2021 River Basin Management Plan

Physical modifications challenge Published: October 2019

Contents

1. Summary

Four in ten of our rivers, lakes, estuaries and coasts are not achieving their ecological and environmental objectives due to the effects of physical modifications.

Urban, industrial, and agricultural development over thousands of years has left a legacy of physical structures and modifications in and around the water environment. Both historic and current activities; including farming, water supply, shipping, urban development and flood risk management, are still putting significant pressure on wildlife within our catchments and coastal waters. Many natural features have been destroyed or harmed, and, along with it, the ability to create and maintain physical habitat; creating a poor place for wildlife and nature.

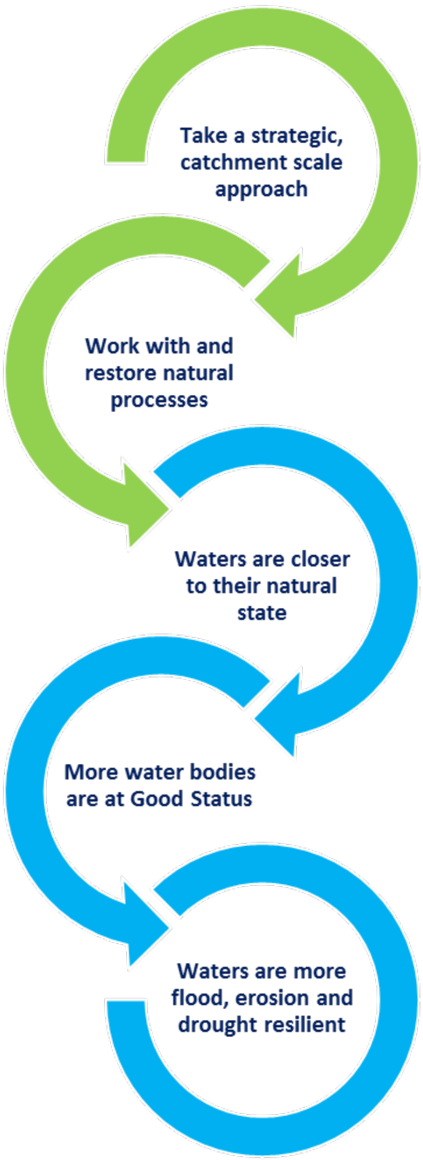
In this narrative we outline the nature, extent and consequences of physical modifications for the water environment and its ecology. Furthermore, we present a range of catchment scale, strategic priorities that hit right at the centre of our ambitions for a healthier water environment (Figure 1). They include actions that work from `soil to sea`; across entire river catchments and within estuarine and coastal settings. Four priority objectives include:

- **Remove** redundant structures and modifications.
- **Provide** space for rivers and coasts to move and adjust.
- **Improve** new developments and activities.

- **Keep** soil on the land and out of our waters.

We also consider what opportunities exist to drive future action, and what needs to be done to increase the rate of progress towards meeting these objectives. We also investigate how these objectives can work alongside other catchment priorities and the ever growing pressures placed on our environment. As we know, the impacts of climate change will have an increasing effect on our natural environment: we will have to adapt and change our behaviours in response to these changes. This needs to happen alongside an ever-growing population with an increasing demand for space and resources. Understandably, we have much to do. We are already starting from a good place: we have done a lot of the groundwork already. Given the challenges ahead though, we will have to do much more and think even bigger.

Figure 1. Managing physical modifications: strategic approach and outcomes



2. Headlines

- The waters and landscapes in England have been physically altered and manipulated for centuries; we continue to modify them today.
- In 2015, 83 per cent of our surface waters had a standard of ecology that was recorded as less than good. Physical modifications remain a primary pressure. In 41 per cent of all waters in England, physical modification is identified as a reason for not achieving good status.
- Despite significant effort and investment over the last ten years, the amount of physical modification in the environment remains unchanged; it may even be increasing.
- Our rivers, catchments, estuaries and coasts have lost many of their natural features and the function that shape them. This impacts on wildlife and the natural environment. It places a strain on our existing environment, and can compromise its ability to function in the future. It restricts our options for managing and adapting to climate change and population pressures.
- A step change is needed. Increased efforts to protect and enhance the natural forms and features within our landscape. Opportunities exist to drive these changes within our existing and future national and local planning policy and funding mechanisms. Better use and sharing of available data and information will be essential.

3. A case for change

Built structures and physical modifications within our rivers, catchments and coastlines are the primary reasons our waters have an ecological quality that we class as less than good. Currently, 41 per cent of the waters in England are not achieving their ecological objectives due to physical modifications[i]. In 2015 this figure was estimated to be 39 per cent[ii]. At best, this represents no significant progress over the last five years and at worst it signals a minor backwards step.

This is despite huge effort and investment at policy and local scale, delivering local benefits for our water environment. For example, this year we helped enhance 1,719 km of our water environment and created 460 hectares of new habitat[iii]. We now have 91 marine conservation zones designated for our coasts. However, as a whole, the headline statistics for England's waters remain disappointing.

The government's strong ambitions for the water environment are presented in the 25 Year Environment Plan (25 YEP)[iv]. It provides a clear message about reducing pressures on the environment, protecting natural services, restoring habitats and biodiversity, and balancing the needs of society within a growing economy. Climate change mitigation and adaptation is a key cross-cutting theme.

We will need to reverse a trend that has developed over the last 6000 years[v]. We have physically modified our rivers, estuaries and coasts to improve our quality of life. Done to meet specific needs and with the best of intentions, but without the knowledge or foresight to account for potential harmful effects in the future. From the draining of the fenlands for agriculture to the building of towns and cities, physical alterations are found in all types of water environments and adjacent landscapes.

Completely unaltered environments no longer exist. Habitat surveys conducted a little over ten years ago showed that over 50 per cent of rivers banks and beds have been physically altered; reinforcing and re-sectioning for drainage, navigation and controlling floods[vi]. Our coastal environments have experienced similar modifications, with 56 per cent of estuarine and coastal water bodies identified as heavily modified. Since 1860 important salt marsh habitats have been drastically reduced from more than 200,000 hectares to just 34,000 hectares (a loss of almost 85 per cent)[vii]. It is also estimated that over 90 per cent of our native oyster biogenic reefs have been lost and more than 50 per cent of our water bodies no longer have seagrass where it was once present.

Reversing these trends and managing our waters will be challenging; we will need to do things differently in the future. Our rivers, estuaries and coasts will need greater space and freedom to function naturally and provide greater resilience from continued economic and population growth, and from the effects of climate change. We must tackle legacy and new physical pressures and target effort not just at the water's edge but right across our catchments and landscapes. Without built infrastructure or managed and productive landscapes, our lives and communities could not exist. So we have a dual role; to provide goods and services for our communities and businesses, whilst protecting and enhancing those same environments we use and enjoy.

4. Evidence: catchments and coasts under pressure

4.1 Activities

Physical modifications stem from a wide manner of activities (see list below). They include alterations (such as channel straightening or dredging) and built structures (such as walls, embankments, weirs and sluices) to reduce flood risk, aid navigation, prevent coastal erosion and drain and reclaim land for agriculture. They also include activities on land that can have consequences for the water environment. Excess soil erosion from poorly managed farm land can lead to modifications within rivers and lakes, changing their shape and size. The common types of structures, activities and modifications, with possible physical impacts are highlighted in Table 1.

Activities that can physically modify the landscape and water environment:

Managing flood risk – actions to reduce and manage the extent and impacts of river and coastal flooding. A spectrum of interventions from engineered structures to broader scale, nature based solutions.

Managing coastal erosion – actions to slow rates of erosion and risk to coastal communities. Range from hard interventions to solutions that work with natural processes.

Rural land management – actions to support the use of land for food and timber (e.g. land drainage) and also the consequences of some cultivation and livestock grazing practices, such as soil loss, increased run-off.

Urbanisation and infrastructure – actions to support the needs of urban development, such as rail, road construction, flood risk management, river channel and coastline alteration.

Inland navigation – channel deepening and straightening (much is historical), maintenance of these features, impoundments and weirs to ensure navigation.

Ports and harbours – construction of quays and harbours, but also ongoing maintenance dredging for safe navigation.

Water supply and power generation – impoundments such as dams and weirs to maintain water supply for drinking, industry and farming purposes. Water flow modification for power generation. Some coastal energy facilities may affect coastal and inland waters.

Fishing – coastal and estuarine fishing for commercial purposes can modify seabed and disturb sediment. Freshwater fishing may alter bank side vegetation and riparian zones.

Aggregate extraction – material may be removed from coastal zones and some rivers, with consequences for channel forming processes such as scour and deposition.

Recreation – Some modifications to support activities such as jetties, marinas, whilst other activities may operate at catchment land use scales.

Improving nature – some interventions to restore/enhance the water environment may have knock-on consequences elsewhere.

