No Regrets
Planning for Sea Level Rise and Climate Change and Investing in Adaptation
A Good Practice Guide
Sea level rise is inevitable and could be as much as several metres over the next few centuries. Significant changes in climate are also likely during this century and beyond.

Coastal communities are particularly vulnerable to the impacts, with the most significant and immediate being an increasing risk of flooding and erosion.

Climate change could also lead to more frequent and severe droughts and heatwaves. People, businesses, agriculture, forestry, habitats and ecosystems will all be affected.

We must adapt. The risks are too great to carry on with business as usual. Changes will be needed to the built environment, infrastructure, the way we manage the land and the coastline, and the way we live and work.

Planners and others involved in infrastructure investment have a vital role to play in delivering adaptation. This guide demonstrates how adaptation can be delivered in practice, in a way that is positive, proactive and achievable, by:

- Taking a broad view of the local context and how it is changing over time
- Engaging and empowering local communities
- Working in partnership
- Working with nature rather than against it
- Planning for the long term, using flexible adaptation pathways
- Enabling changes in land use and making provisions for moving vulnerable communities and infrastructure
- Building the right kind of development in the right place
- Investing intelligently in infrastructure which provides multiple benefits

Case studies provide inspiring examples of good practice from around the UK, including the Coastal Communities 2150 project and the Coastal Pathfinders Programme.

Local authorities and other organisations involved in planning, decision-making and infrastructure investment are encouraged to follow these examples and plan for the long-term future of coastal communities in the South East of England and further afield.
Introduction

This guide sets out how decision-makers in planning and infrastructure investment can work with communities to plan for adaptation to sea level rise and climate change in coastal areas.

Sea levels and the climate are changing, and we are already feeling the effects. The impacts of sea level rise and climate change are likely to continue for hundreds of years. It is not possible to predict the precise rate and nature of change that will take place, but we will all be affected and there are likely to be very significant impacts on future generations. Coastal communities are particularly vulnerable.

The scale of the potential impacts means that we must take action. It is essential that we plan for the long term to adapt to sea level rise and climate change. Given the uncertainty over what will happen and when, the way that we plan needs to be flexible, allowing for different pathways to be taken in the event of a range of possible sea level or climate outcomes. Decision-making needs to be staged, allowing the right adaptation measures to be implemented at the right time. As far as possible we should prioritise actions in the short term which we are not likely to regret at a later date. Further information about how to plan for the long term using flexible adaptation pathways can be found on page 31 of this guide, including a case study for Newhaven in East Sussex.

This guide is designed to encourage and enable decision-makers to help coastal communities plan how best to adapt to sea level rise and climate change. It describes the risks, explains why adaptation is necessary, demonstrates that it is achievable, makes the case for investment and highlights the benefits of getting it right. Some of the options for adaptation in coastal areas are discussed and good practice tips are provided for planning, investment and project delivery, illustrated with a series of case studies.

The guide is primarily aimed at decision-makers with a responsibility for planning and infrastructure investment. This includes town and country planners, other county, district and town or parish council officers and councillors, national parks including the South Downs National Park Authority, utility company investment managers, highways authorities and other infrastructure operators such as Network Rail, Coastal Groups, and Environment Agency Flood and Coastal Risk Managers.

It may also be of interest to others, such as house builders, architects, directors of businesses in the areas affected, trade associations, and the National Farmers Union.

Work on the guide was funded by the Southern Regional Flood and Coastal Committee as a follow-up to the Coastal Communities 2150 project. The content was produced by LDA Design and Lindsay Frost Consulting. It has been written in the context of the English planning system and many of the case studies are from the South East of England, focusing on the Coastal Communities 2150 pilot areas in Kent, Sussex and Hampshire in particular.

As planning is a devolved matter, the approach taken in Scotland, Wales and London may in some instances differ from that set out in this guide. However, it is hoped that much of the content will still be useful and of interest in other locations across the country which are affected by similar issues.
Figure 1: Many protected habitats, protected landscapes, heritage sites and some of the highest grade agricultural land are in coastal areas.
Sea level rise, climate change and the risks to coastal communities

Evidence shows that sea levels have been rising and the climate has been changing for over a century. These changes are projected to continue throughout this century and beyond, and coastal communities will be particularly vulnerable to the impacts.

Sea levels in South East England have risen by around 20cm since 1900, with the rate of change increasing in recent decades. An exceptional run of storms from December 2013 to March 2014 contributed to the wettest winter in England for at least 250 years, and the storm surge in early December 2013 caused the highest tides ever recorded on some parts of the coast. A significant long-term increase in average temperatures has also been observed, and 2014 was the warmest year on record, both globally and in the UK.

Emissions of carbon dioxide and other greenhouse gases from human activity are extremely likely to have been the main cause of global warming over the last half century. This in turn is very likely to have contributed to global sea level rise in recent decades, which has been caused by melting polar ice sheets and glaciers, thermal expansion and changes in salinity of the oceans as the climate warms.

Regionally, sea levels can also be affected by vertical land movement. This includes South East England, where land has been gradually sinking since the end of the last ice age. Sea levels in South East England could be around a metre higher by the end of this century. Even if we reduce global emissions radically and rapidly, sea levels are very likely to continue rising for centuries beyond that.

Other projected changes in climate in South East England include warmer and wetter winters, more intense downpours, warmer summers with more extreme temperatures on very hot days and more regular, extended heatwaves, and drier summers with a higher risk of droughts.

We might also see more frequent and powerful storms, with resulting waves and tidal surges that could exacerbate the effects of sea level rise, although the UK Climate Projections were not able to predict this with confidence.

Coastal areas are particularly vulnerable to the impacts of sea level rise. Many valuable assets are located in these areas, including homes, businesses, road and rail links, ports, power stations, high grade agricultural land, protected landscapes, protected habitats and heritage sites.

Some of the most significant impacts will include an increasing risk of flooding, erosion, storm damage and saltwater incursion to fresh groundwater and surface watercourses. Other impacts of climate change could include heatwaves, droughts, and changes to flora and fauna, in turn affecting farming, forestry, the landscape, habitats and other ecosystem services. Left unchecked, the consequences could be severe for communities, the economy and the environment.

In addition to taking urgent action to address the causes of sea level rise and climate change, it is essential that we adapt to the impacts which are already inevitable. The risks are so great that we cannot carry on with business as usual. The further ahead we plan, the better the outcomes are likely to be and the easier they will be to achieve. Progress is being made, but more action is needed.

References:
1 Rising sea levels in the English Channel 1900 to 2100, Haigh, Nicholls and Wells, Maritime Engineering Volume 164, Issue MA2, Institution of Civil Engineers (2011)
3 Winter Storms December 2013 to early January 2014 and Late January to February 2014; Wettest Winter for England and Wales Since 1766, both from the Met Office (www.metoffice.gov.uk)
4 Environment Agency data
5 NASA, NOAA Find 2014 Warmest Year in Modern Record, Nasa website (www.nasa.gov, 16/1/15)
6 2014 confirmed as UK’s warmest year on record, the Met Office (www.metoffice.gov.uk, 5/1/15)
8 UK Climate Projections, Defra (2009) and advice from the Environment Agency
9 How Will Climate Change Affect Me?, Climate South East website (www.climatesoutheast.org.uk)
10 Adapting to Climate Change: UK Climate Projections, Defra (2009)
Figure 2: Shoreline Management Plan preferred policies for management of the coastline up to 2100 (see page 49 for further information)
Managing increasing flood and erosion risk

More effort will be needed to manage flood and erosion risk in future. Shoreline Management Plans and Catchment Flood Management Plans describe the long-term risks and preferred policy for areas of coastline and river catchments respectively. Further information on these plans can be found using the links provided on page 49 of this guide. Flood Risk Management Plans, which are due to be published for each river basin district before the end of 2015, will set out the approach to managing flood risk from all sources including rivers, the sea, surface water, groundwater and reservoirs.

Traditional, hard or engineered shingle flood and coastal defences will continue to play an important role, but over time they will become too difficult or costly to maintain in some locations as sea levels continue to rise. In the short to medium term the extent of maintenance and repairs needed for existing defences and drainage systems is likely to increase. Where pumps are used to drain land, the energy requirements and running costs are also likely to go up.

Local protection is recommended for buildings and infrastructure at risk of occasional flooding, including isolated properties in locations which are not protected by communal flood defences. Flood-proof covers for doors, windows, air-vents and other openings, raised damp-proof courses and sealed floors ('tanking') can all help to keep floodwater out. During bigger floods it may be necessary to accept flooding in the building, as the weight of water could cause walls to collapse if kept outside.

