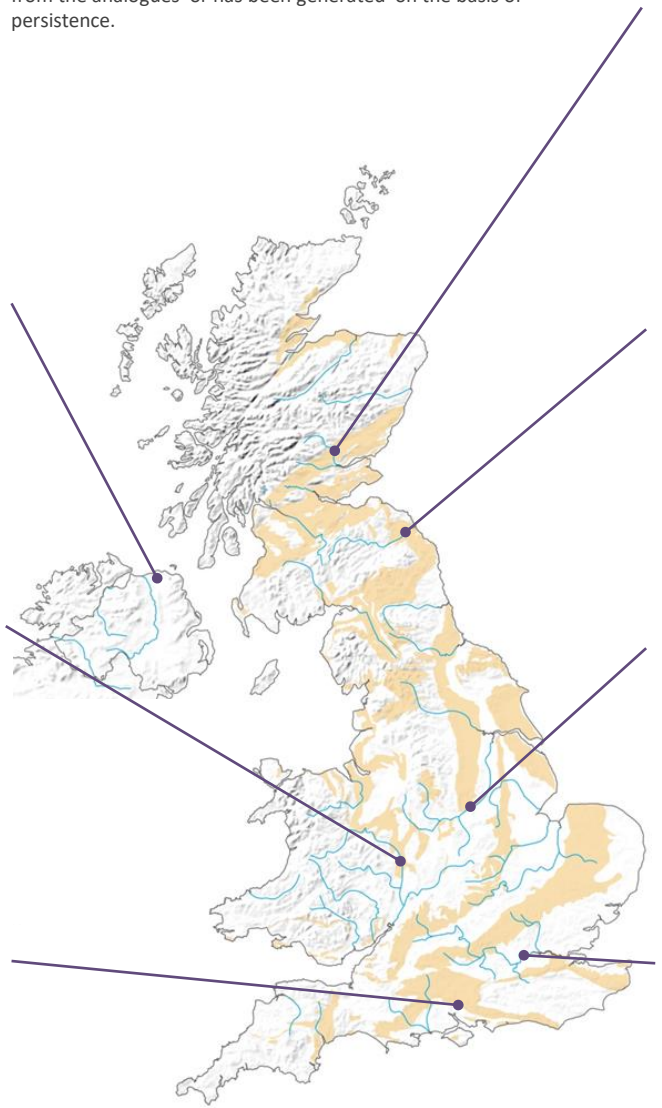
These figures provide insight into the hydrological analogue methodology for a set of sites from across the UK.

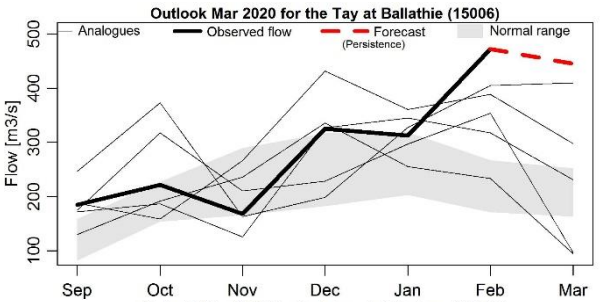
In each of the time series graphs the bold black line represents the observed flow during the past six months. The grey band indicates the normal flow range (the normal band includes 44% of observed flows in each month). The selected analogues are shown as thin lines and the trajectories that flows took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

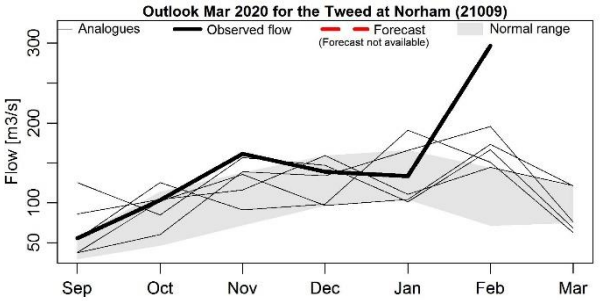


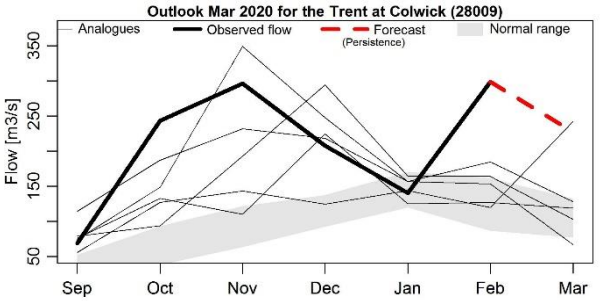


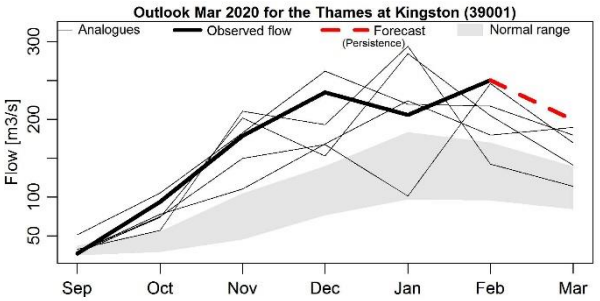












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RIVER FLOW ANALOGY

March 2020

UK Centre for Ecology & Hydrology

Outlook based on hydrological persistence and analogy

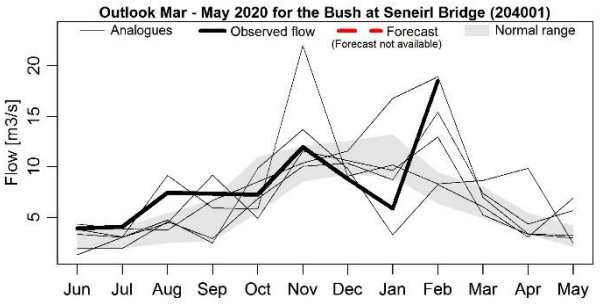
Site-based: 3 month outlook

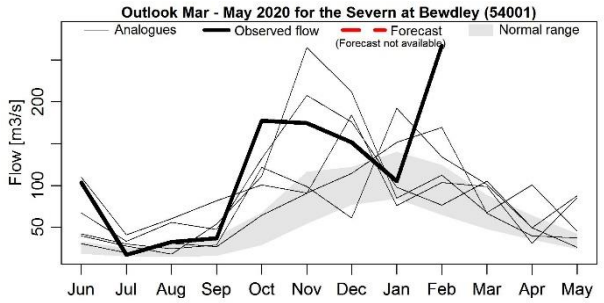
Period: March – May 2020

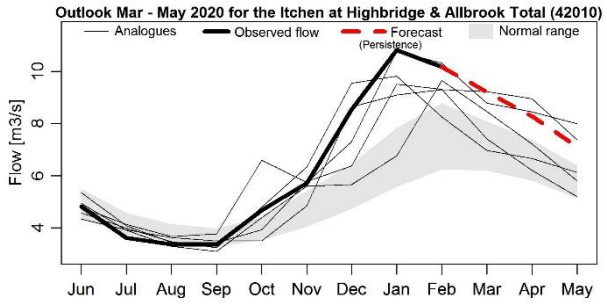
Issued on 05.03.2020 using data to the end of February 2020