Table 1. Types of structures, alterations and activities, with possible impacts

Modification type	Examples	Possible physical impacts
Built structures in or next to watercourses and coastlines	• Culverts • Bridges • Weirs / dams • Bank reinforcements • Embankments • Jetties and quays • Coastal development / reclamation	Loss of habitat, reduction in morphological diversity, disruption of natural erosion and sedimentation processes, reduced connection to floodplain, loss of upstream to downstream connectivity (sediment, wildlife), cliff line erosion and beach loss/gain.
Physical alterations of watercourses and coastlines	• De-silting / dredging / planform change • In-channel and riparian vegetation clearance • Channel widening • Seabed trawling / excavation • Water management (flow changes)	Habitat loss, change channel / coastal shape, disruption to sedimentation processes, bank erosion / scour, channel and seabed disturbance.
Land use activities within the wider catchment	• Crop production • Livestock grazing • Woodland / land cover management • Land drainage	Channel change, siltation, erosion, conveyance capacity, run-off and flow modification, change to catchment sediment yields.

4.2 Pressures

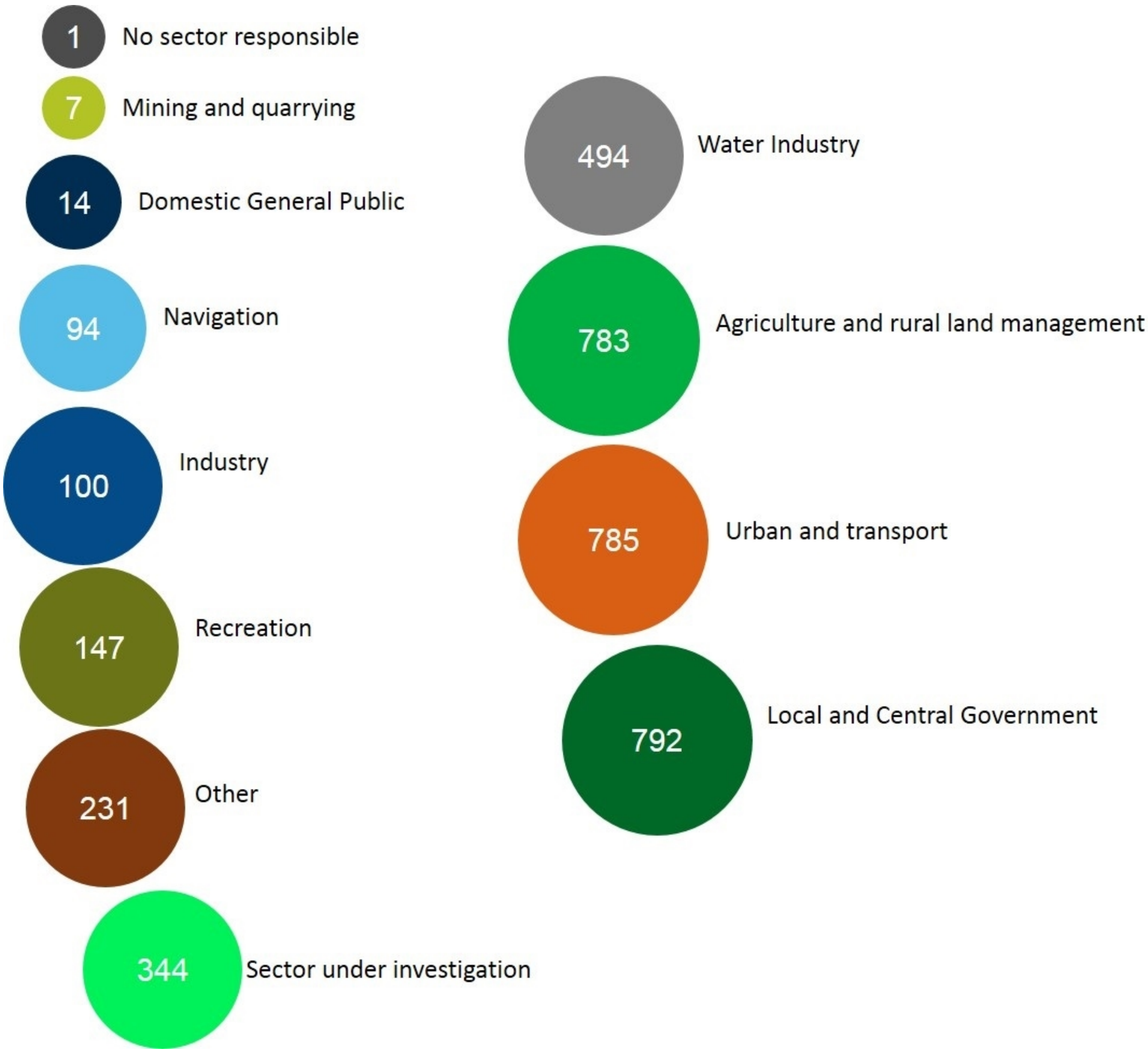
Key information, collected and assessed for our river basin management plans highlights the broad nature and extent of the physical modification pressure.

- Physical modifications remain a primary pressure. In 41 per cent of waters, physical modification is identified as a reason for not achieving good status.
- Many physical modifications we see today are a legacy of historic activities[viii], they can remain in the environment for a long time with impacts still present today.
- Physical modification continues to be diverse and complex in character, with many activities and potential impacts (Table 1).
- Almost every sector contributes to physical modifications in the water environment in some form (Figure 2).
- Eighty percent of physical modifications that impact ecology, are in water bodies with protected uses.

Even from this broad perspective, it is quite obvious that physical modifications represent a hugely complex and diverse set of potential pressures within our waters. They are embedded within the very fabric of the whole water environment. Many pressures originate in the headwaters of our rivers, but the impacts are felt downstream; including in our estuaries and coasts. Other pressures extend locally and then stop, whilst others impact for many kilometres. Some pressures are fleeting, whilst many more have a longer lasting, continuous influence on the environment.

The interplay between the built environment and the natural physical environment can be extremely complex, with negative and positive feedbacks. Our understanding of these relationships, supplemented by data and research from studies across the UK and abroad, direct our policies and inform all of our decision about what we do in the environment.

Figure 2. The total number of physical modifications recorded as a reason for not achieving good status/potential, compiled per sector.



4.3 Impacts

The main pressures and potential impacts on the physical condition of our waters are highlighted in Table 2. The physical condition of the features and functions we can see within water courses and landscapes[1] is extremely important. These landscape features and processes serve many important functions. They provide physical habitat for plants and animals; provide substrate for fish spawning and can help reduce water pollution. Not only do they serve the environment, they support other essential services too. They can help reduce flooding, allow boats to navigate, reduce the effects of drought and help provide clean drinking water. At the coast, for example, saltmarsh can dampen wave energy and help support coastal flooding and erosion management. They can augment the benefits we achieve from our coastal defences. Unfortunately though, these benefits are declining, as they continue to diminish in extent and number. There is 85 per cent less saltmarsh compared to natural levels many decades ago.

4.4 Ecology classification

The wildlife in our waters (its ecology) is used to define overall water quality. Through the river basin management planning process, we give our waters one of five ecological quality status classes (bad, poor, moderate, good and high). This classification process uses local and national data, computer modelling, local investigations and other sources of information.

In waters with protected uses (heavily modified water bodies) or those that are artificial, such as canals and reservoirs (artificial water bodies), classification is established using other measurements; including the presence or absence of mitigation within a water body. This is a useful indicator of physical condition and used as a proxy indicator of ecological potential, or likely ecology, given the conditions within a water body with protected uses.

The classification information, supported by bespoke local investigations helps identify why some waters do not achieve a good ecology classification. Table 2 shows the type and extent of ecological impacts from physical modifications, where it is identified as a reason for not achieving good. The physical condition figure reflects the large number of waters in England with protected uses, and the mitigation measures approach used for classification in these waters.

This information helps design programmes of measures; actions to improve the quality of our water environment, including actions to address pressures from physical modifications. We also look at the types of modifications and their associated uses. It helps us set ecological objectives for our waters and ensures important current and future uses or services are not compromised.

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[1] The term morphology describes the shape and physical features we see in our rivers, lakes and at our coasts and estuaries. For example, how beaches are formed, where channels erode and the movement of soil and sediment through a catchment.

Table 2. Impacts from physical modification on classification elements.

Classification element affected by physical modifications	**Percentage of all waters not achieving good**
Physical condition	60
Fish	25
Aquatic invertebrates	9
Aquatic plants	6

Physical condition is based on the adopted mitigation measures approach for classification in heavily modified and artificial waters

5. Challenges: physical modification pressures

Despite investment spent managing physical modifications (£68 million of government funding between 2009 and 2015 on mitigation measures[ix]), the impact these modifications have on the ecological and natural function of our waters remains high. In addition, the loss of natural processes within our waters and the impacts from soil loss on the workings of our rivers, catchments and coasts are significant. Based on our current understanding, we think the four priority pressures we need to address are:

- legacy pressures from historic modifications
- reduced natural functioning within our waters
- future developments and associated pressures
- pressures from the land, including impacts from soil loss and increased sedimentation in our waters

We consider these pressures in light of future climate change forecasts and population growth estimates. The additional pressures these changes will put on the natural environment and our ability to adapt to and mange added environmental risk (e.g. flooding) are likely to be significant.

