This evidence paper was provided as part of the Environment Agency's response to the Independent Water Commission's call for evidence in April 2025.

This paper is not a fully systematic review of the whole state of the water environment. It is a review of the water environment that is focused on the water industry.

This review was produced internally using Environment Agency expertise. It is not a fully externally peer reviewed and steered document. This means it is not the same as one of our standard 'state of the environment' reports, which are conducted over a longer time period with more external input and review.

Environment Agency

Evidence Paper

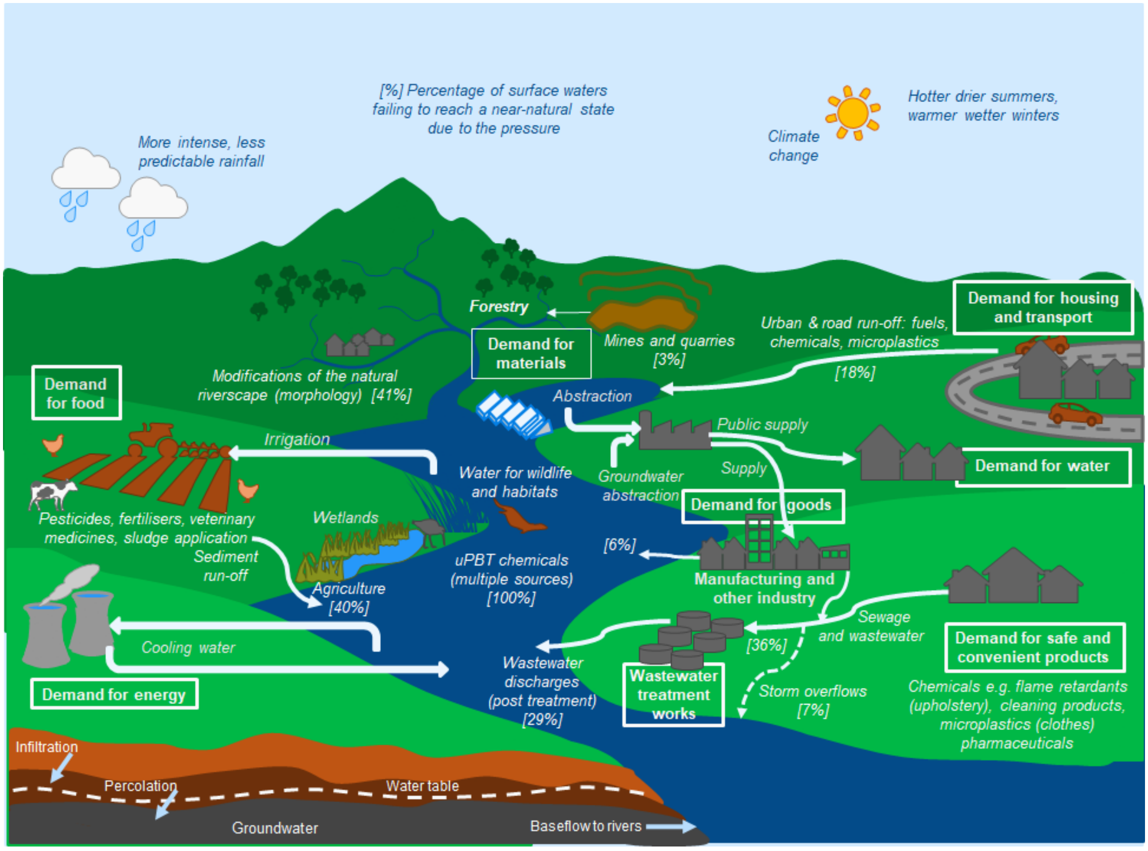
State of the Environment

Introduction

The rivers, lakes, estuaries, coasts and groundwater that form the water landscape in England have been altered or abstracted so that they no longer form a ‘natural’ water cycle.

River channels, banks and beds have been modified in the past for urban, industrial, agricultural and rural development. Both historic and current activities including farming, water supply, shipping, urban development and flood risk management, are still putting significant pressures on wildlife within catchments and coastal waters. Many natural features have been damaged, and along with it, the ability to maintain habitats for nature and wildlife.

Figure 1. Pressures on the water environment.



Connectivity in a river essentially looks at how natural the flow is, and whether materials and organisms can move spatially in a natural system.[1] Where there are barriers such as weirs, the river is considered to be ‘disconnected’ because the barrier stops the natural flow or migration of fish for example. This might prevent fish reaching spawning grounds upstream. Mitigation of this barrier could include taking the weir out or putting in a fish pass. These physical barriers (physical modifications of the environment) give an indication of the extent of past modification of river environments. Currently, 3.3% of the total river network in Britain is fully connected.[2] In addition, over 17% of arable land shows signs of erosion, and 2.2 million tonnes of topsoil are eroded annually in the UK. This all has implications for water pollution, essential soil function and ecosystem resilience.[3] Ecological function is an important regulator of water quality by reducing soil erosion and limiting the run-off of sediment and nutrients into water bodies. It has been shown that catchments with more diverse species on land and in the water are better at removing nutrients from sediment and water.[4]

Groundwater is also fundamental in supporting many of the "on the surface" water features and their dependent ecosystems. It supports unique and internationally important ecosystems such as chalk streams and wetlands, as well as providing base-flow to rivers. It is also a significant source of drinking water and supports agricultural and commercial activities.

Climate change, population growth, unsustainable agriculture, depletion of non-renewable resources, industrial output and pollution will have significant implications for maintaining and improving the current availability and quality of water and ecosystem function in the future.

Society creates these demands on the environment, and society chooses what to protect and what to surrender. Natural environments provide aesthetic value, recreation opportunities, mental health benefits, space for wildlife and other essential services such as water quality regulation, and carbon sequestration. But the landscape is also used to provide food security, energy, reservoirs and other features to provide water security, flood mitigation, the disposal of waste, and space for urban development to support a growing population. There are trade-offs and risks; for example, we could choose to import rather than manufacture certain products, but then we would have less control over their production, and for example, the chemicals they contain that could leach into the environment. The willingness of society to pay for environmentally derived goods and services is another factor, as is the public's understanding of the need to conserve the environment to protect the services delivered.

On 30th July (2024) the government announced a rapid review of the Environmental Improvement Plan to be completed by the end of the year to deliver legally binding targets to save nature. This plan covers the whole environment and considers interactions between different aspects of it.

1. Summary by significant issue

The Environmental Improvement Plan identified the top issues affecting water bodies and preventing them from achieving near natural state as:

- physical modification (41%)
- pollution from agriculture and rural land (40%)
- pollution from wastewater (36%)
- invasive non-native species (25%)
- pollution from towns, cities and transport (18%)
- changes to natural flow and levels of water (15%)
- pollution from abandoned metal mines (3%)

In the categories above, a water body can fail for more than one reason, so the totals do not add up to 100%. Importantly, the 'pollution from wastewater' category refers to water bodies affected by water industry permitted discharges,[i] (see section 4) not just to storm overflows. Storm overflows account for 7% of water bodies failing to reach good ecological status within that 36% wastewater category.[5]

Storm overflows

In a combined sewerage system, wastewater (sewage) from household or trade premises' toilets, sinks and drains, is mixed with surface water runoff, primarily from rainfall, for example via road drains, in a single pipe. If the quantity of this water is in danger of exceeding the carrying capacity of the pipe, storm overflows[ii] are designed to operate to allow a proportion of the sewage to be discharged direct to the environment.[iii] Under these circumstances, storm overflows are operating within their permit conditions. Without storm overflows in the combined sewer system, the water would back up in the pipe, and spill into urban areas.[6,7]

The data for 2023[8] shows a 54% increase in the number of sewage spills compared to 2022, and a 13% increase compared to 2020. This increase is partly because 2023 was named by the Met Office as the 6th wettest year since its records began in 1836. However, heavy rainfall does not affect water companies' responsibility to manage storm overflows in line with legal requirements.[9] By the end of 2023, 100% of storm overflows were fitted with an event duration monitor (EDM), meeting the Environment Agency's target on this. This gives us much more information about where and when storm overflow discharges are happening,

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[i] 'Pollution from wastewater' primarily involves the 9 main water and sewerage companies in England (responsible for 35% of failures) but there are a small number of other wastewater issues (1% of failures).

[ii] The terms 'storm overflows', 'sewer overflows', and 'combined sewer overflows' are taken to be synonymous in this context.

[iii] Some areas operate on a single sewer system. In these areas wastewater from rainfall does not enter the sewer system, and there is less chance of an overflow being needed. Most areas, however, are on the combined system.

and we can use the data to inform compliance and investigation work. It also provides a clear framework for water companies to focus investment. Overflows operating in dry weather conditions – dry spills – can be more of a problem.[10]

Preventing spills requires increasing water infrastructure such as the construction of the Thames Tideway Tunnel 'Super Sewer'[11] or diverting surface water away from combined sewerage systems.

