frontiers

Supplementary Material

Transitions in modes of coastal adaptation: addressing blight, engagement and sustainability

Sally Brown*, Emma L Tompkins, Natalie Suckall, Jon French, Ivan D Haigh, Eli Lazarus, Robert J Nicholls, Edmund Penning-Rowsell, Charlie E L Thompson, Ian Townend, Sien van der Plank

*** Correspondence:** Sally Brown: sb20@soton.ac.uk

1 Oversized tables from the main text

Two oversized tables from the main text are shown in this Supplementary Material in Section 5. These are:

- Supplementary Table 1: Example of methods of education and engagement to prepare for coastal change. Suitability of methods was determined through the associated references plus discussions within the author team.
- Supplementary Table 2: Non-defence adaptation interventions that could be used to promote effective policy transitions.

Supplementary Table 1 provides the detailed analysis behind Figure 5 of the main manuscript, and Supplementary Table 2 the full options behind Table 6 of the main manuscript.

2 Terminology

In the main manuscript, we use terminology that is often poorly defined or inconsistently used in the literature. We therefore provide more complete definitions for the following terms: blight, coastal blight, coastal change, coastal zone management, contentious policy change, shoreline management, and transitions.

Blight, or 'urban decay', often evolves around abandoned buildings and infrastructure, high local unemployment, increased poverty, depopulation, low quality of life and deprivation. Blight is rarely researched explicitly (Pinto et al., 2021), and is often discussed as an urban planning issue without detailed analysis of its underlying drivers, consequences or potential solutions. Despite its prevalence, there is no agreed definition of blight. Blight broadly affects quality of housing, living standards, and the functioning of society, as for example, defined by City of Baton Rouge (2022): 'conditions upon or affecting premises, which are hazardous to the health, safety or welfare of the public, and/or conditions which are detrimental to property values, economic stability, or to the quality of the environment'.

Coastal blight is a specifically coastal phenomenon. We define coastal blight as the deterioration in the function and structure of social and physical elements within coastal communities following either economic, natural or policy shocks or ongoing stresses that result from contentious policy change (as

defined below). Coastal blight is not a term that is commonly used in the research literature; instead coastal researchers tend to focus on policy impacts and coping with shocks and stress within a given area (e.g. Cooper and McKenna, 2008). We make use of this term primarily because it was frequently referred to (unprompted) by multiple participants at the workshops.

Coastal change is widely used in the literature to cover a wide range of physical system changes that increasingly take place in the context of anthropogenic activity such as development, engineering, governance, management and planning. We define coastal change as: 'bio-physical, social-economic and engineering change in space and time impacting between the coastal zone [defined by user], that may be permanent or temporary, from event-driven to centennial scale processes'. This includes erosion, accretion, landslip and flooding in dry or wetlands; changes to ecology, ice or land levels that shift mean sea-level; additional or removal of infrastructure or engineering or changes in its function; and migration to, and mobility within, and economic development in the coastal zone.

Coastal zone management is the 'the planning and allocation of resources within a given area' (Townend, 1992), often delivered in the form of integrated coastal zone management, i.e. 'a dynamic, multi-disciplinary and iterative process to promote sustainable management' (Commission of the European Communities, 2000) including information, planning, decision making, management and monitoring, with the cooperation of stakeholders to balance multiple needs within the limit of natural dynamics (Commission of the European Communities, 2000).

Under the Shoreline Management Plans (SMP) for England and Wales, a coast may shift between being protected to being left to evolve under a policy of no active intervention, for example through a cessation of defence maintenance. This kind of policy change, is likely to be contentious. A **contentious policy change** is defined as a shoreline management policy transition where multiple stakeholders have concerns, especially a transition from a fixed shoreline due to protection (hold the line) to a mobile shoreline (linked to no active intervention or managed realignment). This will likely result in shoreline retreat and previously unexpected and/or unwanted coastal change. Contentious policy change has the potential to induce coastal blight and deprivation if not appropriately managed.