5.1. Legacy structures and modifications

Built structures and modifications reflect centuries of development, and many still support industry and water services. For others, their use has changed: an abandoned canal may now provide value for nature, or old weirs support important local fishery interests. Some are an important part of our cultural heritage. Arguably, a great many no longer provide any current or obvious future value, or the service they do provide is no longer effective or efficient.

Importantly, these structures and modifications can affect the health of our waters. With no current use and uncertain future value, a great many are a burden on the environment. Efforts to remove them will improve the physical condition of our waters and support action taken elsewhere; with little impact on growth and development.

Evidence supporting our river basin management plans indicate physical modifications are a reason for not achieving good ecology in 41 per cent of all waters. Of those we have recorded (3792 in total), up to 80 per cent of these physical modifications may support a protected use and the scope for potential removal therefore, may be limited. However, this means that 20 per cent of physical modifications identified in the river basin plans have no currently recognised use, and perhaps offer potential for full removal. This is a significant number in itself. It highlights the scale of effort needed to address those pressures we have recorded and assessed within the river basin planning process.

Actions to manage problematic structures are identified within the programmes of measures, developed as part of the river basin planning process. This programme alone helped implement over 600 mitigation measures in support of physical modification improvements. However, information about legacy structures and modifications in river basin plans is arguably less well developed for smaller, headwater streams that feed into the bigger rivers.

5.1.1. Extent

In England and Wales, the total length of headwater (first and second order) streams is approximately 125,000 km, or 73 per cent of the total river network. As such these smaller tributary rivers and streams are hugely important for aquatic ecology within our river catchments[x]. By comparison core asset information in large rivers (the Main River network, managed by the Environment Agency), represents less than 15 per cent of the total river network in England. Flood risk management asset information, for example, holds core data for over 73,000 Environment Agency and third party structures on main rivers.

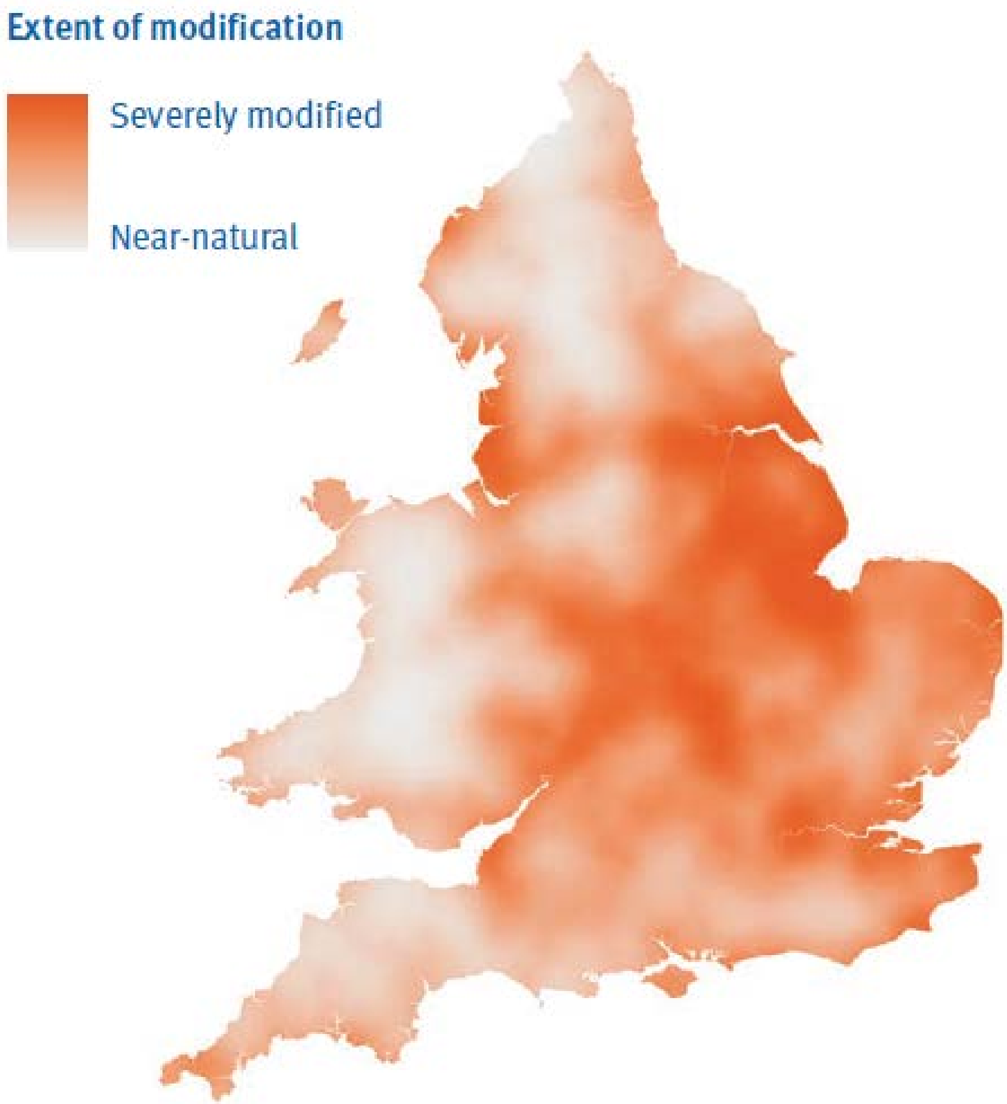
Significantly, a recent report highlighted centrally held databases may underestimate the extent of physical structures in our waters[xi]. For in-stream barriers (e.g. weirs and impoundments) they calculated the amount of under-representation to be at least 66 per cent. Fundamentally, these in-channel barriers remove or reduce connectivity from our river networks resulting in only 3.3 per cent of our catchments being fully connected. This is ecologically significant; impacting fish migration and other wildlife and physical functioning across entire catchments.

We can`t tackle everything, and our river basin planning process quite rightly takes a risk based approach to managing the environment and is driven by available funds and policy. However, planned and co-ordinated action typically occurs within larger waters. Additional effort to identify and remove redundant structures in smaller waters will help drive greater improvement across waters as a whole.

5.2. Reduced natural functioning

The river network in England is a little over 300,000 km in length. It includes our major urban rivers, but also the small streams and becks found in remote, rural corners of the country. As a consequence of engineering and modification, almost half of our rivers show signs of historic or active bank reinforcement, re-sectioning or straightening[vi]. The map in Figure 3 highlights the distribution and extent of river channel modifications (based on field survey from 2006 and 2008). Many kilometres are devoid of natural features and forms, they are entrenched into their surrounding landscapes, disconnected from floodplains and valley floors. They are unable to adjust their shape and dimensions in response to changes in water flow and sediment supply. Even those in the iconic landscapes of Cumbria, old channel walls and straightening for land management purposes have removed the natural dynamism from many kilometres of our valleys and floodplains.

Figure 3. Extent and severity of channel modifications in England (and Wales)[vi].



Similar types of modification occur at our coastlines and on the banks of our estuaries. Current Environment Agency information indicates that 44 per cent of our estuaries and coastal waters have ecological status less as less than good because of physical modifications.

A lack of natural processes (e.g. sediment movement, erosion and deposition) in constrained waters, can often lead to poor habitat quality; unable to recover from disturbances[viii]. Furthermore, many wetlands, pools, saltmarshes and other important floodplain and coastal habitats are disconnected and abandoned, too dry to support natural habitat.

Constraints on movement and adjustment in our waters are important in many other ways. Straightened, uniform channels typically transfer waters downstream much more effectively than in many naturally functioning channels. In some cases this can influence the timing and duration of flood peaks and may increase flood risk[xii].

Recognising this, flood management can incorporate actions to slow the flow in some sections of river. Restoring meander bends, roughening-up channel banks and re-connecting floodplains can help in this respect[xiii].

Natural systems have a role to play in the adaptation and management of emerging pressures. Watercourses and coastlines that can move and adjust in response to floods and higher sea levels can offer valuable climate resilience benefits. Though of course, these benefits can only be realised once other factors, including housing, business developments and other important assets have been accounted for.

Taming of our rivers and coast, by straightening, moving and strengthening has supported growth and development for many centuries. Many modifications continue to provide benefits that society cannot do without. We must maintain them appropriately. The fenland drains, for example are successfully managed; they provide valuable land drainage, whilst maintaining good ecology and wildlife[xiv].

