This publication was withdrawn on 17 June 2025.

This document has been replaced by the National Framework for Water Resources 2025: water for growth, nature and a resilient future.

Appendix 4: Longer term environmental water needs

Water resources national framework

16 March 2020

Version 1

We are the Environment Agency. We protect and improve the environment.

We help people and wildlife adapt to climate change and reduce its impacts, including flooding, drought, sea level rise and coastal erosion.

We improve the quality of our water, land and air by tackling pollution. We work with businesses to help them comply with environmental regulations. A healthy and diverse environment enhances people's lives and contributes to economic growth.

We can't do this alone. We work as part of the Defra group (Department for Environment, Food & Rural Affairs), with the rest of government, local councils, businesses, civil society groups and local communities to create a better place for people and wildlife.

Published by:

Environment Agency
Horizon House, Deanery Road,
Bristol BS1 5AH

www.gov.uk/environment-agency

Further copies of this report are available from our publications catalogue: http://www.gov.uk/government/publications or our National Customer Contact Centre: 03708 506 506

Email: enquiries@environment-agency.gov.uk

Contents

1. Introduction

This appendix to the water resources national framework sets out our approach to the work that informs section 5.4.2 of the national framework 'Further work exploring longer term changes to protect the environment'. It provides further detail on the modelling, data sources and the assumptions we have made. It also gives more detailed results. It is intended for anyone who wants to understand this work and particularly for regional water resources groups to help them plan in this area.

2. Aims

The main aim of this work is to make sure that decisions on changes to water abstraction to protect the environment are future-proof and that opportunities are realised by:

- developing scenarios that set out a range of possible impacts from climate change and demand
- modelling the scenarios to understand the range of futures we might be facing
- producing data and trends showing the likely impacts for regional groups to use in their long term planning
- understanding the potential scale of the shortfall in water availability that could result from changes in abstraction under the environmental scenarios

3. Scenarios

This section introduces the scenarios we have explored. These include:

- business as usual
- enhanced
- adapt
- combined

Under each scenario we have analysed what abstraction recovery would be needed to meet the Environmental Flow Indicator (EFI). The EFI indicates the proportion of natural flows that are required to support the environment in any given waterbody. Depending on the sensitivity of the waterbody it typically indicates that somewhere between 80% and 90% of natural low flows are protected.

3.1. Business as usual

Under this scenario our policy and regulatory approach remains the same. This means that we continue to protect the same percentage of natural flows for the environment. Along with this, flow and groundwater balance tests evolve as a proportion of natural flows as these are changed by the impacts of climate change. In this way the environment adapts to climate impacts on flows and groundwater.

3.2. Enhanced

The enhanced scenario sees greater environmental protection for Protected Areas and Sites of Special Scientific Interest (SSSI) rivers and wetlands, principal salmon and chalk rivers. This is achieved by applying the most sensitive flow constraints as appropriate to boost environmental protection. Flow and groundwater balance tests evolve as a proportion of natural flows as climate change alters those flows.

3.3. Adapt

Under this scenario our policy adapts to accept that we might not be able to achieve current environmental objectives in a shifting climate. This means recovery to a lower standard in some heavily modified waterbodies (HMWB). Flow and groundwater balance tests evolve as a proportion of natural flows as these are altered by the impacts of climate change.

3.4. Combined

Under this scenario we combine our business as usual, enhanced and adapt approaches. This balances greater environmental protection for Protected Areas, SSSI rivers and wetlands and principal salmon and chalk rivers with a view that good status (as defined under the Water Framework Directive) cannot be achieved everywhere in a shifting climate. We have looked at this approach at a national level but it requires more detailed local analysis to better understand how best to protect the environment.

4. Methodology

4.1. Background

The Environment Agency owns and manages the Water Resources Geographical Information System (WRGIS) database. The WRGIS is used to calculate water availability on a Water Framework Directive (WFD) waterbody scale. To calculate water availability it looks at the balance between the flow in the river, the quantity needed to support the ecology and the water that can be licensed for abstraction. To do this the WRGIS database contains natural flow data (what flows would be under natural conditions) and artificial influence data including: surface water abstractions, groundwater abstractions, discharges and influences from reservoirs.

For each waterbody we start with the natural flow that would be in the river in the absence of any artificial influence.

An Abstraction Sensitivity Band (ASB) of high, medium or low sensitivity to abstraction is assigned to each waterbody based on a combination of physical, macroinvertebrate and fish typology. The ASB defines the EFI, which indicates the quantity of water we want to maintain in the river to protect the ecology and subsequently the amount of water we can allow for abstraction.

Table 1: Percentage allowable abstraction from natural flows at different sensitivity bands and at different flow snapshots (Q30 is the highest and Q95 is the lowest flow)

	Q30	Q50	Q70	Q95
ASB3 ‘high’	24%	20%	15%	10%
ASB2 ‘moderate’	26%	24%	20%	15%
ASB1 ‘low’	30%	26%	24%	20%

We then account for existing artificial influences to calculate three scenarios:

- recent actual – abstraction rates are based on abstraction returns, typically a 6 year period, 2010 to 2015
- future predicted – abstraction rates are based on recent actual abstraction rates multiplied by a growth factor to project abstraction to 2050. For the purposes of this work the future predicted scenario is not capped at the licensed limit, so it could include where future demand exceeds the current licensed limit
- full licensed – abstraction rates are based on full licensed quantities

We screen all river waterbodies (except those in flow regulated rivers) to show where abstraction impacts may be causing flows to fall below EFIs when the flow is low. Low flow is defined as Q95, that is, the long term average flow exceeded 95% of the time. If the flow in the recent actual scenario is higher than the EFI at Q95, then the waterbody is compliant. If the recent actual scenario falls below the EFI at Q95, the waterbody is non-compliant. There are three bands of non-compliance which are defined by the degree of deviation from the EFI.

Table 2: Describes compliance and non-compliance at different abstraction sensitivity bands.

