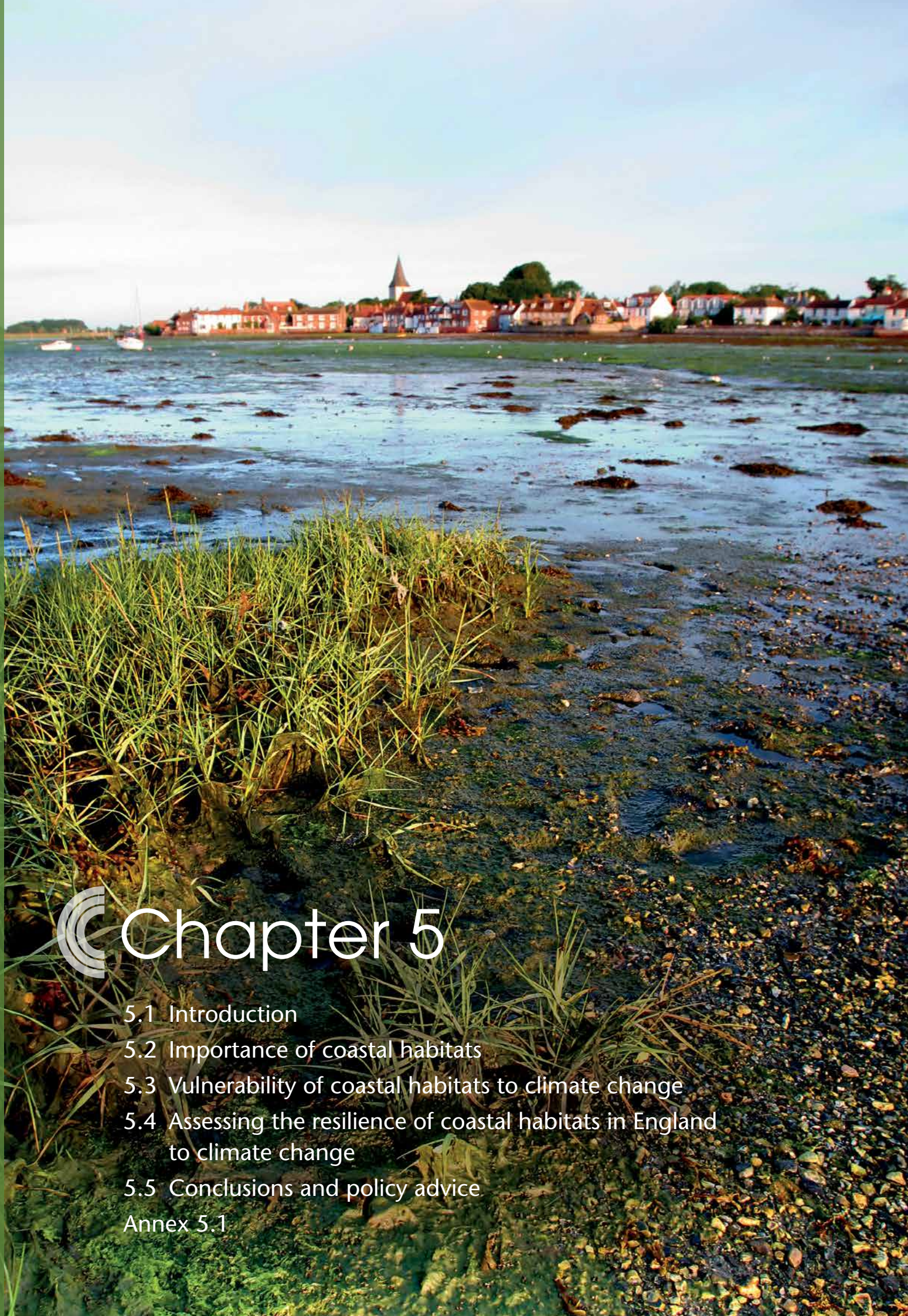


Chapter 5

Chapter 5:
Regulating services – coastal habitats

Key messages

The 105,000 hectares of coastal habitat along the coastline in England play a critical role in reducing flood and erosion risks to people, properties and land. Around half of all sea defences are protected and buffered against waves and storm surges by these habitats. Many of the remaining defences are protected by some form of mobile sediment or modified beaches, which require regular artificial recharge.

These coastal habitats comprise internationally important sites for biodiversity and are highly valued culturally. They include saltmarsh, mudflats, shingle beaches, sand dunes and sea cliffs.

Setting back the defences and restoring coastal habitats, known as 'managed realignment', is an important adaptation to rising sea levels. Managed realignment gives coastal habitats space to migrate inland as sea levels rise. Maintenance costs of realigned defences are typically lower than those of the original defences. Realigned defences often have lower construction costs when compared to refurbishing the original defences to cope with higher sea levels.

Potential risks

Coastal habitats, excluding mudflats, have declined in extent by 20%, from around 62,000 hectares in 1945 to 49,000 hectares in 2010. This loss has primarily been due to development, conversion to agricultural use and coastal erosion. The loss of mudflats has not been quantified but is likely to be of similar magnitude.

In the future, up to three-quarters of intertidal coastal habitats may not be able to adapt naturally to sea level rise where they are blocked from migrating inland by sea defences, known as 'coastal squeeze'.

Protecting coastal areas from flooding and erosion in the face of sea level rise will require greater effort in the future. In part, this will involve increased investment in maintaining and improving the 3,000 km of existing coastal defences. Annual coastal spending requirements are expected to rise from current levels of £125 million to in excess of £200 million by 2030.

Options for strategic action

Long-term plans for the coastal zone in England have a goal to realign some 10% of the coastline by 2030, rising to nearly 15% by 2060. The implementation of these plans, developed by local authorities in partnership with the Environment Agency and community groups, would involve breaching or removing some flood and erosion defences. This would create around 6,200 hectares of coastal habitat by 2030, at a cost of £10-15 million per year. It would then rise to 11,500 hectares by 2060. Our modelling suggests that achieving the 2030 goal would save between £180 million and £380 million in capital and maintenance costs over the long-term, when compared to the cost of replacing and maintaining hard defences.

The rate of managed realignment since 2000 would need to increase five-fold, to around 30 km each year, to meet the 2030 goal. Around 1% of the coastline has been realigned since the 1990s. Projects currently in the pipeline should realign an additional 0.8% to 2016. Together, these should create 2,200 hectares of new coastal habitat.

Creating 6,200 hectares of habitat by 2030 could be achieved without losing a single property. Most of the realigned land would be agricultural, and one third of it would be high-grade. This represents 0.1% of all high-grade agricultural land in England. Even without any further realignment, some of this land may become inviable for conventional agricultural production due to saline intrusion.