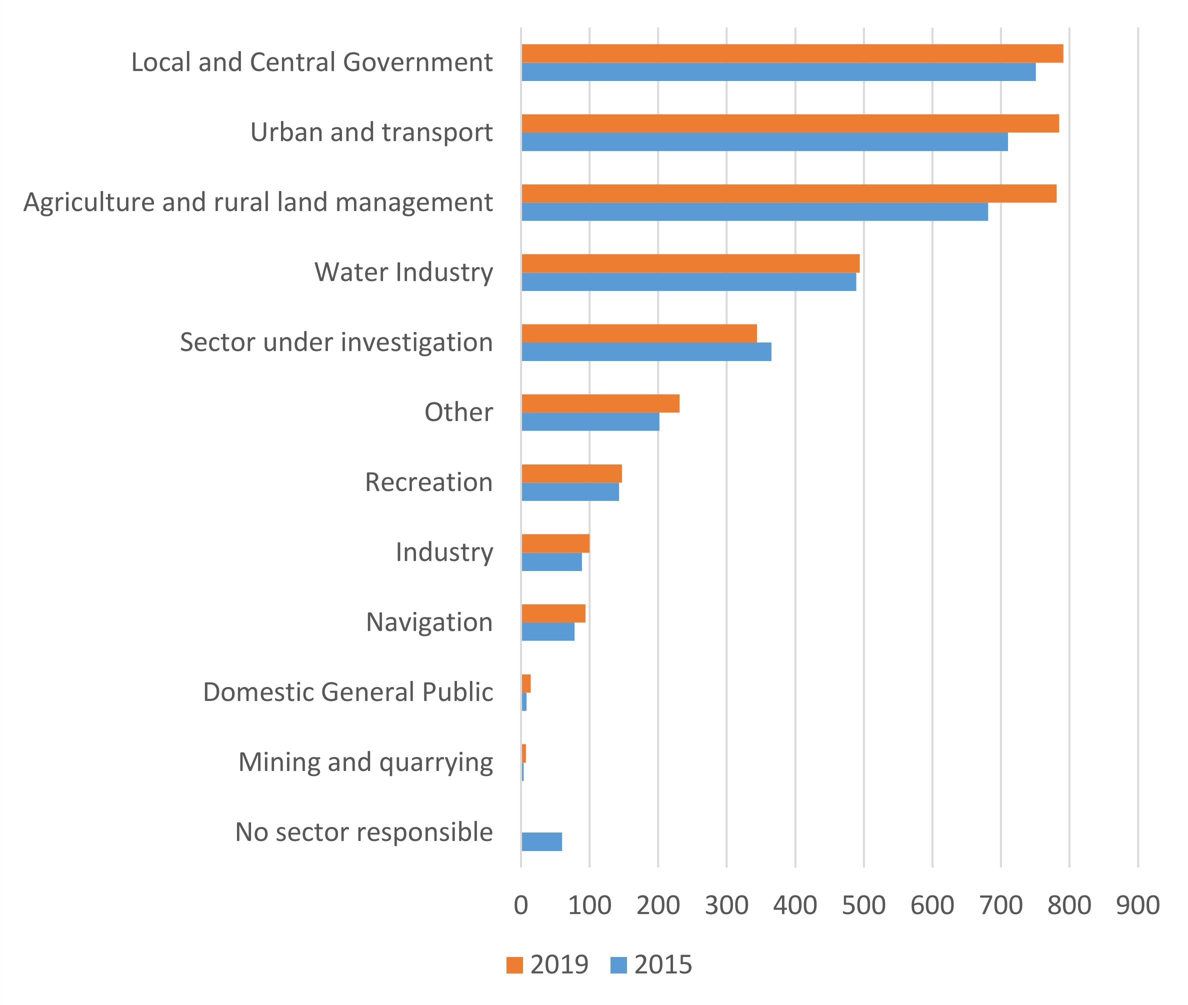
However, there is potentially a huge bank of opportunity to do much more. With control and planning, working with nature provides an ongoing opportunity to put some of the lost dynamism back into our rivers and coastal environments. Letting our waters do this naturally, by providing the space and freedom to recover, can offer a cost effective approach for broad-scale restoration and landscape resilience.

5.3. Future growth and development

Additional effort to protect and improve the environment, as part of new developments, is required. Set within the context of the government's 25 Year Environment Plan, new development must consider the effects of changing climate, increasing population and growing land use pressures.

As indicated earlier, a little over forty percent of our waters are failing their ecological objectives due to the effects of physical modifications[xv] with no improvement over the last four years. A breakdown of these figures highlights this trend is found across all main sectors investigated (Figure 4). Given the good progress we have made locally and across the nation as a whole (4,483km of waters enhanced since 2016[iii]), through our catchment working, investments from government grants and private developers, these figures are disappointing. Although very coarse and subject to some changes in assessment between reporting periods, these figures do indicate new modifications remain a priority concern, hindering further good progress and achievement of our long-term ecological targets for our waters.

Figure 4. Recent trend in the number of physical modifications pressures identified as a reason for not achieving good status. Plotted for individual key sectors.



It highlights a key challenge: to ensure future development does not stifle the good work being made locally. A lot has been done over the last decade or so to maximise enhancement opportunities and minimise risks. Development in coastal waters[xvi] and rivers[xvii] is better managed through permitting and other controls, and planning guidance has improved urban and rural development. Major infrastructure projects are very carefully designed to ensure the water environment is looked after[xviii]. However, further work across government, business and our growing partnerships is needed to ensure the right sort of development is done in the right place and supports the achievements and successes we are seeing elsewhere.

5.4. Pressures from the land: soil and sediment in our waters

Across England (and Wales), agriculture is estimated to account for 75 per cent of the sediment (including soil) lost to the water environment[xix]. For every 1 km length of watercourse in England there are 50 hectares of adjacent land. Nearly 70 per cent of it is utilised for agriculture and this activity is one of the most significant influences on water quality and water-dependent ecosystems.

Soil loss and sediment movement within our waters is an ongoing natural process. Without it, our rivers, floodplains and beaches would simply not exist. However, some land management, urban development and construction practices can cause excess erosion; changing our rivers and streams un-naturally, often many hundreds of kilometres downstream. Some forestry operations, which cover 10 per cent of the land in England can also add to this figure.

Soil and sediment in the water environment affects water quality and these impacts are well documented within the accompanying fine sediment pressure narrative). However, elevated levels of sediment can also lead to significant changes of the physical forms and features, affecting key physical habitats. Excess sediment in our waters can lead to the following:

- Reduced quality of fish spawning and migration habitat.
- Choking of channels (lowland rivers in particular) and reduced marginal habitat.
- Excess infilling of riparian and floodplain wetlands.

Sediment pressures contribute to less than good ecological quality in approximately 5 per cent of our waters. Over time and often in combination with other channel modifications (for example, channel straightening), sediment can cause substantial physical changes. Accumulated gravels can cause shoals to develop; rivers can move around sediment islands and features. Lakes can change shape as deltas appear and grow. These changes can occur naturally, but too much sediment in the wrong place can impact other functions. For example, it can block critical water abstraction infrastructure. It can fundamentally alter river flows; changing how quickly flood water moves downstream or onto adjacent land. It can hinder navigation or restrict the effectiveness of mooring facilities.

Management can incur significant ongoing maintenance costs, such as dredging to maintain navigation, port and harbour operations and manage flood risk. In 2015/16, as part of the channel maintenance programme, the Environment Agency spent £22 million dredging and maintaining river channels to help reduce flooding. Similarly, water companies budget for sediment-related maintenance in and around important assets, such as off-take pipes and impoundments. Although good practice maintenance is generally applied, these actions can pose some inherent environmental risks. The Environment Agency's handbook on channel management[xx], highlights some of these risks in more detail and what can be done to reduce or avoid them. Moreover, it identifies the importance of managing soil at source; often reducing the need for more intensive intervention within river channels or along coastal shipping lanes.

5.5. Emerging pressures: climate and population

Our environment is going through levels of change not seen in millennia. Emerging challenges such as climate, population and land use change are dramatically affecting our environment, our lives and livelihoods. These changes will test how well our landscapes can adapt and respond to bigger floods, higher tides and increased demands put on our soils. They will test the way management can adapt and change; where we need to intervene or where the only option is to let go. We will need to manage increased risks but also seize opportunities and do things differently. Either way we must build resilience into our physical landscapes, across our catchments and at our coasts.

5.5.1. Climate

New climate change projections for the UK (UKCP18)[xxi] confirm the UK's climate will shift towards "warmer, wetter winters and hotter, drier summers":

- All areas of the UK will be warmer in future, with more warming in summer than in winter. Hot summers are expected to become more common.
- Summers are expected to become drier, particularly in southeast England; winters are projected to become wetter, particularly in northern UK.
- Sea level will rise by between 0.4 and 1 metre by 2100, and by up to 4 metres by 2300, even with large reductions in greenhouse gas emissions. Increasing sea level will increase the risk of storm surges.

5.5.2. Population and land use

The population of England is projected to increase by about 12 per cent, from 55.3 million in 2016 to about 62 million in 2041[xxii]. There will be regional variation in this growth with London and the south east likely to see the biggest increase.

Population and climate changes will inevitably change land use. It is anticipated people will live in smaller family units so the number of households is forecast to increase by 23 per cent by 2041. Such change will result in greater pressure for homes, work places, transport, energy, drainage and water infrastructure, increasing the spread and density of urban land use.