Abstraction Sensitivity Band	Compliant with EFI	Non-compliant Band 1 (up to 25% below the EFI at Q95)	Non-compliant Band 2 (25-50% below the EFI at Q95)	Non-compliant Band 3 (up to 50% below the EFI at Q95)
ASB3 ‘high’	<10% lower than natural flow	<35% lower than natural flow	<60% lower than natural flow	>60% lower than natural flow
ASB2 ‘moderate’	<15% lower than natural flow	<40% lower than natural flow	<65% lower than natural flow	>65% lower than natural flow
ASB1 ‘low’	<20% lower than natural flow	<45% lower than natural flow	<70% lower than natural flow	>70% lower than natural flow

The WRGIS calculates water availability at 4 flow snapshots. From high to low, these are: Q30, Q50, Q70 and Q95. These are calculated for each integrated waterbody, where an integrated waterbody is the combination of all Catchment Assessment Management Assessment Points and also all WFD river, lake and transitional waterbodies.

The WRGIS is also used to calculate the 4 groundwater tests and overall groundwater status for the WFD.

The WRGIS is a snapshot of water resource data and information which is used for the purposes of calculating water availability. We have chosen to use the WRGIS to explore the environmental scenarios for the national framework because it allows us to run climate and sustainability change scenarios together. It also allows us to understand the likely scale and distribution of any non-compliance with environmental standards that would result from each scenario.

4.2. Defining a baseline

To establish a starting point, or baseline, for 2025 we accounted for the planned licence changes we expect to be in place by 2025. Planned licence changes have been identified and matched to abstractions in the WRGIS database. Where specific quantity changes have been identified, largely for the National Environment Programme (NEP5) and Asset Management Programme (AMP7) schemes, these new licence quantities have been applied. This has included the removal of 13 licences. Other changes we took into account include those relating to:

- time-limited licences in the most seriously damaged waterbodies
- licences in the unused and under-used licence programme
- non-water company licences linked to sites remaining in the restoring sustainable abstraction programme

Where specific licence quantities were not available we've taken the largest of either the recent actual or 70% of full licensed quantity as the new licensed quantity. No changes have been made to discharges.

The baseline reflects the Abstraction Plan[1] ambition so we have assumed that:

- waterbodies that were at good ecological status in 2016 will remain at good
- planned implementation schemes in NEP and AMP will enable the relevant waterbody to achieve good ecological status by 2027
- waterbodies that were assessed as uneconomic to solve in the abstraction plan will continue to be uneconomic to solve in this analysis and have therefore been excluded from the baseline

These are broad assumptions, made on a national scale for the purposes of the national framework. The results of this modelling should not supersede local investigations that have used more detailed assumptions or modelling.

4.3. Estimating abstraction in 2050

For this analysis we need to estimate abstraction and discharges in 2050. To do this we apply a growth factor to the recent actual abstraction and discharge rates to produce future predicted abstraction and discharge rates. These numbers are used in the future predicted scenario calculations. We have allowed the future predicted rates to exceed the fully licensed rates as this represents where abstractors may require more water in 2050 compared to what they are licensed to abstract now.

We applied the growth factors per sector.

---

[1] Water Abstraction Plan

Table 3: Growth factor per sector applied to abstractions

Sector	Growth factor	Source
Water company	Factor per water resource zone	Based on difference between 2020 to 21 and 2044 to 45 Distribution Input from revised draft WRMP (WRMP table reference 11FP)
Amenity and environment	1	Flat forecast of 1
Horticulture	2.01	Based on the average for horticulture for the 4 scenarios explored in the Cranfield report: Task 2 Agricultural demand forecasts (Part II): future demand. April 2018
Spray irrigation agriculture	1.44 (for all except spray irrigation - anti frost)	*
Other agriculture	1 (Includes spray irrigation: anti frost)	Flat forecast of 1
Power generation	1.22	Based on demand forecast scenarios using the Department of Energy and Climate Change 2011 Updated Energy Projections for 2030.
Paper	1.11	*
Food and drink	1.25	*
Chemical	1.22	*
Other spray irrigation (non-agriculture)	1	Flat forecast of 1
Industry and any others	Factor per water resource zone	Based on the difference between from 2020 to 21 and 2044 to 45 non-household use from revised draft WRMPs (WRMP table reference 23FP + 24FP)

*Source: Understanding future water demand outside of the water industry work completed by Wood Environment & Infrastructure Solutions UK Limited

Table 4: Growth factors applied to discharges

Sector	Growth factor	Source
Water company	Factor per water resource zone	Based on difference between 2020 to 21 and 2044 to 45 Distribution Input from revised draft WRMP (WRMP table reference 11FP)
All other sectors	Factor per water resource zone	Based on the difference between from 2020 to 21 and 2044 to 45 non-household from revised draft WRMPs use (WRMP table reference 23FP + 24FP)

We have applied the growth factors to the recent actual abstraction and discharge rates to estimate what abstraction and discharge may be in 2050. We used these figures to calculate the future predicted scenario. In some cases the future demand may exceed the full licensed quantities we have in the WRGIS. This same abstraction and discharge data has been applied to all the environmental scenarios.

We use the comparison of the future predicted scenario (for the different environmental scenarios) against the recent actual scenario from the 2025 baseline to represent the estimated change in abstraction between 2025 and 2050.

Because this analysis is focused on understanding the scale of changes to abstraction potentially required to protect the environment – reducing the impact of actual or predicted abstraction – we have modelled future increases in abstraction based on predicted demand. However there is a risk that abstraction could increase beyond this in places leading to deterioration in flows and groundwater levels. Licence changes to remove that risk would be larger than those reported in this analysis.