Agriculture

It is also worth noting that a lot of agriculture does not operate under the same permitting system, the Environmental Permitting Regulations (EPR) as other industries. Intensive pig and poultry farms are regulated under EPR. Other agriculture is managed through advice and incentives, such as Catchment Sensitive Farming, and Environmental Land Management Schemes (ELMs) as well as under regulation such as the Silage, Slurry and Agricultural Fuel Oil (SSAFO) regulations (2010) and since 2018, under the 'The Reduction and Prevention of Agricultural Diffuse Pollution (England) Regulations', also known as the Farming Rules for Water.[12]

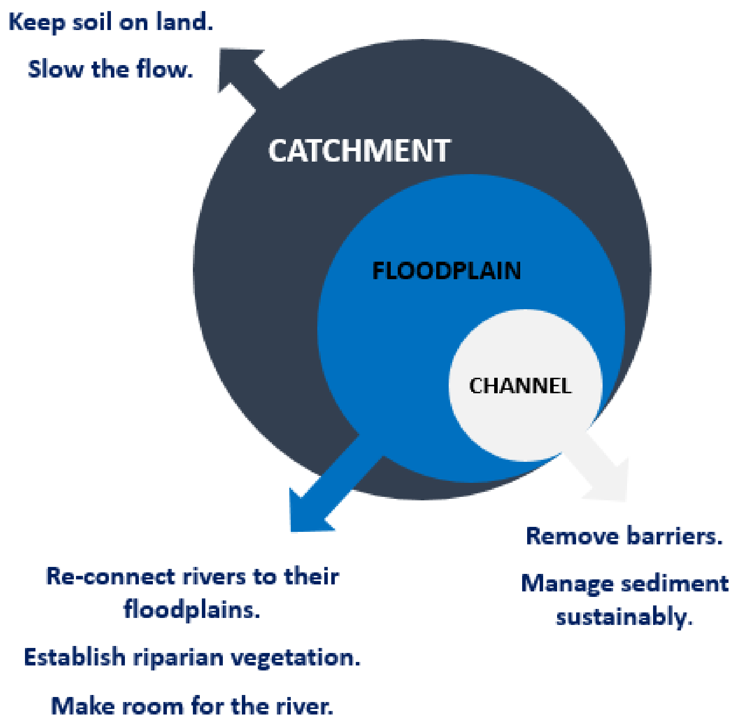
1.1 Physical modification: Nature recovery

Physical modification (morphology) is not just about structures such as dams, weirs, culverted streams etc, but also as 'the physical health of habitat' and directly linked to the ecological functioning of habitat and the wildlife within it.

Habitat surveys have shown that over 50% of rivers banks and beds have been physically altered and 56% of estuarine and coastal water bodies have been identified as heavily modified.[13] The restoration of natural functioning water landscapes is a key aim of the Environmental Improvement Plan (EIP). However, restoring natural river processes and functional habitats often requires concerted action from multiple stakeholders and can be difficult to orchestrate, co-ordinate, fund, and evidence the improvement in ecological function.[14,15]

Action is not effective unless it is taken at a system scale. A nested approach (Figure 2) set within three broad landscape units indicates the appropriate scale of intervention. Freshwater catchment scale interventions aim to keep soil on land and slow the flow of water. Within catchments at the floodplain scale, the priorities are to re-connect rivers to their floodplains, establish riparian vegetation and make room for the river while at the channel scale the focus is on removing barriers and managing sediment sustainably.

Figure 2. Managing physical modifications and improving the condition of freshwaters.[16]



Invasive non-native species (INNS) have their own impact on aquatic habitats but also tend to be a confounding factor in water body morphological restoration efforts. INNS can also affect how the habitat copes with stress from other pressures, such as nutrients and sediment.

Not all non-native species are damaging to the environment. Across all habitats, about 10% of the non-native species in Britain have a negative impact and are considered invasive. But in freshwaters this rises to 40%.[17] INNS have a negative ecological effect on aquatic habitats, alter riparian habitats, and flow. Habitats in poor physical condition are more vulnerable to INNS, where they have an advantage over other species.

INNS also tend to have an advantage in the constructive phases of restoration because of the disruption to the natural habitat needed by native species. But if they can be kept out until the habitat returns to more normal function, then the native species re-established have a greater chance of outcompeting the invasive species.[18]

The Environment Agency has estimated that more than 70% of water bodies across all surface water categories in England are at risk of deterioration because of invasive non-native species (85% of lakes, 71% of rivers and transitional waters and 56% of coastal waters).[19]

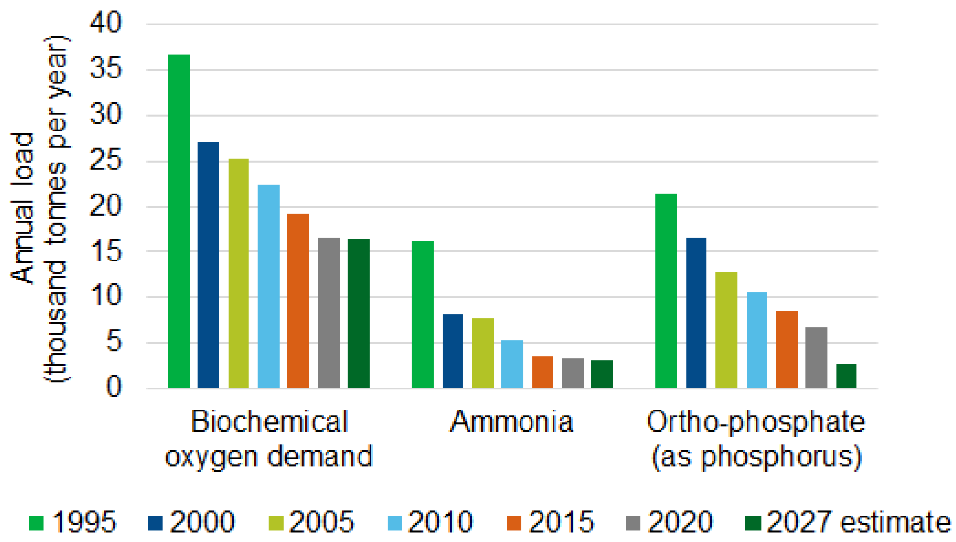
1.2 Nutrients

Discharges of nutrients into water bodies has increased eutrophication in fresh and saline waters.[20,21] This causes diverse problems such as toxic algal blooms, loss of oxygen, fish kills, and loss of biodiversity.[22,23]

Phosphorus and nitrate in surface and groundwaters increased with population growth, and the increased use of artificial fertilisers and sewage sludge application on agricultural land. Phosphorus also increased due to the introduction of phosphorus-based detergents, but limits introduced in 2013 and 2017, now make this a minor contribution.[24]

By 2027, a large programme of phosphorus reduction will mean around 95% of the population served by wastewater treatment works (WwTWs) discharging to freshwaters will be connected to one with phosphorus removal (although this is based on 1995 populations).[25] Pollution reduction action at WwTWs has also reduced biological oxygen demand (a measure of organic pollution and nutrient enrichment) and ammonia (Figure 3).

Figure 3. Pollutant loads discharged by water companies in England.[26]



However, a recent study suggests that WwTWs upgrades to minimise phosphorus emissions may not always have a widespread or transformative positive effect on nutrient concentrations in river basins as a whole.[27] Predictions suggest that river phosphorus compliance may improve by only 2% nationally, on a river length or water body basis, as a result of the water industry investment to 2027. This is because, although the water industry is 70% compliant with its 'fair share' of the phosphorus reductions needed to meet good status for river phosphorus, agriculture is only 48% compliant.[28] This constrains progress.

Large UK water companies could be losing about 25% of mains water to ground and surface waters through leakage.[29] Most tap water is dosed with orthophosphate[30] to reduce how much lead dissolves into the water, so leaks can add significant amounts of phosphorus to ground and surface waters. In urban areas this can be around 1200 tonnes/year, equivalent to up to 25% of the WwTWs input to rivers.[31] Water companies now have leakage targets to achieve.

With the reductions planned by the water industry, the contribution of agriculture to total phosphorus loads in freshwaters becomes increasingly important. There have been significant reductions in agricultural fertiliser phosphorus inputs to land since the 1980s related to improved manure use, plateauing of yields and economic pressure, including the cost of fertiliser.[32] However, there has been a surplus of phosphorus applied to agricultural land over the last 70 years that has created 'legacy' reserves of phosphorus in the soil which contribute to the risks of pollution.[33] Agriculture and rural land management has now overtaken water industry WwTWs as the most common cause of water bodies not achieving good status for phosphorus.

Phosphorus, like other chemicals, will bind to sediment.[34] It will be released back into the water column when the phosphorus concentration in the overlying water reduces. It can take years for the phosphorus to be fully released from the sediment, and for the concentration in the overlying water to finally reduce.

1.3 Chemicals

A wide range of factors influence the production, consumption and environmental emissions of chemicals, with demand for products and the resulting environmental pressure from chemicals predicted to increase further in the future.[35] Key sectors affecting chemical contamination of the environment include agriculture, the water industry, and consumer use of everyday products. Climate change and the drive for net zero are likely to alter the chemicals societies use, produce and treat, and how sensitive the receiving environment is to their effects.

Pathways

Chemicals travel through natural and human-influenced pathways. They can be washed across land and into water bodies through runoff, which is dependent on many factors, including the type and properties of land cover such as vegetation type, soil texture and moisture content, and the level of compaction. Intense rainfall can wash away top layers of soil, resulting in chemicals adsorbed to soil particles reaching water bodies. Natural air or water currents will move chemicals, and dredging activities can remobilise a chemical from the sediment into the water column. Urban drainage and wastewater treatment is an important pathway transporting chemicals from terrestrial environments to rivers and the coast. In addition, runoff from roads can transport a range of pollutants and this is increasingly being recognised as a serious problem.[36,37]

The properties of chemicals themselves will affect whether, and to what extent, they are subject to runoff losses. A water-soluble chemical is more likely to be washed away by rainfall. Runoff and loss of soil from highly contaminated land, such as areas around historic mines, can cause significant concentrations of hazardous substances to enter nearby water bodies over extended periods of time. This often results in chronic exposure of local wildlife populations to chemicals.

The properties of some chemicals mean that they are able to leach from the surface into aquifers below the surface of the ground, and travel within these. This includes, for example, fertilisers, pesticides and sewage sludge, sources such as leaking sewers or storage tanks, and accidental spills of chemicals such as solvents or petroleum products. It takes time for contaminants to pass through the unsaturated zone, depending on the characteristics of the contaminant and of the soil and the underlying geology.[38] It can take up to 60 years for peak nitrate concentrations to be detected at the water table.[39] Similarly, cessation of releases at the surface can take time to show up as a reduction of contaminants in groundwater.