Damage can be minimised by using water resistant materials on the ground floor such as tiles, raising electrical wiring, fittings and appliances, and fitting pumps in basements or under-floor areas. Valuable items can be used or stored on upper floors. It is worth incorporating these measures when properties are maintained or refurbished. Flood risk monitoring, advanced warning systems, emergency response and recovery activity also remain vitally important in areas that are at risk, now and in future.

Eventually, hard defences will need to be raised and strengthened if they are going to maintain the risk at an acceptable level. While this would allow existing communities and infrastructure to operate in much the same way as today, it would require significant investment in ever higher sea walls, quaysides and other defences along the shoreline and riverbanks.

These could be intrusive, affecting views and access to the waterfront, and putting pressure on habitats, particularly intertidal areas between the sea and the coastal defences which will be subject to a process known as "coastal squeeze". Once built, hard defences will require increasingly expensive ongoing maintenance.

The risk to people and property will also increase substantially in the event of failure, breach or overtopping of these defences in extreme conditions. Ultimately, in some locations, a threshold is likely to be reached beyond which it is no longer affordable or feasible to continue with traditional hard defences.

When this threshold is reached, allowing coastal inundation and erosion to take place without any further action to adapt existing communities and infrastructure is unlikely to be acceptable due to the impacts on residents, businesses and the environment. More sustainable, long-term plans will be needed, which work with rather than against nature where possible.
‘Soft’ coastal defences comprise more natural features which help to reduce the impact of waves on the coastline and the risk of erosion and flooding to inland areas. Examples include areas of intertidal habitat such as saltmarsh, raised or restored beaches and dunes where these are a feature, and offshore reefs.

Managed coastal realignment involves moving hard coastal defences further inland where appropriate, allowing some areas to flood or erode naturally, and creating space for features such as salt marsh to develop over time.

Soft coastal defences and managed realignment require a larger area of land than hard defences, but they can also make a positive contribution to the landscape and visual amenity, and provide important space for leisure and recreation and habitat for wildlife.

Although there will be costs associated, particularly where managed realignment is required, there may be savings on long-term maintenance and other economic benefits. In some locations, it may not be feasible to maintain the coastline in a fixed position and manage flood risk to an acceptable level in the long term. As a result, some areas of land will be subject to increasing erosion or more regular inundation from the sea. Some areas may even face permanent inundation.

Vulnerable buildings or infrastructure may eventually need to be abandoned as the risk or the cost of managing flooding and erosion become too high. In these circumstances, great care will be needed to manage the impacts on the community, the local economy and the environment and assist those in need, particularly those on low incomes.

Abandoned land may need to be cleared and decontaminated to reduce pollution risk and make areas safe. This could also have a particularly significant impact on the historic environment.

Some existing buildings and infrastructure may need to be cleared from areas where the risk is increasing and replaced in new locations, for example on higher ground or further
inland. This could disrupt existing communities and would create demand for new land for development elsewhere, potentially in the countryside or areas with landscape or green belt designations.

Inappropriate new development is prevented in areas of flood risk through the existing planning system. Some new development or re-development may be appropriate in flood risk areas where there is a demonstrable need for development to support the existing community and local economy and there is a lack of suitable alternative land at lower risk of flooding.

Where new development or re-development takes place in areas at risk of flooding either now or in future, it should be designed to be appropriately resilient in line with planning policy. This means ensuring that the development is safe for its lifetime, without increasing flood risk elsewhere.

Development which is more resilient to flooding could for example include buildings and other infrastructure on raised or floating platforms, houseboats and increasing used of water-based transport. Buildings can also be designed to accommodate flood water, for example in ground-floor void spaces which can be used for car parking or other less vulnerable uses at other times. Access routes and other infrastructure must also be carefully designed and maintained for safe use during flooding.

Where flood-resilient development does take place in areas at risk of flooding, it is important to ensure that future changes in use which could exacerbate flood risk either on-site or elsewhere are avoided, such as void spaces being filled in or used for purposes other than the original design intent.

In some areas, climate change will also increase the risk of surface water flooding or flooding from rivers (fluvial flooding) during periods of intense rainfall. Where higher sea levels prevent rivers from draining into the sea or slow the rate of drainage, the extent, depth and duration of flooding could increase. A number of measures can be applied in suitable
Reconnecting rivers with the flood plain to create upstream flood storage and wetland habitat

Lawns and other permeable surfaces in front and back gardens

Ponds

Willow and rock revetments to reduce erosion

Additional tree planting on hillsides

Improved hedgerows and grass and wildflower field margins

Green roofs

Reversion of some arable fields to pasture

Fields ploughed along contours

Figure 5: Some of the options for managing surface water and flooding from rivers

locations to help alleviate this risk, in addition to traditional flood defences or providing local flood protection for the most vulnerable properties, as described above.

Riverbanks can be realigned or existing defences removed to reconnect rivers with the flood plain. This increases the amount of water stored on suitable areas of land upstream, reduces the risk to communities downstream and also avoids the increasing costs of maintaining riverbanks and drainage systems. This approach can also return rivers in rural areas to a more natural state, create wetland habitat, and improve the environment for leisure and recreation. It may however have knock on effects for other land uses including agriculture.

Slowing or storing rainwater run-off from land can help to reduce surface water and fluvial flood risk. Infiltration of water into the ground and storage in upper catchment areas can be encouraged by increasing woodland cover in suitable locations, planting or improving hedgerows, and changing the way land is managed for example by retaining more land as permanent pasture, reducing compaction of soils or ploughing with the contours of the land. These measures can also reduce erosion of soils, helping to manage silting of drainage channels and watercourses.

Sustainable drainage systems (SUDS) have an important role to play, and the National Planning Policy Framework requires new development to prioritise the use of SUDS. Options for SUDS include permeable paving, soft landscaping, green space, green roofs, swales and ponds. Many of these measures also offer ecological and amenity benefits.

Managing supply and demand for fresh water

Action will be required to manage both demand for fresh water and supply, to adapt to an increasing risk of drought and saline incursion to water supplies caused by rising sea levels.
Demand can be reduced rapidly during times of drought by imposing temporary restrictions on water-use such as hosepipe bans or in extreme cases standpipes. However, more proactive and sustained action will be needed to manage demand over the long term. This will include being more efficient in the way that we use water, for example having a quick shower instead of a bath, or installing water-efficient fittings such as low-flow showers and taps and reduced or dual-flush toilets. These features can be fitted for little or no extra cost when replacing bathrooms and kitchens in existing homes and other buildings, and some very low cost measures can be taken at any time such as fitting a hippo or similar device in the toilet cistern to reduce the capacity of flush.

Water meters, which are being installed in homes as an ongoing programme by the water companies, are likely to encourage people and businesses to be more efficient in the way that they use water and will also make it easier to identify leaks. Rainwater or wastewater from showers and sinks can also be captured and used within buildings or in communal systems for non-potable uses such as flushing toilets or watering the garden.

In addition to improving water efficiency in existing homes and businesses, water efficient fittings, meters and rainwater harvesting or greywater reuse can be even more practical and cost-effective to design into new development. In areas of serious water stress, or areas where there is a significant risk of this arising in future, the nature and design of development that takes place will need careful management to avoid exacerbating the problem.

The Building Regulations set a maximum water consumption standard for all new homes in England. In line with the recommendations of the Housing Standards Review, local authorities will be able to set a tighter water consumption standard for new homes in areas where a need for greater levels of efficiency can be demonstrated.

Supply-side management can include improving efficiency in the system, increasing
water storage and looking at alternative water supplies. Reducing leaks is an important priority in terms of improving efficiency, including from water mains and reservoirs. In some locations it may also be necessary to reduce evaporation from reservoirs and ponds and there are a number of ways of doing this. One possibility recently demonstrated by a farmer in Berkshire is to develop floating solar farms on reservoirs which generate energy while reducing evaporation.

Water storage can be increased by building reservoirs, ponds and tanks. Increasing the amount of rainwater which filters through the ground rather than running directly into surface watercourses can help to recharge underground aquifers. Many of the measures described earlier which help to slow rainwater run-off rates will also help with groundwater recharge, for example planting more trees in suitable locations or increasing the permeability of ground cover. This can also help to reduce flood risk by reducing the amount that runs off into drains and watercourses.