4.4. Estimating natural flows in 2050

It is widely accepted that climate change will affect natural river flows in the future. This is an important consideration for this analysis so we used existing data to estimate the impact. The latest climate scenarios are from UK Climate Projections 2018 (UKCP18). However, at this time, there is no widespread analysis of river flows using UKCP18 so it was not possible to use UKCP18 as part of this analysis. Instead, to estimate natural flows for 2050 we considered two evidence sources:

- Future Flows Hydrology (FFH)[2]: provides time series of river flows at 276 gauged locations from 1950 to 2098 using a medium emissions scenario. FFH is made up of an 11 member ensemble of climate model derived time series each of which is an equally plausible future outcome - the underlying climate model is HadCM3 which also provided the basis for the UKCP09 projections
- the Marius hydrology datasets[3] provide monthly time series of river flows on a national 1km grid and daily time series of river flows for 260 gauge locations - the time series

[2] Future Flows Hydrology data

[3] Marius Hydrology data

are available for three time periods; historic baseline (1900 to 2006), near future (2020 to 2049) and the far future (2070 to 2099) - the future periods are simulated using the RCP8.5 emissions pathway

After considering both evidence sources we opted to use the FFH dataset in this work to remain consistent with the current Environment Agency guidance to water companies.

FFH provides 11 ensemble members, each representing different climate model configurations and assumptions. To decide which of the 11 ensembles to use, analysis was undertaken for the 2080s time horizon. This is because the climate change signal is strongest at more distant time horizons and less influenced by natural climate variability.

The results for the 2080s show 2 of the 11 ensemble members (AFIXJ and AFIXK) as being the driest. There is no single ensemble member which is the driest everywhere and there is spatial variation in the impacts. In general AFIXK is the drier scenario in the south and east whilst AFIXJ is typically drier in the north and west.

We chose AFIXK as the ensemble member to use based upon the climate change impacts across the lower half of the flow duration curve (Q95-Q50) in the 2080s and applied this ensemble for the 2050 natural flows.

For each integrated waterbody we took the percentage change between the current period and 2050 at Q30, Q50, Q70 and Q95. Each integrated waterbody has a percentage change assigned by either:

- river basin: waterbody takes the river basin average
- modelled: waterbody lies in a Future Flows catchment directly
- donor: waterbody takes its impacts from a donor future flows catchment

Small adjustments were made to some waterbodies that failed one or both of the basic assumptions needed in the WRGIS. These assumptions are that:

- flows must accrete downstream - the WRGIS will not calculate correctly where there are negative sub-catchment flows - it will allow for zero accretion
- waterbodies have a greater sub-catchment flow at high flows than they do at low flows

The analysis shows there is less natural flow in 2050, in particular in the north west of England (please see section 5.2 for more details on the results).

4.5. Estimating groundwater availability in 2050

To assess the status of a groundwater waterbody there are 4 tests. The tests consider groundwater balance, impacts on dependent surface waters, impacts on dependent wetlands and abstraction-induced intrusion of saline water into groundwater. All of these must be passed for the combined status to be good.

To manage the complexity of this modelling we have assumed that reducing groundwater abstraction to achieve natural flows will deliver most environmental improvements and will in turn improve the groundwater status. However, this is not guaranteed as it is possible for the groundwater balance to be in deficit after reductions in abstraction necessary to meet river flow requirements have been made.

Recent research from the British Geological Survey (BGS) has reviewed the impact of climate change on groundwater recharge and found that recharge may increase slightly by

2050, despite a shift to a shorter recharge period[4]. This suggests that, although it represents a simplification, excluding the groundwater balance test from this analysis is unlikely to miss significant climate impacts.

4.6. Defining the business as usual scenario

Under the business as usual scenario, the policy and regulatory approach remains the same as the current approach. We continue to protect the same percentage of natural flows for the environment as described in section 4.1. The volume of water this represents changes in line with the predicted change in natural flows by 2050.

4.7. Defining the enhanced scenario

Under the enhanced scenario we provide greater environmental protection for Protected Areas and SSSI rivers and wetlands and principal salmon and chalk rivers by applying the most sensitive flow constraints. This involved identifying the relevant waterbodies and changing the designated abstraction sensitivity band applied to that waterbody (this then changes the volume of water protected through the EFI).

For Protected Area and SSSI rivers: relevant waterbodies have been identified using a list of designated riverine sites provided by Natural England (NE). We have based our analysis on the long-term Common Standards Monitoring Guidance (CSMG) targets for rivers as set out in the Joint Nature Conservation Committee Guidance[5]. We recognise that there may be local agreements which identify a more appropriate target but these are not included in this project. CSMG identifies targets based on river size and flow condition and as such differs from the range of targets we currently use within WRGIS. For the purposes of this analysis we have generated a new subset of ASBs. These have been as closely matched as possible to the CSMG relevant waterbodies based on the information currently available.

Table 5: Percentage allowable abstraction from natural flows at different abstraction sensitivity bands equivalent to CSMG

Type	Abstraction sensitivity band	Q30	Q50	Q70	Q95
River	ASB4	10%	20%	15%	10%
Headwater	ASB5	15%	15%	10%	5%
WFD high hydrology	ASB6	10%	10%	10%	5%

ASB 4, 5 and 6 are only used for the purpose of this national framework environmental scenario work. They are not part of the standard water availability calculation.

[4] Summary of results for national scale recharge modelling under conditions of predicted climate change, Mansour, M., Hughes, A. (2018)
[5] Joint Nature Conservation Committee Guidance - add reference

The principal salmon river waterbodies are based on the 42 'principal' salmon rivers identified for England. An enhanced ASB3 is applied to those waterbodies which are currently assigned an ASB of less than ASB3. However, we have ruled out those waterbodies where salmon are unlikely to be present or outside of natural spawning areas (based on a high level review by the Environment Agency).

Chalk river waterbodies have been identified based on Environment Agency's data and given an ASB3 recognising their global importance and the unique habitat they provide.

We also identified groundwater waterbodies that contain Groundwater Dependent Terrestrial Ecosystems (GWDTE) that are Protected Areas in England. We then identified the surface waterbodies associated with these GWDTE. An ASB3 has been assigned to these surface waterbodies.