As a result, chemicals can gradually accumulate in groundwater and contaminate drinking water supplies.[40] For example, evidence suggests this is the case for certain PFAS (per-and poly fluoroalkyl substances) chemicals, which are very mobile in soil and water.[40]

'Forever' chemicals

Some chemicals, including those classed as persistent, bioaccumulative, and toxic (PBT) especially *ubiquitous* chemicals of this type (uPBTs) pose hazards of greater concern. For example, exposure to environmental concentrations of some PFAS chemicals, a type of uPBT, have been associated with various adverse impacts on the health of humans and wildlife globally.[41,42,43]

It is societal use of chemicals and pharmaceuticals for their many beneficial properties; medicines, flame retardants for fabrics, cleaning agents, cosmetics etc that creates the problem. For example, PFAS is a chemical family consisting of around 5,000 individual substances. In manufacturing, PFAS chemicals are favoured for their durability and useful properties such as non-stick, water repellence and anti-grease. They are used in the manufacture of many domestic products, including:[44]

- skin creams and cosmetics
- car and floor polish
- rinse aid for dishwashers
- textile and fabric treatments
- food packaging and microwave popcorn bags
- baking equipment
- frying pans
- outdoor clothing and shoes

But released to the environment down sinks, drains and sewers, they are often referred to as 'forever chemicals' because of their resistance to biodegradation and persistence in the environment. The Environment Agency supports water companies in their risk assessments where PFAS chemicals are being detected in raw water.

Liquid waste generated from business and industrial sites, including chemically contaminated waste, requires a trade effluent consent from the local water company when it is being discharged to the sewage network. These consents specify requirements that the site effluent must comply with, including with regards to quantity and quality. Monitoring of levels of specific chemicals in discharges provides WwTWs with data that enables them to check for compliance with Environment Agency issued Environmental Permits.[45,46]

The Chemicals Investigation Programme

The Chemicals Investigation Programme (CIP) has been running since 2010, and aims to better understand the occurrence, behaviour, and management of chemicals in the environment.[47] The programme is co-ordinated by the UK Water Industry Research (UKWIR) group and involves collaboration between water companies in England, Wales and Scotland, and the respective national regulators.

CIP has given us insights into chemicals present in wastewater treated effluent, sewage sludge, groundwater and receiving water bodies. The third phase, CIP3, concluded in 2022. It investigated sources of chemicals, trend analysis, emerging and watch list substances, microplastics and anti-microbial resistance.

The fourth phase is currently being developed and will include monitoring over 300 chemicals and microplastics in groundwater, sewage sludge, wastewater treatment works' influent and effluent, surface waters, marine modelling, fish, plants, sediment and more.

Good chemical status

No surface water bodies in England currently meet the Water Framework Directive (WFD) conditions for 'good chemical status'. These reported failures reflect improved methods for measuring and assessing water bodies for uPBT chemicals including mercury, polybrominated diphenyl ethers (PBDEs), certain polycyclic aromatic hydrocarbons (PAHs) and perfluorooctane sulfonate (PFOS - a type of PFAS). If uPBT chemicals are excluded from the assessment, 92% of estuaries, 93% of rivers and all lakes and coastal waters would achieve good chemical status.[48]

In 2019, 45% of groundwater bodies achieved good chemical status, with nitrate the main cause in those that failed. The groundwater nitrate failures are mainly linked to the General Chemical and Drinking Water Protected Area test, both of which use the drinking water standard for nitrate. These tests have not changed since the first River Basin Management

Plans (RBMPs). There are also some nitrate failures for the Groundwater Dependent Terrestrial ecosystem (GWDTE) test and that test has a nitrate threshold that varies according to the ecosystem.

Soluble pollutants, including PFAS, are frequently detected in groundwater, and may be considered as chemicals of emerging concern. We are finding a range of PFAS in groundwater across England, but PFAS is not currently included in the chemical classification for groundwater; if it were, we would see more groundwater bodies failing. During each classification cycle we are required by The Groundwater (Water Framework Directive) (England) Direction 2016 to update the list of substances included in the risk assessment and classification. The PFOS EQS standard was used in the 2019 groundwater classification (surface water test), but due to a lack of monitoring data this led to only one groundwater body failure. PFAS was added to the Environment Agency's Groundwater Quality Monitoring Network in 2021, and we now have a good (but not full) coverage.[49] Due to this increased PFAS monitoring we anticipate more failures of the groundwater chemical surface water test in the 2025 classification.[50] There are currently no statutory drinking water limits in England for PFAS. Guideline values to protect human health via ingestion through drinking water are published by the Drinking Water Inspectorate.

Many persistent chemicals are now banned, but because of their historic use and the longevity of the products they were used in, they are still present in the environment today and can continue to cause environmental damage.[51] For example, many persistent organic pollutants (POPs) are now banned or restricted in the UK, but because they break down very slowly they can remain in the environment for decades. The Stockholm Convention requires Parties to adopt and introduce measures to reduce releases of POPs into the environment with the aim of minimising human and wildlife exposure.[52] Estimates of emissions to air, land and water for all Stockholm Convention Annex C substances (unintentional releases from anthropogenic sources) did decline significantly in the UK in the period 1990 to 2014, largely due to policy actions targeting major point sources.[53]

Mine water pollution is another legacy issue.[54] Rising groundwater levels following the cessation of coal or metals mining and mine water dewatering can transfer contaminated water to other water bodies, and potentially to the surface. The Environment Agency operates mine water pump and treat schemes to prevent inflow of mine water into the aquifer and the consequence of potentially polluting abstractions from it and supports the development of other treatment schemes such as passive filtration.

As a result, *legacy contamination is a significant 'sector' affecting contamination levels.* And as with morphological problems, legacy chemical problems are often the most difficult to mitigate. The control mechanisms for chemicals are largely 'upstream' of their presence in the environment.[55] Once in the environment, they can be extremely difficult and costly to remove.

Regulation

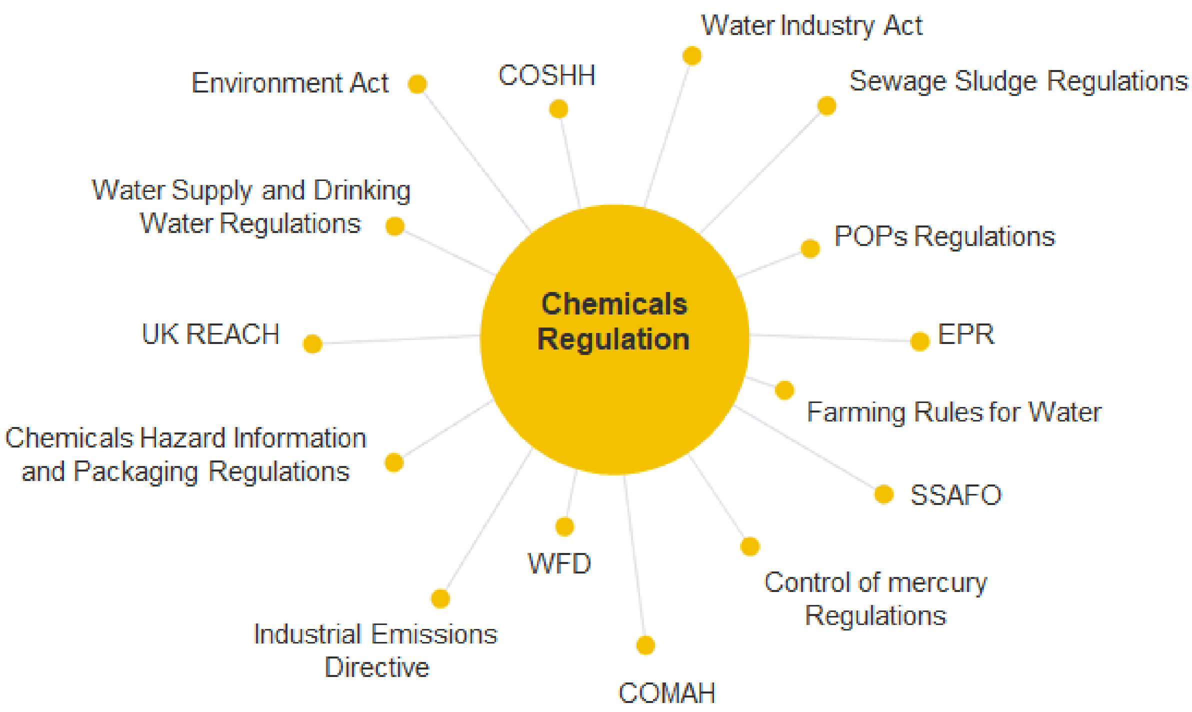
Regulation is the main mechanism in place to minimise both emissions of chemicals to the environment and the risks posed by chemicals. Regulation has reduced emissions of chemicals to the environment, but significant challenges remain, in part because of the volume and diversity of different chemicals now in circulation. There are also large numbers of emerging contaminants, the behaviour and effects of which are not yet well understood.

Products are assessed before they come to the market, such as through the regulation on the Registration, Evaluation, Authorisation and Restriction of CHemicals (REACH). But many chemicals were in use prior to the regulations we have now, and new chemicals continue to be developed and used. Many of these will not represent a risk. However, assessing the risks of more subtle longer-term effects is a challenge and we do not fully understand the potential effects mixtures of chemicals with similar properties have on the environment.[56]

The Environment Agency participates in international networks to identify concerns early. Our Prioritisation and Early Warning System (PEWS)[57] helps us gather intelligence from monitoring and allows us to direct our efforts to investigate emerging challenges and target our actions to those chemicals with evidence of highest potential for harm.

There are also various grant and funding mechanisms to help reduce environmental chemical inputs, amongst other pressures (Figure 4).

Figure 4. Illustration of some regulatory instruments for chemicals.[iv]



1.4 Abstraction

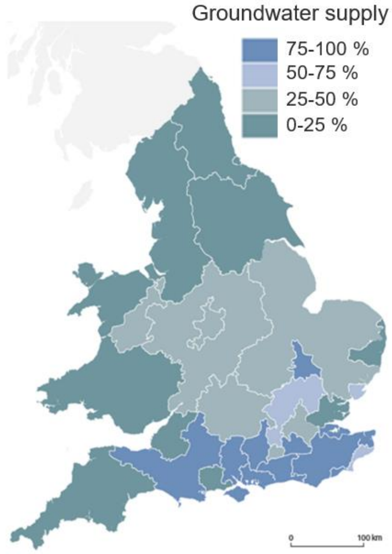
The Environment Agency controls how much water is taken using a permitting system, regulating existing licences, and granting new ones. This is done using the catchment abstraction management strategy (CAMS) process and abstraction licensing strategies. '[Managing water abstraction](#)' sets out the approach and regulatory framework within which the Environment Agency manages water resources.