In England and Wales, the term **shoreline management** is used as a policy framework for managing one aspect of the coastal zone - the hazard - and its effects on erosion and/or flooding (Townend, 1992; Nicholls et al., 2013). Compared with coastal zone management, shoreline management is more focused on policy, rather than resources.

Transitions are long-term and fundamental changes in the way socio-technical functions are provided (Geels, 2010). In this paper, transitions refer specifically to changes in shoreline management policy that imply the protection of less of the coast in the context of evolving social-economic, physical, environmental and climatic change considerations. Empirical evidence suggests such transitions have been accompanied by debate, dissent, and reflection on their merits (Kalt, 2021)

3 Key flood policy documents, and flood events affecting flood policy evolution in England and Wales

Throughout history, many severe coastal flooding events have affected the UK coast, with major social, economic and environmental impacts. These floods have been driven by large storm surge and wave events associated with westward moving extratropical storm systems, coinciding with high spring tides (Lewis et al., 2011). The Surgewatch database (Haigh et al., 2015, 2017) includes multiple sources of data that record the frequency and severity of coastal flood events around the UK since 1014 AD, and classifies these by severity of impact (1-6). Since the 1870s, the UK has experienced a significant high-impact coastal flood roughly every 12 years (see Table 1, Supplementary Tables 3 and 4). Over the same time period there has been a changing understanding of the causes of coastal floods, and the appropriate policy, regulatory or resource approach (Supplementary Table 4), where path dependency can be seen unfolding. Starting in the mid- to late-19th century (Nicholls et al., 2013), engineering technologies improved, finance became more available and societal needs changed. Confined to parish boundaries, defences were initially ad hoc, creating discontinuities in protection and the sediment budget (c.f. Topley, 1885). In 1911, it was recognised by the Royal Commission on Coastal Erosion and Afforestation (1911) that local authorities or property owners should be able to adopt their own protection schemes to protect the foreshore where their land is at risk from damage from the sea. Subsequently the number of defence schemes around English and Welsh coasts increased into the early 20th century, coinciding with the growth of coastal towns and tourism (Nicholls et al., 2013). During the Second World War, coastal defence efforts decreased. Efforts to protect the coast greatly increased again in the aftermath of the 1953 east coast storm surge, which led to extensive flooding from the Humber to Kent and 307 deaths in eastern England (Met Office, 2011) and about 30 in Scotland. The length of coastal defences continued to increase, but again, these were largely piecemeal (Leafe et al., 1998) with limited coordination between neighbouring local authorities. This led to unwanted consequences, such as inducing a long-term sediment deficit and enhanced down-drift erosion, prompting further demand for defence, and leading to wider environmental deterioration (Leafe et al., 1998; Frew, 2012; Nicholls et al., 2013).

By the 1980s, the effectiveness and suitability of ad hoc hard defence started to be questioned, in favour of more sustainable management involving consideration of the whole coastal system (Ledoux et al., 2005; Pontee and Parsons, 2010; Nicholls et al., 2015). In 1993, the intention to generate shoreline management plans emerged (MAFF, 1993; Pontee and Parsons, 2010), aiming to generate more forward thinking, strategic shoreline management policies across local authorities and over time (Pontee and Parsons, 2010). Formal first round 'Shoreline Management Plans' (SMP1) were published by the late 1990s, based on the mapping of natural sediment sinks or alongshore drift divides, rather than administrative boundaries (Motyka and Brampton, 1993; DEFRA, 2006a, 2006b). Of the four policy options ('Do Nothing', 'Retreat the existing line', 'Hold the existing line' or 'Advance the existing line'), the most common approach was to maintain the status quo and continue the present management practice (Nicholls et al., 2013). This ignored longer term risk and assumed funding for defences would continue to be available, mainly addressing short-term stakeholder expectations. In most cases this short termism led to planned retention of existing defences to protect residents, regardless of cost, engineering challenge, growing risks, and wider sustainability issues such as sediment supply and down-drift erosion.