Desalination plants can be used to produce potable water from saline watercourses, although the energy demands are substantial. Desalination is currently more of a priority overseas in very hot, dry climates such as the Middle East and Australia. However, desalination plants could become more prevalent in England in future to overcome water shortages in times of drought. Infrastructure can also be installed to transfer water from areas with a surplus to areas with a deficit.

Reducing the risks associated with heatwaves

In the medium to long term, average temperatures are expected to rise. Heatwaves are projected to be more common and more intense, with the risk of overheating and related impacts increasing significantly.

Around 20% of homes in England could already be experiencing overheating during
hot weather, according to research by the Committee on Climate Change. Other buildings including hospitals and schools are also at risk of overheating, even in today’s climate. Extreme high temperatures can also damage roads, railways and other infrastructure. The risk of overheating is particularly great in dense urban areas which are subject to the urban heat island effect, which can cause temperatures to be several degrees higher than in the surrounding countryside.

Many of us are able to cope with a limited amount of discomfort and inconvenience during heatwaves, adapting our behaviour and activities temporarily if needed. However, some people are more vulnerable, facing a greater risk of heat-related illness and even death. According to the Committee on Climate Change, premature deaths from overheating could triple to 7,000 per year by the 2050s. The NHS has developed a Heatwave Plan for England which sets out measures for emergency response.

Various measures can be installed in buildings or the urban environment to reduce the risk of overheating. Using blinds or shutters on windows helps to reduce the effect of direct sunlight, while increasing the amount of exposed brickwork, concrete and other heavy materials inside buildings and opening windows at night helps to cool the building down. Green roofs, green walls and street trees help to shade buildings and reduce temperatures. Green open spaces and water features or SUDS also help to cool temperatures locally while providing comfortable places for people during hot weather.

Mechanical ventilation or air conditioning in homes and other buildings may eventually become more common, although it will be important to find efficient ways of controlling temperatures without using more energy where possible.

More heat resistant and resilient materials and designs can also be specified for infrastructure, and overheating on public transport can be reduced with simple measures like painting the roofs of buses and trains white, opening windows or using air conditioning.

It is easier to design these features in to new development from the outset, although some measures can be taken to retrofit existing building and communities. In new development, a significant emphasis is placed on reducing winter heat loss to save energy and carbon emissions. Careful attention is needed to avoid increasing the risk of overheating at other times of year as a result of increasing insulation standards, which could lock in problems for the future.

**Adapting agriculture and forestry**

Some agricultural land could be subject to more regular flooding or saline incursion into surface or groundwater in future. Where agricultural land is affected by planning and investment decisions, it will be important to work with farmers and other stakeholders to manage the transition and enable adaptation.

Flood plains and inter-tidal areas could still be productive, for example for cultivating suitable plants such as samphire, grazing sheep on saltmarsh, or breeding fish in the bends in the river and pools that form on the flood plain. Other types of agriculture may be forced onto higher ground where soil and conditions are suitable. Farm buildings and infrastructure such as barns, intensive livestock units, slurry pits and grain dryers may also need to be moved out of areas at risk.

Action can also be taken to reduce the risk to agriculture and forestry from the wider impacts of climate change and take advantage of the opportunities such as extended growing seasons. This will include using a more diverse range of plant species which are resilient to changing climate conditions and new threats from pests and diseases.

Farmers are already adapting their crops and techniques to cope with a changing climate, for example by planting deeper rooted cereal varieties to cope with drier soils. Crops which are suited to warmer climates could also become more common, including sunflowers, grapes, apricots and citrus trees. Planting shelter belts or improving hedgerows can also help to protect crops from extreme weather.

Livestock management practices may also need to change. This will include preventing and treating diseases and pests which could become more prevalent in this country as the climate changes. Animals may need more shelter during hot summers to avoid heat stress, while extended periods of outdoor grazing may be more feasible during warmer winters.

Measures to reduce rainwater run-off and soil erosion will be important, including woodland planting in suitable locations, compaction relief
Since climate change impacts are expected to lead to changes in the types of crops that can be grown, farmers will need to consider alternative crops suited to warmer climates, such as grapes, sunflowers, and citrus trees. This might involve diversifying their crops and planting them in areas that are better suited to climate change impacts. A range of other measures are needed to help farmers adapt to climate change. These include changes to soil management practices, the use of climate-resistant crops, and diversification of farming activities. The potential for increased carbon emissions due to deforestation can be offset by adapting our approach to forestry, prioritizing the promotion of biodiversity and the inclusion of a greater variety of tree species, which will help the environment adapt and become more resilient to the impacts of climate change.

While habitats and ecosystems are valuable in their own right, the wellbeing of people and communities and the success of the economy rely on the health of the surrounding environment. We receive multiple benefits from well-functioning habitats and ecosystems, including food, materials, fuel, clean air, water, medicine, and cultural and recreational benefits. If they deteriorate, so will the resources and other benefits they provide.
Habitats and ecosystems will be affected by the direct impacts of sea level rise and climate change as well as some of the actions taken to adapt. Sea level rise will result in significant changes to coastal habitats. Habitats will roll back inland on undefended areas of the coast as some areas are permanently inundated and the extent of intertidal areas changes. The salinity of some freshwater habitats and groundwater could also increase.

In areas with hard defences, coastal or fluvial squeeze will reduce the extent of intertidal areas as sea levels rise. Where habitat loss is unavoidable, similar habitat can be created elsewhere to mitigate or compensate for the effects. For example new wetlands, saltmarsh and coastal grazing marshes are being created as part of managed realignment schemes.

There will also be physical impacts of extreme weather including flooding and droughts, gradual migration of species northwards or to higher ground as temperatures rise over the long term, changes in the timing of the seasons and potential impacts on synchronisation between species as a result, affecting important processes such as pollination and changes in the profile of pests and disease.

Resilience to climate change can be supported by improving the condition and extent of existing habitats and ecosystems, encouraging biodiversity, controlling the spread of invasive species and connecting areas of land to allow species to migrate and adapt gradually. Particular attention should be given to the impacts on protected habitats. However, even in protected habitats it will also be important to allow for some degree of change.

Shading rivers and streams by planting trees in suitable locations, and managing water abstraction and rainwater run-off from land in order to maintain water levels and water quality will help to protect freshwater ecosystems. Making space for the natural development of rivers and coasts where possible will also be important, for example allowing beaches, sand dunes and inter-tidal mudflats to roll back further inland as sea levels rise.

Figure 9: Some of the options for enabling habitats and ecosystems to adapt
Delivering adaptation through planning and infrastructure investment

Planning and infrastructure investment have a critical role to play in delivering adaptation to sea level rise and climate change along the coast. Case studies from around the UK, including the Coastal Communities 2150 project and the Coastal Pathfinders Programme, demonstrate how adaptation can be delivered in practice, in a way that is positive, proactive and achievable.

Many of the adaptation options described in this guide could not be achieved overnight, due to the cost and complexity of making them happen. We need to plan ahead and adapt over time, as the effects of climate change become clearer and the right moments arise to take action. For example, we might choose to improve buildings and infrastructure as they undergo substantial refurbishment or maintenance, move them or significantly improve their design when they come to the end of their life, and plan new development carefully with a view to the long term.

Certain organisations and individuals, including the Environment Agency, local authorities and the Marine Management Organisation, have particular responsibilities for parts of the process, including implementing government policy on planning and flood and coastal erosion risk management, controlling and seeking funding and managing important assets like land and infrastructure. Many of these organisations have their own plans for responding to sea level rise and the wider impacts of climate change. These are summarised in the section on Stakeholders and Responsibilities (page 43).

Integrated Coastal Zone Management provides an overarchingly approach for drawing the relevant parties together to ensure effective, joined-up decision-making in coastal areas, both on land and at sea. Local authorities are well placed to lead the process of Integrated Coastal Zone Management, working with the Environment Agency and other local partners, and they are strongly encouraged to adopt this approach by the Planning Practice Guidance.

There is no strict definition for the geographical bounds of a coastal zone, but the definition might for example take into account political and administrative boundaries, the area influenced by a shared coastal process such as tidal flooding, erosion and longshore drift and deposition, or the area occupied by particular coastal or marine industries. The recommended approach to Integrated Coastal Zone Management comprises a cycle of information collecting, planning, decision-making, management and monitoring of implementation.

In this guide we have not set out to provide comprehensive guidance on how to develop and apply planning policy on climate change and related issues, how to manage coastal areas through approaches such as Integrated Coastal Zone Management, or how to deliver development and infrastructure projects; these subjects are covered more fully elsewhere and some useful sources of guidance are listed in Further Information (page 49).