Clearer financial incentives that consistently reflect the ecosystem services provided by reinstated coastal habitats could help increase the pace of realignment. Such action could facilitate some of the existing negotiations with landowners on changes to land use.

Local authorities and the Environment Agency should develop a more transparent programme for implementation of their long-term coastal plans to provide greater certainty to local communities. Sustaining efforts to concentrate scarce resources in protecting strategic stretches of coast, while reinstating natural habitat elsewhere, will require difficult choices about future development of the coastal zone in England.

5.1 Introduction

This chapter assesses the resilience of coastal habitats to climate change in England. We focus on coastal habitats because they:

- provide a wide range of services, including those that are particularly important from an adaptation perspective, namely the regulation of flooding and coastal erosion risks;
- are sensitive to changes in climate, particularly sea level rise; and
- have been subject to decades of degradation from land use change and erosion in some locations. This has increased their vulnerability to the impacts of climate change.

The chapter reviews how land use change has affected the vulnerability of coastal habitats and assesses how climate change may affect them. It focuses on one of the main ways of adapting to the loss of coastal habitats: setting back the defence line or 'managed realignment'. Finally, the chapter looks at the barriers to managed realignment and provides advice on how these could be overcome.

5.2 Importance of coastal habitats

The 105,000 hectares of coastal habitat in England[1] provide a wide range of services (Box 5.1).

Box 5.1: Ecosystem services provided by coastal habitats

Flood and erosion hazard regulation

Coastal habitats, particularly intertidal habitats, can provide a buffer in front of sea defences by dissipating or absorbing wave and tidal energy. Up to half of the wave energy is dissipated in the first 10–20 metres of a vegetated saltmarsh surface.[2]

Eroding cliffs have the potential to provide large volumes of sediment for each metre of recession, from 10,000 m^3 in southern cliffs, to 70,000 m^3 in North Norfolk. Depending on the nature of the cliffs, between 20% and 80% of this volume may contribute sand and gravel towards the build-up of beaches.[3]

Carbon storage

Coastal habitats accumulate sediment and therefore act as carbon sinks. Sediment depth remains largely un-quantified. The relatively small extent of these habitats means they do not play a significant role in carbon storage on a national scale.[4]

Cultural services

Many coastal habitats are highly valued for their cultural significance and for tourism. In 2005, there were around 250 million visits to the UK coast. Around one third of these visits were to natural habitats, such as beaches, sand dunes, shingle and cliffs.[5]

The coast holds an important place in the national psyche. Coasts provide cultural, social, historical, artistic, and physical and mental health benefits to society.

1 Environmental Change Institute et al. (2013) for the Adaptation Sub-Committee. The area of coastal habitat was derived from a combination of Natural England's Priority Habitat Inventories and the Environment Agency's Saltmarsh Survey (Phelan et al. 2011). Note that the area identified (105,000 ha) is lower than the 194,000 hectares of coastal margins in England identified by the UK National Ecosystem Assessment, as quoted in Figure 1.1. The UK National Ecosystem Assessment figure is derived from the Land Cover Map (LCM) 2007, which is based on satellite imagery, whereas the habitat inventory data is based on vegetation surveys and monitoring in the field.
2 Möller and Spencer (2006). This refers to exposed macro-tidal UK east coast marshes under average tidal inundation depths.
3 James and Lewis (1996).
4 The contribution of coastal habitats to carbon storage is currently being investigated as part of a major UK Research Council project: Coastal Biodiversity Ecosystem Service Sustainability (CBESS).
5 UKTS, United Kingdom Tourism Statistics (2006); VisitBritain (2007).

Box 5.1: Ecosystem services provided by coastal habitats

Provisioning services

Saltmarsh can be used for grazing or wildfowling and thus provide meat and wool.[6]

Mudflat and shallow water enable aquaculture, act as nurseries, grazing and reproduction grounds for fish stocks, and can be used to grow some crops, such as samphire.[7]

Biodiversity

The coasts of England comprise internationally important wetlands and sites for migratory bird populations.

Coastal habitats make up around 40% of the Special Areas of Conservation (SAC) network in England designated under the EU Habitats Directive.[8]

Sources: UK National Ecosystem Assessment (2011b), Chapter 11 (Coastal margins) and Chapter 17 (England).

Coastal habitats play an important role in protecting people, property and land from flooding and erosion risk.

- Around 2.3 million people live in the coastal floodplain (680,000 hectares) and 1 million properties are located there. About 10% of these properties (100,000 properties) are at significant risk from coastal flooding.[9]
- A further 60,000 properties are also located in areas at risk from coastal erosion.[10]
- Around 60% of the coast line is protected by some form of artificial defence,[11] with 390,000 properties protected from a 1 in 200 year coastal flooding event.[12]
- For just under half (46%) of the protected coastal area, defences are buffered from waves and storms by coastal habitats. Many of the remaining defences are protected by some form of mobile sediment or modified beaches, which require regular artificial recharge.

5.3 Vulnerability of coastal habitats to climate change

Coastal habitats have an important role to play in helping the coastal zone respond to climate change. They are however under threat from development pressures, sea level rise and increasing storminess, particularly where they are blocked from migrating inland by fixed defences such as sea walls.

Coastal habitats are formed and modified by the natural processes of sediment movement (erosion/accretion) and vegetation succession (colonisation/dieback). Most coastal habitats can re-establish themselves after extreme events. When unconstrained they could be resilient to some elements of climate change, such as rising sea levels, through natural processes of submergence and emergence.[13]

Artificial defences protect properties, agricultural land, communities and infrastructure from coastal flooding and erosion. Such coastal defences can, however, hamper and obstruct coastal

6 Luisetti et al. (2011).
7 JNCC, Joint Nature Conservation Committee England site list (2012).
8 HR Wallingford (2012) for the Adaptation Sub-Committee.
9 Environmental Change Institute et al. (2013) for the Adaptation Sub-Committee.
10 These properties are defined as houses located in erodible coastlines that are predicted to be at risk within the next 100 years under a central scenario.
11 Nicholls et al. (2013), using Channel Coastal Observatory data. Beach management accounts for 10% while other methods of holding the line, such asseawalls, revetments, groynes, timber structures, represent almost almost.
12 The definition of a 1 in a 200 year event is highly uncertain, as this time scale includes a high degree of predictive uncertainty around meteorological forcing (see IPCC 2007).
13 Rees et al. (2010).