For each waterbody a final assumed ASB has been identified to be used for this scenario work. It was decided to exclude the estuarine sites from the national framework scenario exercise due to the reduced risk to estuarine sites.

4.8. Adapt

Under the adapt scenario we have identified waterbodies where we could consider not reducing abstraction back to the EFI but instead to the boundary between bands 1 and 2 of non-compliance.

These waterbodies have been selected because:

- they are not water resource HMWBs but designated as HMWBs for other purposes so the natural conditions of these waterbodies are substantially altered, for example, by land drainage, navigation or flood risk management purposes
- they do not have any planned water resource AMP schemes associated with them so they are unlikely to improve
- they do not have an overall ecological potential of good

Additionally we selected further surface water waterbodies that:

- are not HMWB
- already have a hydrological regime objective of less than good (set for 2015)
- do not have an overall ecological status of good
- do not have a reason for not supporting good for abstraction related activity
- do not have planned AMP7 implementation schemes

We identified groundwater waterbodies where there is a water balance deficit at fully licensed quantities. Under recent actual rates the waterbodies would still be at poor status because it would still have a deficit water balance at recent actual. We then looked at not reducing abstraction to be compliant with the EFI but instead to the boundary between band 1 and band 2 non-compliance for the surface waterbodies that overlay the identified groundwater waterbodies.

4.9. Combined

Under the combined scenario we looked at the results from the 3 scenarios. At a national level, we have considered how in a catchment system we might combine the scenarios within the catchment to best manage resource availability in the future. Where a waterbody meets the criteria for both the enhanced scenario and the adapt scenario we have taken a precautionary approach and applied the enhanced protection to the waterbody. This scenario needs consideration at a regional level to better explore how the different scenarios can be combined to offer both protection to the environment and water availability to abstractors.

5. Results

5.1. 2025 baseline

The 2025 baseline is the starting point for this environmental scenario work. It sets out where we assume we will be in 2025 after planned changes have been made to abstraction licences.

The results suggest that in 2025, even after the 2020 to 2025 actions are implemented, a considerable reduction in abstraction may still be required. This is in the region of 880 Ml/d to meet our current planned ambition for 2027. We recognise that there is another 2 years for improvements to be made which may reduce this gap. Nevertheless, this represents a potentially significant volume of water and requires further iteration locally with reference to existing investigations to understand more fully.

The gap between the actions in place to address unsustainable abstraction and our ambition for 2025 has been calculated here in a simplified way. Further work is required to better understand how much of this represents a genuine shortfall and how much is due to the simplified methodology applied. This work is an initial modelling exercise, therefore we did not incorporate any local quality assurance of the results or take account of local modelling results. We have not cross referenced these results with other lines of evidence, such as the WFD investigation outcomes which may influence surface water compliance and groundwater status.

Our baseline assumes water companies have implemented the licence changes that are included in Ofwat's 2019 Price Review between 2020 and 2025 to tackle unsustainable abstraction. If licence changes are not made through this work then further reduction in licence quantities may be required to achieve sustainable abstraction by 2025. The baseline also includes commitments set out in the Abstraction Plan for other sectors.

5.2. Flows in 2050

Climate change will have a significant impact on flows and water availability in 2050. Figure 1 suggests, under the climatic scenario we have used, that the north east, north west and the south west would see the greatest change in low surface water flows (Q95). The south east is less affected due to its geology and the buffering capacity of groundwater in the region. However, it too sees a decrease in natural flows in most catchments by 2050.

Figure 2 shows the available resource for abstraction if the reduction in surface water flow from climate change is combined with fixing the EFI at the level it is now, irrespective of the changes brought by climate change to natural flows. This suggests that at low flows there would be no surface water available for abstraction in the north and west without reservoir storage. Along with very limited water available across most of the south and east. We do not think that fixing the EFI at current levels is a viable approach to take. However it does provide a useful illustration of the scale of the pressures facing the environment in 2050 from climate change.

Figure 1: Shows potential percentage changes in natural surface water flow by 2050 at low flows (Q95)

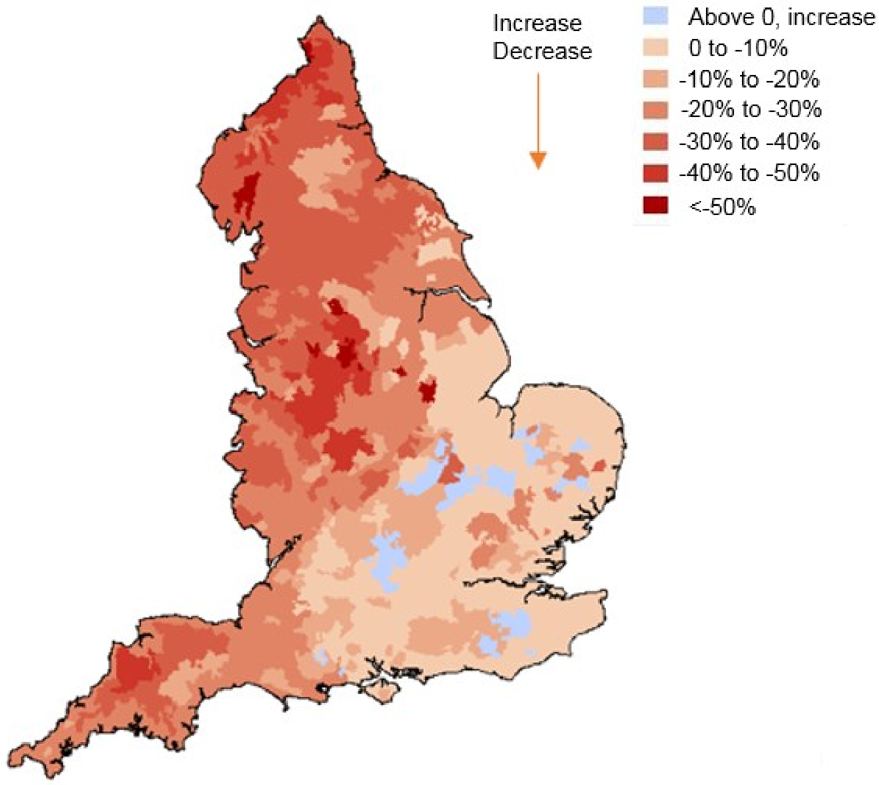


Figure 2: Shows natural available resource for abstraction at low flows (Q95) in 2050 if we protect surface water flows for the environment at current volumes