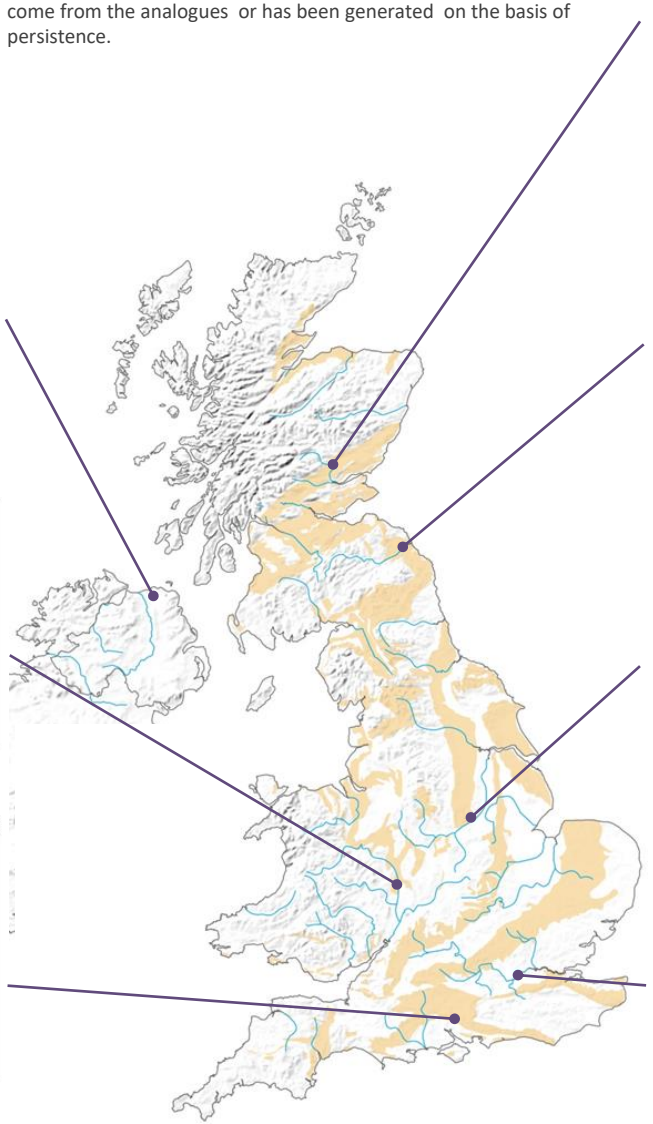
These figures provide insight into the hydrological analogue methodology for a set of sites from across the UK.

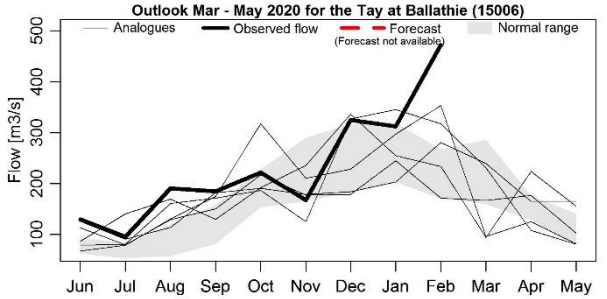
In each of the time series graphs the bold black line represents the observed flow during the past nine months. The grey band indicates the normal flow range (the normal band includes 44% of observed flows in each month). The selected analogues are shown as thin lines and the trajectories that flows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

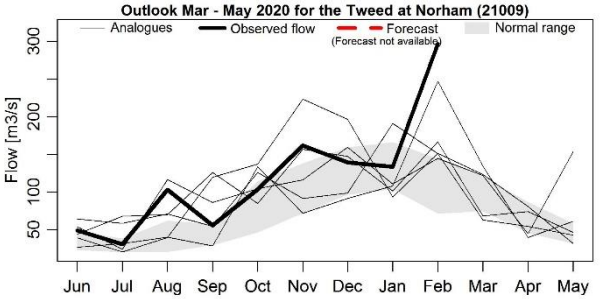


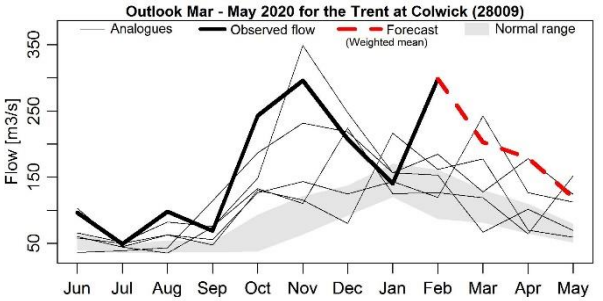


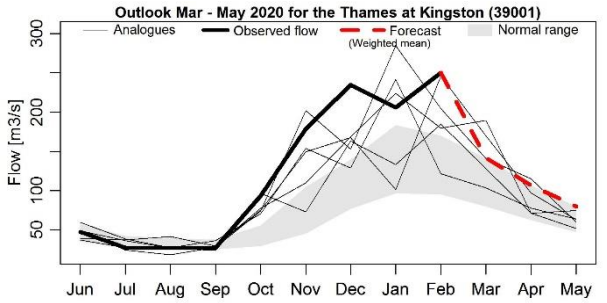












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UK Centre for Ecology & Hydrology