It was soon recognised that many historic defences would be increasingly challenging to maintain, both financially and physically (Pontee and Parsons, 2010). This is especially the case in areas of low population densities or limited infrastructure to protect. This prompted further questions of how to manage the coast sustainably (Leafe et al., 1998; Burgess et al., 2004; Nicholls et al., 2013), and led to a second round of Shoreline Management Plans (SMP2), published between 2006 to 2011 (DEFRA, 2006a, 2006b). Major changes in SMP2 included: (1) Planning timescales extended to 100 years,

broken into three epochs, Epoch 1: the next 20 years (present day), Epoch 2: the following thirty years (medium term), and Epoch 3: a further fifty years (long term); (2) Division of the coast into 1,998 policy units (similar to SMP1), representing homogeneous lengths of coast determined by morphology, geology and human coastal use, including defences; and (3) Every Epoch and policy unit being allocated one of four management options: 'No Active Intervention (NAI)', 'Hold The Line (HTL)', 'Managed Realignment (MR)' or 'Advance The Line (ATL)'. Changes in the use of these management options over the epochs are shown in Figure 1 of the main manuscript.

As a consequence of SMP2, there is an increasing number of policy units/lengths of coast slated for a significant policy change, especially HTL in Epoch 1 to MR/NAI in Epoch 2 (Supplementary Table 5). With time, the potentially damaging impact of the designation of MR or NAI in the first or second Epoch was recognised, and the additional adaptation needs faced in these areas led to the creation of 'Coastal Change Management Areas' - CCMAs to promote appropriate planning in areas undergoing coastal change (Ministry of Housing, Communities & Local Government, 2012; Royal Haskoning DHV, 2019). CCMAs support the anticipated process of change by providing a platform to resolve issues relating to coastal change and new development / infrastructure proposals (Royal Haskoning DHV, 2019), but remain under used (Kirby et al., 2021). Despite this re-envisioning of future erosion and flood impacts on the coast and the shift away from coastal protection to living with coastal change, it was still evident in 2018 that implementing current SMP2 would cost £18 to £30 billion over the 21st century. Furthermore, for around 149km to 185km designated as HTL (out of approximately 7,330km of English coastline) this would not be cost beneficial, with a further 1,460km of coast designated as HTL as having a lower benefit to cost ratio than the government funds today (Committee on Climate Change, 2018). There is thus an increasing need for improved frameworks to accommodate coastal change and contentious policy transitions.

The challenges of transitioning from a 'protect' or 'defend' mentality to one of greater acceptance of erosion or flooding contributed to three further UK consultations in 2019 and 2020 on coastal change, flood and erosion risk management and climate change adaptation (DEFRA, 2019, 2020; Environment Agency, 2019a). Interim findings from these consultations noted that supporting communities affected by coastal change will not be easy, and called for an explanation on funding strategies, the 'need for clear national leadership', communication for communities affected and improved delivery mechanisms to support adaptation measures (Environment, Food and Rural Affairs, 2019). Subsequently the Environment Agency's Flood and Erosion Risk Strategy for England was published in 2020 (Environment Agency, 2020a) advocated greater resilience to flooding and coastal change. The governments of England and Wales are aware that their coastal management policies are not viable for some areas (Committee on Climate Change, 2018), and in our workshops concern was expressed that there was insufficient funds available in many cases. However, the historical context is also important and it is noteworthy that choices made about the type of, and positioning of coastal defences 150 years ago are still affecting policy decisions made today.

In 2019, the SMPs were reassessed again (the 'SMP2 Refresh' running to 2023) to assess delivery, evidence and potential barriers to change. The refresh aims to ensure that SMPs reflect changes in evidence, experience and policies that may have occurred since their development in the late 2000s, while enabling them to act as 'live' and accessible documents. While not a full revision of the SMPs, the refresh plans to improve consistency and clarity between the plans, while re-establishing their profile and influence, and identifying management triggers to clarify policy transitions and funding availability (Environment Agency, 2020b).