Of the over 14 billion litres of public water supplied each day, nationally, around 30% comes from groundwater sources (Figure 5[58]), and 70% from surface water sources.[59]

[iv] N.B. Figure 4 illustrates some regulatory mechanisms for chemicals but is by no means comprehensive.

The groundwater contribution rises to 50% in the south-east of England, and in some localised regions, 100% of the public water supply is from groundwater.[60] How much groundwater is used for public water supply depends on local geology and the availability of other water sources.

Figure 5. Groundwater as a percentage of water supplied for public use in 2019.[58]



The rivers, lakes and groundwater that currently (or will in the future) supply more than 10m^3 per day of water for human consumption, or serve more than 50 people, are identified as Drinking Water Protected Areas (DrWPAs).[61] In England all groundwater bodies are DrWPAs. It is a statutory obligation under the WFD to have measures in place that aim to reduce treatment of water intended for human consumption within the DrWPA. These measures are incorporated into the Water Industry National Environment Programme (WINEP) and River Basin Management Plans.

Drinking Water Groundwater Safeguard Zones focus improvement actions in areas where the quality of abstracted water is poor. The area of the safeguard zone is targeted to the location of the pollution affecting the water body, or where pollution affecting an abstraction has been identified with high confidence. They are usually based upon existing groundwater Source Protections Zones (SPZs). Within these zones there will be strict enforcement of existing measures for pollutants and activities, and possibly new voluntary measures.[62]

SPZs are defined around large and public potable groundwater abstraction sites. Their purpose is to provide additional protection to safeguard drinking water quality by constraining the proximity of activities that could affect a drinking water abstraction.

The EIP has the following targets for sustainable abstraction:

- reducing the damaging abstraction of water from rivers and groundwater, ensuring that by 2021 the proportion of water bodies with enough water to support environmental standards increases from 82% to 90% for surface water bodies and from 72% to 77% for groundwater bodies
- restoring 75% of our one million hectares of terrestrial and freshwater protected sites to favourable condition, securing their wildlife value for the long term

The EIP B5 indicator shows changes in the percentage of surface waters (rivers, lakes, reservoirs and estuaries) and groundwater (including wetlands fed by groundwater) where sustainable abstraction criteria are met. River flows and groundwater levels are sustainable when they support ecology that is only slightly affected by human activity. The indicator responds to changes in water use, both in relation to leakage and personal consumption. This indicator is also sensitive to effects of future climate change on rainfall and consumption and shows the need for adaptation.[63]

Current levels of abstraction are assessed as unsustainable in 27% of groundwater bodies and 15% of surface waters.[64] There has been little or no overall change in the percentage of ground and surface water bodies achieving sustainable abstraction criteria since 2018. However, this is based on 2 data points so should be considered as indicative and not evidence of a clear trend.[65]

England's revised draft regional and water resources management plans suggest that by 2050, there could be a supply deficit of around 5 billion litres of water per day between the sustainable water supplies available and the expected demand. The is based on updated demand forecasts, additional reductions associated with protecting and improving the environment, and better representation of the baseline supply position without drought measures included.

To resolve this deficit, significant action is needed on both demand management and on resource development. Around half of the deficit needs to be met from each type of option. Demand management will be vital in the initial period because of the long lead times for major resource development.

The National Framework for Water Resources sets out the strategic water needs for England and its regions, across all sectors from 2025 to 2050 and beyond. The national framework report marks a move to strategic regional planning. It sets out the principles, expectations and challenges for 5 regional groups (made up of the 17 English water companies and other water users). These have been developed and agreed by the regional groups, other major water abstractors, government, regulators and stakeholders.

Regional planning is needed because the statutory water company water resource management plans (WRMPs) alone are unlikely to provide the right strategic solutions for the whole nation. They address how the company will develop water resources for its customers' needs only. The national framework puts aside water company boundaries and considers the needs of the whole region and of other water users. It looks at how these needs fit with the national water picture and how we can provide the resilience and environmental protection needed.

In Sussex, Cambridgeshire, Suffolk and Norfolk, housing and business growth are being constrained because growth in abstraction would risk environmental damage and contravene environmental laws. These issues will become more widespread if society does not reduce demand and prevent increased abstraction in environmentally sensitive areas.[66]

Plans to reduce demand include:

- using water more efficiently and metering; [water efficiency labelling will be made mandatory by 2025]
- reducing leakage
- new supply options such as reservoirs, desalination, water recycling and upgrades to water treatment works

There are approximately 200 chalk streams in the world, with 85% of these in south and east England. These unique habitats are located within areas which have experienced the highest population growth in the country, and many suffer from over-abstraction. In 2019, 84% of chalk streams were failing to meet good ecological status.[67]

1.5 Sector linkages

In many of the issues surrounding water quality and quantity, the agricultural sector and water industry sector are linked. For example, diffuse pollution from agriculture causes deterioration in water quality and increases treatment costs for the water industry to put it into supply.

The water industry takes chemicals, nutrients and microplastics out of sewage effluent so the discharge to receiving waters meets the required standard,[v] but those substances partition into the biosolids produced, a large amount of which is then applied to agricultural land, with the possibility of run-off taking them back into the receiving water.[68]

1.6 Urban areas

Urban areas and the transport network are a source of environmental contaminants that includes hydrocarbons, metals such as zinc, cadmium and copper, plastics, nutrients, ammonia, pathogens and sediment. In 2019, 18% of water bodies were identified as being damaged by pollution from towns, cities and transport.[69]

Physical modifications to water bodies is the top pressure in urban areas, affecting around 43% of water bodies. This includes culverting, embankments and channel straightening. The original reasons for these modifications often makes it difficult to restore the natural water body. Sources of pollutants entering the water environment include drainage, misconnections and urban runoff. It is not always easy to identify the source of this type of

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[v] There may be a need to be clear about the two roles of water industry – to treat water to put into domestic/industrial supply, and the treatment of sewage with discharges to receiving waters, and to differentiate between them.

pollution or those responsible. This means that using established approaches to controlling polluting activities, such as through permits, cannot be as easily applied because there may be more than one source of pollution. The pressures on the water environment caused by towns, cities and transport are increasing and are likely to made worse by climate change and population growth.[70]

Misconnections

Misconnections are defined as part of a drainage system connected to the wrong receiving wastewater network. An example is a toilet or home appliance pipe discharging to the surface water network. This results in inadequately treated effluent entering the environment. The number of households where there are sewerage network misconnections is unknown, but in 2010 it was believed to be around 300,000 across England and Wales. In most cases this leads to pollutants entering watercourses and groundwaters, having a harmful impact on the environment and ecology. The Environment Agency estimates that misconnections affect about 9% of all bathing beaches and around 15% of the kilometres of water covered by the Water Framework Directive.[71]

Overflows and intermittent discharges

Intermittent discharges of effluent in the drainage network are designed to occur in emergencies or as a result of an exceptional weather event (see section 1). Combined sewerage networks carry both foul water and surface water to sewage treatment works. As part of this system, overflows operate intermittently to discharge when the system is unable to accommodate increased flows due to heavy rainfall events. Discharges from overflows often enter nearby water bodies, carrying untreated sewage and urban runoff. Leaking sewerage pipe work and other aging infrastructure can also pollute both surface and groundwater.

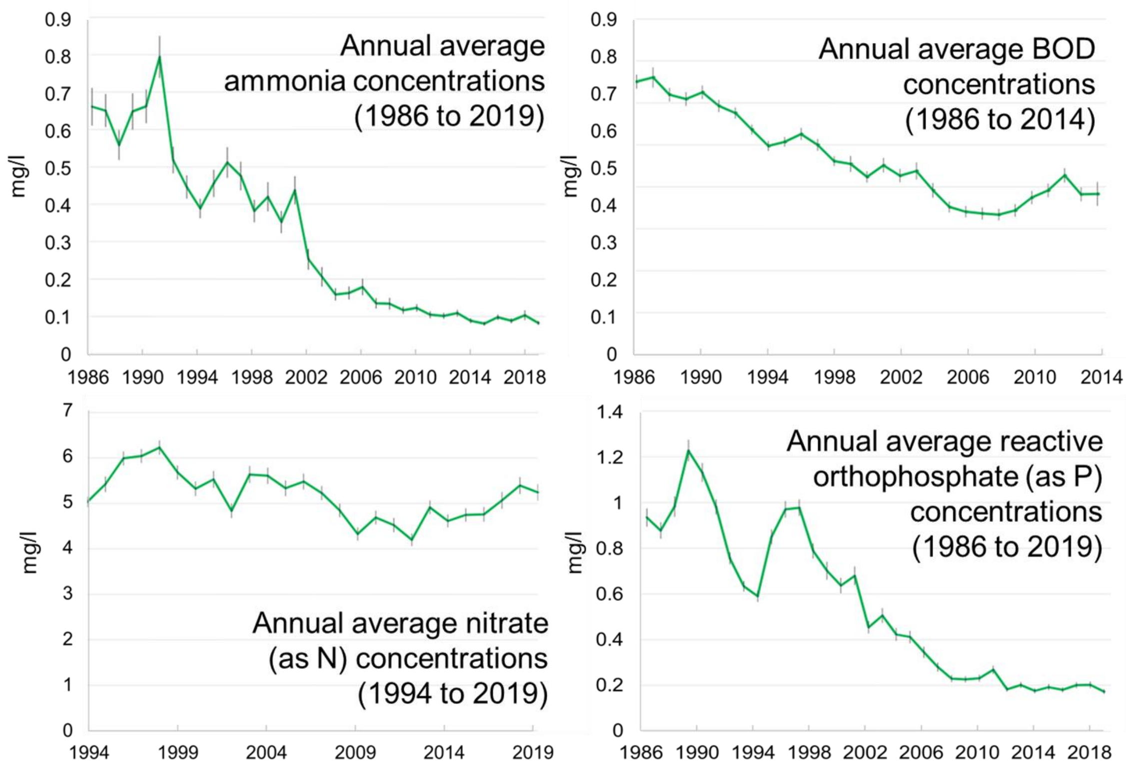
These discharges, although dilute, are almost always untreated discharges and so pose a risk to the environment, aesthetics, and potentially create human health risks.[72] Climate change, bringing more intense rainfall events, will tend to make these overflows happen more frequently without additional storage infrastructure in the system.