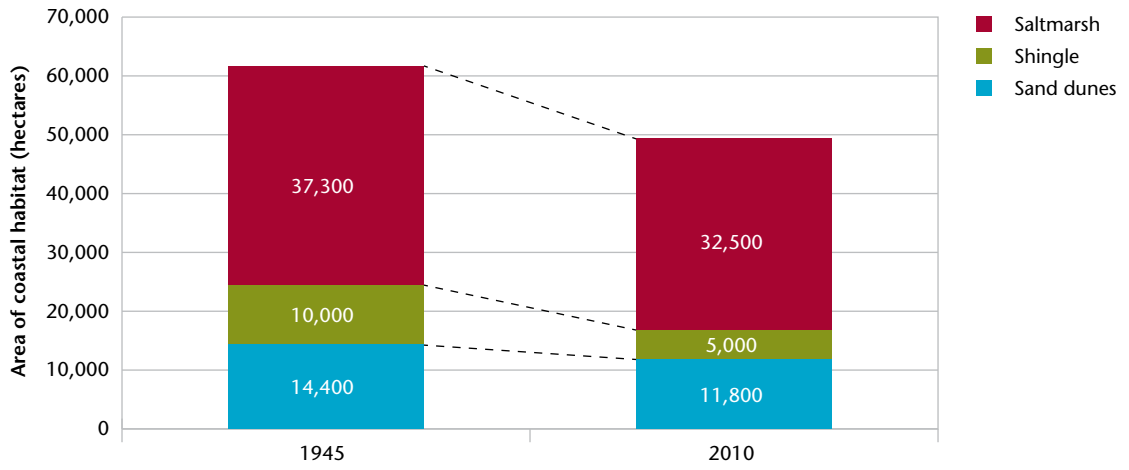
processes, preventing coastal habitats from migrating inland as sea levels rise. This process, known as 'coastal squeeze', results in a reduced capacity for adaptation to coastal change.

In England, much of the large stock of seawalls, tidal flood embankments and coast protection structures, including groynes and breakwaters, were built in the nineteenth and twentieth centuries. They will require substantial investment during the coming century if their life is to be extended.

Coastal habitats have been in decline in some locations for more than a century. In part this has been the result of coastal squeeze, but mainly it has been due to other pressures such as development, dredging sands and gravels for construction purposes and agricultural intensification.

- Coastal habitats have declined by 20% from 1945 levels, a loss of around 13,000 hectares (Figure 5.1).

Figure 5.1: Historical decline of coastal habitats



Source: Adapted from UK National Ecosystem Assessment (2011b) quoting Jones et al. (1993) and Delbaere (1998) for sand dunes and Morris et al. (2004), Doody (2008) and Cooper et al. (2001) for saltmarsh.
Notes: In total, around 13,000 hectares of coastal habitats (saltmarsh, shingle and sand dunes) have been lost since 1945. This represents 20% of the original area of 61,700 hectares of coastal habitats, excluding mudflats.

  - Shingle beaches incurred the largest relative loss (50%), due to infrastructure development such as power stations or industrial plants, dredging and shorefront development and promenades.
  - Sand dune losses (18%) were mainly due to development of housing, tourism, golf courses, agricultural land claim and, in some places, afforestation.
  - Saltmarsh has declined by about 13% due to reclamation for agriculture or development. Natural processes of saltmarsh colonisation and dieback have in the past varied over time and according to location, for example accretion in the Wash and Northwest of England and extensive dieback in the estuaries of Essex and the south coast.[14]
  - Sea-level rise of around 10 cm since 1900 is thought to only have been responsible for around 2% of sand dunes losses and 4.5% of saltmarsh losses.[15]

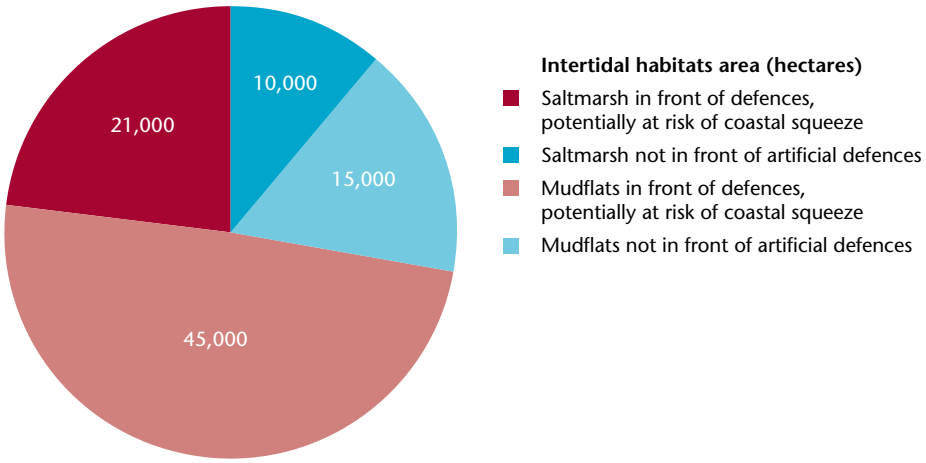
14 Foster et al. (2013).
15 French (1997) for saltmarsh, UK Biodiversity Action Plan Tranches 1 and 2 (1995-1999) for sand dunes, quoted by the UK National Ecosystem Assessment (2011b).

- The condition of designated coastal sites has been declining. A majority of Special Areas of Conservation assessed between 1998 and 2006 were in unfavourable condition, including 76% of vegetated shingle, 66% of sand dunes and 57% of saltmarsh.[16]

Sea level rise and coastal erosion are expected to increase losses in the future, particularly where coastal habitats are prevented from migrating inland naturally.

- Rising sea levels will increase wave overtopping and flood risk on the coast.[17] Studies predict a net negative impact on coastal habitats due to sea level rise.[18]
  - Projected increases in sea level range from between 45 cm and 80 cm by the end of the century in South-East England. Taking into consideration the melting of large ice sheets (still low probability), the estimated increases of sea level range between 93 cm to 1.9 m by 2100 for the UK. There is considerable uncertainty around storm surges and wave heights, with annual maximum wave heights projected to be anywhere from 1.5 m smaller to 1 m higher than currently.[19]
  - All types of habitat may also gain from accretion in some parts of the coastline because of the increase in the supply of sediment from updrift. This effect is however projected to be lower overall than the losses from submersion and erosion, as demonstrated by coastal modelling of the North Norfolk coast.[20]
- Our analysis suggests that nearly three-quarters (72%) of intertidal coastal habitats (66,000 hectares out of 91,000 hectares) are at risk of coastal squeeze, as they are located seaward of artificial defences (Figure 5.2). Those at lowest elevation are at highest risk. Where the tidal range is large, as it is round much of the coast of England, sea level rise can affect habitats several metres above mean sea level.[21]

Figure 5.2: Intertidal coastal habitats at risk of coastal squeeze in England (hectares)



Source: Environmental Change Institute et al. (2013) for the Adaptation Sub-Committee.
Notes: The locations of all coastal habitats (Natural England's MAGIC data resource and Environment Agency satlmarsh dataset after Phelan et al., 2011) were mapped in relation to Shoreline Management Plan policies for each stretch of coastline. Habitats are considered at risk of squeeze where they are located seaward in front of a 'Hold the line' policy in the first epoch (2010-2030), or in front of 'Managed realignment' policy in the first epoch that has not yet been delivered (7/9th of managed realignment policies, see Table 5.1).