This guide aims to add value by highlighting some key points of good practice for delivering adaptation in coastal areas. Case studies from around the coast are used in the following sections to demonstrate how you can take advantage of the opportunities and overcome some of the challenges to make real progress. A number of these case studies are taken from the Coastal Communities 2150 project. Coastal Communities 2150 worked with coastal communities in the UK, France, Belgium and the Netherlands to engage local people in the process of planning for long-term adaptation to sea level rise and climate change.

The project was led by the Environment Agency, with other UK partners including Hampshire County Council and Kent County Council. In each location, community groups were formed to consider the long-term impacts and options and develop a vision and action plan for adaptation. A report is available which provides an overview of the work, with examples of good practice and lessons learned, available from www.cc2150.eu.
New ways of delivering adaptation to sea level rise and climate change are also being tested in other areas around the coast. These include a number of locations which were supported by the Coastal Pathfinders Programme, a government funded programme in 2011 to test new and innovative approaches to coastal planning and management. While these examples of good practice are a good start, more needs to be done to ensure that all areas of our coastline are adequately prepared for the future. This guide is designed to help by setting out how this can be done.

We have drawn the good practice points together into seven themes, which relate to and build on the key principles of Integrated Coastal Zone Management:

- Taking a broad view of the local context and how it is changing over time
- Engaging and empowering local communities
- Working in partnership
- Working with nature rather than against it
- Planning for the long term, using flexible adaptation pathways
- Enabling changes in land use and making provisions for moving vulnerable communities and infrastructure
- Building the right kind of development in the right place
- Investing intelligently in infrastructure which provides multiple benefits

The following sections discuss each of these themes in turn.

Taking a broad view of the local context and how it is changing over time

Because climate change and sea level rise have many wide-ranging implications, it is essential to start with a broad view of the local context. This will help to identify local opportunities or challenges to be addressed and understand how different issues are interrelated. A review of the local context might take into account, for example:

- Location of settlements and the make-up of local communities
- Sectors of the local economy and the nature of economic activity
- Infrastructure, including transport links, ports, airports, communications and utilities
- Character and condition of the landscape, the seascape, the built environment, the natural environment and cultural heritage
- Coastal processes, flood risk and how these are currently managed

It will be important to understand as far as possible how these different features are changing over time, both due to climate change and other factors such as demographic shifts, development, and growth and decline in different economic sectors such as fishing, shipping, and tourism. A historical perspective will also be helpful to put future trends into context, and many of these issues will relate to the national and international picture.

This review might include undertaking a climate change risk assessment, which local authorities are encouraged to produce as part of the evidence base for Local Plans, or taking into account the findings if one has already been completed.

A huge wealth of information is available in each of these areas and local authorities in particular will already hold or have access to much of the data needed, while the Environment Agency and other organisations have made a significant amount of data readily available online.
Ongoing programmes of research are continually adding to the resources available. There are too many to mention in this guide, but particularly useful examples include work by the Met Office and the UK Climate Impacts Programme and the Environment Agency’s Climate Ready support service. These and other useful sources are listed in the Further Information chapter of this guide.

Presenting the local context in a clear and accessible format will help to promote public interest in the coast, encourage people to think about how climate change will affect the area, and enable individuals and relevant organisations to plan for adaptation.

Continuing improvements in technology, techniques and data sources are making it easier to compile, analyse and present this information, not least advances in how information is shared over the internet, mobile technologies and the use of Geographical Information Systems (GIS) for mapping. These can also be used for collecting data, for example from monitoring devices or input from individuals, and making links between different datasets.

---

**Case study: Belgium’s Coastal Atlas**

A Coastal Atlas has been produced for the whole of Belgium’s 67km North Sea coast, from the French border in the west to the Dutch border in the east, up to 15 km inland and the continental shelf up to 56 km out to sea. Much of the coast is urbanised with resorts, port towns, and major infrastructure, but there are also important terrestrial and marine natural habitats. The whole area is particularly vulnerable to climate change.

Information is conveyed in text, maps, diagrams and photographs in four languages (Dutch, English, French and German) both in hard copy and online. The website offers maps that cannot be found anywhere else and which can be downloaded in interactive formats. There is also a regularly updated databank, and set of sustainability indicators, to check how well the Belgian coast is adapting.

The Atlas was produced by Belgium’s Co-ordination Centre for Integrated Coastal Zone Management (ICZM) with funding from the EU’s INTERREG IVA programme, and is available from www.coastalatlas.be.
Engaging and empowering local communities

Everyone will be affected by climate change and we all have a role to play in adaptation. Engaging and empowering local communities and working with the range of stakeholders in coastal areas will be fundamentally important if we are to make progress.

Local communities need to be engaged in the process and feel empowered to act. Being aware and informed about the opportunities and challenges that lie ahead is an important starting point. Information about climate change, sea level rise and the implications for coastal communities needs to accessible, interesting and relevant to a range of people.

This could involve a variety of formats, such as facts and figures, illustrations, diagrams, timelines, storytelling, maps, talks; anything that helps to get the information across in a way that suits people of different ages and levels of background knowledge.

It will be important to reach out to the range of people and organisations in the community, at different times and through various means. Online communications, including websites and social networks, may now be one of the most effective ways to make information available, but other media will still be important, including local newspapers, radio, local events, leaflets and exhibitions in public spaces.

Working through existing community groups and organisations like schools is also helpful. Constructive, open and honest dialogue should be encouraged to ensure that plans for adaptation are informed by the experience and views of local people and they have ownership over the results. This reflects the requirement in the National Planning Policy Framework for “early and meaningful engagement and collaboration with neighbourhoods, local organisations and businesses”.

This might include developing a shared, long-term vision for how the community will adapt to climate change and sea-level rise, which was the approach taken in Coastal Communities 2150 (see case study). This long-term vision can then inform other planning and development processes, including preparation of Local Plans and Neighbourhood Plans.
Case study: Engaging local people through Coastal Communities 2150

Coastal Communities 2150 (CC2150) set out to actively engage people in vulnerable coastal communities in the process of planning for long-term adaptation.

Teams in Hampshire, Kent, Sussex and parts of Belgium and the Netherlands developed a broad range of public communications and engagement materials, tools and techniques to enable people to envisage how their communities and coastal areas could change over time and the challenges that would present. These included:

- Animated fly-through videos and interactive tools that show how coastal areas could change with different amounts of sea level rise
- Illustrations and photomontages which visualise changes in the coast, landscape and communities
- A book telling local stories of change
- A pub quiz on climate change and sea level rise
- Seminars and workshops
- Lessons at local schools and the establishment of an environmental youth group
- Activities for families and children, such as building miniature houses on the shore, to see which best resist the incoming tide
- Postcards, leaflets and factsheets for tourist offices and visitor destinations
- Websites and online consultation
- A climate trail with permanent, visual displays to tell the story at key locations

The project reached out to thousands of people through these activities, including politicians, local authority officers, businesses, and members of the public.

The final project report sets out lessons learned about which tools and techniques worked well and how to deal with challenges such as presenting complex, technical information. It is available from www.cc2150.eu.
Case study: Community visions and action plans for adaptation

Views and ideas contributed by local people through the CC2150 engagement activities in England were used to inform the development of a community vision and action plan for adaptation in each of the participating areas.

Local community groups were established to steer the development of each vision and action plan. Each group brought together local volunteers for regular meetings and workshops to review the evidence, plan engagement activities, review feedback, develop their long-term vision for adaptation and agree actions.

All of the visions identified significant long-term changes which could take place in each area. The options considered included managed realignment, improvement of hard coastal defences, and relocation of some of the most vulnerable assets including homes.

The visions described the communities’ priorities for how they wanted their local areas to adapt. These included retaining access to the waterfront for leisure and recreation, ensuring the health and wellbeing of local people including the most vulnerable, minimising impacts on the landscape and habitats, and maintaining sustainable local economies. The visions can be used to inform future decision-making about which adaptation options to take forwards.

The action plans focused on low cost, win-win actions which could be taken forwards by members of the community in the short to medium term. These included continuing communications, raising awareness, promoting community participation in decision-making and adapting individual homes and businesses.

However, most of the action plans did not make conclusions on major planning or investment decisions, such as how or when coastal defences would be improved or replaced. This is because the resources, remit and responsibilities of the community members involved were limited. This demonstrates the crucial role that local planning authorities and infrastructure operators have to play in making adaptation happen.