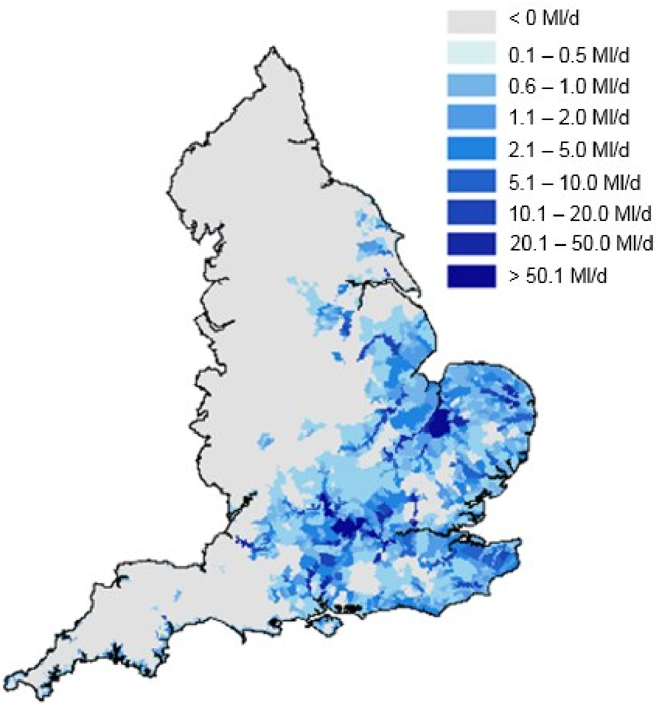
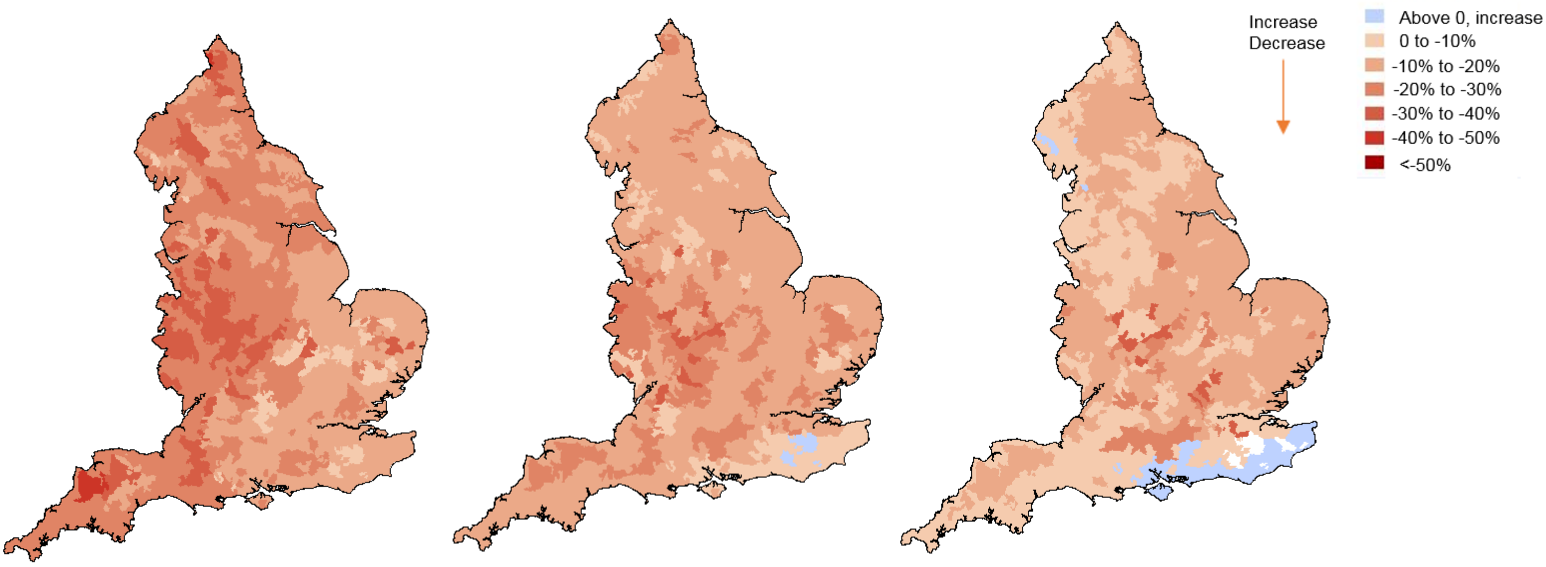


Figure 3 shows the potential percentage change in natural surface water flow by 2050 at different flows. We can see at each flow snapshot there is a decrease in surface water flows with the exception of a few catchments.