16 JNCCC, Joint Nature Conservation Committee (2007). This is based on a limited extrapolation to UK resources.
17 HR Wallingford (2002).
18 Lee (2001) assessing SAC, SPA and Ramsar sites in England and Wales. These figures do not account for the implementation of Shoreline Management Plans, which would result in net gains.
19 Murphy et al. (2009), Marine and coastal projections.
20 Dickson et al. (2006).
21 Further details on the breakdown of intertidal habitat elevation is available in Environmental Change Institute et al. (2013) for the Adaptation Sub-Committee.

– Coastal erosion and sea level rise are not the only processes that may lead to loss of coastal habitats in the future. Development for major infrastructure projects, such as ports, energy generation and transport, as well as recreational pressures, such as golf courses, could lead to a further loss of habitat. However, it is difficult to estimate the scale of these future losses robustly.

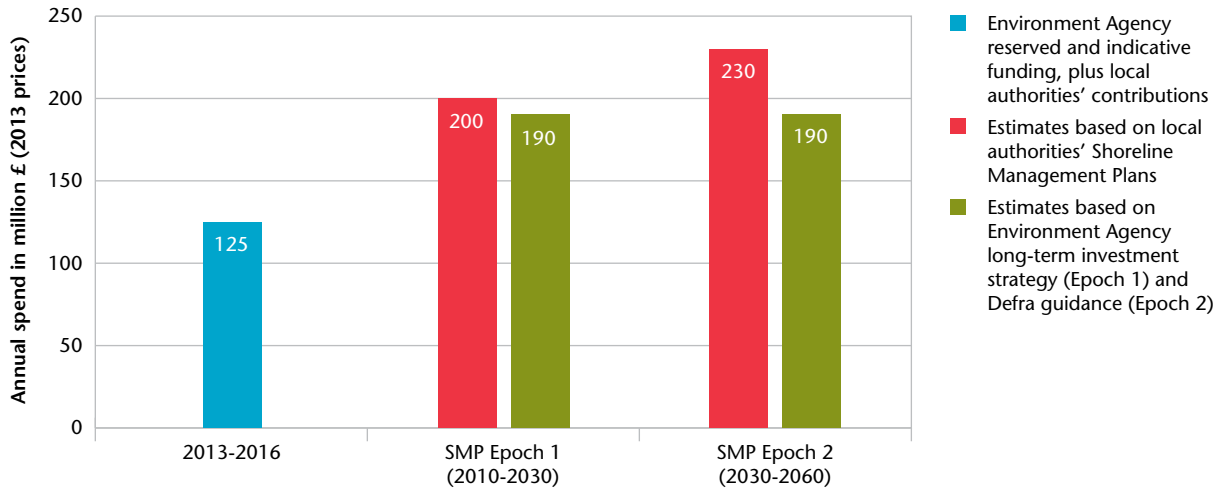
5.4 Assessing the resilience of coastal habitats in England to climate change

Protecting coastal areas from flooding and erosion in the face of sea level rise will require greater effort in the future. In part, this will involve increasing levels of investment in maintaining and improving coastal defences. The spending requirement for coastal defences is expected to rise from current levels of £125 million each year to in excess of £200 million by 2030 to keep pace with sea level rise and increased storminess, because of associated increases in construction and maintenance costs (Figure 5.3). Continued reliance on hard defences will add further pressure to defence costs.

Protecting and enhancing coastal habitats will be an important part of adapting to climate change on the coast. Habitats in good condition and with the space to retreat inland as sea levels rise will have the best chance of adapting in the face of climate change.

We examine the long-term plans of local authorities for the coastline (Box 5.2) to assess the scale of the adaptation effort needed and its progress.

Figure 5.3: Current spending levels on coastal defence and estimates of future spending requirements for the first two epochs of Shoreline Management Plans (SMPs)



Source: For current spending levels: Environment Agency 2013-14 programme of works and Department for Communities and Local Government Finance Settlement for 2009/10. For the estimate of future needs: Environmental Change Institute et al. (2013) for the Adaptation Sub-Committee, Environment Agency Long-term Investment Strategy (2009), and Defra Shoreline Management Plans guidance (2006)
Notes: The current spending levels (blue bar) are the sum of the Local Authorities coastal protection expenditure as reported by DCLG, and the Environment Agency reserved (2013-14) and indicative (2014-16) funding (only considering coastal erosion and tidal flooding schemes contained in the 2013-2014 programme of works). The Shoreline Management Plans estimates (red bars) for future spending needs is based on the implementation costs which have been extracted from the 20 English Shoreline Management Plans, and harmonised in terms of discounting rates (see Environmental Change Institute et al. (2013) for the Adaptation Sub-Committee). The estimates based on the Environment Agency (green bar) consider the additional funding of their long-term investment strategy for flooding and coastal erosion risk management to keep risk constant (£20 million/year to 2035). The share allocated to coastal works to 2035 is isolated (£6.6 million/year), using the average split between coastal and fluvial works in the 2013-14 programme of works (33% coastal) as a proxy. This additional funding was added to the current spending levels to estimate future spending needs (first green bar) over the first epoch (2010-2030).For the second epoch we applied the 1.5 factor recommended by Defra (2006) to the current spending levels (blue bar), to reflect the expected increase in costs due to climate change (second green bar).

Box 5.2: Shoreline Management Plans (SMPs)