2. Water quality changes over time

2.1 From past to present

In 2022, the Environment Agency analysed long-term trend data for phosphorus, nitrate, ammonia, and biochemical oxygen demand (BOD, a measure of organic pollution) as important measures of water quality. The data gathered at harmonised monitoring sampling points between the mid-1980s and 2019, represent mostly sites at the lower end of principal rivers in England. The results showed that water quality in those rivers had improved over the last 30 years (Figure 6).

Figure 6. Trends in average annual concentrations of key pollutants calculated from harmonised monitoring sampling points between the mid-1980s and 2019.



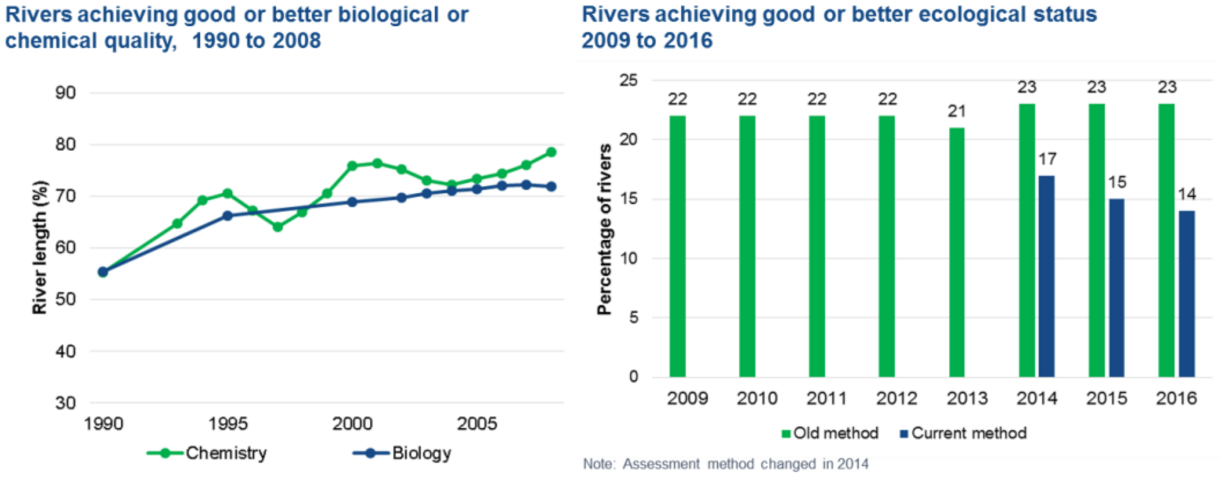
Compared to a baseline of average concentrations in 1990:

- ammonia concentrations reduced by about 85%
- BOD concentrations reduced by 40% to 45%
- phosphorus concentrations reduced by about 80% to 85%
- no particular trend was observed for nitrate.

The 1994 Urban Waste Water Treatment Directive in particular is regarded as having been effective in driving a significant reduction in pollutant discharges from sewage treatment works (Figure 3).[73] In the early 2000s, assessment of water quality under the WFD started to include a wider range of indicators, with a focus on an apex indicator linked to a good ecological environment.[74]

Changing analytical methods, or the focus of an assessment, can change the perception of the statistics. A river ‘passing’ an assessment one year may ‘fail’ the next, but it can be an artefact of the assessment rather than reality (Figure 7). The apparent downward shift from around 70% of rivers at good or better biological quality around 2007 to 22% of rivers at good or better ecological status in 2009 in Figure 7 is an example of this. There wasn’t a sudden drop in river water quality. Instead, the WFD good ecological status indicator assessed a much broader range of indicators associated with good ecological function, including aspects of habitat. It's a measure of our greater understanding of the factors that influence a more natural river condition.

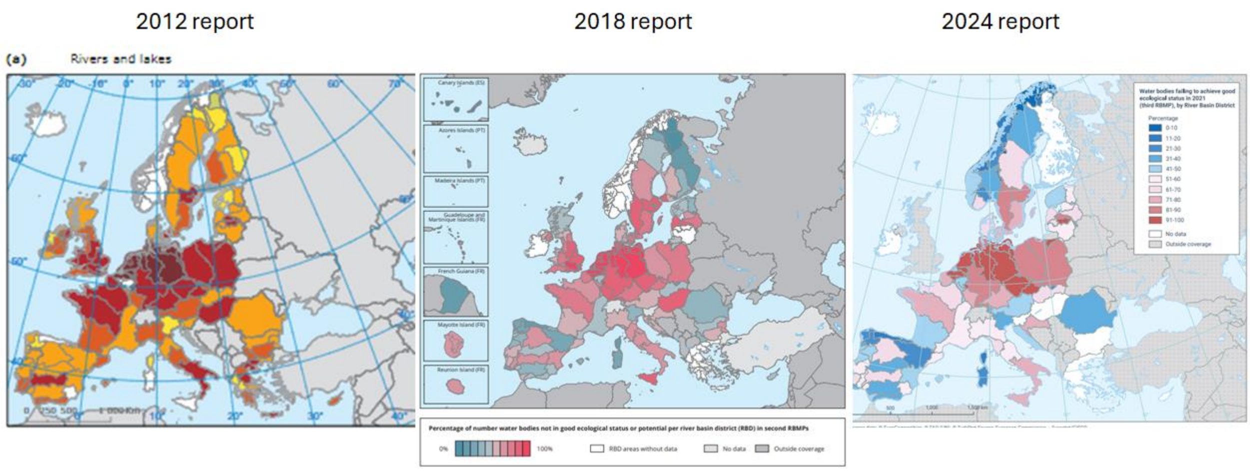
Figure 7. Comparison of water quality assessments used between 1990 and 2016.[75]



2.2 Current state

In the last 5 to10 years, the assessment of good ecological status under the WFD has plateaued, still at a relatively low level.[76] This is due to the improvements becoming more difficult as we encounter more complex problems. There can also be a time lag between implementing policies and improvements in the ecology. Climate change and population growth are also driving deterioration in the water environment, making improvement more difficult.[77] This is evident across Europe (Figure 8), not just in the UK, and the UK has the additional problem of being one of the most densely populated countries in Europe,[78] increasing pressures on the environment.

Figure 8. The European Environment Agency assessment of progress towards good status. (More red = more NOT at good status.)



In 2019 (the last year of assessment), 14% of rivers, and 16% of all surface water bodies met 'good ecological status'. This has not substantially changed since 2016. The 16% figure does not show the complete picture, because of the 'one out all out' rule of the WFD in compiling the results. Whichever is the lowest standard achieved in one test, becomes the standard for the water body. In the assessment, 79% of the individual elements tested were at good status. The 25 Year Environment Plan (25 YEP) (2018) B3 indicator (Figure 9) gives more detail.

Bathing waters

Bathing waters are assessed in a different way again. Assessment applies only to waters designated for bathing, and only in the bathing water season of May to September. Water samples are tested for two types of bacteria, E coli and intestinal enterococci, which indicate organic pollution in the water.[79] The results are also a rolling 4-year average, so the 2024 results are the average of 2021 to 2024 inclusive. At some bathing waters we can also provide information when bathing water quality is likely to be temporarily reduced because of pollution incidents or other factors like the effects of rainfall or tides.

In 2024, 92% of bathing waters in England met minimum water quality standards, with 85% of bathing waters being rated as 'good' or 'excellent'. But, 27 new sites were designated, 18 of which were rated as 'poor'. This 'poor' rating isn't unexpected as they haven't been managed for bathing before, and it can take time to bring them up to bathing water standards.[80] Without the newly designated bathing waters, 95% of sites would meet minimum standards in 2024, slightly less than 96% last year.