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Environment Agency

Outlook based on modelled flow from historical climate

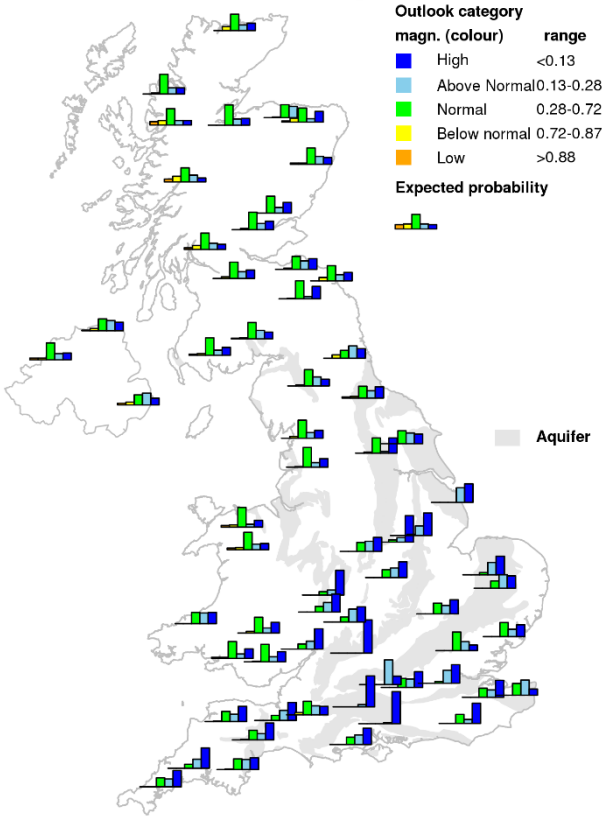
Overview

Period: March 2020 – August 2020

Issued on 06.03.2020 using data to the end of January

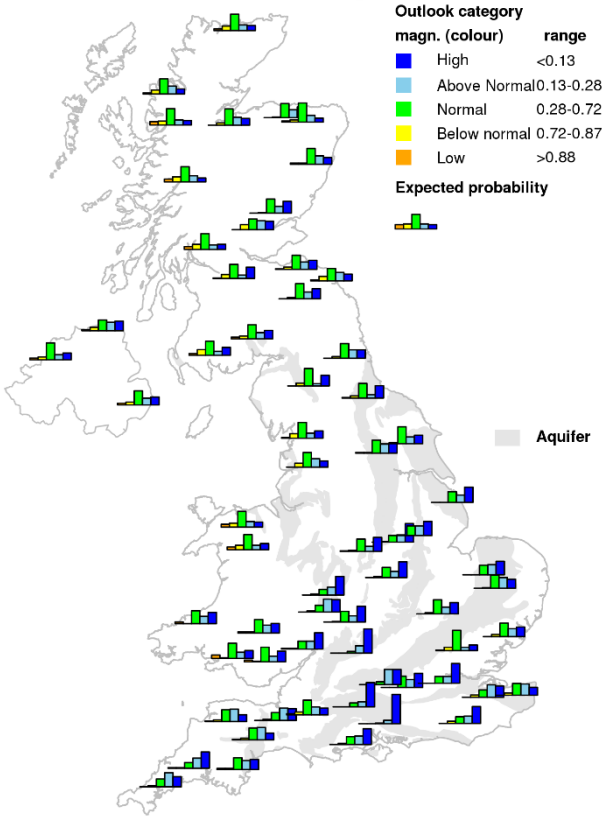
Following an exceptionally wet February, river flows in central and southern England and southern Wales are likely to be above normal to high for the next one-to-three months. Elsewhere across the UK, flows are likely to be normal to above normal for the next one-to-three months.

1-month river flow outlook starting Mar 2020



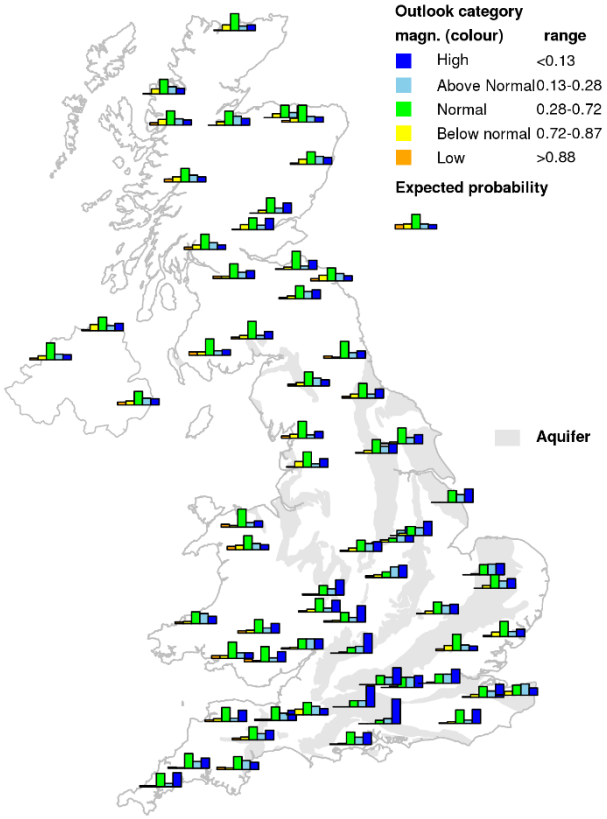
This outlook is based on monthly ensembles of historical sequences of observed climate (rainfall and potential evapotranspiration) that form input to a hydrological model. The outputs are probabilistic simulations of the average river flow over the forecast period (1 to 12 months ahead), at each location.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

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

UK Centre for Ecology & Hydrology

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Environment Agency

Outlook based on modelled flow from historical climate

Overview

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

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

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

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RIVER FLOW FROM HISTORICAL CLIMATE

March 2020

UK Centre for Ecology & Hydrology

Current Daily Simulated Subsurface Water Storage Conditions

Based on subsurface water storage estimated for **29th February 2020**

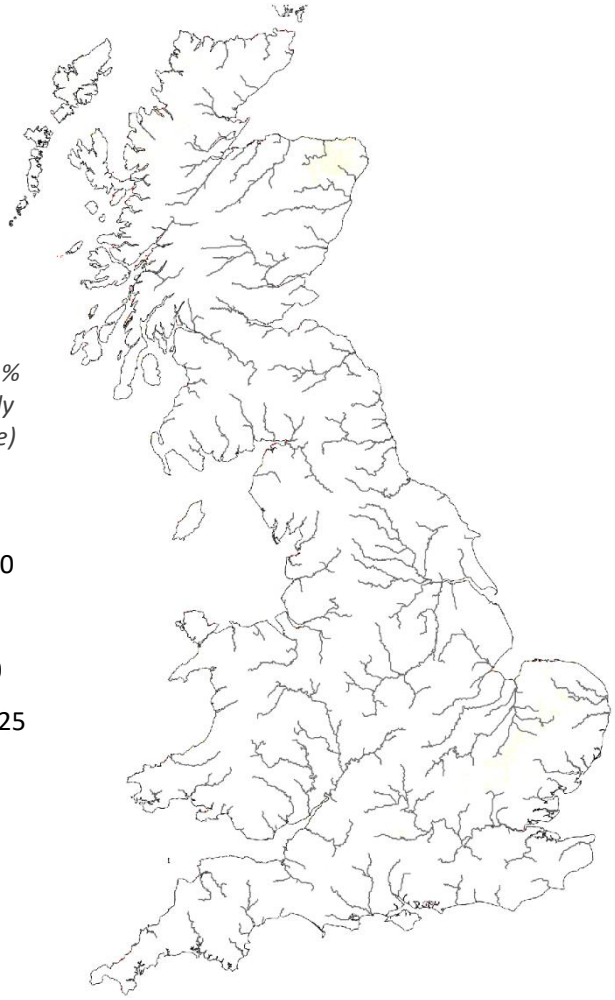
Issue date: 04.03.2020

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.