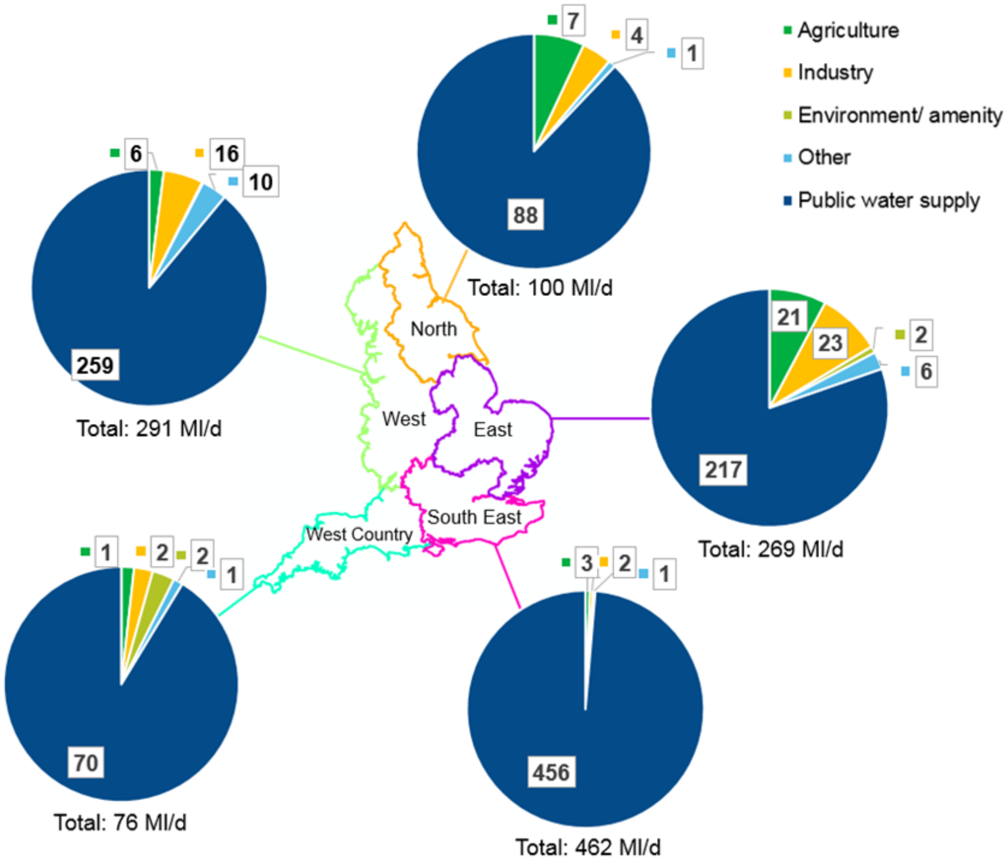
Figure 3: Percentage change in natural surface water flow by 2050, moving left to right Q70, Q50 and Q30 (lower flows to higher flows)



5.3. Business as usual

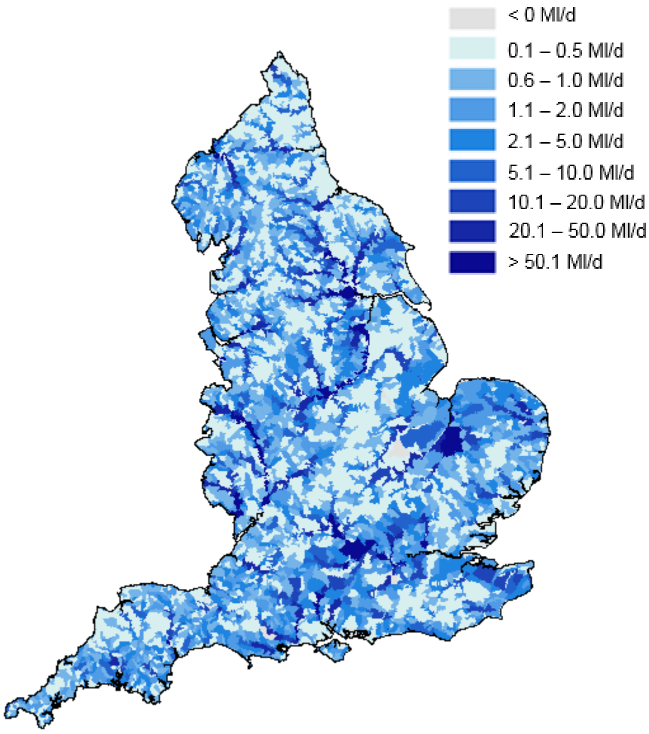
Our analysis suggests that significant reductions in abstraction are required to maintain the current ambition in the abstraction plan in future. The total reduction, including public water supply and other abstractors, is estimated at around 1200 Ml/d by 2050. Figure 4 gives an indication of the potential changes in abstraction needed by region and by sector under this scenario from now to 2050. Due to the limitations of this analysis they should not be taken as representing the actual changes required to abstraction licences.

Figure 4: An indication of the potential reductions in abstraction by region in Ml/d under 2050 business as usual scenario



If we compare the water available under this scenario (Figure 5) with that available if we were to fix the quantity of water provided to protect the environment at the volume it is now (Figure 2), we see that there is significantly more water available under the business as usual scenario. This difference is because the quantity of water protected for the environment has decreased in line with the reduction of natural flows in 2050 under the business as usual scenario. This means the environment, as well as abstractors, would have to adapt to climate change.

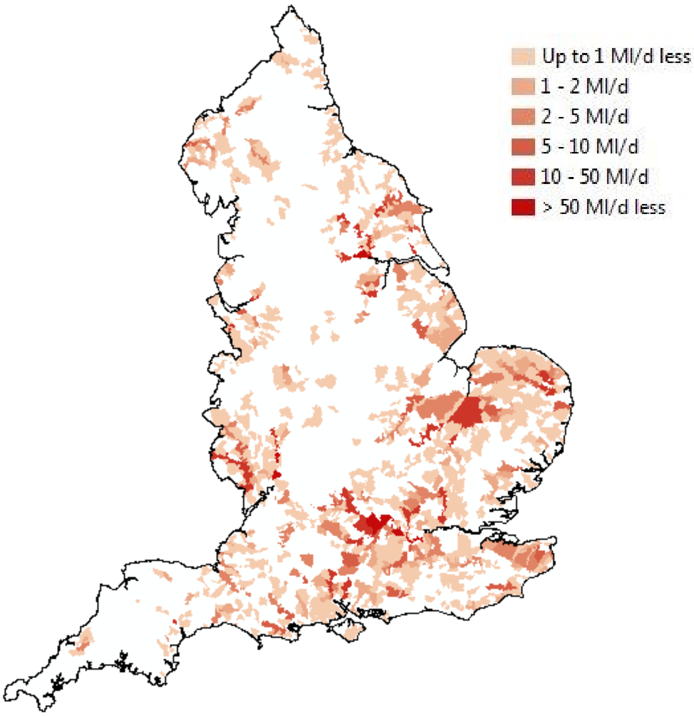
Figure 5: Natural available resource for abstraction under business as usual scenario