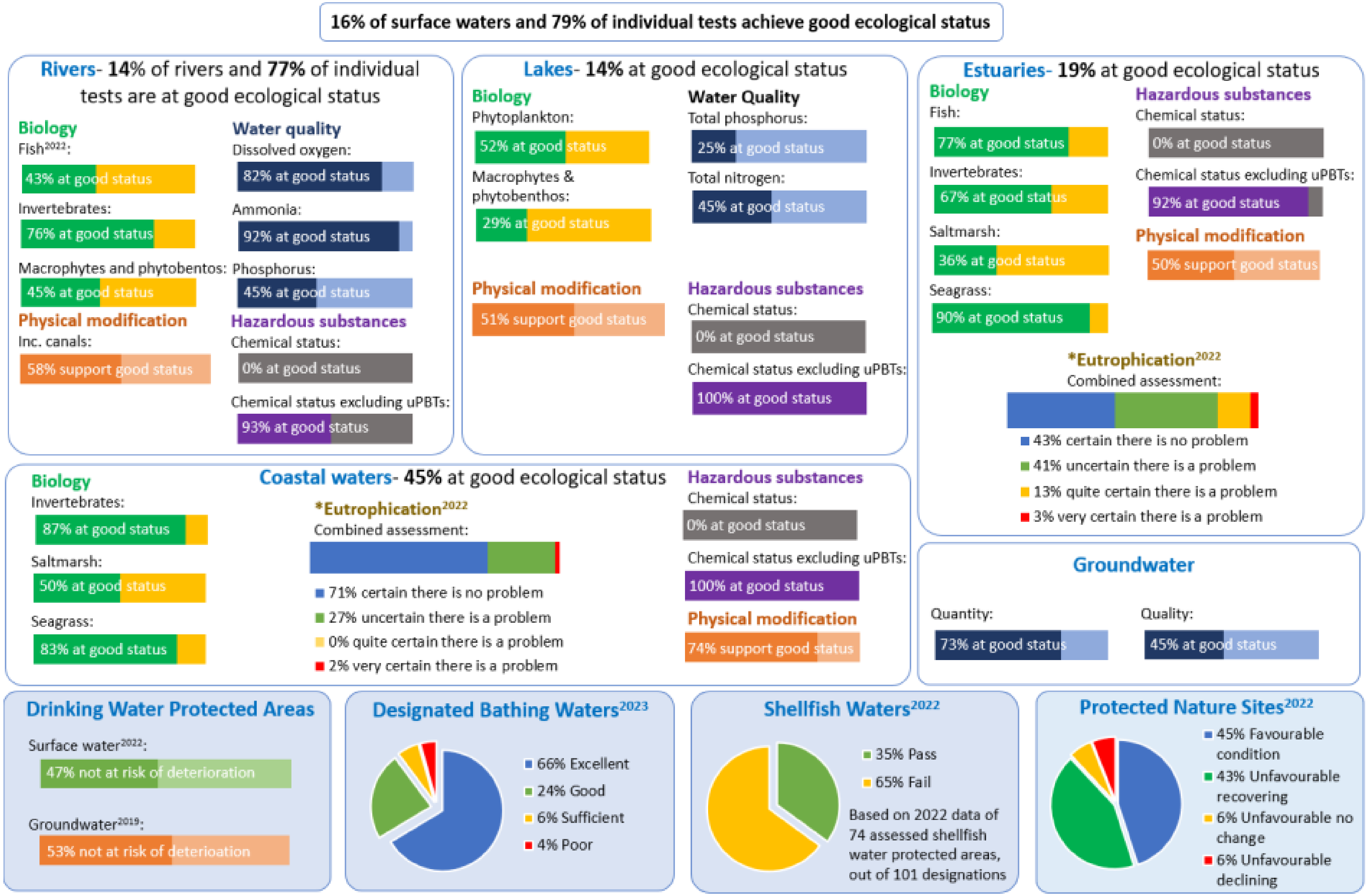
Changes to monitoring and assessment

The assessment of water quality is changing again. Monitoring always changes over time because we develop new tools and analyses and because how we view, use, and value the environment changes. The WFD brought in "good ecological status", and it is now useful long-term data. But it has proven challenging to separate out the evidence of environmental change over time from the targeted monitoring evidence designed to identify pressures and solutions.[81] We have also recognised we have not been measuring some aspects of the water environment that are important in providing the goods and services that the economy and people rely on. The 25 YEP brought in the concept of natural capital, new indicators and new targets. Some, like the B3 indicator (Figure 9, State of the water environment) use the same or similar metrics as the WFD, for example 'good ecological status'. Others such as the 25 YEP target of 'making sure that there are high quality, accessible, natural spaces close to where people live and work, and encouraging more people to spend time in them to benefit their health and wellbeing' focus more on the value of the environment to people.

To improve the way we assess change in the environment, the government funded the Natural Capital and Ecosystem Assessment (NCEA) programme to design and deliver an unbiased and holistic view of the state of and trends in the water environment, how it changes over time and the benefits it provides society. A set of national scale surveillance monitoring networks will complement pressure-specific local monitoring programmes, allowing us to track and evaluate national-scale changes to the water environment.[82] The NCEA River Surveillance Network (RSN) will also be looking at:[83]

- using time series analysis to identify trends, seasonality, and any anomalies that may inform us about the changing health of the river ecosystem over time
- calculating mean annual average nutrient concentrations across all rivers in England or the proportion of rivers in pre-specified concentration bands
- bringing RSN data together with the surface water flow and temperature networks to develop deeper data insights into England's surface water environment
- examining the relationships between the biological and physico-chemical quality and catchment variables derived for the 'analysis ready water network' (ARWN)
- using existing indices such as the River Macrophyte Nutrient Index to describe the nutrient status of rivers

Figure 9. Summary of 25 YEP B3 indicator: State of the water environment. Updated 2024.[84]



Figures are percentages of water bodies assessed; where referred to as 'at good status', this is good or better status and potential
For percentage figures supporting good status and potential under Physical modification, this data is taken from the Reasons for Not Achieving Good Status (RNAGS) dataset (March 2019)
Not all indicators update annually: unless more recent data is available as stated, all data was sourced 2019
Hazardous substances: uPBTs are substances that are ubiquitous, persistent, bio-accumulative and toxic.
The 2019 WFD water body classification data is available on data.gov.uk. For other data marked * or for an accessible version of this slide contact enquiries@environment-agency.gov.uk

3. Evaluation

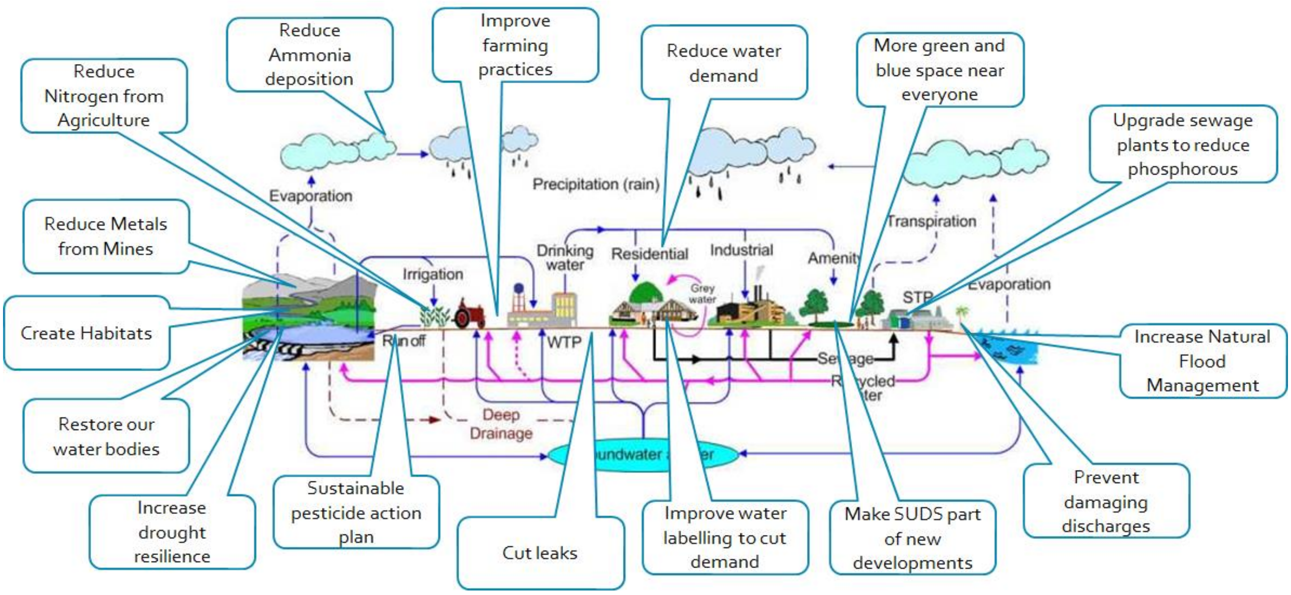
Evaluation looks at what works and what doesn't, and potentially whether one solution offers greater value for money than another. It determines what effect policies, and their mechanisms (interventions), have on environmental condition and delivering water quality improvements.

Some policies are easier to track than others. For example, when wastewater treatment works put technologies in place to reduce the phosphorus, BOD and ammonia discharged, it can be measured at the works, and we can see the effect in the harmonised monitoring scheme measurements (Figure 6). The impact of other interventions can be more difficult to establish, for example where:

- pollutant inputs are diffuse rather than point source
- the intervention is advisory rather than regulatory
- multiple policies and interventions influence an outcome
- there is a significant lag time between action and outcome

Where there is a substantial lag time between putting the intervention in place, and the expected outcome, it may take years, possibly even longer, to determine whether the intervention has worked or not. Temporal lags in species' responses to conservation action can mask the ability to observe progress towards restoration success.[85] That consequently also risks the cost of the investment in the intervention made. Ideally interventions should be trialled at smaller scales, and robust evaluation studies undertaken, before significant roll-out of the intervention.

Figure 10. Representation of multiple policies delivering the 25 YEP goal 'Clean and plentiful water'.[86]



In the past, evaluation studies weren't required for much of the Environment Agency's work, and not everything needs the same level of evaluation. Depending on the water mechanisms included, internal Environment Agency studies have found around 20% to 30% of current mechanisms have so far had, or are planning, formal evaluation. Examples of mechanisms with evaluation include Catchment Sensitive Farming (CSF), the Water Environment Improvement Fund (WEIF), Local Nature Recovery Strategies (LNRS), Slurry Infrastructure Grants (SIGs), the Water Industry Natural Environment Programme (WINEP), and the Flood Capital Programme.

3.1 Learning from evaluation

A key recommendation from the OEP includes the development of a monitoring, evaluation and learning framework to assess progress towards EIP targets.

Evaluation studies in agriculture have been undertaken for some years, but evaluation in other areas of water interventions are less well advanced. This is a known gap. For example, we rely on the Catchment Based Approach to support the achievement of key outcomes of the Water Framework Directive and EIP, but robust evidence of its impacts is lacking. Evaluation studies do provide the potential for implementing more efficient and effective interventions in the future.[87] Good evaluation should encompass both the policies themselves and the delivery mechanisms that are used to deliver them.