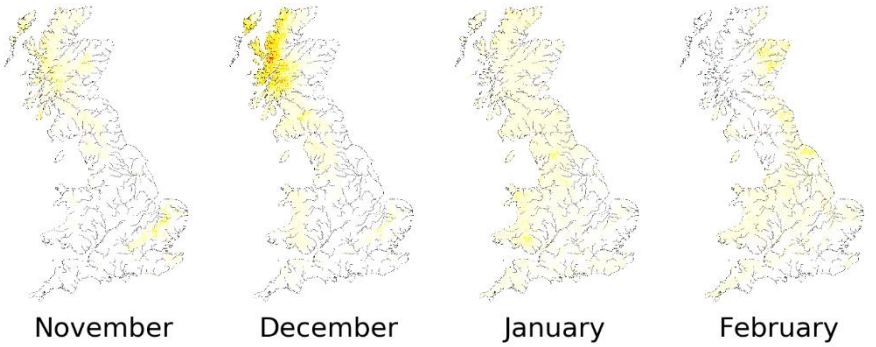
SUMMARY: At the end of February, most of the country is experiencing relative dryness levels that are not higher than average for this time of year.

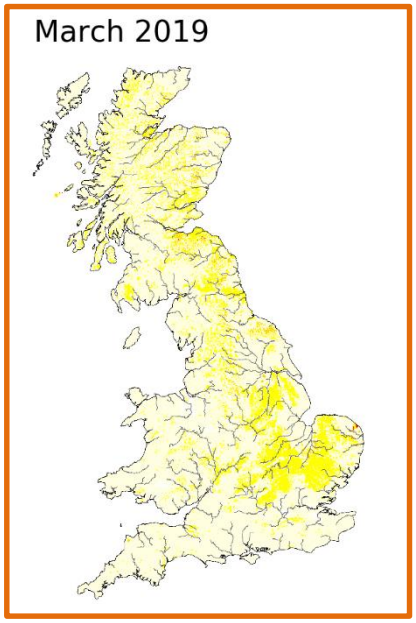
Relative Dryness

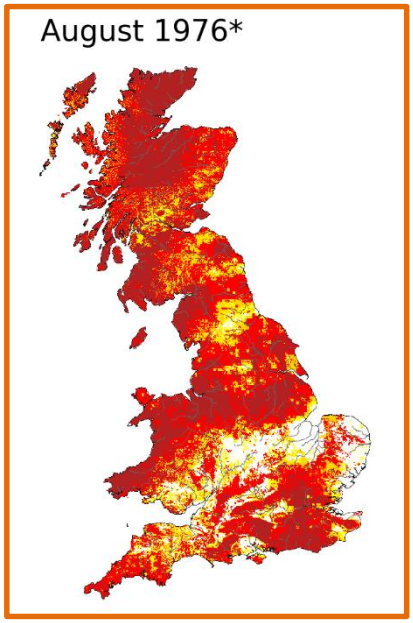


Water storage anomaly as a % of minimum storage anomaly (zero indicates average value)

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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UK Centre for Ecology & Hydrology

Current Daily Simulated Subsurface Water Storage Conditions

Based on subsurface water storage estimated for **29th February 2020**

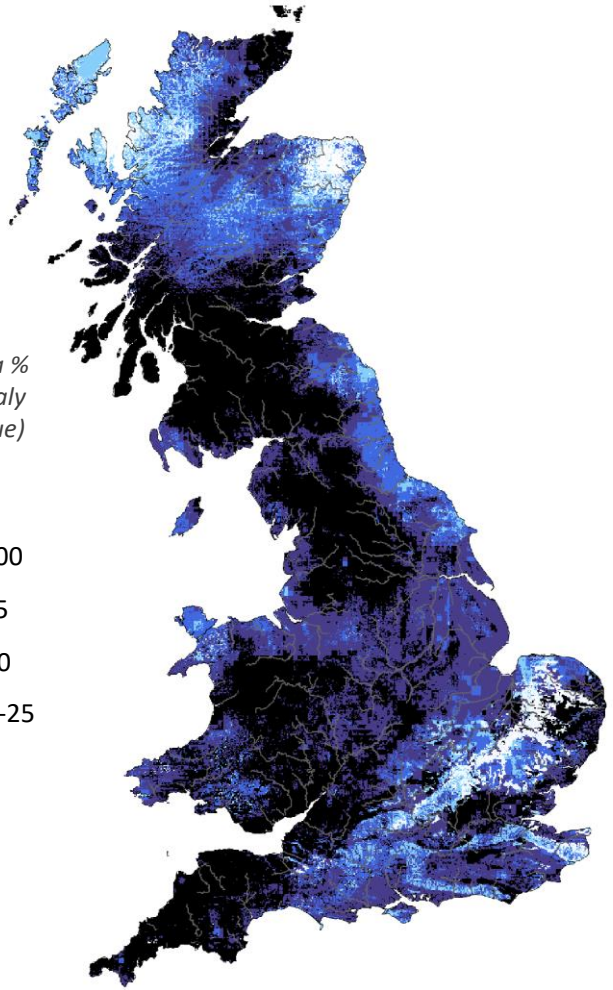
Issue date: 04.03.2020

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.

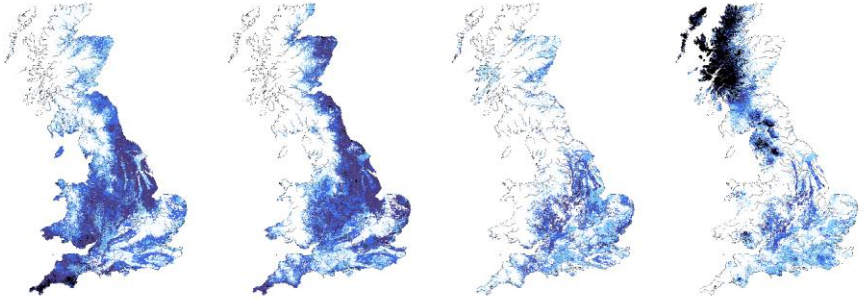
SUMMARY: At the end of February, multiple regions across the country are experiencing extreme relative wetness. In particular, most of the west coast of Britain is substantially wetter than normal.