On completion, launch events were held to publicise each community’s vision and action plan and encourage more local people to get involved in implementing them. An important goal was to ensure that activity in each community would continue beyond the end of the CC2150 project.

The visions and action plans are available from www.cc2150.eu; www.kentcoastalcommunities2150.org.uk; and www.solentforum.org/current/CCATCH.
Working in partnership

Working in partnership with a wide range of stakeholders is an important principle in local planning, river basin and catchment management planning, Integrated Coastal Zone Management and various other decision-making processes.

Various partnerships and other groupings already exist which could provide an effective forum for climate change adaptation in coastal areas or contribute to that process.

If a new partnership is to be established to undertake the process of planning for adaptation, it will be important to have a clear understanding of the purpose, scope, membership, legal status and governance structure. This may be set out in a Terms of Reference, Constitution or Memorandum of Understanding agreed by the members.

The Severn Estuary Partnership is a good example of a partnership that brings together all those with an interest in the coastal area to take an integrated approach to its management. Established 20 years ago, it is an independent, non-statutory initiative coordinated by local authorities and statutory agencies and involving fishermen, farmers, and other local businesses. It works across all sectors to facilitate effective communication, establish common principles for sustainable use of the estuary, coordinate estuary-wide actions, and promote and publicise the estuary and add value to estuary management.

Existing partnerships with a role to play in adaptation:

- Regional Flood and Coastal Committees
- Coastal Groups or Partnerships
- Maritime or Coastal Forums
- European Marine Site (EMS) Management Groups
- Area of Outstanding Natural Beauty (AONB) Partnerships
- Climate Change Partnerships
- Local Enterprise Partnerships
- Local Nature Partnerships
- Neighbourhood Planning Forums

In addition to playing a role in engagement, planning and decision-making, partnerships can be formed to fund, deliver, own and manage development and infrastructure projects. Such partnerships might have a short-term legal basis for a particular project, such as a contract or joint venture, or a longer-term formal structure.

Funding might be pooled or transferred to particular organisations or individuals within the partnership for delivery. Provision will also need to be made for long-term ownership or management of assets. Many schemes to reduce flood risk are now being delivered in partnership. The flood alleviation scheme in Newhaven was delivered with funding and involvement from a range of partners (see case study).
Case study: Taking a partnership approach to flood alleviation in Newhaven

Newhaven is a port and industrial town at the mouth of the River Ouse, and is the focus for economic regeneration in this part of Sussex. The area is subject to a number of climate change risks, particularly coastal flooding. A tidal surge flooded residential properties in Newhaven and closed the railway line which runs along the coast to Seaford in December 2013.

A flood alleviation scheme is being delivered to raise the standard of flood defence for over 430 homes and 390 businesses in the town, costing an estimated £9 million.

The main funding will come from the UK government in national Flood and Coastal Erosion Risk Management Grant in Aid, but there will also be significant financial contributions (around 30%) from the Coast to Capital and South East Local Enterprise Partnerships (LEPs), reflecting the importance they attach to the economic regeneration of Newhaven and the protection of existing and planned employment areas from flooding, as part of the “City Deal” for the Greater Brighton area.

Network Rail is also making a substantial financial contribution towards works to install a flood gate on the main railway line, believed to be only the second in the UK. Other contributions are being sought from the landowners and developers who will benefit from the scheme.

Working with nature

In addition to being of value in their own right, natural systems and processes provide a broad range of goods and services which help to support human health, wellbeing and economic success. Ecosystem services are the benefits which nature provides for human well-being, society and the economy. They include:

- **Provisioning services**: the goods people obtain from ecosystems, including food, water, fuel, raw materials and genetic resources
- **Regulating services which control conditions**, including the processes that regulate the climate and water flows; air, water and soil quality; pollination; and pests and diseases
- **Cultural services**, including aesthetic, spiritual, educational and recreational benefits
- **Supporting services**, which provide the basic infrastructure for life, including photosynthesis, nutrient cycling, and soil formation

Understanding and working with nature where possible will enable us to achieve more sustainable outcomes. This means taking a more proactive approach than assessing and mitigating the environmental impacts of policies, strategies and projects through formal processes including Strategic Environmental Assessment, Sustainability Appraisal, Environmental Impact Assessment and Habitat Regulations Appropriate Assessment.

The ecosystem approach has been fundamental to the development of the Partnership Management Plan for the South Downs National Park. An overview of the ecosystem services provided by the National Park is included in the introduction to the document, and this understanding informs the policies on farming, forestry and woodland, water, tourism and other aspects of management.

In addition to informing planning and decision-making, applying this kind of thinking can help to identify, develop and raise funding for projects which support adaptation to climate change and sea-level rise while enhancing the natural environment and benefiting local communities. The Medmerry coastal realignment scheme in Sussex is a great example of what can be achieved by working with nature (see case study).

When the social and economic benefits provided by the natural environment are clear, their value can be estimated and used to make the business case for funding or direct payments to those who help to maintain them.

Payments for Ecosystem Services (PES) schemes provide incentives to farmers and landowners to manage the land in a way which will deliver these services to an agreed standard through a voluntary agreement. A number of pilot studies have been undertaken across England, including the Slowing the Flow project in Pickering, North Yorkshire, which sought to reduce flood risk downstream and improve water and soil quality, by changing land management practices and planting additional woodlands to slow the flow of water through the river catchment. This approach builds on established schemes such as Environmental Stewardship and the Woodland Grant Scheme which are already widely taken up by landowners.
Case study: Medmerry managed realignment, West Sussex

Medmerry is the largest coastal realignment scheme on the open coast in the UK. It is sited on the west side of the Manhood Peninsula, which juts out into the English Channel south of Chichester. This is a flat coast line protected by shingle beaches, which are vulnerable to breaching and overtopping in storm conditions, resulting in regular flooding by the sea. Rather than building up the beaches to ever higher levels, as sea levels rise, the Agency decided to work with nature.

The scheme involved building up some 7km of new earth walls inland, breaching the existing shingle beach and forming a large new saltmarsh habitat. This helps to absorb wave energy and manage flood risk for 350 homes, two holiday parks, and a sewage treatment works. It also provides important compensation for loss of intertidal saltmarsh habitat elsewhere, allowing other flood defence schemes to proceed around the Solent.

The new habitat is now an RSPB Reserve with extensive walks and cycle tracks for people to enjoy and benefits for local businesses. It is a model for win-win climate change adaptation, combining improved flood defences with new natural habitats and opportunities for recreation and business on the coast.

The £28 million scheme was carried out by the Environment Agency from 2011 to 2013. At all stages, the scheme was developed in close consultation with a stakeholder group embracing a wide range of local interests.

Planning for the long term, using flexible adaptation pathways

Most of the organisations with a responsibility for planning and major infrastructure are required to take climate change and sea level rise into account in the development of policies and plans, either through the National Planning Policy Framework, National Policy Statements for Nationally Significant Infrastructure Projects, or the requirements of the Climate Change Act (2008). Local authorities and infrastructure operators typically plan for limited time horizons of 10 to 20 years, whereas climate change and sea level rise are projected to continue for centuries. This means that there is little focus on the long-term vulnerability of key infrastructure and other assets to climate risks and when they will need to be managed, upgraded, replaced or relocated.

Flood Risk Management Plans, Shoreline Management Plans, Catchment Flood Management Plans and Strategic Flood Risk Assessments are an exception because they consider risk and preferred policies over the next 100 years, with an allowance for climate change and sea level rise. Ideally we also need to consider what might happen beyond that. Long-term planning also needs to consider other forms of climate risk, particularly the impact of hotter drier summers and drought or water stress, and seek to make the most of the benefits and opportunities which climate change could present.

Planning for the long term does not mean making decisions about what will happen hundreds of years in advance, but it does mean ensuring that the decisions we take now are informed by an awareness of the long-term prospects.

It is only by doing this and considering the more extreme outcomes envisaged in the sea level rise and climate scenarios that we can understand where more radical action will ultimately be needed. This will leave us better equipped to adapt when the time comes, by keeping options open and maximising flexibility for future generations. It will be important to prioritise the actions that address the biggest immediate risks, have a long lead-in time, relate to new buildings and infrastructure with a long lifespan, or are beneficial whatever happens.

It will also be important to avoid actions which could exacerbate the risk further down the line or reduce our resilience and capacity to adapt. Once this long-term planning exercise has been undertaken for a given area, local organisations can take the implications into account in their own plans for the short to medium term, including the Local Plan developed by the local planning authorities.