A summary of the key documents based on the authors' experience, knowledge, internet searches and literature (e.g. French, 2004; Nicholls et al., 2013; Environment Agency, 2020a; Department for Levelling Up, Housing and Communities and Ministry of Housing, Communities and Local Government, 2022a) are shown in Supplementary Table 3 and Supplementary Table 4. Where documents have been updated, only the first date of publication of a document is shown, unless revision implements a very significant change of strategic direction. Many government policies have been driven by extensive inland flooding. These events are not mentioned, as the focus is on coastal flooding, but government-commissioned reviews, which had significant implications for coastal policies, are (e.g. Easter floods of 1998, Autumn 2000 floods). Specific flood events that have a severity score of at least five out of six are mentioned, following an analysis by (Haigh et al., 2017).

4 Methods

Three workshops were held in June and July 2019, with one national workshop to gather national or strategic perspectives and two regional workshops to explore regional and implementation perspectives. Each meeting started with a presentation to introduce the topic, following by a series of discussion questions (Supplementary Table 6 and Supplementary Table 7) in small groups led by a facilitator with notes written verbatim. Feedback to the wider group happened at the end of each part of the meeting. Delegates also fed back final thoughts through a questionnaire (Supplementary Table 8 and Supplementary Table 9) and freehand post-it notes.

5 Supplementary tables

Supplementary Table 1. Example of methods of education and engagement to prepare for coastal change. Suitability of methods was determined through the associated references plus discussions within the author team.

Example of communication method of education and engagement	Example of reference	Audience				Pros									Cons							
		Children	Householders	Planning and policy	Public	Allows for questions	Community involvement	Formal	Informal	Personal link and meaning	Raises general awareness	Relationship building	Targets those locations at risk	Warning of hazard	Could induce early blight	Limited reach & diversity of audience	Onsite maintenance	Physical location limiting	Risky locations can be missed	Scaremonger, needs careful narrative	With time, may be forgotten	Would need to search to find out more
Add erosion risk to a property search	NGO-EHH		X	X				X			X			X	X	X				X		
Children's books (e.g. stories, poetry)	Environment Agency & Flood and Coastal Erosion Risk Management Research and Development Programme (2019)	X				X			X		X	X										
Citizen science (e.g CoastSnap)	Harley et al. (2019), Hart and Blenkinsopp (2020), Turner et al, (2022)	X			X		X		X			X						X	X			
Community events (e.g. carnival, village fayres)	PS-Cn	X	X		X	X	X		X	X		X	X	X	X				X			
Continuing Professional Development events	RTPI (2021)			X		X		X				X					X					
Educational resources for schools (e.g. lesson plans)	DEFRA (2012a), Fisher and Cooper (2021), The Flood Hub (2022a)	X				X		X	X	X		X			X							
Film and animation (e.g. with community involvement), theatre, opera	Daniels and Veale, (2014), Nettley et al. (2014), Forkbeard Animations (2017), Environment Agency & Flood and Coastal Erosion Risk Management Research and Development Programme (2019)		X		X	X	X		X	X		X		X	X		X				X	
Gaming	Pontee and Morris (2011), Environment Agency & Flood and Coastal Erosion Risk Management	X			X				X			X			X		X					X