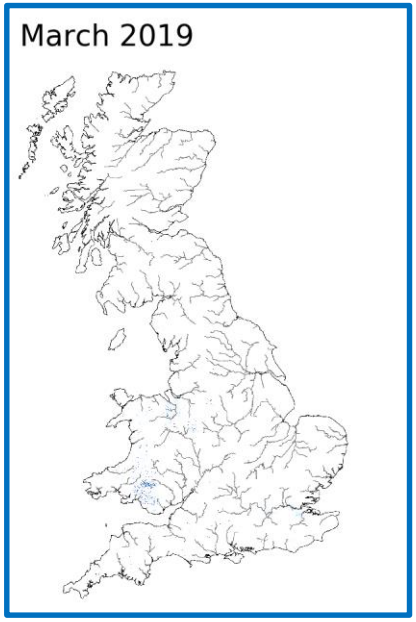
Relative Wetness



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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UK Centre for Ecology & Hydrology

Current Daily Simulated Subsurface Water Storage 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: March 2020 –August 2020

Issue date: 04.03.2020

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

Mar

Apr

May

Jun

Jul

Aug

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

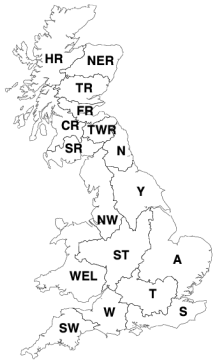
HR	Highlands Region
NER	North East Region
TR	Tay Region
FR	Forth Region
CR	Clyde Region
TWR	Tweed Region
SR	Solway Region

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

March 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 **29th February 2020**

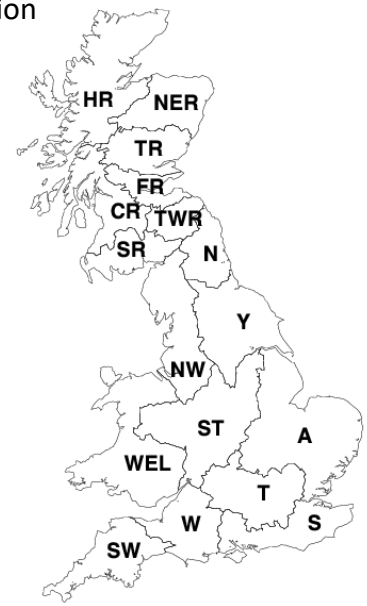
Issue date: 04.03.2020

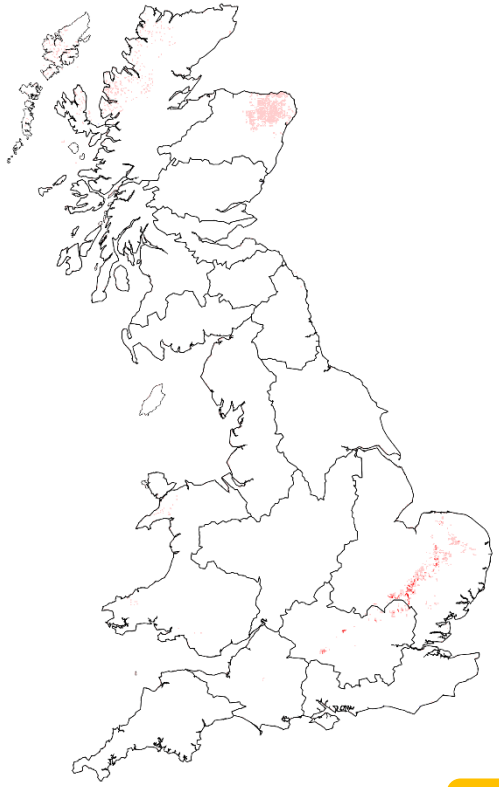
These maps show the Grid-to-Grid (G2G) hydrological model simulated subsurface water storage, expressed as an anomaly from the historical monthly mean (1981-2010), presented on a 1km grid and as regional means.
Subsurface storage deficits, i.e. where the subsurface water storage anomaly is less than 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	
0	HR	Highlands Region
0	NER	North East Region
0	TR	Tay Region
0	FR	Forth Region
0	CR	Clyde Region
0	TWR	Tweed Region
0	SR	Solway Region
	ENGLAND	
0	N	Northumbria
0	NW	North West
0	Y	Yorkshire
0	ST	Severn Trent
0	A	Anglian
0	T	Thames
0	W	Wessex
0	S	Southern
0	SW	South West
	WALES	
0	WEL	Welsh





Water storage deficit (anomaly, mm)

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

OUTLOOK BASED ON CURRENT CONDITIONS

March 2020

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UK Centre for Ecology & Hydrology