Major projects such as flood defences, property developments, new transport routes or water supply infrastructure are big investments which are difficult or costly to reverse. Their design is dependent on assumptions made at the outset about the climate over the lifetime of the asset, which can be many decades. While there is broad consensus that sea levels are rising and the climate is changing, there is considerable uncertainty about how much change we are likely to see and how soon it will be happen.

A number of different scenarios have been developed for how the climate could change over time, depending on various factors including the extent to which global carbon emissions are reduced and the way that the climate system responds. This uncertainty presents a significant challenge when planning for the long term.

This uncertainty can be overcome by applying the “flexible pathway” approach to long-term planning. This is an incremental approach to adaptation with staged, risk-based decision-making in response to evolving knowledge and conditions. Flexible adaptation pathways comprise one or more possible sequences of no-regrets, low-regrets, and win-win options and identify thresholds beyond which major policy changes or investments will be needed:

- **No-regret actions** are cost-effective under current climate conditions and beneficial whatever the outcome in terms of climate or sea level
- **Low-regret actions** are relatively low cost and are likely to be beneficial under predicted future climate or sea level scenarios
- **Win-win actions** contribute to adaptation and provide other social, economic and environmental policy benefits
- **Major policy changes or investment decisions** have significant, long-term consequences and costs associated with them, and require considerable analysis and public debate before a decision is made
Flexible adaptation pathways were first developed for the pioneering Thames Estuary 2100 project. Since then the approach has been taken up in a number of other areas across the world, on a variety of geographical scales from the major metropolitan area of New York City to small, vulnerable, coastal communities in Australia.

There is no standard methodology for developing and applying flexible adaptation pathways. The following approach is suggested, based on a worked example developed for the Ouse valley in Sussex as part of this project (see case study):

1. Identify current and potential future hazards for a range of different sea level rise and climate change scenarios
2. Describe assets and infrastructure in the local area and identify vulnerabilities
3. Assess the risk to assets and infrastructure, and identify thresholds such as a given increase in sea level beyond which the risk becomes unacceptable
4. Develop an initial list of adaptation options
5. Group adaptation options into no-regrets, low-regrets, win-win and major policy or investment decisions
6. Prioritise adaptation options and develop one or more sequences of staged actions which will be taken as defined thresholds are met

It will be important to engage local communities and other stakeholders in the process of developing flexible adaptation pathways and ensure their buy-in to the outcomes. Technical input will also be needed to inform some of the tasks, such as modelling of future river flows, tides and flood risk under different scenarios for climate change, and cost-benefit analysis of different adaptation options. Climate conditions, costs, benefits, the future funding regime, and other relevant factors cannot be known so far in advance. The important thing will be to use reasonable assumptions, consider scenarios that cover a range of possible outcomes, and ensure that the maximum flexibility is available to future generations to make decisions and take further action when the appropriate time comes.

Once the flexible adaptation pathways have been developed, the immediate actions can be implemented and short to medium-term actions can be incorporated into local policies and plans. It will be important to monitor climate change and sea level rise over time and review any updates in the future climate projections, revising the pathways or scheduling subsequent adaptation actions as the thresholds are approached.
UKCP 09
Sea level rise projections for south-east England to 2095

Sea level rise (metres increase over 1990 levels)

<table>
<thead>
<tr>
<th>UKCP 09 Low (37cm)</th>
<th>UKCP 09 Medium (44cm)</th>
<th>UKCP 09 High (53cm)</th>
<th>UKCP 09 H++ A (93cm)</th>
</tr>
</thead>
</table>

Flexible adaptation pathways

Notes

NR LR WW: No regrets, low regrets and win-win actions

X: Critical threshold at which planned 2010 strategy infrastructure requires improvement or replacement

Y: Critical threshold at which it is no longer feasible to continue raising tidal river walls

Figure 10: Example of flexible adaptation pathways for the lower Ouse valley in East Sussex
The lower Ouse valley in East Sussex was a pilot area for the Coastal Communities 2150 project. It combines seaside and inland towns, separated by a rural river valley and down land which form part of the South Downs National Park. The area is vulnerable to a range of climate change impacts, in particular sea level rise and several different forms of flooding. As well as affecting urban and rural development, this poses risks to important transport, energy and other infrastructure links between the coast and inland areas.

The immediate way ahead, to the early 2020s, is set by a 2010 strategy to improve flood defences in the coastal town of Newhaven and maintain the existing tidal river defences up the valley to Lewes. Alongside this, a range of short-term “no regrets” and “low regrets” actions can be taken which make sense for all or most future sea level and climate scenarios, such as beach recycling and replenishment at Seaford or controlling development on the tidal flood plain.

Towards the end of the 21st century, several different pathways may open up for climate change adaptation. As well as continuing the no / low regrets actions, these pathways could include:

- Raising coastal, tidal and river defences in line with sea level rise
- Relocating development and infrastructure away from high-risk locations
- Allowing tidal river walls to breach and new saltmarsh to form on the flood plain
- A secondary river channel and /or a tidal barrage at Newhaven to overcome scouring and undermining of the town’s flood defences

At this stage, it is difficult to choose a preferred pathway as there is limited information available about what will happen when. Further work is necessary to refine the pathways, assess the risks, determine the thresholds beyond which significant changes will be needed, consider the costs and benefits, and use them to inform local planning and infrastructure investment decisions.
Enabling changes in land use and making provisions for moving vulnerable buildings and infrastructure

As the risks increase with climate change and sea level rise, in the long term it may not be feasible or affordable to continue to defend some coastal communities from flooding and erosion or the costs and other impacts of doing so may significantly outweigh the benefits. In these places it will be necessary to have a planning system which enables changes in land use and makes provisions for moving vulnerable buildings and infrastructure.

There are provisions in the National Planning Policy Framework for local authorities to facilitate the relocation of existing development affected by increasing risk of coastal inundation, erosion or other forms of flooding including from rivers as a result of sea level rise and climate change.

Local Plans can identify a Coastal Change Management Area (CCMA) in areas “likely to be affected by coastal change (physical change to the shoreline through erosion, coastal landslip, permanent inundation or coastal accretion)”12. CCMA's enable planning policies to be adopted which enable and facilitate the process of change over time while managing the impacts. They can also be used to restrict or prevent inappropriate development in areas at risk or development which will have a further impact on physical changes to the coast.

Some development may be permitted, including essential infrastructure, or provided there are clear plans to manage the impacts of coastal change within the lifetime of the development and it does not affect coastal change processes elsewhere. Planning permission may be temporary, with conditions to remove the development and restore the site at the end of its lifetime.

Local authorities can facilitate removal of properties and relocation or “rollback” away from areas at risk by allocating land elsewhere for affected development and habitats to relocate to, or granting planning permission for development to be relocated to areas where planning would normally be refused. Where properties are to be demolished, the residents may be given support for relocation.

One way of supporting relocation could be to identify land for those affected to build replacement homes. Where such land is identified in areas which would not normally be used for housing, planning policy could be adopted to enable development by those with a need to relocate, along the lines of rural exception sites. In these cases, those affected would then also benefit from the uplift in land value due to the change in land use.

Further to this, granting permission to build a small number of additional properties for immediate sale can enable those affected to raise funds to offset the cost of relocation and demolition of their former property, an approach that has been demonstrated in the Deux Caps area of France. Establishing a Community Land Trust is another way of facilitating the process of relocation.

Where demolition is not imminent, “buy and lease back” arrangements can help to finance the process of relocation, whereby the local authority buys a property or property that is at risk of coastal change and rents it to the previous owner or an unrelated tenant, or uses it as a holiday let. These approaches have been applied in several locations as part of the Coastal Pathfinder Programme, including Happisburgh on the North Norfolk coast (see case study).

Fareham Borough Council has designated two CCMA's in its emerging Local Plan Part 2: Development Sites and Policies, which has been through Examination. The CCMA from Hook Spit to Workman’s Lane is proposed as a result of likely permanent inundation due to overtopping of the existing seawall, following the establishment of a policy of no active intervention in the Shoreline Management Plan. The second, from Hook Park to Meon Shore, is proposed as a result of erosion risk along a line of cliffs where again there is a policy of no active intervention.