	Research and Development Programme (2019), Skinner (2020), Lawrence et al. (2021),																					
Guidance from professional bodies (e.g. property level resilience)	CIRIA (2022a), Liverpool Victoria (2022), The Flood Hub (2022b)		X	X				X		X				X	X						X	
Information boards	Carapuço et al. (2017)				X	X		X	X			X			X			X	X			
Information booklets and newsletters (hard and soft copies)	Landmark Information Group (2022a), Liverpool Victoria (2022), The Flood Hub (2022b)				X			X	X			X		X	X							
Landscape visualisation tools (e.g. retreat lines)	Jude et al. (2003), DEFRA (2012a), Rouse et al. (2013), Nettley et al. (2014), Day et al., (2015), Bolsen et al., (2018), Altinay and Williams (2019)		X		X			X	X	X		X		X	X	X					X	X
Letters delivered and signed for to householders at risk	BC-En 1, NGO-EHH		X					X			X			X	X	X				X		
Songs, music and dance (e.g. protest music)	Seddon (2011), Environment Agency & Flood and Coastal Erosion Risk Management Research and Development Programme (2019), The ClimateMusic Project (2021), BBC (2022)				X				X	X	X				X							
Photographs and similar imagery (e.g. before, after, future)	Carapuço et al. (2017), Thomas et al. (2021), Zia (2022)				X	X	X		X		X	X	X	X	X	X					X	X
Policy briefings	O'Neill and Wentworth (2021), CIRIA (2022b), Hull City Council (2022)			X				X				X		X	X							
Policy scenario to envisage future	DEFRA (2012a), Rulleau and Rey-Valette (2017), Lipiec et al. (2018)			X	X	X		X	X	X				X		X	X				X	X
Public meetings	DEFRA (2006b)		X		X	X	X	X				X	X	X	X		X		X			
Social media and online campaigns	Bird et al. (2012), ABI (2014), Coleman (2021), Environment Agency (2022a, 2022b), Landmark Information Group (2022b), The Flood Hub (2022b)		X	X	X			X	X	X		X		X	X							X
Talks to community groups	Dichmont et al. (2016)	X			X	X	X		X	X		X	X				X						
Traditional media reporting	O'Neill et al. (2013)				X				X	X		X			X							

Supplementary Table 2. Non-defence adaptation interventions that could be used to promote effective policy transitions.

Mechanism	**Intervention**	**Reference**
Community	Enhance local visitor economy	DEFRA (2012a)
	Hazard mitigation plans	Bryne and Grannis (2012)
	Invest in key services, replace infrastructure	Bale (2018), Lawrence et al. (2020)
	Relocate key infrastructure and transport systems inland (via disinvestment) so that other investment follows	Bryne and Grannis (2012)
'Compensation' and financing	Climate change resilience or adaptation funding	Woodruff et al (2020)
	Demolition costs, clean up costs	DEFRA (2012a), Lawrence et al. (2020)
	Greater compensation for owners of their first home (over second) and greater for length of ownership	Rulleau and Rey-Valette (2017), Rulleau et al. (2017)
	One off pay out based on the market property, a new house or donation in cash, condemn building	Alves et al. (2020), Byrne and Grannis (2012), Lawrence et al. (2020), Rulleau and Rey-Valette (2017), Rulleau et al. (2017)
	Removal costs, relocation assistance, help for renters	DEFRA (2012a), Lawrence et al. (2020)
	Tax increment financing (TIF): higher / special tax for protected properties	Woodruff et al (2020)
Insurance	Limiting the number of times building back can occur or restrict by proportion of property damaged	Bryne and Grannis (2012)
	Payout due to natural risk (e.g. Barnier Fund)	André et al. (2015), DEFRA (2012a)
	Restricting when insurance will pay out or payouts restricted with adaptation measures - restrictions for erosion, deliberate damage. No insurance for incomers (Grandfather principal).	Dávila et al. (2014), Facilitator
	Risk pooling between countries to support insurance access for disaster risk	Martinez-Dias et al. (2019)
	Subsidised insurance	Henderson (2018)
Planning	Change in building use / restricted building use	André et al. (2015), DEFRA (2012a), Kirby et al. (2021)
	Exaction and coastal development - develop, but preserve the right to retreat, plus pay fee or buy a bond to do so	Bryne and Grannis (2012)