Agricultural land use is also likely to change with an increased need to feed a larger population, not to mention changes in which crops and animals can be produced in our changing climate. This is likely to result in:

- Greater intensification of agricultural land use.
- Changes in the types of crops grown with loss of grassland to make way for increased fodder and arable crop production.
- Increased biomass production for fuel.

5.5.3. Consequences for our water environments

Climate change modifies the prevailing weather patterns; changing the frequency and size of storms, floods and ocean currents. These changes will permanently alter our landscapes; we will not be able to put them back. The rate of change is likely to speed-up and the scale of change will increase. Importantly, changes in the landscape will occur suddenly. We must be prepared for these sudden and often unexpected changes.

As winters become wetter and rainfall more intense, events similar to those experienced recently in England (e.g. Storms Eva and Desmond in 2015/16), though exceptional at the time, will possibly become more frequent and widespread.

For river catchments, the physical forms and features within the landscape can change dramatically and include:

- Whole scale channel movement.
- Cutting of new river channels across floodplains.
- Swathes of boulders deposited on farmland.
- Gully erosion into once stable hill slopes.
- Collapse of river banks and river-side infrastructure.

Effects at the coast and within estuaries will be in response to changing sea levels, increased wave energy and altered tidal patterns. Coastlines are expected to become much more susceptible to erosion, permanently changing the position and nature of our coastlines.[xxiii] By the 2080s, up to 1.5 million properties may be in areas with a 0.5 per cent or greater annual level of flood risk and over 100,000 properties may be at risk from coastal erosion[xxiv].

Combined with a growing population and shifting land use, climate change poses some considerable challenges for the physical landscape and how it is used and managed.

- Fundamental change in the amount and condition of physical habitats - with implication for aquatic and terrestrial biodiversity.
- Modified river and floodplain features and connectivity, and their ability to convey flood water.
- Managing coastal change as risk from erosion and flooding increases.
- Managing urban development and rural land use priorities in our floodplains and at our estuaries and coasts.

The government's 25 YEP commits to 'making sure that all policies, programmes and investment decisions take into account the possible extent of climate change this century'. Building resilience into our landscapes, and adapting to these growing pressure will require continued work with our partners; embedding consistent approaches to risk management and making sure we adapt and respond to changing circumstances.

Working with natural processes is fundamental for building resilience across catchments. This may involve de-intensification of land use and re-connecting fragmented parts of the water environment (e.g. flood plains from river systems). It will also involve built infrastructure to manage critical resources and protect us from floods, erosion and other hazards.

6. Priorities: our main objectives

Working with nature to restore physical complexity in river and coastal systems is critical, and it can be done without compromising existing and future protected uses. However, action will not be effective unless it is taken at a system scale.

Given the scale and importance of the priority physical modifications pressures, we have identified four priority objectives to help develop and direct actions to address them. They encompasses a range of priority objectives set within the freshwater and marine environments. A nested approach (Figure 5) set within three broad landscape units indicates the appropriate scale of intervention.

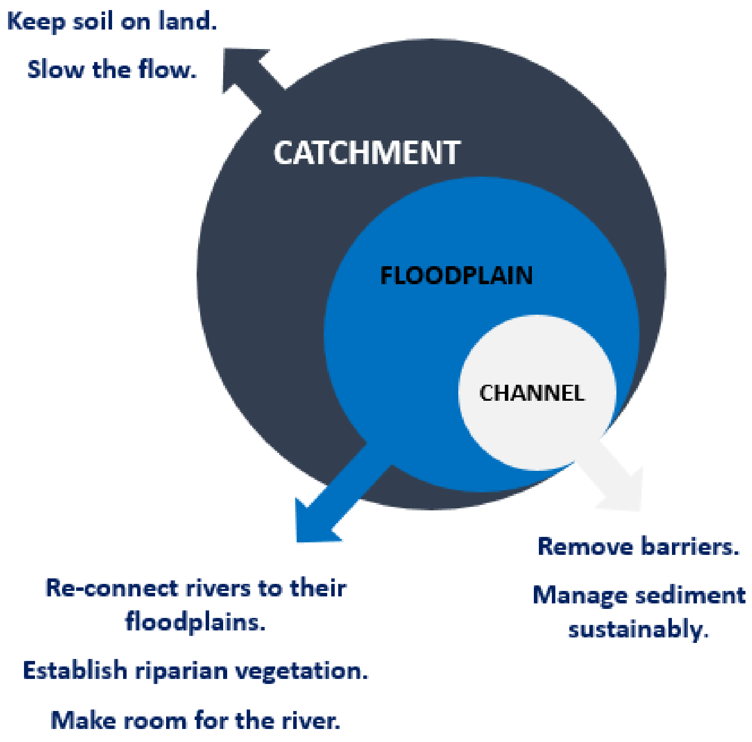
The four priority objectives include:

- **Remove** redundant structures and modifications.
- **Provide** space for rivers and coasts to move and adjust.
- **Improve** new developments and activities.
- **Keep** soil on the land and out of our waters.

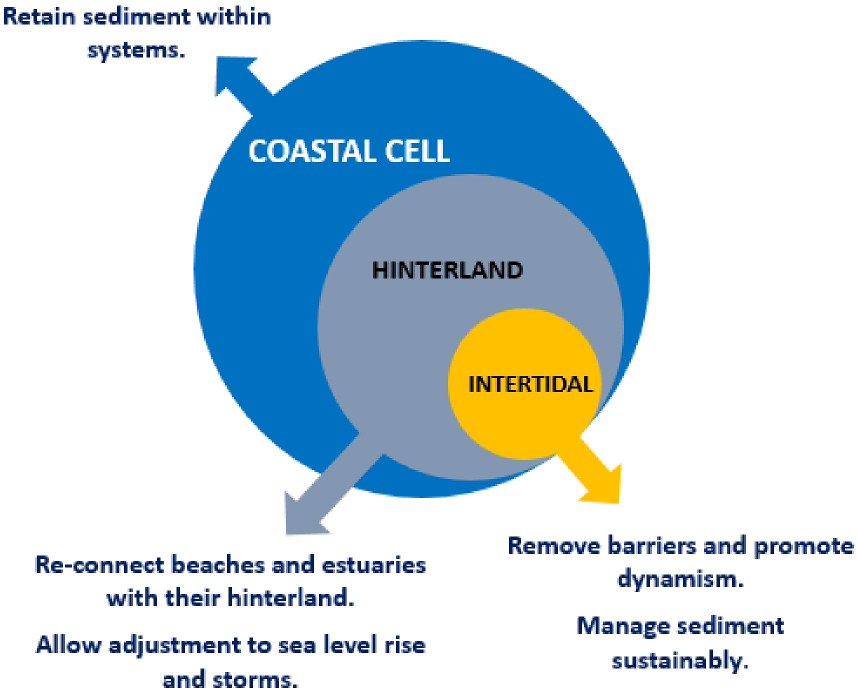
We describe these objectives and how they will help improve the physical environment and support catchment resilience.

Figure 5. Managing physical modifications and improving the condition of our waters.

Catchments and freshwaters:



Coasts and estuarine waters:



Coastal cell: a discrete area of coastline with a closed sediment budget; Hinterland: the coastal floodplain; Intertidal: the zone between Mean High and Low Water.

6.1. Removing redundant structures and modifications

Many redundant structures within our water environment no longer offer significant value and can compromise the health of our waters. Where practical, efforts to accelerate their removal should be encouraged.

The removal of redundant structures can offer local and much broader benefits. For example, it can help recover lost habitat near newly exposed river banks. Or in the case of weir or culvert removal, provide access to many kilometres of spawning territory. The Ribble Catchment Conservation Trust, amongst many others, observed significant increase in fish populations following the removal of a large weir[xxv]. The amount of potential ecological benefit depends on many other catchment conditions, including water quality and other natural or artificial modifications.

More significantly, the removal of structures can initiate a broader recovery of natural physical functioning; helping support restoration as part of a targeted programme of works over much larger scales. The IUCN report on river restoration[viii] highlights assisted natural recovery as a cornerstone of good restoration practice.

Additional benefits of asset removal, particularly those in a state of disrepair, include lowered risk of accidents and potential liability issues, health and wellbeing and overall amenity improvement. Urban regeneration or flood risk management schemes, have visual amenity as a priority in many cases.

Importantly, the removal of modifications can improve environmental resilience – or the ability of elements within the environment to withstand or recover from disturbances[xxvi]. Aquatic wildlife, for example, is typically more resilient to the combined pressures of heat and drought in waters that have fewer modifications, as there is a greater range and diversity of natural habitat available[xxvii].

At the coast, managed realignment can involve the removal of part or all coastal structures, allowing the re-introduction of tidal regimes to areas of low-lying land. Many schemes provide multiple benefits (for example, restoration of lost intertidal mudflat and saltmarsh habitat, and reduce flood and erosion risk).