- Local authorities on the coast have been cooperating with neighbouring authorities to produce long-term strategies to manage a stretch of coastline. Each stretch is broken down into coastal cells, which take into account the large-scale coastal interactions that cross local authority boundaries. The Environment Agency has a statutory responsibility to take a strategic overview of flood and coastal erosion risk management at the national level.
- These regional strategies, known as Shoreline Management Plans (SMPs), start with a large-scale assessment of the risks of flooding and erosion, and the drivers of change on the coast. They then identify policies to reduce these risks to people and the developed, historic and natural environment, in the context of social, economic and environmental priorities for the coastal zone.
  - The first generation of Shoreline Management Plans was published in 1995 and subsequently, the second generation of 22 plans covering England and Wales were produced between 2007and 2011.[22]
  - SMPs were mostly led by a local district council or in some cases by a regional office of the Environment Agency, and drafted by a steering 'Coastal Group', comprising the Environment Agency, all local authorities covered by the Plan, Natural England and others as required (e.g. port authorities).
- On the same stretch of the coast, different policies can apply over the three epochs considered, spanning a century (0-20, 20-50 and 50-100 years).[23] The primary management policies[24] are:
  - '**Hold the line**' by maintaining or changing the standard of protection, prioritising the protection of highly valuable assets (e.g. infrastructure) or densely-populated areas.
  - '**No active intervention**', which is mostly applied to coasts that do not have an artificial defence because they are not at risk from flooding or erosion or because they have low human vulnerability.
  - '**Managed Realignment**', which is generally applied to non-built-up previously reclaimed agricultural land and to eroding coastal cliffs. 'Managed realignment' involves either (i) removing or deliberately breaching flood defences to allow flooding up to higher ground or a new defence line, or (ii) realignment of coastal cliff frontages to allow cliff erosion up to a new defence line.[25] Managed realignment partially or fully reinstates natural processes of inundation, erosion and accretion. It may involve building new defences, set back on the landward side of the original defences.
- Although Shoreline Management Plans are non-statutory, they can influence long-term decision-making for coastal communities.
  - In line with Defra's coastal management framework,[26] authorities should use the plans to devise schemes that will implement the Shoreline Management Plans preferred policies. They will therefore influence the Environment Agency's decision to fund protection schemes for flooding and coastal erosion risk management, and its long term investment strategy.
  - Local planning authorities' development plans and development management decisions should take account of any long-term coastal change identified in the Shoreline Management Plans, as well as the specific preferred policies.

To deliver these plans in estuaries, the Environment Agency also coordinates estuary strategies, such as those in the South-West (Exe, Severn) and the South-East (Cuckmere).

Sources: Defra Shoreline Management Plans guidance (2006).

22 http://www.environment-agency.gov.uk/research/planning/105014.aspx
23 Defra recommends to use 2005 as a baseline year. In this chapter, we use 2010 as a baseline year to reflect the fact that SMPs were published between 2007 and 2011.
24 A fourth management policy is to advance the defence line, but in practice this has not been taken up by the Shoreline Management Plans.
25 This explains why some, but not all realignment schemes lead to habitat creation.
26 Accessible in Defra's Shoreline Management Plans guidance (2006).

Managed realignment as an adaptation response

Managed realignment allows coastal habitats to respond naturally to sea level rise by removing barriers to inland migration. Managed realignment can help limit the projected increase in the cost of coastal defences in the long term.

- Coastal defences that are buffered from waves and storms by coastal habitats require lower capital and maintenance costs.
- When artificial defences are breached or reach the end of their lifetime, defences built on a realigned line may require lower capital costs for the same standard of defence. Research suggests for instance that, due to wave height reduction, a seawall with vegetated saltmarsh fronting the wall can be 20 cm lower than a wall fronted by unvegetated tidal flats.[27]
- The Environment Agency have told us that maintenance costs savings may be modest due to additional costs, such as new pumping stations, the need to maintain the breach in the old seawall, and in some cases a continued need to maintain the old wall. Reduced capital costs are also not automatic, as new defences tend to have wider crests and shallower sides.[28] Our analysis shows that these factors can considerably affect the cost-effectiveness of the managed realignment schemes, especially when they are smaller (less habitat area created per kilometre of defence).[29]

Managed realignment can also compensate for habitat loss and provide environmental benefits. Habitat creation provides various environmental benefits (Box 5.1). These have been valued between £680 and £2,500 per hectare, including carbon storage benefits.[30]

Allowing previously defended cliffs to erode naturally in order to restore sediment movement can also be an appropriate adaptation option when benefits downdrift more than outweigh the localised losses to cliffs. A research case study looking at a stretch of the East Anglian coast showed that artificial defences on eroding cliffs can starve and interrupt sediment supply downdrift. This lowers the protective beaches in front of floodplains, consequently increasing flood risk further down the coast.[31] Removing the defences on these cliffs would lead to economic losses on the cliffed coastline, but these losses would be more than outweighed by benefits in flood-prone areas downdrift.

27 Möller et al. (1999), King and Lester (1995), experiment in a macrotidal setting in North Norfolk.
28 This is due to maintenance requirements, the quality of available construction material and sea level rise allowances, which can cause crest heights to be as high as or even higher than the old defences (Environment Agency personal comment).
29 Scotland's Rural College (2013) for the Adaptation Sub-Committee.
30 Low estimate derived fromScotland's Rural College estimated environmental value (£550 ha per year) based on Eftec (2010) median environmental values, combined with the carbon storage value (£130 ha per year) based on DECC 2012 prices (with £57 per tCO_2eq as a central estimate for non-traded carbon). High estimate obtained by summing up the indicative value of saltmarsh and mudflat (£1,500 ha per year in £2011 prices) based on Eftec (2010), and the central estimate for carbon storage (£1,000 ha per year) based on Brander et al. (2008).
31 Dawson et al. (2009).

Managed realignment goals in the Shoreline Management Plans

Shoreline Management Plans propose setting back nearly 10% of the coastline by 2030, rising to nearly 15% by 2060 (Table 5.1).[32]

- Achieving this goal would mean realigning around 30 km of coastline every year to 2030. It would also create around 6,200 hectares of coastal habitat by 2030 and 11,500 hectares by 2060.[33]
  - Meeting these goals would reduce the amount of coastline where there are artificial defences from around 54% currently to 47% in 2030 and 41% in 2060.
  - About two-thirds of this realignment would take place in the southern part of the East coast, the Northwest, and the western part of the South coast. Some coastal authorities, mainly around the East coast, plan to realign up to a third of their coastline (Figure 5.4).
  - Just under a of third of the plans (7 out of 22) propose realigning between 15% and 30% of their stretch of coastline (Annex 5.1).

Table 5.1: Summary of Shoreline Management Plans goals

Policy options	Current state of the coastline	SMPs preferred policy		
		0-20 years	20-50 years	50-100 years
	% of the English coastline, in km			
Hold the Line (HtL)	54%	47%	41%	39%
No Active Intervention (NAI)*	43%	43%	44%	44%
Managed Realignment (MR)	2%	9%	14%	16%