	Incorporation of risk into spatial plans	Robert and Schleyer-Lindenmann (2021), Rocle and Salles (2018)
	Land zoning - no build zones	André et al. (2015), Alves et al. (2020), Bryne and Grannis (2012), Henderson (2018), Kirby et al. (2021), Lambert (2013), Lawrence et al. (2020), Robert and Schleyer-Lindenmann (2021), Rocle and Salles (2018)
	Move central government administrative service inland (to encourage others)	Alves et al. (2020)
	Raise new buildings on stilts / adapt existing buildings / adaptation integrated into building codes	Robert and Schleyer-Lindenmann (2021), Rocle et al (2020)
	Relocation of whole buildings intact	Mcglashan (2003)
	Relaxed planning permission to develop inland / designated roll back land for targeted development	André et al. (2015), DEFRA (2012a), Henderson (2018), ULA-Sc
	Standards of practice through regulations or enshrined in law	ULA-Sc
	Seasonal land use / changes in land use / limiting land use to low risk activities	Lambert (2013), Bryne and Grannis (2012)
	Tax incentives to steer development	Byrne and Grannis (2012)
Purchasing land and/or property	Buy and rent / lease back property / temporary lease	André et al. (2015), André et al. (2016), Defra (2012), Revell et al. (2021)
	Enhance local visitor economy	DEFRA (2012a)
	Hazard mitigation plans	Bryne and Grannis (2012)
	Mandatory pre-purchase information of risks	NGO-EHH
	Natural flood management – greater incentives and purchase of land to enable greater working with nature.	Townend et al. (2021)
	Progressive abandonment of properties and neighbourhoods	Lambert (2013)
	Property or land purchase, government acquisition programmes (includes compulsory purchase at / not at market price)	André et al. (2015), Happisbugh Village Website (2022), Henderson (2018), Lambert (2013), Lawrence et al. (2020), Revell et al. (2021)
	Separating the usufruct (the right to use an asset and collect income) from bare ownership (right to dispose)	André et al. (2015), André et al. (2016),
	Voluntary and / or right to purchase via Land Trusts: Demolish property to open space	Henderson (2018)

Supplementary Table 3. Colour scheme for the type of event, document or infrastructure noted in Supplementary Table 4.

Colour	**Type**
Dusty pink	Coastal flood event based on a score of at least 5 (severe) out of 6 (disaster) severity from (Haigh et al., 2017)
Grey	EU legislation, directive, recommendations
Cherry	UK or Welsh Government act or law or statutory regulation
Blue	UK or Welsh Government management strategy, policy, guide or regulation (including funding schemes)
Green yellow	Insurance sector
Green	Research / commissioned report
White	Infrastructure building or resource

Supplementary Table 4. Key flood and erosion policy, regulation documents, resources and flood events affecting UK flood policy evolution since 1862, a time around when a time when concerted actions on the coast, related to flooding, began to be formalised. For colour codes, see Supplementary Table 3.