References:
12 Planning Practice Guidance, Flood Risk and Coastal Change, Coastal Change Management Areas, Paragraph: 071 Reference ID: 7-071-20140306
Case study: Assisting homeowners with relocation in North Norfolk

Parts of the North Norfolk coast consist of soft cliffs which are vulnerable to rapid erosion of up to 2 metres per year but this can be as much as 20 metres in a severe winter with a series of violent storms. Problems are particularly acute around the small town of Happisburgh, which has lost buildings and infrastructure to the sea in recent years. As part of Defra’s Coastal Change Pathfinder Programme, which ran from 2009 to 2011, North Norfolk District Council was awarded £3 million to explore ways of dealing with local coastal erosion issues, including:

- Community and business engagement
- Managing the impacts of coastal erosion including loss and damage to coastal assets
- Using the planning system to facilitate relocation of assets
- Financial mechanisms to facilitate relocation of houses and people

As part of this process, North Norfolk District Council adopted a policy which allows the owners of permanent dwellings threatened by erosion within the next 20 years to apply for planning permission to relocate to land where it would not normally be granted. The increase in land value obtained when planning permission is granted can be used to offset some of the costs of relocation if the new plot is sold to a third party. In some cases the Council can also assist with demolition costs.

The findings of the Coastal Pathfinders Programme in North Norfolk and other locations around the coast have been published, providing useful information for other communities that will face similar risks as climate change accelerates coastal change.

Source: Coastal Change Pathfinder Projects: Final report, Defra (2012); Planning Opportunities for Owners of Property at Risk from Coastal Erosion, North Norfolk District Council Coastal Services (2013)

Images courtesy of Peter Lawton
Building the right kind of development in the right place

With new development it is important to ensure that resilience to future climate change and sea level rise is considered from the outset. The National Planning Policy Framework requires local planning authorities to take into account the impacts of climate change over the longer term including flood risk, coastal change, water shortages and changes to biodiversity and landscape. New development should be planned to avoid increasing vulnerability to these impacts.

In areas at high risk of flooding or in Coastal Change Management Areas, inappropriate development should be avoided. Development will only be allowed in these areas in exceptional cases, where it can be demonstrated that there is a need which cannot be met elsewhere, the benefits of development outweigh the risks, the risks to the development will be managed to an acceptable level over its lifetime and the risks will not increase elsewhere as a result.

Various adaptation measures described in the previous chapter can be designed into new development from the outset to reduce the risks and promote resilience over its lifetime.

Effective pre-application engagement in development planning with the local authority and the Environment Agency can help to inform this process. Recent waterfront developments in Shoreham, Littlehampton and Newhaven demonstrate what can be achieved (see case study).

---

Case study: Delivering resilient waterfront development in Shoreham, Littlehampton and Newhaven

The Sussex towns of Shoreham, Littlehampton and Newhaven are struggling to retain their niche role in the fast changing port business. All three have river mouth locations, with limited draughts for larger vessels, but they have managed to retain fishing and trade in bulky materials such as timber and aggregates. Newhaven also maintains its ferry link with France.

The changing role of these ports has created a need for regeneration and released land for redevelopment. Residential apartments overlooking the water are often proposed by developers, supporting regeneration and providing other benefits including improvements to the public realm and access to the waterfront. However, such locations are vulnerable to tidal flooding and consideration of long-term flood risk is a critical part of the planning process.

Developers of waterfront properties in Shoreham, Littlehampton and Newhaven worked with the local authorities and the Environment Agency prior to submitting planning applications to agree measures including raised ground floor levels, ground-floor parking and habitable rooms on upper floors, flood defences and gates, and means of egress and escape in flood conditions.
Maximising the benefits of infrastructure investment

Adapting to climate change will create a need for investment in new infrastructure or improvements to existing assets, including flood defences, energy and water supply networks, drainage infrastructure, roads and other transport networks, and green infrastructure such as parks and other open spaces.

Infrastructure planning, investment, and delivery are carried out by a wide range of different organisations, including large private companies which are publicly regulated, government agencies, local authorities, business-led Local Enterprise Partnerships, and Local Nature Partnerships. All have different priorities, resources, planning horizons, governance and procedures for delivering infrastructure.

Coordinating this activity and making targeted investments informed by the long-term adaptation pathways (see above) will help to ensure that adaptation is achieved in an efficient way which maximises the benefits for every pound spent. Coordination and long-term planning will also enable opportunities to be taken to build in adaptation as and when routine maintenance and renewals are undertaken (eg when replacing railway lines or replacing sewage and water treatment works).

Multi-functional infrastructure projects which support adaptation while meeting other needs will have a much stronger business case for investment. For example, the improvements to coastal defences in Margate were used as an opportunity to support economic regeneration (see case study) while Lambeth Council has changed the way it manages streets and open spaces to help with climate change adaptation, enhance biodiversity and save money on maintenance (see case study).

Working with the various infrastructure providers and understanding the available funding sources and criteria at an early stage will help to identify opportunities, shape the way projects are designed and developed to maximise the benefits, and increase the likelihood of securing funding for implementation.

This could include contributions from local businesses, communities and landowners who stand to benefit, as well as developers. Applying some of the good practice described earlier on working together, working with nature and planning for the long-term will support this process.

Sustainable models should also be established for the long-term ownership, maintenance and management of infrastructure. The infrastructure may be adopted by the local authority, the Environment Agency or a third party, and community models can also be established for long-term asset management. Finding ways to secure revenues over the lifetime of the asset will help to cover the costs of maintenance and future improvements.

These could include, for example, income from a cafe or other venue like the wedding chapel on Blackpool’s rejuvenated seafront, event-hire charges for parks and open spaces, revenues from renewable energy generation incorporated into the scheme, or a service charge to residents of new development enabled by the scheme.
Case study: Sustainable street works in the London Borough of Lambeth

Every year, local highway authorities spend millions on maintaining and improving streets and public open spaces. Recent work in the London Borough of Lambeth demonstrates that some of this could be directed towards adaptation, so the public realm not only looks better, but is also ready for more intense rainfall and hotter, drier, summers.

Lambeth, an inner city borough serving many diverse communities, has for some years been building adaptation into maintenance and investment in its streets and open spaces, which together occupy over 30% of the land in the borough. Led by innovative public engagement using models, street posters, and mock-ups with straw bales in the street, Lambeth’s engineers have developed a range of street and open space works to manage more intense rainfall and higher temperatures. These include:

- Removing hard surfaces and installing permeable paving
- Installing roadside grass strips to absorb and slow run off
- Installing rain gardens to increase run off absorption
- Tree and shrub planting
- Using parks to store water and maintain more comfortable outdoor temperatures
- Installing green roofs
- Using vacant land for food production and biodiversity

These initiatives have proved popular with local people, improved the local environment, helped to reduce surface water flooding, allowed Lambeth to adapt to a changing climate and often proved cheaper than conventional hard-surface street works.


Images courtesy of LB Lambeth
Case study: Coastal regeneration in Margate, Kent

Like many other British seaside resorts, Margate has suffered a long decline in trade, leading to high levels of social and economic deprivation and a poor quality environment. Climate change offers the town both an opportunity and a threat. Warmer, sunnier, summers could help revive demand from holidaymakers, but higher sea levels and more frequent storms could increase the threat of flooding from the sea.

The local council have been pursuing an integrated programme of economic regeneration in the town, which is starting to show some success, particularly with the striking new Turner Contemporary Art Gallery on the seafront. The Margate flood and coastal protection scheme has played an important role in securing this regeneration while managing the risks associated with rising sea levels.

The scheme included strengthening the stone pier, reconstructing existing sea walls, installing hydraulic and manual flood gates, and constructing a new stepped structure from beach to promenade. Significant improvements were also made to the public realm as part of the scheme, including new seating, lighting, and restored 19th century railings which enhance the setting of the art gallery and other waterfront homes and businesses.

Cost savings during construction of the £5.2 million project enabled further improvements to be made along the seafront including refurbishment of the marine pool on Margate Sands. The award-winning scheme was completed in spring 2013 and has been very well received locally.


Images courtesy of Christopher Tipping
Various organisations and individuals have an interest in coastal areas and responsibilities including setting policy, managing land and other assets, planning and decision-making about investment. Communication, collaboration and partnership working between these stakeholders will be essential for adaptation.