Outlook Based on Modelled Flow from Rainfall Forecasts

Overview

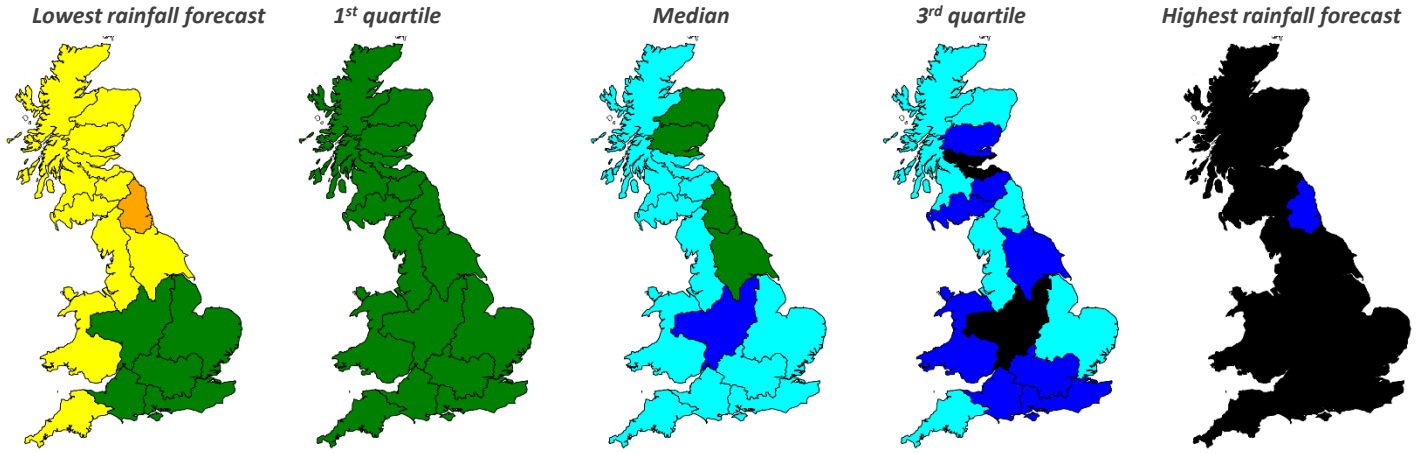
Period: March 2020 – May 2020

Issued on 04.03.2020 using data to the end of February

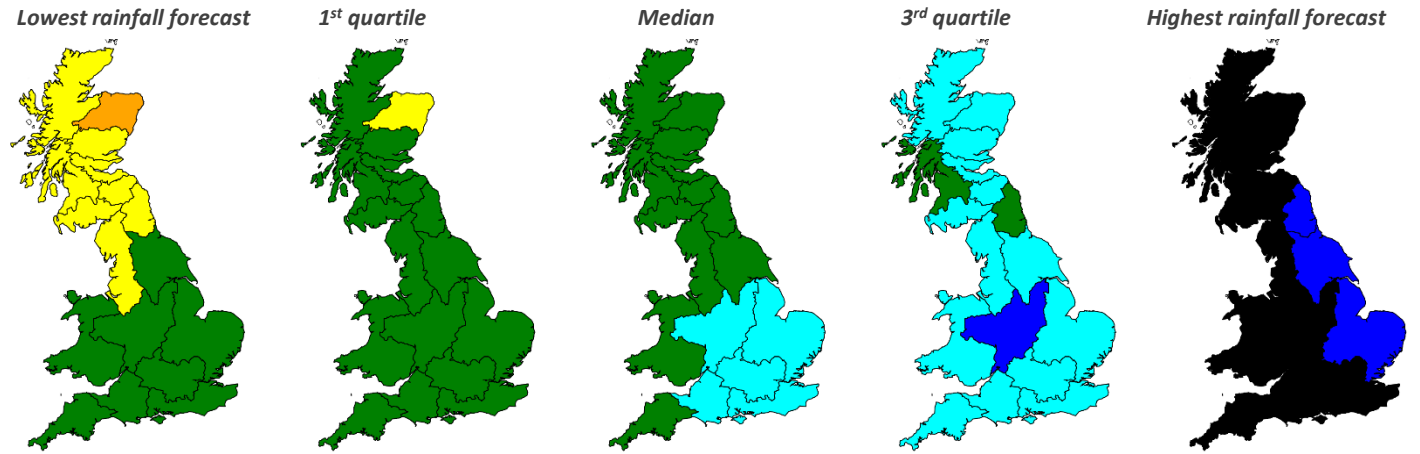
SUMMARY: During March, river flows across the majority of the country are most likely to be in the *Above normal* range or higher. River flows in the Midlands are more likely to be *Notably high to Exceptionally high*.

Over the next 3 months river flows across Northern England, Scotland and Wales are most likely to be in the in the *Normal range* or above. Flows in the South East and Midlands are most likely to be *Above normal* or higher.

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

March 2020

UK Centre for Ecology & Hydrology

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

Period: March 2020 – May 2020

Issue date: 04.03.2020

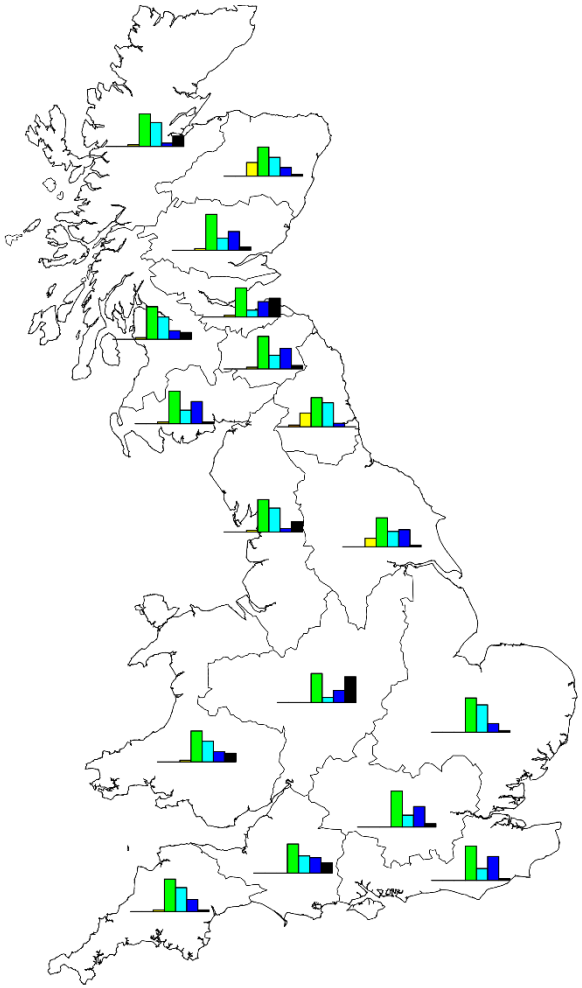
The regional maps illustrating the regional river flows for five members of the Met Office ensemble of rainfall forecasts give some indication of the range of possible river flows in the coming months. As noted previously, the actual flows could be more extreme than the flows generated by either the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

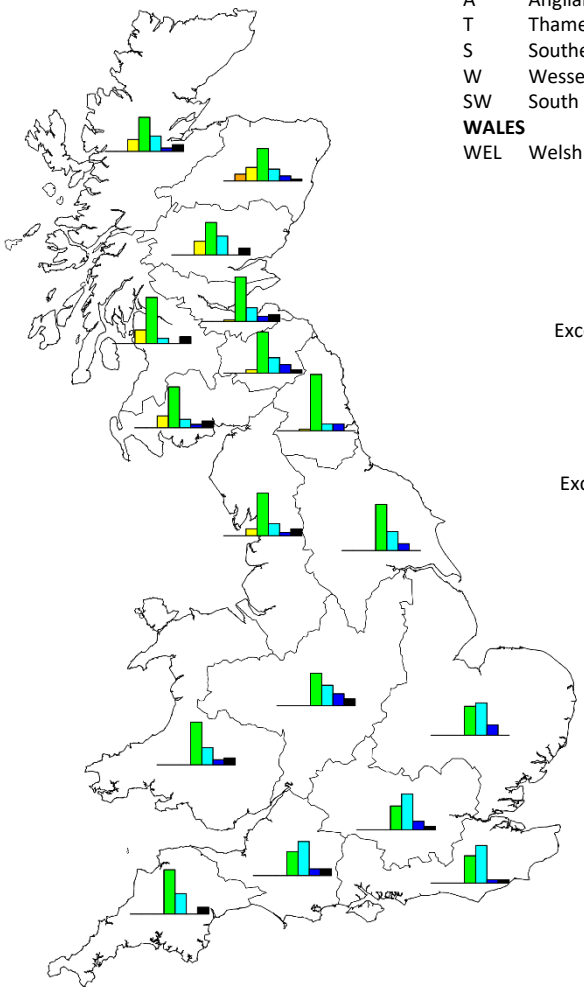
SUMMARY: During March, river flows across the majority of the country are most likely to be in the *Normal range* to *Notably high*, with the potential for *Exceptionally high* flows. River flows in the Midlands and southeast Scotland are likely to be in the *Normal range* to *Exceptionally high*.