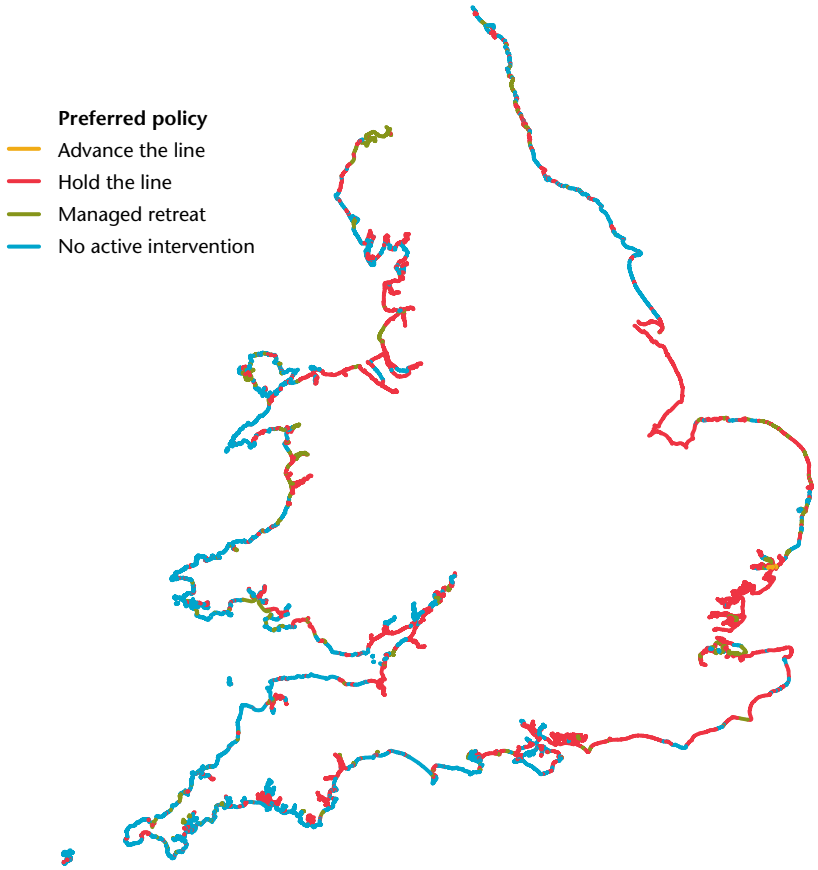
Source: Environment Agency National Coastal Erosion Risk Mapping (2011), ABPmer managed realignment database (2013), Shoreline Management Plans (2008-2010) accessible from the Environment Agency.
Notes: Shoreline Management Plans preferred policies were extracted from NCERM. For the current state of the coastline, we estimated the length of the coastline that had been realigned to date, using an average ratio (20) of hectares created per kilometre of coastline realigned derived from data on past schemes (ABPmer) and local authorities projections in the Shoreline Management Plans. Estimates for the proportion of coastline where 'hold the line' is currently the main policy vary from 46% (Masselink and Russel, 2008, based on Eurosion, 2004), to 58% (Environment Agency National Flood and Coastal Defence Database, 2012) and 60% (Nicholls et al., 2013). Our estimate (54%) is derived by calculating the amount of coastline that would need to switch from a 'hold the line' policy to a 'management realignment' one to achieve the Shoreline Management Plans' goal to realign 9% of the coastline in the first epoch. The percentages may not sum to 100% due to rounding.
*No active intervention refers in part to sections of the coast that have less need to be actively managed (non-erodible, non-floodable), as in parts of the South-West.

These long-term plans for realignment are concentrated mostly in sparsely populated areas of the coast, dominated by agricultural land.

- Our analysis finds that all of the 6,200 hectares of coastal habitat due to be delivered by 2030 could be created without losing a single property.[34]
- Achieving the longer-term 2060 goal of 11,500 hectares may involve some property loss, based on current patterns of development. Future development in these areas could make it harder to meet that 2060 goal. On the other hand, planning for the long term will help to facilitate future adaptation by helping communities to manage the regeneration of areas in which land use may change.

32 Note that as we approach this date and better knowledge and evidence is available, these goals may be revised to a higher or lower figure.
33 These amounts also include the area of coastal habitats that has been created or is planned to 2016 of around 2,200 hectares.
34 Environmental Change Institute et al. (2013) for the Adaptation Sub-Committee.

Figure 5.4: Shoreline Management Plans options for the the first epoch (2010-2030)



Source: Environment Agency National Coastal Erosion Risk Mapping (2011)
Notes: This map covers preferred managed options indicated in the 22 Shoreline Management Plans covering England and Wales.

Realigning around 10% of the coastline would affect 0.1% of England's high-grade agricultural land by 2030.[35] Even without any further realignment, a proportion of this land would become inviable for conventional agricultural production due to saline intrusion.

- Our estimates suggest that up to 10,000 hectares of agricultural land may be at risk of saline intrusion. These areas are mostly located along the East Coast.[36]
- This loss of high grade agricultural land could be offset by taking advantage of the provisioning services (aquaculture, fish nursery and grazing) that realigned habitats can provide (Box. 5.1). In the Alkborough Flats realignment scheme,[37] the annual loss of food production was more than compensated by developing these new uses.

Delivering managed realignment in practice

The rate of managed realignment would have to increase five-fold from the current levels of around 6 km of coastline realigned every year to around 30 km, in order to meet the 2030 goal stated in the Shoreline Management Plans.

35 Or around 1,750 hectares. Assuming a third of the agricultural land where realignment would happen is high-grade, as was the case historically (ABPmer, 2013) and in natural areas in coastal floodplain behind coastal habitats (Environmental Change Institute et al. for the Adaptation Sub-Committee, 2013).
36 Environmental Change Institute et al. (2013) for the Adaptation Sub-Committee.
37 Case study in UK National Ecosystem Assessment (2011b), Chapter 11 (Coastal Margins).

- The rate of habitat creation would need to double to 300 hectares each year[38] to create about 6,200 hectares by 2030 (Figure 5.5).
- About 1% of the coastline has undergone managed realignment since 1991, and another 0.8% is planned over the next 3 years. About 1,300 hectares of coastal habitat were created by 39 schemes,[39] and 7 additional large schemes planned by 2016 should bring the total area created to 2,200 hectares.
- High grade (Grade 1 and 2) agricultural land makes up one third of the realigned area to date, the remaining being lower-grade agricultural land, as well as other undeveloped land.

Implementing the current plans for managed realignment would cost between £10 million and £15 million each year.