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Government</strong></td>
<td></td>
</tr>
<tr>
<td>Department for the Environment, Food and Rural Affairs (DEFRA) (lead for climate change adaptation)</td>
<td>Set national policy for management of the coast and overall government funding for coastal management (DEFRA)</td>
</tr>
<tr>
<td>Department for Energy and Climate Change (DECC) (lead for climate change mitigation)</td>
<td>Set national policy for reducing carbon emission and mitigating our impacts on climate change (DECC)</td>
</tr>
<tr>
<td>Department for Communities and Local Government (DCLG)</td>
<td>Set national planning policy (DCLG)</td>
</tr>
<tr>
<td>Department for Business, Innovation and Skills (BIS)</td>
<td>Promoting economic growth and regeneration in coastal communities (BIS)</td>
</tr>
<tr>
<td>Department for Culture, Media and Sport (DCMS)</td>
<td>Set national policy for managing cultural activity, heritage, and sport on the coast (DCMS)</td>
</tr>
<tr>
<td><strong>Government agencies</strong></td>
<td></td>
</tr>
<tr>
<td>Environment Agency (EA)</td>
<td>Executive and regulatory action to implement national policies</td>
</tr>
<tr>
<td>Marine Management Organisation (MMO)</td>
<td>Managing coastal assets (EA, MMO, NE, EH, HA)</td>
</tr>
<tr>
<td>Natural England (NE)</td>
<td>Allocating national funding to coastal management (EA, NE)</td>
</tr>
<tr>
<td>English Heritage (EH)</td>
<td>Decisions on planning appeals affecting the coast (PINS)</td>
</tr>
<tr>
<td>Sport England (SE)</td>
<td></td>
</tr>
<tr>
<td>Planning Inspectorate (PINS)</td>
<td></td>
</tr>
<tr>
<td>Highways Agency (HA)</td>
<td></td>
</tr>
<tr>
<td><strong>Local authorities</strong></td>
<td></td>
</tr>
<tr>
<td>Unitary authorities</td>
<td>Landowners on the coast</td>
</tr>
<tr>
<td>County councils</td>
<td>Asset and infrastructure managers, particularly coast defences, drainage, highways and coastal amenities</td>
</tr>
<tr>
<td>District or borough councils</td>
<td>Operating authorities responsible for managing the coast (Coast Protection Act 1949)</td>
</tr>
<tr>
<td>Town and parish councils</td>
<td>Local planning authorities promoting sustainable development of coastal communities</td>
</tr>
<tr>
<td></td>
<td>A democratic voice for coastal communities</td>
</tr>
<tr>
<td>Stakeholder</td>
<td>Role</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>National park authorities</td>
<td>Landowners on the coast Local planning authorities serving national park purposes and promoting sustainable development of coastal communities</td>
</tr>
<tr>
<td>North York Moors, South Downs, New Forest and Exmoor NPs include coastal areas</td>
<td></td>
</tr>
<tr>
<td>Port and harbour authorities</td>
<td>Landowners and managers of port /harbour estates, infrastructure and associated assets Navigation maintenance and rights</td>
</tr>
<tr>
<td>Commercial companies and statutory bodies responsible for managing port and harbour operations, including navigation rights</td>
<td></td>
</tr>
<tr>
<td>Local Enterprise Partnerships (LEPs)</td>
<td>Improving infrastructure to support economic growth Skills development and training Funding to support local business growth Attracting inward investment</td>
</tr>
<tr>
<td>Partnerships of local authorities, businesses and other organisations</td>
<td></td>
</tr>
<tr>
<td>Utility and infrastructure companies</td>
<td>Asset and infrastructure managers Supply of electricity, water, gas, telecoms, railways to coastal communities</td>
</tr>
<tr>
<td>Including Network Rail, water companies, electricity and gas distribution network operators, power generators, British Telecom and other telecommunications companies</td>
<td></td>
</tr>
<tr>
<td>Coastal groups and partnerships</td>
<td>Developing long-term plans for coastal management for “coastal cells” Sharing information and good practice on coastal management Training and skills</td>
</tr>
<tr>
<td>Voluntary partnerships involving the organisations listed above</td>
<td></td>
</tr>
<tr>
<td>Stakeholder</td>
<td>Role</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Emergency services</strong></td>
<td>Preparation for, and response to, major incidents affecting the coast such as flooding and storms</td>
</tr>
<tr>
<td>Police</td>
<td></td>
</tr>
<tr>
<td>Fire and rescue</td>
<td></td>
</tr>
<tr>
<td>NHS / Ambulance</td>
<td></td>
</tr>
<tr>
<td>Maritime and Coastguard Agency</td>
<td></td>
</tr>
<tr>
<td>RNLI</td>
<td></td>
</tr>
<tr>
<td><strong>Coastal landowners</strong></td>
<td>Managing land and assets on the coast</td>
</tr>
<tr>
<td>Individuals and businesses owning land on the coast, including farmers</td>
<td></td>
</tr>
<tr>
<td><strong>Other organisations</strong></td>
<td>Managing land and assets on the coast</td>
</tr>
<tr>
<td>eg National Trust and Royal Society for the Protection of Birds (RSPB)</td>
<td></td>
</tr>
<tr>
<td><strong>Coastal communities and visitors</strong></td>
<td>Taking individual responsibility for personal safety and assets</td>
</tr>
<tr>
<td>People who live or work at, or visit, the coast</td>
<td></td>
</tr>
</tbody>
</table>
Conclusions

Sea level rise is inevitable, and it is likely that we will also face significant changes in climate over the course of this century and beyond. We must take action to adapt. Taking a flexible, long-term approach to planning and decision-making will be essential.

Sea level rise is inevitable, and it is likely that we will also face significant changes in climate over the course of this century and beyond. Questions remain over the extent of the changes that will take place, the speed at which they will happen, and the consequences for communities, the economy and the environment. One thing that is certain is that we must take action to adapt. The risks are simply too great to carry on with business as usual.

Adapting to climate change will require us to make a range of changes to the built environment, infrastructure, the way we manage the land and the coastline, and the way we live and work. The highest priority for coastal communities will be to manage increasing flood and erosion risk along the coast and the tidal extent of rivers.

In other locations, managing surface water and flooding from rivers will be important. We will also need to find ways of managing supply and demand for fresh water, reducing the risks associated with heatwaves, adapting agriculture and forestry, and enabling habitats and ecosystems to adapt.

Getting this right will require local authorities and other organisations to work together, taking an integrated approach to planning and infrastructure investment for a given area of the coast, in line with the principles of Integrated Coastal Zone Management. It is essential that vulnerable communities are engaged in the process and that plans for adaptation are informed by a thorough understanding of the local context and local priorities, working with rather than against nature where possible.

Given the uncertainty, planners and infrastructure managers need to develop flexible pathways for long-term adaptation which consider the range of possible outcomes and adaptation options. These can then be used to inform short to medium-term planning and decision-making.

Future decisions on adaptation will need to consider how it can be made as affordable and cost-effective as possible for all concerned. To facilitate this it may be necessary to enable changes in land use, make provisions for moving vulnerable communities and infrastructure, build the right kind of new development in the right places, and invest intelligently in infrastructure which offers multiple benefits.

The many examples of good practice set out in this guide demonstrate that adaptation to sea level rise and climate change can be delivered in practice, in a way that is positive, proactive and achievable. The flexible pathways approach used in the Newhaven case study is a good example of how no and low regrets actions can be taken now as the early steps towards a safe and secure future for coastal communities that are at risk.

Local authorities and other organisations involved in planning, decision-making and infrastructure investment are encouraged to follow these examples and plan for the long-term future of coastal communities in the South East of England and further afield.
Further information

UK Climate Impacts Programme
(www.ukcip.org.uk)

The Committee on Climate Change
(www.theccc.org.uk)

The National Adaptation Programme,
Defra (2013)

The Environment Agency Climate Ready
Service

Climate UK (www.climateuk.net)

Various useful datasets for understanding the
local context available from www.data.gov.uk

Shoreline Management Plans (available
from www.gov.uk/government/publications/
shoreline-management-plans-smps)

Catchment Flood Management Plans
(available from www.gov.uk/government/
collections/catchment-flood-management-
plans)

The Coastal Handbook, Second Edition,
Environment Agency (2010)

Understanding the Risks, Empowering
Communities, Building Resilience: The
National Flood and Coastal Erosion Risk
Management Strategy for England, Defra
(2011)

The Channel Coastal Observatory
(www.channelcoast.org)

National Planning Policy Framework,
Department for Communities and Local
Government (2012)

Planning Practice Guidance, Department for
Communities and Local Government
(www.planningguidance.planningportal.gov.uk)


Living with Environmental Change
(www.lwec.org.uk)

Farming Futures
(www.farmingfutures.org.uk)
This guide was produced by LDA Design with input from Lindsay Frost Consulting and published by the Environment Agency, August 2015.