Title	Year	Description
Harbour Transfer Act of 1862	1862	Prevented any work without approval of the Admiralty. This prohibited sediment extraction to protect the coast (HM Government, 1862).
Scotland and east coast floods	1897	North-westerly gale on 28th November 1897 impact Scotland and east coast of England with the highest tide in living memory causing breaching of dykes and seawalls, plus overtopping. Resulted in one death. Buildings, roads and farmland flooded (Haigh et al., 2017)
Royal Commission on Coastal Erosion and Afforestation 1911	1905-1911	Royal Commission to analyse erosion and flooding. Identified: where the sea encroaches the land; damage that could be caused; desirable measures to prevent damage. Considered: who should have power to protect the coast and tidal rivers; laws altering control of the foreshore; reclamation of tidal lands; experimenting with afforestation in reclaimed land (Royal Commission on Coastal Erosion and Afforestation, 1911).
Norfolk and Suffolk floods	1912	Gales and heavy rain on 26th August 1912 caused a number of deaths and loss of livestock in August. Transport, agriculture land and towns flooded (Haigh et al., 2017).
Central southern England floods	1912	Mid-Atlantic storm on 26th December 1912 resulting in wave overtopping and seawalls being destroyed. Coastal infrastructure was destroyed and homes flooded (Haigh et al., 2017)
North of England and Wales	1927	Atlantic storm on 28th October 1927 leading to defence failure. 6 deaths plus livestock, 1,200 properties damaged, transport and energy affected (Haigh et al., 2017).
East coast flood, notably London	1928	A North Sea storm on 6th January 1928 breached defences. 14 deaths in London. Properties flooded, transport and energy disruption (Haigh et al., 2017). Triggered consideration of a Thames Barrier but austerity of the 1930s and World War II changed priorities.
Land Drainage Act 1930	1930	Established the key UK Government Ministry of Agriculture, Food and Fisheries (MAFF) ‘grant aid’ funding system for coastal works that lasted 80 years (until 2010) (HM Government, 1998).
White, Gilbert F., Univ of Chicago PhD thesis, ‘Human adjustment to floods: A geographical approach to the flood problem in the United States’	1942	PhD thesis: challenged idea that floods are best addressed by engineering solutions, noting ‘Floods are ‘acts of God,’ but flood losses are largely acts of man.’ Widened the menu of options via 8 types of human (or engineering) adjustment: 1. elevating land, 2. abating floods by land (watershed) treatment, 3. protecting against floods by levees and dams, 4. providing emergency warning and evacuation, 5. making structural changes in buildings and transportation, 6. changing land use to reduce vulnerability, 7. distributing relief, and 8. taking out insurance (White, 1942). This work is particularly significant as it influenced the entire discipline (Macdonald et al., 2012).
Civil Defence Act 1948	1948	Post-war legislation to protect the public against attack. Initiated the focus on ‘defence’ / ‘protection’ in public areas (HM Government, 1948a)
Water Act 1948	1948	Construct and maintain water works (HM Government, 1948b).
Coastal Protection Act 1949	1949	Legislation to protect the UKs coasts. Unlawful to excavate or remove any materials on the foreshore down to 50 feet. Formalised coastal engineering/protection. Financed the Coastal Protection Board. Ministers can contribute towards the cost of such schemes (HM Government, 1949)
The east coast ‘big flood’	1953	The storm surge associated with the storm of 31 January–1 February 1953 was the most damaging natural disaster in western Europe in the 20th century, with the loss of over 1,800 lives in the Netherlands (Gerritsen, 2005) and over 300 deaths in eastern England (Baxter, 2005) and about 30 deaths on the Scottish coast. Flooding was due to the overflowing, overtopping, outflanking and failure of defences. Thousands of homes flooded, transport, energy and agriculture