5.4. Enhanced

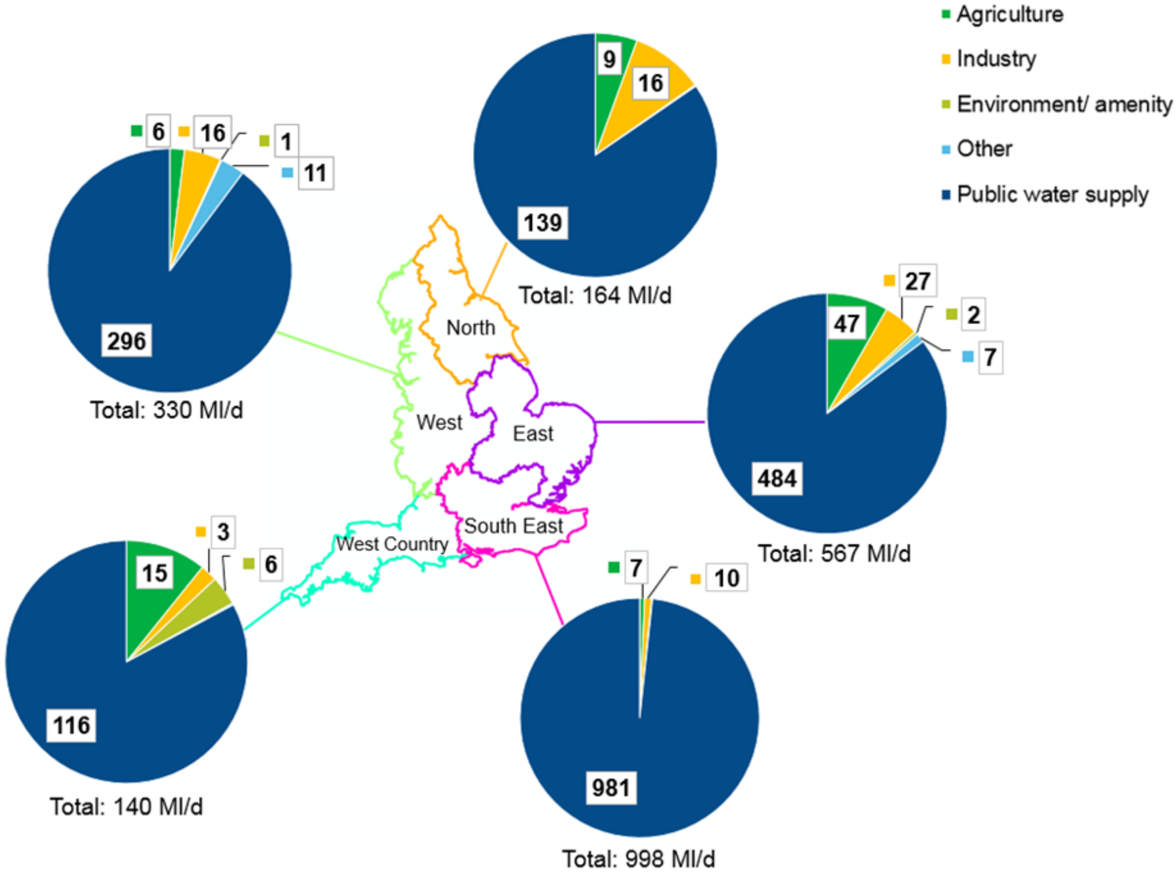
The enhanced scenario continues our policy of the EFI evolving as a proportion of natural flow. Under this scenario we have protected a greater proportion of the flow for the environment compared to the 2025 baseline. This is because we have applied more stringent sensitivity scores to a subset of waterbodies (see description of the enhanced scenario). Figure 6 shows there is less water available for abstraction in those waterbodies where we are protecting more water for the environment than we are in the business as usual scenario.

Figure 6: Reduction in naturally available resource at Q95, under the enhanced scenario compared with the business as usual scenario at 2050



Based on this scenario the potential recovery required by 2050 is 2200 Ml/d. Figure 7 gives an indication of the potential changes in abstraction needed by region and by sector under this scenario from now to 2050. Due to the limitations of this analysis they should not be taken as representing the actual changes required to abstraction licences.

Figure 7: An indication of potential reductions by region in Ml/d under the 2050 enhanced scenario



5.5. Adapt

Under the adapt scenario we continue our policy of having the EFI as a proportion of natural flow. Adapt protects the environment to the same extent as the business as usual scenario. This means we have the same number of waterbodies that are non-compliant under both the scenarios, but we have identified surface water and groundwater waterbodies where we would not reduce abstraction all the way back to the EFI. In these cases we seek to return flows to the boundary between bands 1 and 2 of non-compliance. This is because under WFD we have set an objective that is less than good. In these cases we have accepted that the waterbody cannot be returned to good ecological status.

This means the volume of reductions in some waterbodies under the adapt scenario will be less compared to the business as usual scenario. Under the adapt scenario we have calculated that the potential recovery required by 2050 is 1160 Ml/d (excluding the baseline). The potential reduction under this scenario is therefore similar to the reduction required under the enhanced scenario. This is because, where a waterbody meets the criteria for both the enhanced scenario and the adapt scenario, we have taken a precautionary approach and applied the enhanced protection to the waterbody.