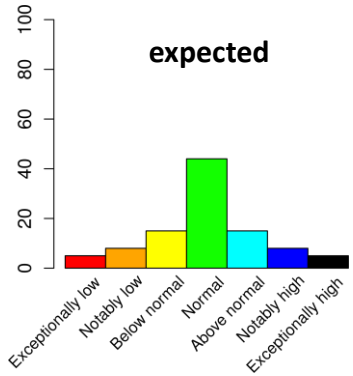
Over the next 3 months river flows across England and Wales are most likely to be in the in the *Normal range* or *Above normal.* Flows in Scotland are most likely to be in the *Normal range*. Across the majority of the country there is a chance of *Exceptionally high* flows.

1-month



3-month





SCOTLAND

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NER	North East Region
TR	Tay Region
FR	Forth Region
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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

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Notably high flow	87-95
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Notably low flow	5-13
Exceptionally low flow	< 5

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RIVER FLOW FROM RAINFALL FORECASTS

March 2020

UK Centre for Ecology & Hydrology

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

Period: March 2020 – May 2020 Issue date: 04.03.2020

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 March, river flows across the majority of the country are most likely to be in the *Normal range* to *Notably high*, with the potential for *Exceptionally high* flows. River flows in the Midlands and southeast Scotland are likely to be in the *Normal range* to *Exceptionally high*.

Over the next 3 months river flows across England and Wales are most likely to be in the in the *Normal range* or *Above normal.* Flows in Scotland are most likely to be in the *Normal range*. Across the majority of the country there is a chance of *Exceptionally high* flows.

SCOTLAND

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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
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1-month ahead	A	NW	N	ST	SW	S	T	Welsh	W	Y	CR	FR	HR	NER	SR	TR	TWR
Exceptionally high flow	2	14	0	36	2	2	5	12	14	2	10	26	14	2	2	5	5
Notably high flow	12	5	5	17	17	33	29	14	21	24	12	21	5	12	31	26	29
Above normal	38	33	33	7	33	17	17	29	24	21	31	10	33	26	19	17	19
Normal range	48	45	40	40	45	48	50	43	40	40	45	40	45	40	45	50	45
Below normal	0	2	19	0	2	0	0	2	0	12	2	2	2	19	2	2	2
Notably low flow	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Exceptionally low flow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

3-months ahead	A	NW	N	ST	SW	S	T	Welsh	W	Y	CR	FR	HR	NER	SR	TR	TWR
Exceptionally high flow	0	10	0	10	10	5	5	10	10	0	10	10	10	2	10	10	5
Notably high flow	14	5	10	17	0	5	12	7	10	10	0	7	5	7	5	0	12
Above normal	45	17	10	29	29	52	50	24	48	26	7	19	21	17	12	26	21
Normal range	40	60	79	45	62	38	33	60	33	64	64	62	48	45	57	45	57
Below normal	0	10	2	0	0	0	0	0	0	0	19	2	17	19	17	19	5
Notably low flow	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0
Exceptionally low flow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Outlook based on modelled groundwater level & climate forecast