The case study below illustrate the benefits of removing redundant or non-effective physical structures.

Case study: Coastal rock-armour and gabions removed, Brancaster, Norfolk:

- Physical Modification - Deteriorating rock armour (rip-rap) and gabions fronting sand dunes.
- Action taken - Removal of features to allow roll-back and the development of a more natural form. A secondary defence embankment was created landwards of the dunes.
- Benefits - Intertidal habitats created between the new defence and the dunes to protect the embankment from wave attack.
- Main partners / funding - Central government flood defence grant in aid, EU LIFE

Case study: Embankment removal on the River Kent at Staveley, Cumbria[xxviii]:

- Physical Modification - Embankment formed from historic dredging spoil and standing up to 60cm above floodplain.
- Action taken - Removal of 800m of embankment and river bank protection, followed by tree planting and reseeding.
- Benefits - Reconnection of river with floodplain, flood risk downstream is reduced. Restoration of wide range of physical habitats.
- Main partners / funding - South Cumbria Rivers Trust, Environment Agency, Natural England, United Utilities, EU Life, Greater Manchester Combine Authority.

6.2. Space for rivers and coasts to move and adjust

Half of our entire river network and a similar proportion of our estuaries and coastal environment is modified in some form, based on 2016 data from the river basin management plans. Many kilometres no longer have the space or freedom to move and adjust. We can help biodiversity and improve our resilience to climate change by returning some of this lost space, allowing rivers to recover.

"…techniques that encourage natural processes and help rivers [and coasts] to recover by themselves are recommended..." (International Union for the Conservation of Nature UK, 2016).

These approaches and techniques are vital if we want achieve government ambitions, signalled in the 25 YEP. Encouraging restoration of our waters, at scales commensurate with these ambitions will be necessary.

6.2.1. Natural recovery

Lost or degraded features within our waters can recover by themselves, given the time, space and freedom to do so[xxix]. In the right circumstances, straightened channels will start to re-meander (see box 2) and beaches and sand-spits will reform. Bank side trees and floodplain wetlands will develop where natural conditions allow. These adjustments and changes can occur by themselves, or with some assistance. We should encourage natural recovery, where appropriate and safe to do so. In some cases we will have no choice, nature will re-assert itself and we will have to manage and adapt to these changes accordingly. However, by providing the space for movement and adjustments in some lower risk locations, we can help reduce or offset the potential risks in more critical places.

Natural recovery is encouraged over and above more intensive restoration approaches, for the following reasons:

- The results are more in keeping with the location and support the expected range of plants and animals.
- They result in more resilient and sustainable habitat conditions, compared to `structure-based` restoration designs.
- Construction and maintenance costs are reduced as natural processes do the work of restoration and maintain the restored features.
- They are capable of restoring whole river–floodplain or coastal ecosystems rather than individual habitat elements or species.
- They support the restoration of other important ecosystem services such as flood management.

It is recognised in some cases (for example, saltmarsh) practical intervention is the only way habitats and associated benefits can be restored.

Case study: Localised natural channel change over a 16 year period on the River Caldew, Cumbria.

2000 (top left): modified channel with very few natural features; 2010 (top right): natural recovery initiated following high flows; 2014 (bottom left): continued recovery as features are encouraged to develop; 2016 (bottom right): river meanders and gravel features formed as river recovers.

Possible benefits are dependent on local conditions and land use/infrastructure, but can include:

- Ecology – physical habitat creation
- Flood risk – local flow reduction and sediment storage

6.2.2. Benefits for biodiversity

The importance of restoring river, estuarine and coastal habitats for biodiversity is well established[xxx]. It drives action within our waters and is built into our regulatory, planning and operational work. Some of the key benefits for biodiversity are:

- Riparian vegetation and bankside trees provide food and shade for animals.
- Wide river corridors provides habitat and important shelter, feeding areas and migration routes.
- Pools and wetlands help provide refuges for invertebrates and fish during low flows.
- Gravel bars and are important for certain insects, providing food for fish and other animals.
- Coastal sand dunes provide habitat for plants and animals.
- Mud flats and saltmarshes provide feeding grounds for migratory birds.

Habitat `connectedness` is important. Catchment and coastal habitats that are joined up across large areas provide much greater and more sustainable benefits over single or discrete habitats. Therefore restoration that helps connect physical habitats and natural landscape features offer significant advantages over small, discrete habitat improvements.

6.2.3. Climate resilience, flooding and drought

The government's 25 YEP commits to 'making sure that all policies, programmes and investment decisions take into account the possible extent of climate change this century'.

Working with nature and nature-based approaches continue to support flood risk and coastal erosion management[xxxi]. They support drought management and help mitigate the impacts of other pressures. Recently published guidance highlights the benefits of working with natural processes for flood risk management, particularly during moderate floods in small catchments [xiii]. It highlights the benefits of flood peak reduction of up to 30 per cent in some cases. At the coast, examples include the provision of flood protection for up to 143 properties through the re-establishment of 322 ha of saltmarsh habitat.

Natural recovery is used to help maintain flood protection and reduce maintenance requirements. The case study below highlights work undertaken to encourage natural recovery between Cley and Salthouse on the North Norfolk coast[xxxii].

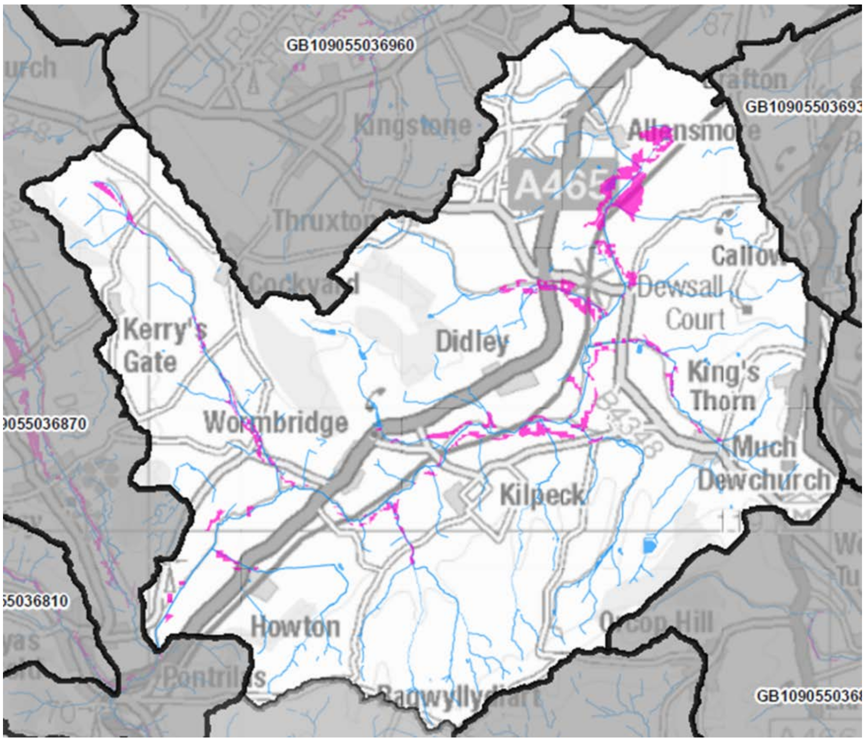
Case study: Part of a scheme of projects to restore natural function to 8km of the North Norfolk coast, using managed realignment, soft engineering, withdrawal of management and redesigning existing defences to create habitat and improve resilience to climate change and flood risk by working with natural processes.

At Cley to Salthouse the project restored the natural functioning of the shingle barrier beach after decades of intervention to facilitate natural post-storm recovery and maintain appropriate flood protection whilst reducing or removing maintenance requirements. The existing drainage system within the hinterland was also improved to return water to the sea following overtopping and reduce the impact of tidal flooding on freshwater habitats. Roll-back, flattening and occasionally breaching of the shingle ridge has occurred in response to storms, but was followed in each case by natural recovery and gradual development of a more sustainable (dissipative) beach profile. For example the now naturally functioning shingle ridge at Cley, although breached in the 2013 storm surge event, closed naturally within weeks despite initial concerns that it would need artificial manipulation.

Re-connecting rivers to their floodplains can improve climate resilience by providing the space for expansion or room to `flex` – a little like a pressure valve on a kettle. Floodplains with interconnected channels, wetlands and woodland have significantly more degrees of freedom than single-thread channels[xxxiii]. This freedom can help dampen-out the effects of the biggest floods or the severest of droughts. These complex systems were once much more common within our valleys and floodplains. By returning some of this lost dynamism back into our watercourses, we can use the natural landscape to reduce flooding and erosion in more vulnerable locations, reduce the effects of drought on our wildlife and help moderate water temperatures.

Figure 6 shows potential locations for floodplain reconnection and channel restoration potential. This is a snap-shot from a small catchment in Herefordshire. It is taken from a set of strategic maps covering the whole of England and helps signpost a range of areas for potential restoration and natural channel-floodplain recovery.