6. Assumptions and limitations of the work

The national framework scenarios presented here are for planning purposes only. More detailed local and regional analysis is required to inform decision making. This section sets out the assumptions we have made and the limitations of the work.

We have used the February 2019 version of the WRGIS database. The WRGIS is a snapshot in time and is the best national information we have available on water availability. However it does not represent catchments in as much detail as more locally-specific models can. Also, WRGIS may differ from other models in the assumed distribution of the impact of abstractions.

The WRGIS includes estimations of some unlicensed activities. They are included because they impact on the water balance. Many of these unlicensed activities will come into the licensing regime as part of our work to remove exemptions from the abstraction licensing scheme (known as 'New Authorisations'). Once this is complete we will have more accurate information available than we do today.

The baseline calculations were completed on a national scale and should not supersede local investigations that have used more detailed modelling work.

To establish the 2025 baseline we had to estimate several licence reductions as the exact licence quantities were not available. Once these licence changes are identified and implemented this could alter the scale of reduction needed to achieve sustainable abstraction in the baseline.

We have applied the Abstraction Plan ambition to the 2025 baseline. This may include waterbodies that have been identified in national datasets as an outstanding issue but have in fact been dealt with on a local scale. These can be quickly removed by regional and local refinement.

We have allowed the future predicted abstraction and discharge rates to exceed the fully licensed rates. This represents where abstractors may require more water in 2050 compared to what they are licensed to abstract now. In practice these licence limits are likely to constrain abstraction under certain scenarios, reducing the impact of abstraction.

We have only completed analysis under one of the 11 possible ensembles from the Future Flows dataset. Other ensembles may not be as dry as the scenario we have used (AFIXK) or may show different spatial impacts.

Recovery calculations are based on recovery to the EFI other than in the Adapt scenario, where some waterbodies are only recovered back to the band 1 non-compliance boundary.

Recovery calculations start by reducing groundwater abstraction first. Any remaining recovery calculations consider changes to the surface water licences but only where the surface water licence does not have a flow constraint, is not from a reservoir or lake or level dependant catchment and does not have an upstream supported flow.

7. Future work

This analysis has given us an initial indication of the potential impacts of climate change on future water availability and the flows needed to protect the environment. There are some areas of work where further analysis would be beneficial.

7.1. Climate change impacts on groundwater

The resource availability assessment in the WRGIS for groundwater waterbodies uses an annual recharge value. An annual assessment does not reflect the seasonality in climate change impacts of a shorter recharge period. When taken on an annual basis the groundwater balance varies slightly, with a possible overall small increase.

The BGS climate change review suggests that, although total groundwater recharge is not likely to reduce and may increase, the recharge period could reduce from 5 months to 3 months. Taking into account drier soil moisture deficits and the implications of a shorter recharge window, the seasonal variability may have a more significant impact on resource availability with a greater risk of lower summer groundwater levels. Lower groundwater levels would result in lower base flows, therefore there is a potential risk of rivers becoming more vulnerable.

Further analysis will be needed to understand the seasonal impact on summer groundwater availability. This is particularly important in the east and south east which are very reliant on groundwater for abstraction and have sensitive ecosystems that also depend on groundwater such as chalk streams.

7.2. Climate change impacts on reservoir storage and regulated river systems

During this analysis we have not changed the modelling of reservoirs or regulated river systems. Further work on a local or regional scale would need to consider how reservoir storage could be affected. This should include how the regulation of flow may have to change to adapt to climate change. We have not included Natural Resource Wales' model of climate change impacts on the River Dee.

7.3. Combining scenarios

The likely impacts of climate change suggest that a business as usual or an adapt approach will be insufficient to protect some sensitive or ecologically important rivers. To achieve the best environmental outcomes, regional groups may need to take a balanced approach that draws elements from the enhanced, adapt and business as usual scenarios.

We have explored a combined approach at a national scale. It has highlighted a number of overlaps where a waterbody meets the criteria for both the enhanced scenario and the adapt scenario. In these cases we have taken a precautionary approach and given the enhanced protection to the waterbody. We suggest regional groups should review where these overlaps occur to better understand how best to protect the environment at a local scale and what opportunity a combined scenario might provide regarding access to water.

7.4. Information and data provision

To support the development of regional plans, the Environment Agency will provide further information to the regional groups. We will provide maps that indicate the abstraction reductions that may be required within each region. These will be broken down into catchments for both the business as usual and the enhanced scenarios. Regional groups can use these maps to help prioritise the catchments that may require the greatest reductions in abstraction. Alongside the maps we will provide a list of abstractions within the region and detail the waterbodies they impact. This information can be used to filter the abstractions that may require review or reductions to protect the environment.

We will also provide a list of waterbodies within the region and how they have been considered under the different environment scenarios for the year 2050. These lists can be used to help consider the environmental ambition appropriate for each catchment and waterbody. This includes identifying where the environment can be better protected by reducing abstraction but also waterbodies that may have more water available for abstraction.

8. List of abbreviations

AMP - Asset Management Programme

ASB - Abstraction Sensitivity Band

CSMG - Natural England's Common Standards Monitoring Guidance

EFI - Environmental Flow Indicator

FFH - Future Flows Hydrology

GWDTE - Groundwater Dependent Terrestrial Ecosystems

HMWBs - Heavily Modified Water Bodies

NEP - National Environment Programme

SSSI - Site of special scientific interest

WFD - Water Framework Directive

WRGIS - Water Resource Geographical Information System

Would you like to find out more about us or your environment?

Then call us on

03708 506 506 (Monday to Friday, 8am to 6pm)

email

enquiries@environment-agency.gov.uk

or visit our website

www.gov.uk/environment-agency

incident hotline

0800 807060 (24 hours)

floodline

0345 988 1188 (24 hours)

Find out about call charges (www.gov.uk/call-charges)

Environment first:

Are you viewing this onscreen? Please consider the environment and only print if absolutely necessary. If you are reading a paper copy, please don't forget to reuse and recycle.