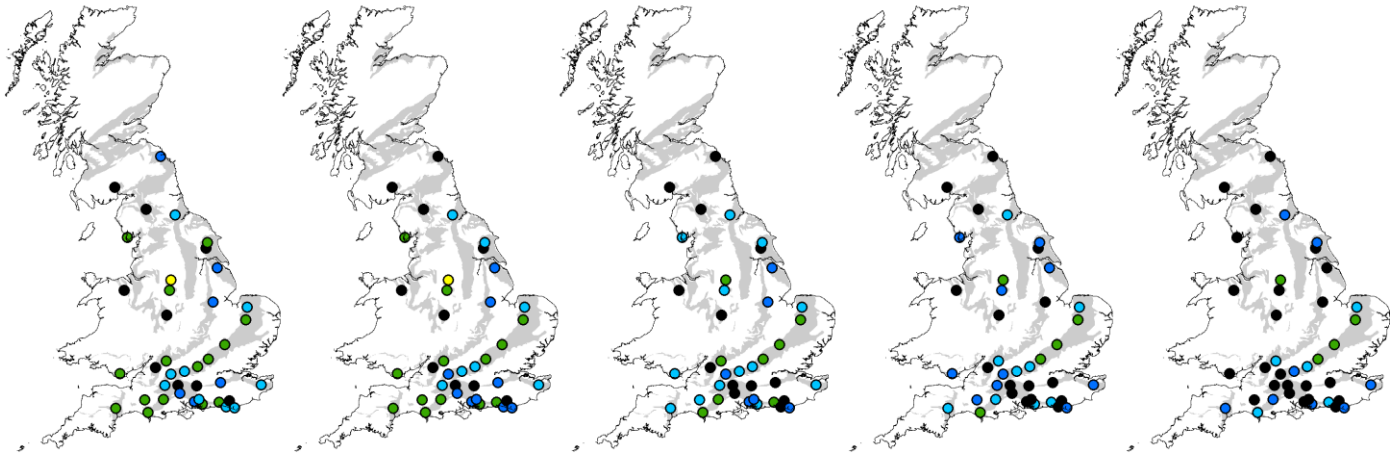
Overview

Period: March 2020 – May 2020

Issued on 09.03.2020 using data to the end of February

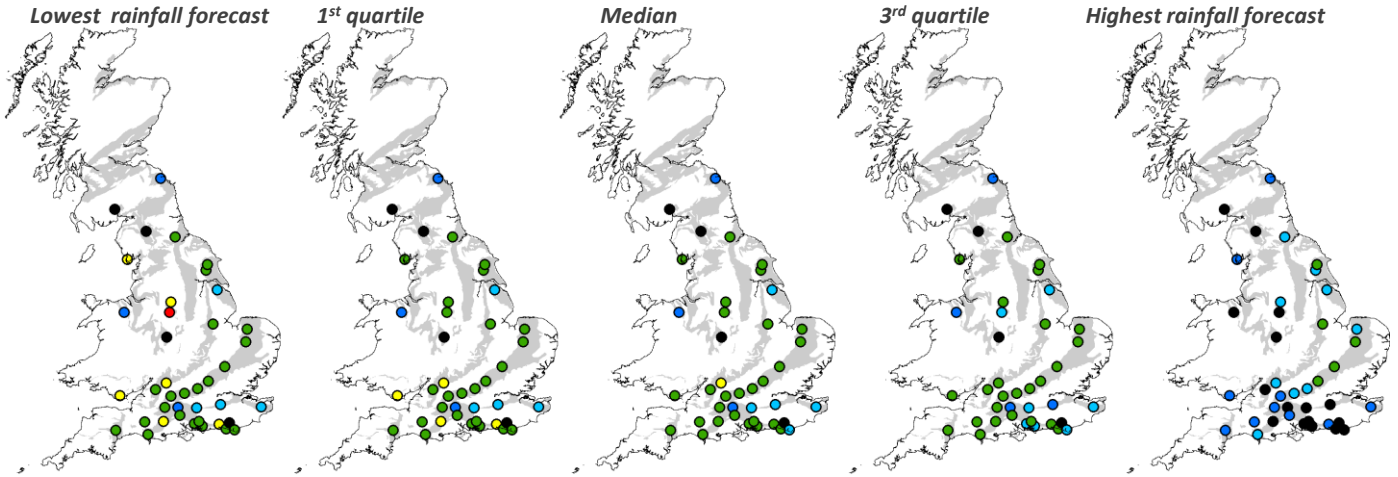
Above normal to exceptionally high groundwater levels are predicted to prevail over the UK in the next month. Exceptionally high levels are forecast across a range of lithologies including sites in the Fell sandstone, Permo Traissic sandstones, Carboniferous limestone and Chalk. More normal conditions are predicted throughout the Chalk of East Anglia and the Chilterns in both the 1 month and 3 month forecast. The outlook for the UK becomes more normal in the 3 month forecast, but with above normal levels expected across much of the Chalk of the south of England.

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*

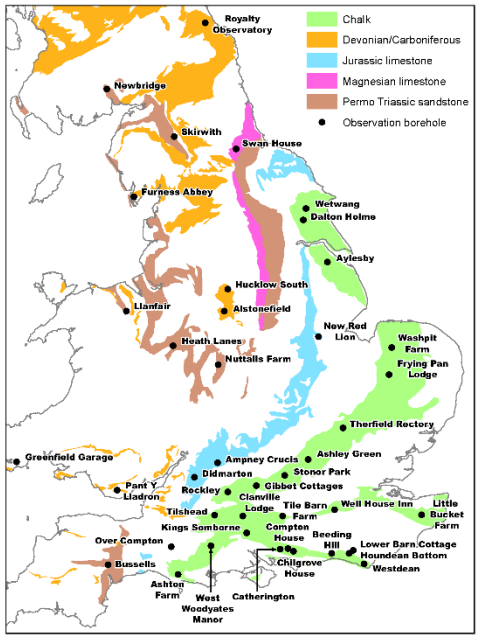


3-month outlook

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



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

GROUNDWATER FROM CLIMATE FORECASTS

March 2020

UK Centre for Ecology & Hydrology

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

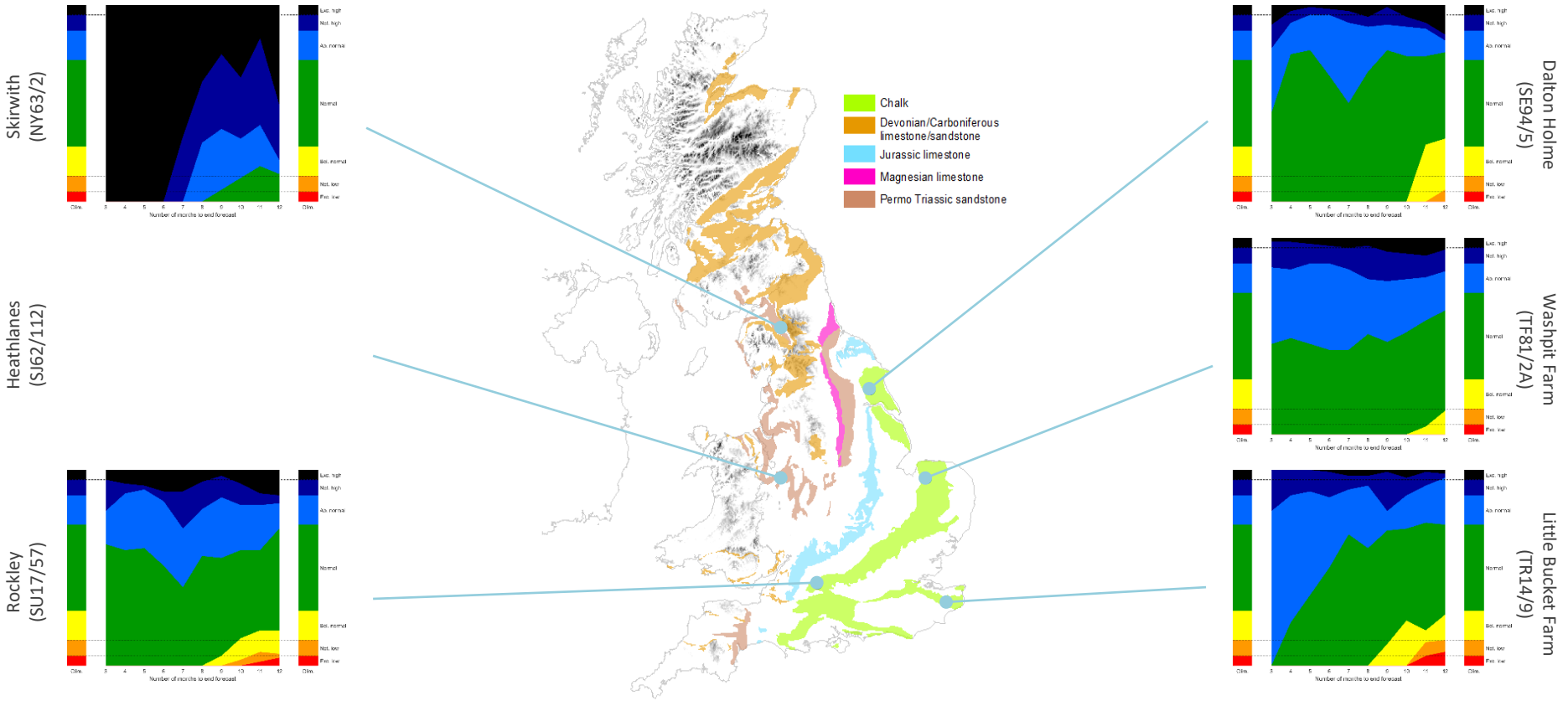
Environment Agency

Outlook based on modelled groundwater from historical climate

Period: March 2020 – February 2021

Issued on 09.03.2020 using data to the end of February

Normal to above-normal conditions are expected across the UK over the next 12 months, becoming more normal in the latter 6 months of the year. Exceptionally high levels are predicted in the Permo-Triassic sandstones at Skirwith for the next 6 months, above normal for the remainder of the year. Note that Heathlanes has been abandoned with no levels since March 2019 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