Figure 6. Floodplain reconnection and natural recovery potential (shown in pink). An illustration from a 72km^2 tributary catchment of the River Severn, Herefordshire.



6.2.4. Other benefits

Restoration of natural forms, physical habitats and processes within our water environment have a wide range of additional benefits. Physical forms and features can help moderate the impact of other pressures (e.g. provide space for aquatic ecology, filter contaminants from land), whilst others offer valuable ecosystem services, including health and wellbeing, and recreational value. Establishing the value of these physical features can help direct action to protect and preserve them. The government's four pioneer projects, including one in Greater Manchester[xxxiv], are helping investigate how a better valuation of natural systems and resources works in different places.

6.3. Improving new developments and activities

Population growth and economic development will mean an increasing demand for housing, infrastructure and development within our catchments and coasts. The government are committed to support this growth but in a way that results in overall improvement for the environment. To achieve these aims, future developments must support the protection and enhancement of our natural landscapes. Furthermore they must function with and adapt to the challenges faced by an ever changing climate.

Controls already exist to help ensure new developments do not cause ecology within our waters to deteriorate, nor compromise the achievement of future water objectives. But the focus in the future is move towards environmental gain and enhancement wherever possible.

Good design, planning and controls can benefit the physical condition of our waters.

6.3.1. Alternative options

Early consideration of all available options can help shape how well a new development supports the environment and other objectives. In some circumstances, an option of no intervention or do nothing may be appropriate, working particularly well when nature itself provides the solution. In other circumstances (for example, housing development, rail crossing), strategic development priorities and local/national planning considerations will play a key role. However, alternative options in the design and build phases can help direct good outcomes for the environment and sustainability. The Environment Agency's permitting approaches (e.g. for developments that may affect flooding[xvii]) incorporate environmental appraisals of proposed options.

6.3.2. Design and operational choices

Environmental enhancement can be built into many new developments and activities. Infrastructure that incorporates natural physical processes into their design offer significant environmental protection and enhancement opportunities. The benefits of working with natural processes to manage flooding and erosion are well recognised. Nature based options and green approaches are used within the river engineering and construction industry[xxxv], to support the implementation of green infrastructure[xxxvi]. Green or natural elements of design can soften the harder elements of construction (see case study below). More substantial environmental enhancements can be won by incorporating solutions that fully work with nature into new developments and activities.

Case study: Green infrastructure is a network made up of natural and semi-natural features that connect and run through our environment. Our waterways form a key part of this green network, and green infrastructure approaches can help conserve and restore these natural features by improving water quality, morphology and natural habitats. The term morphology describes the shape and physical features we see in our rivers, lakes and at our coasts and estuaries. For example, how beaches are formed, where channels erode and the movement of soil and sediment through a catchment.

Green infrastructure approaches strengthen the functionality of river ecosystems by greening new and existing river infrastructure. In doing so, they can help achieve compliance with core environmental and flood legislation. To support the needs of UK environment agencies, technical guidance and decision support advice identifies three core actions to help projects develop successful green approaches:

1. Gathering existing guidance and literature to provide technical knowledge and to promote the informed selection of green infrastructure solutions in river engineering.
2. Compiling and communicating case studies that provide evidence on key aspects of implementation, including construction, engineering performance, environmental functions and social benefits.
3. Identifying critical success factors (motivation, engineering performance, costs and ecosystem services) and assessment of their impact on decision making.

The publication[xxxv] 'Green approaches in river engineering: supporting implementation of Green Infrastructure' brings together strategic frameworks and technical information needed to support the selection of green infrastructure approaches.

A NERC-funded project (Natural Environment Research Council) led by HR Wallingford; partners included the River Restoration Centre, Environmental Policy Consulting, CIRIA, University of Liverpool and University of Nottingham.

Good designs that help protect or enhance the physical environment and offer sustainable choices, can include:

- Accommodating natural processes, provide space for them in the development designs.
- Use the natural landscape to provide the design element(s) required.
- Use natural materials that can re-generate and offer a low-maintenance solution.

- Re-use existing structures often preferred over building new structures.
- Incorporate environmental compensation for any residual impacts, ensuring overall net gain is achieved.

Good design or practice is also important for operational and maintenance programmes. The Canals and River Trust, for example, undertake essential maintenance dredging in a way that minimises impacts on the aquatic flora and fauna. The approach targets higher risk `hot-spots`, determines how best to dispose of dredge spoil and assesses sites for sensitive or protected wildlife. Environmental enhancement may not always be feasible in these and similar waters where specific uses must be protected. Mitigation measures or best practice approaches are often used to enhance the ecological quality without compromising current and future usage[xxxvii].

6.4. Keeping soil on the land and out of our waters

6.4.1. Rural land management

There is no greater incentive for keeping good quality soil on the land than the need for a sustainable food production system. A balance between short-term food supply and a clean environment, able to sustain food production in the longer term, is needed. A recent report on sustainable food production indicate that it should be possible to achieve both[xxxviii].

Through the 25 YEP, the government is signalling a step change requirement in rural land management. Setting clear targets for environmental improvements. One such target is for three quarters of our waters to be at near natural condition. Land management must play a significant role in this and efforts to reduce soil erosion and improve soil quality will be pivotal with healthy soils being a key outcome indicator[xxxix]. Defra's Future Farming and Countryside programme seeks to support these ambitions with a focus less on rules and more on partnership.

The Environment Agency are working to influence Future Farming and Countryside policy once we move away from the EU Common Agriculture Policy – we want to include more for the environment. The Agriculture Bill currently makes provision for paying for 1) public goods including: clean air and water quality, biodiversity, actions to address climate change, and reducing risks from flooding and drought; 2) in connection with improving the productivity of an agricultural, horticultural or forestry activity including resource efficiency including soil health.

Future agriculture funding will primarily be delivered through a new Environmental Land Management System (ELMS). We are working with government to help ensure this system benefits the environment and that actions support the longer term objectives of the 25 YEP. This will be based on the 'public money for public goods' principle. Working with farmers and land managers who wish to improve the environment by entering into contracts in which land managers are rewarded for delivering public goods. Incentives will be prioritised where the greatest environmental benefits can be achieved. Examples include the creation of features to manage soil erosion and reduce transfer into watercourses.

Measures that can tackle soil loss or erosion at source, include:

- Change land use to less intensives uses (e.g. woodland or unimproved grassland) to manage risk
- Restrict certain cultivation operations at high risk times and/or locations (e.g. to avoid compaction and exposure to high rainfall)
- Restrict use of feeding stations at high risk times/locations
- Improve farm yard drainage infrastructure
- Soil management planning: leaving a rough seedbed post-harvest; encourage the use of low ground pressure tyres on machinery and trailers; restricting livestock access to river banks and channels

Measures that can tackle soil movement or transfer pathways include:

- Restore the riparian zone – for example establish/improve riparian woodland and buffer strips
- Fit/improve existing urban/rural sustainable drainage systems
- Create/improve wetlands
- New or improved farm infrastructure (e.g. tracks, gateways, drainage); improve field drain management; break compaction on tram lines and in grass fields
- Fit interceptor traps/gully pots to capture sediments (and contaminants) in drainage water; improve maintenance of interceptor traps/gully pots
- Reduce slope length, consider planting hedges and woodland buffer cross slope strips and beetle banks

Measures will benefit the physical condition of our waters by treating the source (for example, soil erosion) rather than the symptoms (for example, siltation). As a result, changes to rural land management can benefit habitat, biodiversity and also help reduce flood risk and secure a clean and plentiful supply of water supply.

6.4.2. Beneficial use of coastal dredged material

Sediment at the coast is an important component of the natural physical system. To aid navigation, material is often removed (dredged) from estuaries and ports. This dredged material has been lauded in recent times as having potential for habitat restoration, flood protection and climate change adaptation. While a number of studies have illustrated that dredging sediment can have valuable ecosystem benefits, it is rarely utilised to its full ecosystem benefit potential in the UK[xl]. While currently only a tiny fraction (<1 per cent) of the maintenance dredging resource in the UK is used for marsh restoration, this is one benefit that may be examined for reuse on a larger scale in the future. Several successful, albeit small-scale, projects have been implemented over the last 25 years to draw knowledge and learn from.

7. Future opportunities

In future, action to manage physical modifications will need to be much more co-ordinated, work at much bigger scales and achieve multiple outcomes.

Existing government plans and strategies focus on three core areas of water management:

- Water quality.
- Water resources.
- Flood risk and related impacts.

They all have very clear objectives with well-established plans for achieving clean water, plentiful water and protection from the effects of flooding. They also support broader outcomes for the environment; driven by existing river planning objectives and other laws and policies.

However, a strategic approach for improving the physical condition of our waters – to help inform existing corporate and business planning, does not currently exist. This restricts the Environment Agency's and other water user's ability to fully co-ordinate action across existing water and land management functions. Better planning for morphology can:

- Better support river basin management planning; targeting pressures, establishing measures and optimising outcomes for the aquatic ecology, whilst building in catchment resilience.
- Support the allocation of funds to manage flood risk, optimising opportunities to develop sustainable and resilient flood risk and coastal erosion schemes.
- Help direct river and coastal restoration, highlighting opportunities for natural recovery, habitat enhancement and other ecosystem service (e.g. flood risk and water quality).
- Inform planning policy and regulations to ensure risks associated with new developments are minimised and enhancement opportunities are realised.