The Environment Agency has applied structured evaluation to build evidence around some of its interventions in the water system. Key evaluations in progress relevant to the Independent Water Commission include:[88]

- Integrated Governance approaches for water management, and process / impact evaluation of the Water Environment Improvement Fund
- the revised methodology used for the current WINEP
- the Water Industry Regulation Transformation programme

4. The water industry

4.1 Targets

The EIP emphasises the need to improve water quality by addressing pollution from the water industry. It includes the target to reduce phosphorus loadings from treated wastewater by 80% by 2038 against a 2020 baseline, with an interim target of 50% by 2028. Water companies have also averaged 50 serious (category 1 and 2) pollution incidents a year over the last 5 years. The EIP includes a target for water companies to reduce serious pollution incidents to zero.

Nitrogen was not included in this wastewater target, as agriculture is a much larger contributor of nitrogen to the water environment. As the share of nitrogen from agriculture entering the water environment starts to fall, the case for setting a nitrogen target for wastewater will be reviewed.

The water industry provides operator self-monitoring – they are required to supply the Environment Agency with relevant data.

The Environment Agency is also using its groundwater monitoring data and modelling tools to ensure risks to and from the water industry are quickly and robustly identified, with the evidence shared to identify suitable solutions.

4.2 Nutrients

Conditions on permits for discharges are used to regulate phosphorus and nitrogen emissions to receiving waters from WwTWs and industry. Conventional primary and secondary treatment can remove 20-30% of nitrogen from raw sewage, while tertiary treatment can reduce loads by 70-80%. Tertiary treatment is used, for example, where effluent needs to meet the Urban Wastewater Treatment Regulations (UWWTR) for saline waters affected by eutrophication.

Phosphorus concentrations in rivers increased significantly between 1950 and the 1980s due to the introduction of phosphorus-based detergents, population growth and the growing use of artificial fertilisers. In England, currently 55% of assessed river water bodies and 75% of assessed lake water bodies fail the phosphorus standards for good ecological status which aims to prevent eutrophication.[89] Nitrogen compounds, such as nitrate and ammoniacal nitrogen, are the reason that 70 groundwater Drinking Water Protected Areas (DrWPAs) are classed as being at poor chemical status. Within those, there are 227 Safeguard Zones (SGZ) aimed at reducing deterioration. Around 50% of Natura 2000 (N2K) rivers and 60% of N2K lakes currently fail their long-term target for phosphorus.[90]

Agriculture and rural land management has now overtaken water industry STWs as the most common cause of water bodies not achieving good status for phosphorus. This is a significant change from second cycle of the river basin management plans when water industry WwTWs were the most common cause.[91] However, a recent study found that changes in water quality and benthic communities are driven more by treated wastewater discharges compared with land use change.[92]

A programme of phosphorus reduction trials at WwTWs was undertaken by the water companies, through investigations in the Water Industry National Environment Programme of the 2014 Periodic Review. As a result, the Technically Achievable Limit (TAL) for phosphorus reduction was tightened from 0.5 mgP/l to 0.25 mgP/l for the 2019 water industry price review (PR19). In response to the challenge of phosphorus in rivers, a large programme of phosphorus reduction at treatment works is committed as part of PR19. Capital expenditure of around £2.4bn is planned, with schemes at around 900 works, serving 15 million people, aimed at protecting or improving 5500km of river. It is predicted that this will reduce the phosphorus loading from WwTWs to rivers by 87% by 2027, relative to loadings in 1995.[93]

With the reductions planned by the water industry, the contribution of agriculture to total phosphorus loads in freshwaters is increasingly significant. Without further reduction of the agricultural load to national river phosphorus levels, it's proportional contribution could increase from around 25% at present to around 30 to 35% by 2027.[94]

4.3 Sewer overflows

Sewer (or storm) overflows are often in the media. Throughout the sewer network there are overflows that discharge to surface waters during extreme rainfall events (see section 1). This helps to protect sewage works from being overwhelmed and works on the assumption that the polluting sewage overflow will be substantially diluted by the rainwater.[vi] The However, some overflows have been found to operate in dry weather.

There are approximately 15,000 combined sewer overflows in England. Discharges from them affect the water quality of rivers and coasts and are particularly associated with poor bathing and shellfish water quality. All of the sewer overflows across the water network in England have now been fitted with Event Duration Monitors (EDMs), to monitor when the overflows are active. EDM data has also been central to informing Defra's Storm overflows discharge reduction plan, published in 2022. The plan sets out clear and enforceable targets that the water industry must meet. In May 2023, water companies pledged to invest an additional £10 billion this decade to deliver the ambition set out in the plan.

4.4 Sludge and biosolids

Water companies produce sludge during sewage treatment, which can be beneficially used as a soil conditioner or fertiliser on agricultural land. Approximately 95% of sewage sludge produced nationally by WwTWs is recycled to land as biosolids. But the treatment of wastewater to remove phosphorus can make the biosolids produced more difficult to handle.[95] An estimated 43% of the phosphorus load entering WwTWs is subsequently recycled to land where it could re-enter the water via run-off or leaching.[96]

The storage and application of sludge requires strict regulation to prevent environmental harm. Water companies employ various sludge treatment methods, including anaerobic

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[vi] The Victorians introduced 'storm overflows' as a safety valve in the combined sewer system for the management of high flows during heavy rainfall/storms. 'storm overflows', and 'combined sewer overflows' are essentially the same thing.

digestion and lime stabilisation, guided by regulations such as the EPR, UWWTR and The Sludge (Use in Agriculture) Regulations. The Environment Agency has published a Sludge Strategy to address changes in sludge treatment and use, with a focus on the safe and sustainable use of sludge. It will take time to establish the effectiveness of this.

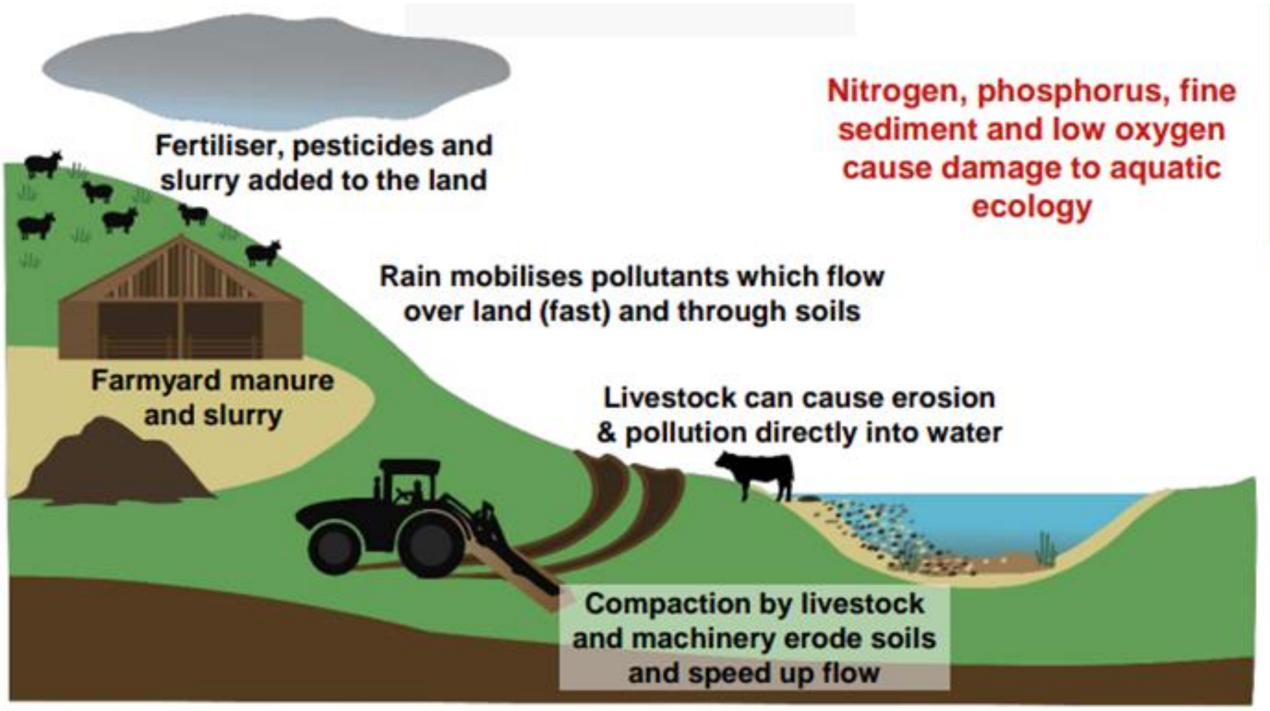
As regulation of WwTW effluent becomes more stringent, larger volumes of chemicals are being removed from the effluent. Some chemicals that are not destroyed by these processes partition to biosolids and may ultimately be applied to land. The final composition of biosolids is highly variable both geographically and/or temporally across England but may include microplastics and uPBTs as well as other chemicals.[97] To minimise the risks associated with changing treatment processes, the Environment Agency has proposed an aim to regulate the production, storage and use of biosolids through permitting procedures.[98]

5. Agriculture

The agriculture sector comprises around 100,000 premises covering 70% of the land in England. It is one of the most significant influences on water quality and water-dependent ecosystems. The main pollutants from farming are:

- nutrients (phosphorus and nitrate) and slurry
- chemicals including pesticides, veterinary medicines, and emerging chemicals
- faecal bacteria and pathogens
- soil erosion and run-off from fields

Figure 11. Pressures from the agriculture and land management affecting water quality.[99]



It is estimated that agriculture accounts for around 61% of the total nitrogen and 28% of phosphorus load in river water in England and Wales. Pesticides and ammonia can also be toxic to many aquatic plants and animals, killing fish and invertebrates.[100]

The Nitrate Pollution Prevention Regulations for farms within Nitrate Vulnerable Zones (NVZs) require farmers to follow an action programme that reduces the risk of nitrate entering water. Since 2002, 55% of England has been designated as an NVZ due to high nitrate levels in groundwater and rivers, and to a lesser extent, eutrophication in estuaries and lakes. Estimates of the effectiveness of NVZs, based on the 2002 programme, put the overall national reduction of nitrate lost to the water environment at between 2% and 7%. Reductions at a catchment scale varied between 2% and 20%. The current NVZ action programme (2016) is more stringent than the last and is therefore expected to deliver greater reductions.[101,102]

5.1 Farm inspections

Environment Agency farm inspections have revealed two of the biggest challenges for farmers is the separation of clean and dirty water, and the management of slurry. Of the serious (category 1 and 2) pollution incidents caused by the agriculture sector in 2022 and 2023, 62% and 64% of incidents involved slurry, and of these, 86% and 65% respectively were containment and control failures. The new Slurry Infrastructure Grant scheme should reduce these problems, but it is too new at the moment to evaluate the results. Separation of clean and dirty water in farmyard areas could have significant benefits in reducing the diffuse loads to water bodies of both nutrients and other chemicals.