- Managed realignment involves negotiating and buying land at the realignment site, artificially breaching defences and, in locations where the site is not bounded by higher ground, construction of a realigned flood defence. Ensuring that intertidal habitat establishes itself may require introducing saltmarsh species and the excavation of drainage channels.[40] When compared with the least cost alternative, which is to do nothing and let the flood defence gradually deteriorate, managed realignment is a costly option.
- The Environment Agency estimates that it costs between £40,000 and £50,000 to create one hectare of coastal habitat.[41] These costs not only include the construction and implementation costs, but also the negotiation, feasibility studies and land purchase. This final component reflects the future value of agricultural benefits if there was no conversion. It should be noted that observed costs on past schemes can vary substantially from one scheme to another.[42]

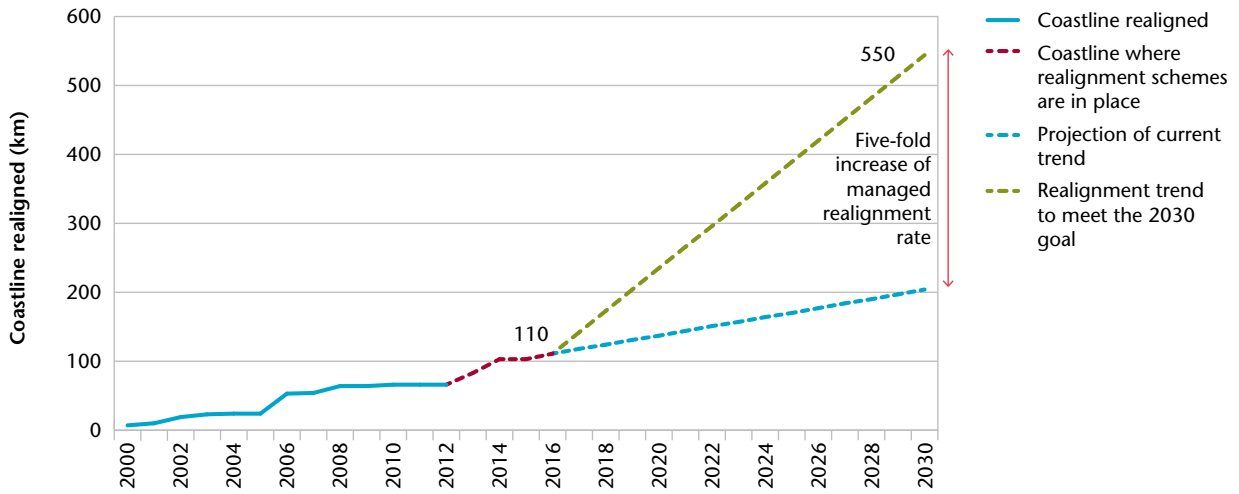
The costs of implementing managed realignment would be more than outweighed by financial savings on construction and maintenance costs, as well as environmental benefits.

- On balance, plans for managed realignment to 2030 will save between £180 and £380 million in reduced maintenance and avoided construction costs compared to holding the line over the lifetime of the schemes.[43]

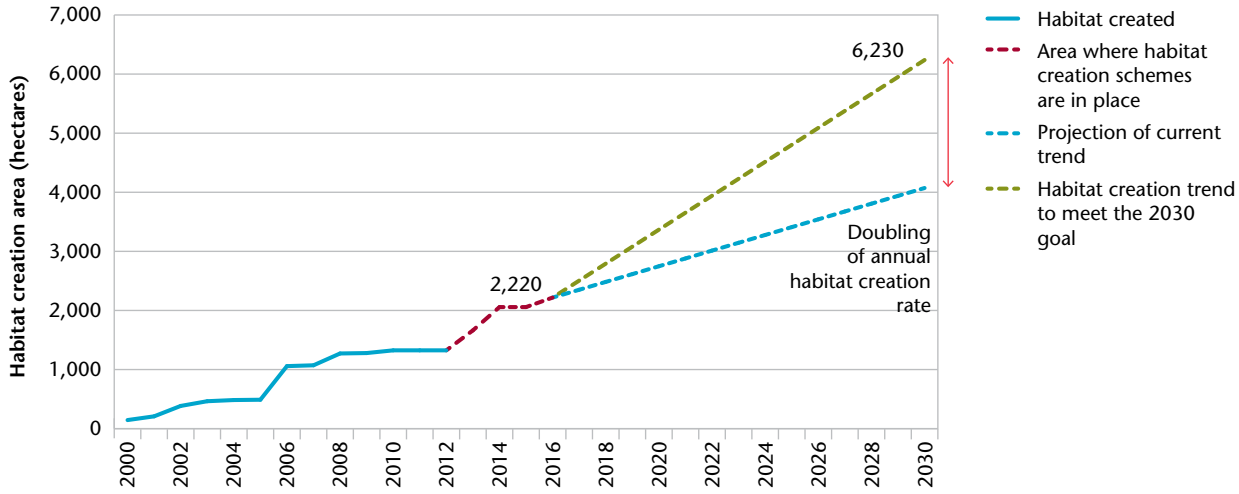
38 On average 132 hectares were realigned each year between 2000 and 2016, taking into account schemes planned with a high and medium degree of certainty (Environment Agency).
39 ABPmer (2013).
40 Turner et al. (2007).
41 Average cost per hectare of habitat created drawn from the Environment Agency costs database (2010), ABPmer (2013) and average construction cost of managed realignment (£1 million per kilometre, from Environment Agency cost database) combined with average agricultural land value (£8,300 per hectare, for grade 1-2 land from Scotland's Rural College). Flows of costs to 2030 are discounted using the social discount rate recommended by HM Treasury Green Book (3.5%) to 2030.
42 Costs per hectare range from £620 per hectare to £273,000 per hectare within the 39 schemes with cost information in the ABPmer database.
43 Investments for realigned defences are annualised to 2030 (3.5% discount rate), accounting for replacement costs 50 years later (2.5% discount rate). Hold the line defences are replaced at a rate of 2% each year. Long-term financial and environmental benefits are accounted for and discounted using social discount rates adapted from HM Treasury Green Book (3.5% for 0-20 years, 3% for 30-50 years, 2.5% for 50-100 years) until 2100 by Defra (2006). Maintenance savings based on annual maintenance costs of £4,500 per kilometre (Scotland's Rural College for the Adaptation Sub-Committee, 2013) for original defences and £2,225 per kilometre for realigned defences (halving assumption from Turner, 2007), and £104,000 per kilometre for original defences (Environment Agency costs database, 2010). Construction savings based on avoided refurbishment of some artificial defences at £3 million per kilometre (Defra 2006 guidance). Defra (2006) recommended factors to account for cost increases due to climate change are applied to all costs (factor of 1.5 in the 20-50 years period, factor of 2 in the 50-100 years period).

Figure 5.5: Managed realignment to date and comparison with 2030 aspiration from Shoreline Management Plans

a) Managed realignment of the coastline



b) Habitat creation



Source: ABPmer managed realignment database (2013), area of managed realignment schemes planned to 2016 (high and medium confidence) provided by the Environment Agency.
Notes: Approximately 66 km of the coastline has been realigned to date, and planned realignment schemes would bring this to 111 km realigned in total by 2016. The average realignment rate between 2000 and 2016 (6 km per year) would need to increase five-fold to about 30 km per year to meet the Shoreline Management Plans aspiration of 550 km realigned coastline by 2030. About 1,320 hectares have been created to date (2012), and habitat creation schemes in place to 2016 would bring this to 2,220 hectares of habitat created in total. The average rate of habitat creation between 2000 and 2016 have been around 130 hectares each year. This rate would need to triple (to around 400 hectares created per year) to meet the Shoreline Management Plans aspiration of 7,500 hectares of habitat creation by 2030.