The Environment Agency are using the 25 YEP to help identify and develop opportunities within existing and future plans and programmes. We have highlighted strategic priorities for managing physical modifications. They are already forming an important element of this developing work area and we will use this consultation to further inform our approach. Within this work, a range of planning, policy and funding opportunities exist.

7.1. Planning and development control

Existing and future planning policy, regulations and interventions will need to work even harder to help improve the physical condition of our waters.

7.1.1. Planning for net gain

The government announced in March 2019[xli] that biodiversity net gain will be mandated in the forthcoming Environment Bill. This is significant as it provides a signal to ensure much needed housing and development is not at the expense of vital habitat. It strengthens existing planning tools, by insisting net gains rather than no net losses. Developers must demonstrate how they are improving biodiversity, such as through the creation of green corridors, planting more trees, or forming local nature spaces.

The improvement of physical habitat within rivers and adjacent corridors are a core component. A trial of the tools by developers and planning authorities will help guide possible further development. Natural England and the Environment Agency will continue to drive its implementation and further development opportunities. In particular how it works within the catchment context and alongside existing plans and procedures (e.g. river basin management).

Establishing environmental net gain in the planning system would also allow the maintenance and improvement of the nation's resilience to flooding, coastal erosion and the effects of climate change. This could include the wider use of best practice land management techniques. Environmental net gain could also provide an opportunity to secure investment in flooding and coastal change benefits through new developments and funding partners.

7.1.2. River basin planning

The river basin planning process is now well established and has helped secure investment to mitigate effects of physical modifications on the water quality and ecology. The river basin management plans are updated on a six-year cycle. Opportunities to refine physical modification management, through the planning processes, should be sought.

- Risk assessments: acquisition and assessment of more up-to-date evidence will help increase our understanding of the pressures from physical modifications and significantly help target action.
- Measuring condition and supporting action: the use of models and data can help refine our current knowledge and predictions about future condition. Based on existing protocol and emerging standards for assessing the physical condition of fresh and marine waters (e.g. REFORM[xlii]), the Environment Agency are starting to develop metrics to help define the physical condition of our waters, to help refine programmes of measures and investment choices.
- Targeting mitigation measures: actions to mitigate certain pressures (associated with important uses) are established via a programme of investigations. Opportunities to improve this process could arguably help achieve better outcomes for the environment and make catchments and coasts more resilient to the emerging pressures from climate change and growing population pressures.

7.1.3. Legal drivers

Key primary legislation, such as the forthcoming Environment Bill will help support improvements in the water environment. This includes, for example, the now mandated net gain for biodiversity. Pulling together the various pieces of legislation that cover fish passage, for example and strengthening legislation for coarse fish would be a step forward in achieving safe passage for fish. When considering fish pass solutions, although not always technically or economically feasible, we consider barrier removal as best practice. As well as addressing fish migration issues it typically provides wider benefits for the river and estuary, such as improving the natural processes and flows.

7.1.4. Regulatory support

Opportunities to further streamline and promote the implementation of small scale, low risk restoration should be encouraged. Activities excluded from authorisations or that work within a framework of general binding rules (GBRs) can support small-scale, locally restoration work. Regulatory advice and guidance helps manage risks and promotes good practice[xliii].

7.2. Funding actions

7.2.1. Rural land management

The Environment Agency are already supporting development of the new Environmental Land Management System (ELMS) which pays landowners for undertaking actions to improve the environment.

Seek further funding opportunities to implement actions that support natural recovery and restoration, for example:

- Public funding for capital and maintenance work to support flood risk and coastal erosion management.
- Government grants for natural recovery (e.g. Water Environment Grant, Countryside Stewardships).
- Investment for partnerships, co-delivery organisations and landowners (e.g. National Trust, RSPB).
- Opportunities for food producers and suppliers to invest in restoration work, and address their needs for Corporate Social Responsibility.

7.2.2. Flood risk and coastal erosion management

The Environment Agency recognises the importance of working with natural processes and the role it plays in supporting flood risk and coastal erosion management. Furthermore, it recognises the role it plays in supporting sustainable development and long-term gains for the environment. Encouraging working with natural processes is a key part of our approach and can take many forms. This includes natural flood risk management measures across rivers and catchments as well as the creation of inter-tidal and coastal habitat. In 2016 the government announced £15 million to learn more about these interventions[xliv]. This funding was allocated to approximately 60 projects across England, creating the natural flood management programme.

The Environment Agency is currently developing a national strategy for flood risk and coastal erosion risk management. Although the strategy has not been finalised, we hope to put environmental enhancement and resilience right at its heart. We want natural flood management to be part of the suite of tools to make places resilient to flooding, while providing multiple benefits.

Central government and local partners invest significant sums in managing flooding and coastal erosion risk. Between 2015 and 2021, the government will invest £2.6 billion, alongside a further £486 million of partnership funding (as of April 2019). This investment will achieve a range of environmental outcomes, including enhancements to hundreds of kilometres of watercourses. With our growing understanding of the impact of physical modifications, we will be better able to design out potential adverse impacts of our flood and coastal risk management work and look for opportunities to deliver mitigation for existing modifications. We continue to develop the evidence base for natural flood management, enabling us to make convincing cases for investment in natural processes which provides multiple outcomes for both people and the environment.

7.2.3. Water resource management

Water companies have a duty to protect and enhance the natural water environment. The Water Industry National Environment Programme (WINEP) will see up to £5 billion of investment by water companies in the natural environment through 2020 to 2025[xlv]. This will help tackle some of the biggest challenges facing the water environment. The current programme 2020 to 2025 will:

- Protect and improve at least 6000km of our waters.
- Protect and improve 24 Bathing Waters and 10 Shellfish sites.
- Protect and improve 1800 hectares of protected nature conservation sites.
- Enhance nearly 900km of river and 4276 hectares through wider biodiversity improvements.

The measures in WINEP represent the basic measures required by water companies to meet their environmental outcomes. However this also presents an opportunity for the industry to develop innovative approaches which will benefit people, wildlife and the economy.

Measures to address pressures from physical modifications are already a core component of the environmental programme. We must work with water companies to ensure investments are directed appropriately and address the pressures from physical modifications. Working with other landowners and authorities is central to these aims. Several water companies are already taking an adaptive approach to their long term water resource planning alongside assessing the resilience of water infrastructure. By joining up planning around drought and flood resilience, for example, we can better help manage these extremes whilst also looking for environmental enhancement.

7.3. Additional opportunities and practical considerations

7.3.1. Alternative funding

Alternative opportunities for funding catchment and coastal restoration include, the Heritage Lottery Fund, developer contribution schemes and investments through Corporate Social Responsibility (for example, food suppliers to invest in environmental improvements).

7.3.2. Trialling techniques and facilitation

Fund and implement trials of relevant interventions across appropriate spatial scales (multi-kilometre / hectare). The Environment Agency is leading proposals for an ambitious five-year programme of work to help support future restoration of key coastal and estuarine habitats. The programme will aim to deliver restoration pilot projects and facilitate their delivery, encouraging collaboration from a range of partners, industry and NGOs. Similar trails of multi-kilometre, catchment-scale natural channel recovery, floodplain restoration and catchment land management would offer significant learning and demonstration opportunities.

7.3.3. Measuring physical condition

The Environment Agency is starting a programme of work to develop metrics to help measure and manage the physical condition of our waters (rivers, estuaries and coasts). This will build on existing data and help support river basin planning programmes, including identification of future risk, developing programmes of measures and targeting of funds.

7.3.4. Pressure mapping

Opportunities to gather and collate readily available information is critical to our understanding of the pressures within the water environment. Physical modification pressure maps were produced for the 2015 river basin management plan; they are now out-dated and incomplete. Updates to these maps will vastly improve our ability to manage these pressures.

7.3.5. Citizen science

We should encourage others to participate in collection of appropriate information, ensuring it is available for others to use. This also helps to connect people with their natural physical environments and appreciate its value.

7.3.6. Education and involvement

River and coastal management and action is about partnerships, communities and landowners. The benefits of restoration, enhancement and the value of natural process should be encouraged (e.g. through conferences, community groups) outside the boundaries of traditional conservation restoration. Farmers and business owners have an important role to play in improving the water environment. Catchment and coastal partnerships and knowledge exchange events help break-down traditional barriers.

8. Choices

Question 1: What can be done to address the physical modification of our rivers and coasts?

Question 2: Giving more space for rivers and coasts to move and adjust naturally, will regenerate habitat, improve wildlife and help us adapt to climate change. What can you and others do to support these changes?

9. Contacts

If you have any feedback or comments on the evidence contained in the summary then please contact:

enquiries@environment-agency.gov.uk

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