The Environment Agency deploys a targeted farm inspection programme. In 2022, at inspections at farms that do not need to be permitted under the Environmental Permitting Regulations, we found non-compliance with environmental regulations at 49% of inspections. At 39% of the inspections, we found non-compliance with at least one of the Farming Rules for Water. The first prosecution brought under the Farming Rules for Water has resulted in the landowner being sentenced to 12 months in prison and ordered to pay £600,000 in prosecution costs.

5.2 Land use change

Pollution reduction from voluntary land management and land use change estimated by the Environment Agency found:

- there is uncertainty on the total contribution of the future environmental land management schemes, as they are being piloted, developed and launched
- nationally average pollution reductions do not reflect the high variability in local outcomes
- the level of pollution reduction that can be achieved can be significantly increased by targeting land use change for water quality

- the pollution reductions that are estimated to be achieved by 2027 will not be enough to meet environmental targets

Population change and concern for food security means there are trade-offs between agricultural practice, pollutant levels, food security and food prices.

Efforts to mitigate agricultural pollution have resulted in a range of interventions aimed at reducing environmental impacts and promoting sustainable development. There is a continued focus on taking an integrated approach to effectively tackle diffuse pollution from agriculture using a mix of advice, incentives, industry led initiatives and regulation. This includes the ongoing development of catchment partnerships and the use of new and innovative techniques such as drone surveys and remote sensing using satellite imagery to inform integrated actions.

6. Water quantity

The UK has a temperate, moist climate with mild winters and warm, but not hot, summers. Average rainfall is highest in the west and the north, with the mountains of Wales and the English Lake District wettest. Some parts of the Lake District receive over 3m of rainfall each year[103]; in contrast, parts of eastern England see an average of less than 500mm each year.

The high land in the west and north is mainly impermeable, which means that rainfall tends to run quickly into rivers and streams. Rivers here are “flashy”, which means flow rises quickly after rainfall, but also falls quickly after the rain has stopped. In southern and eastern England, the chalk rock is permeable, so water sinks into the ground and emerges slowly into rivers, sometimes many months after the rain fell. This means that rivers in these areas tend to respond slowly to rainfall, maintaining flow through all but the driest summers. Limestone in the Pennines and the Cotswolds responds more quickly than chalk but still acts as a reserve that maintains flow for some time after the rain has stopped.

6.1 Interventions in the water cycle

People intervene in the water cycle both deliberately and accidentally, with most interventions being the consequence of another activity.[104] Deliberate interventions include flood management and alleviation, abstraction of water for water supply, industry, power generation and agriculture, and discharges from sewage works and other industrial sources. These interventions have the effect of moving water in time and in space. Flood management either holds water back or encourages it to flow quickly away from vulnerable areas.[105] Abstraction takes water from one place, uses it somewhere else, perhaps at a later time, and returns some to the environment, often some distance from the original source.

Changing land-use can also change the way water flows in the landscape.[106] The variation in geology, soils and vegetation across the UK means there are different underlying hydrological responses to rainfall in different places. Urbanisation and road building creates additional run-off from impermeable surfaces. Water demand for agriculture is expected to increase with temperature due to climate change. Crops may need more irrigation to counteract warmer, drier periods, but increases may be constrained by the availability of suitable soils for growing irrigated crops, and changes in rainfall patterns will affect both rainfed and irrigated agriculture.[107] Different vegetation has different water use requirements, but this can change soil characteristics and thereby change the physical flow of the water through the soil. Drainage of land for farming or for new building can lead to irreversible changes in water tables and river flows.

The biggest human intervention in the water cycle is climate change. Globally the hydrological cycle is intensifying, with more extreme events, including both floods and droughts. In the UK it is affecting the weather patterns, and changes in rainfall duration, location and intensity are contributing to both drought and flooding events. More rainfall is falling in heavy events, and the UKCP18 climate projections show increasing winter rainfall through the rest of the century. Temperatures are increasing. The record-breaking summer temperatures of 2022 are a sign of what can be expected through the rest of the century.

6.2 Droughts

Drought, defined as a prolonged shortfall of rainfall, is a feature of the UK climate. Droughts are experienced infrequently, with notable droughts in 1921 to 1922, 1933 to 1934, 1975 to 1976, 1995 to 1997, 2004 to 2006 and 2010 to 2012.

In 2022, drought developed rapidly in England, with water use restrictions across much of the south and damaging wildfires. The institutional framework for drought planning and management is well established and embedded in legislation. All water companies have to consult on their drought plans, so that people and regulators can see how they plan to deal with dry periods. All droughts are different, but by planning for a range of droughts the worst effects can be avoided. As the climate changes, we can expect to see more hot summers, and there will continue to be occasional, infrequent long droughts.

6.3 Nature Based solutions

Working with nature, including tree planting, peat restoration, species reintroductions, and natural flood management, creates opportunities to restore biodiversity while providing other benefits such as carbon sequestration, flood protection and clean and plentiful water.

Nature-based solutions (NbS) are ways of working with natural processes to provide benefits to people and nature. They are solutions that help mitigate and adapt to climate change, while enhancing biodiversity and contributing to wider benefits such as food and timber production and human health and well-being. NbS involve the protection, restoration and management of natural and semi-natural ecosystems. This enables carbon sequestration, flood mitigation, microclimate regulation, agricultural productivity and the protection of water resources.[108] For example, restoration of peatlands:

- improves water quality through filtration which means water companies can use less chemical treatment
- increases carbon sequestration to help mitigate climate change
- can help provide flood mitigation by acting as a sponge to store water and reduce downstream flooding
- provides habitat for rare species

Natural flood management

A range of ecosystems such as woodlands, peatlands, wetlands and coastal habitats can provide natural flood management (NFM) by slowing run-off after rainfall and by preventing coastal erosion and mitigating coastal surges.[109]

However, the science of NFM is still evolving and developing. Many of the proposed measures have yet to be fully tested during extreme flood events so we are still learning how to design and construct them. It is also important to ensure they do not synchronise flood peaks, inadvertently increase flood risk downstream, or inadvertently create a backwater effect and increase flood risk upstream.[110]

Working with Natural Processes (WWNP) to reduce flood and coastal erosion risk (FCRM) involves implementing measures that help to protect, restore and emulate the natural functions of catchments, floodplains, rivers and the coast. WWNP takes many different forms and can be applied in urban and rural areas, and on rivers, estuaries and coasts.

Enhancing tree coverage (in the right place) for example, improves water quality and soil health by reducing the amount of sediment and pollutants reaching rivers. Trees and woodlands also reduce riverbank erosion and can support flood alleviation as part of catchment based NFM solutions. Trees along rivers also provide shade and reduce summer water temperatures for fish.[111]

Making a river more sinuous can reduce flood peaks, water velocities and attenuate flow by slowing and storing flood water. River floodplain restoration restores the hydrological connectivity between the river and floodplain, which encourages more regular floodplain inundation and flood water storage. This can decrease the magnitude of the flood peak and reduce downstream flood depths especially for high frequency, low return period floods. Leaky barriers usually consist of woody debris and are either formed naturally or can be installed across watercourses and floodplains. They reduce flood risk by intercepting the flow of water in a river. This can help restore river-floodplain connectivity which can reduce flood peaks, slow water velocities, and attenuate flow by storing water on the floodplain.

The Wyre Natural Flood Management project is testing some NFM interventions, including wetland creation, leaky barriers, sloped embankments, alongside peatland and river restoration. It also uses a new financial model which will see the upfront investment repaid through contracts with organisations that benefit from improvements, including water and insurance companies.[112]

6.4 Future pressures

Maintaining high levels of biodiversity protects ecosystem function and is essential for maintaining resilience and delivering the ecosystem services that we rely upon.

Changing rainfall patterns, together with an increased population, will place significant pressure on water supply, particularly in the areas most reliant on groundwater for public use. Climate change will also affect agriculture in terms of changing growing season, crop types and varieties. Warmer temperatures may introduce different pests and pest control measures (such as new chemicals). More intensive rainfall on bare or early cultivated and drilled soils can result in soil erosion[113] and leaching of chemicals or other pollutants into surface waters and groundwater.[114]

Rising temperatures due to climate change also has the potential to change the physical and chemical properties of surface and groundwater, thereby also affecting ecological functions.[115,116] Higher temperatures can alter respiration and photosynthesis rates in microbial communities, increasing the risk of deoxygenation. Increased nutrient loads and lower summer flows would increase the likelihood of algal and cyanobacterial blooms and reduce dissolved oxygen levels. Several aquatic species are at risk from warmer waters. Salmon are affected by increased temperature in both their marine and freshwater life stages. Aquatic food webs are also likely to change, partly as a result of changes in the timing of the life cycles of different species.[117]

The Keeping Rivers Cool initiative uses trees to shade small streams and prevent some of the warming, reducing the impact on trout and salmon. This provides climate change resilience and other benefits such as improving river habitat for people and wildlife, reducing erosion and intercepting sediment and pollutants. Shade from trees can reduce temperatures in small rivers on average by 2 to 4ºC.[118]

A key future risk is population increase and demographic movement. In parts of Sussex, Cambridgeshire, Suffolk and Norfolk, housing and business growth have already been affected, by insufficient water availability. Water resources management plans produced by water companies set out ways to deliver both new supplies of water and reduce water demand by improving water efficiency and reducing leakage. This should help ensure sustainable growth.[119]

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