– These cost savings may be an underestimate as managed realignment can provide flood storage. This would make it possible to defer improvements to other flood defences that would otherwise be needed to counter the effects of sea level rise, either in the tidal rivers upstream of the site, or in other sites downstream.[44]

– Doing nothing, or a bare minimum of maintenance, stores up problems for the future when the sea defences finally do fail and costly action will be required.

44 See Alkborough Flats case study in Everard (2009).

Plans for managed realignment would also compensate for coastal habitat loss, delivering environmental benefits valued at around between £80 and £280 million.[45] Not all of the land set aside for realignment is always transformed into intertidal habitats. For instance, a scheme in the Humber estuary created 170 hectares of intertidal habitats permanently exposed to flooding and 230 hectares to be used as a storage capacity during extreme surge events.[46]

5.5 Conclusions and policy advice

Coastal habitats provide valuable services in reducing the risk of flooding and coastal erosion. These services are threatened by sea level rise. Sea level rise will increase flood and erosion risk on the coast and as a consequence mean higher costs to society to manage this risk in the future. These costs will be even higher if there is continued loss and degradation of coastal habitats as a result of pressures such as development and coastal squeeze.

There has been progress over the last decade in developing long-term strategies for managing the coast. The Shoreline Management Plans are an important step in taking a strategic approach to choosing how to respond to inevitable changes on the coast, based on a scientific understanding of coastal processes. These 'bottom-up' strategies have required local communities to work together across administrative boundaries.

The Shoreline Management Plans recognise the financial and environmental benefits of managed realignment and aspire to realign some 10% of the coastline by 2030 and 15% by 2060. Meeting these goals would help to minimise the increase in coastal management costs and help to ensure the resilience of coastal habitats to sea level rise for the next few decades.

However, the current rate of implementation falls well short of what is required to reach the 2030 goal. Each year between now and 2030, an average of 30 km of coastline would need to be realigned to deliver realignment along 9% of the coastline, creating around 6,200 hectares of coastal habitat in total. The schemes delivered to date have only realigned about 6 km each year on average and created some 130 hectares of coastal habitat each year.[47]

A number of barriers appear to be hindering the implementation of managed realignment schemes.

- **High upfront costs:** Managed realignment schemes involve upfront costs that are higher than the costs of maintaining an existing defence or allowing a gradual decline in its condition. However, over the long term, the financial and environmental benefits of realignment outweigh these costs.

45 Average environmental benefit (£1500 perhectare peryear) based on Eftec (2010)' indicative value for saltmarsh.
46 Everard (2009) for the Environment Agency.
47 Calculated over the 2000-2016 period.

- **Financial incentives:** When the Environment Agency embarks on managed realignment schemes, it will compensate landowners by buying up their land when habitat is created. However, satisfactory arrangements can take years to be achieved. For example, the site selection and procurement period for the Wallasea scheme took seven years, whereas the planning and building of the scheme itself took two and a half years.[48]
- **Public perception:** Many stakeholders have identified the lack of public support, including local political support, as one of the major barriers to implementation.[49] For instance, one study found that potential social and community issues had made it difficult for North Norfolk District Council to accept some of the original Shoreline Management Plan recommendations.[50]

In order to overcome these barriers, the Government should consider:

- **Ensuring appropriate valuation for the services provided by realigned coastal habitats.** The current lack of a transparent methodology to account for the value of the ecosystem services means that the benefits of managed realignment are often not fully accounted for in economic appraisals for flood and erosion schemes. Landowners may not receive adequate compensation. On the other hand one study found that that some land has been bought at a premium in the past.[51] The Government's recently published action plan for developing the potential of payment for ecosystem services highlights flood risk management as a specific area of opportunity.[52]
- **Requiring that local authorities and the Environment Agency develop clearer implementation programmes in line with the preferred options set out in the Shoreline Management Plans.** Ensuring that existing development plans are fully aligned with Shoreline Management Plan goals is particularly important where managed realignment is the preferred management option at some point in the future. This will help ensure that new development does not hinder the implementation of managed realignment.
- **Ensuring an open and realistic approach to adaptation planning on the coast.** Gaining public support requires regular consultation and communication with local communities to help them understand the long term changes that are inevitable on the coast and the costs, risks and benefits of coastal management options. Coastal management planning and implementation involves difficult trade-offs and potentially unwelcome changes for some residents. Local authorities need to adopt an integrated approach to planning how coastal communities can thrive socially and economically while they adapt to rising sea levels.

48 Garbutt and Boorman (2009).
49 Ledoux et al. (2005).
50 Risk and Policy Analysts ltd. et al. (2008) for the North Norfolk Council District.
51 Garbutt et al. (2009).
52 Defra (2013a). Note that the action plan appears to focus more on the potential for fluvial, rather than coastal, flood risk management payment for ecosystem services schemes.

Annex 5.1

Regional breakdown of proposed managed realignment in the first epoch (to 2030)

Shoreline Management Plan number	Name	Km of coastline	Km of regional coastline planned to undergo realignment (% of the regional coastline)
1	**Scottish Border to the River Tyne**	167	**30 (18%)**
2	The River Tyne to Flamborough Head	211	11 (5%)
3	Flamborough Head to Gibraltar Point	204	12 (6%)
4	Gibraltar Point to Hunstanton (The Wash)	122	–
5	**Hunstanton to Kelling Hard**	66	**11 (16%)**
6	**Kelling Hard to Lowestoft Ness**	81	**27 (34%)**
7	**Lowestoft Ness to Felixstowe Port**	103	**27 (27%)**
8	Essex and South Suffolk	559	**38 (7%)**
9	**River Medway to Swale Estuary**	194	**53 (28%)**
10	Isle of Grain to South Foreland	120	0.3 (0.2%)
11	South Foreland to Beachy Head	114	8 (7%)
12	Beachy Head to Selsey Bill	95	12 (12%)
13	Selsey Bill to Hurst Spit	361	12 (3%)
14	Isle of Wight	164	3 (2%)
15	**Hurst Spit to Durlston Head**	198	**46 (23%)**
16	Durlston Head to Rame Head	847	48 (6%)
17	Rame Head to Hartland Point	868	42 (5%)
18	Hartland Point to Anchor Head	361	22 (6%)
19	Anchor Head to Lavernock Point	415	22 (5%)
22	**Great Ormes Head to Scottish border**	795	**124 (16%)**
TOTAL		6,044	**548 (100%)**

Source: Shoreline Management Plans
Notes: Shoreline Management Plans are highlighted (in bold) where they plan to realign a section of their coastline that represents over 15% of their regional coastline. This table is for England only, and omits Shoreline Management Plans 20 and 21 which refer to Wales.