		land (including loss of livestock) significantly flooded (Haigh et al., 2017). Triggered major investment in coastal defences and warning systems over the next 20 years, including the Thames Barrier.
Storm Tide Warning Service	1953	An initial warning system started in September 1953 (Hall, 2015). In response to the East Coast Great Flood 1953, the Storm Tide Warning Service (now named the UK Coastal Monitoring and Forecasting Service) was set up to provide alerts of significant high tides. This was initially based on a network of tide gauges, and then tide and surge numerical models which have been progressively improved over time. This system has been operated by the Met Office since 1978, before the Environment Agency took over warnings in 1996, to provide national forecasts and warnings (Environment Agency, 2009a; Flather, 2000).
Waverley Report 1954	1954	Waverley Report 1954 (Waverley, 1954) was the official response to the 1953 floods, and recommended: improvements in early warning systems; oceanographic research for more efficient warning systems; maintenance of existing second line of defence, construction of new ones where 'potential benefit justifies the cost'; attention to be paid to how the water will be evacuated (in case of overtopping); maximum standard of protection, in general, should be that of the flood of 1953; and prevent sporadic and ill-considered development near the coast.
Gentleman's Agreement 1961	1961	Government 'requested' that insurers provide flood coverage to all occupied dwellings, Insurers informally agreed to provide cover to all permanently inhabited UK domestic properties (Penning-Rowsell et al., 2014).
Flood insurance compulsory for mortgage holders	1970s	Insurance on buildings was made compulsory for mortgage holders in the early 1970s (Penning-Rowsell et al., 2014).
Thames Barrier	1974	Based on suggestions of the Waverley Report (Waverley, 1954), work started on the Thames Barrier, to reduce the risk of future flooding in London (Gilbert and Horner, 1984). The barrier was functional from 1982.
Land Drainage Act 1976	1976	Functions related to land drainage, establishment of land drainage committees, to control and be responsible for rivers, including those under tidal influence (HM Government, 1976).
Enhanced economic appraisal adds discipline to capital scheme investment processes	1977	First of the series of technical manuals produced by the Flood Hazard Research Centre at Middlesex University sponsored by NERC and MAFF to produce systematic benefit:cost assessments of flood risk reduction and land drainage schemes. The latest such nanual (know as the Multi-Coloured Manual) is (Penning-Rowsell et al., 2013).
Irish Sea Scotland and east coast of England floods	1977	Due to a storm on 11th November 1977 over northern Scotland moving towards Scandinavia, the surge resulted in defences breached, possible overtopping and defence failures. Resulted in 1 death, plus livestock. 5,000 properties flooded and agriculture land (Haigh et al., 2017).
East coast of England floods	1978	A storm on 11th January 1978 over northern Scotland moving into the North Sea, resulting in a surge that overtopped and breached defences. Resulted in 1 death, flooding of properties and disruption of services (Haigh et al., 2017).
Southern England, especially Somerset flooding	1981	Multiple low pressure storms in December 1981. On 13th December 1981, a storm over southern Wales and England, resulted in the overtopping of defences and inundation. 24,500 livestock died. Flooded properties, transport routes and a power station (Haigh et al., 2017).
Anglian Sea Defence Management Study	1987-1991	First regional scale study to examine an extended length of coast (Flamborough to the Thames on the East coast) and propose a move away from bespoke local defences to a regional strategic approach (Townend and McLaren, 1988; Townend et al., 1990; Townend, 1991). A regional monitoring programme was also initiated as part of the strategic response. This study provided some of the initial thinking for the development of Shoreline Management Plans and Regional Monitoring Programmes (Nicholls et al., 2013).
Town and Country Planning Act 1990	1990	Regulates land development in England and Wales; states policies and proposals for development / other uses of land locally; considers how national and regional policies affect the physical and environmental planning of local areas (HM Government, 1990).

North, west and east coast flooding around the UK, with impacts particularly felt in Towyn	1990	A storm on 26th February 1990 over northern Scotland moving towards Scandinavia, resulting in overtopping and breaching of defences. Whilst there were no direct deaths, 50 premature deaths were reported. Additionally, 3,076 people were flooded and there was severe disruption (Haigh et al., 2017)
Land Drainage Act 1991	1991	Sets out the functions of local authorities in relation to land drainage. Requires watercourses to be maintained by owners to ensure the free flow of water. Riparian owners must accept the natural flow from upstream but need not carry out work to cater for increased flows resulting from some types of works carried out upstream, e.g. new housing development (HM Government, 1991a).
Water Resources Act 1991	1991	Regulation of flood defence. Function and management of rivers (by the National Rivers Authority) to carry out flood defence provisions (HM Government, 1991b). Relates to the Land Drainage Act 1991 (HM Government, 1991a).
EU Integrated Coastal Zone Management (92 C 59/01) and (94C 135/02)	1992	UN Earth Summit in Rio de Janeiro (1992), need for sustainable and integrated land management of Agenda 21 (United Nations, 1993). Adopted by the European Council in 1992 (92 C 59/01) (European Union, 2002) and in 1994 (94C 135/02) (European Union, 1994). In the UK, this supported shoreline management planning.
EU Habitats Directive 1992 Council Directive 92/43/EEC	1992	Conservation of coastal wetlands. Regulates habitat, to ensure it is not destroyed by coastal development or other means. Conserves rare, threatened or endemic animal or plant species and characteristic habitat types (European Union, 1992).
Environment Act 1995	1995	Formation of the Environment Agency, the national body to take responsibility for flooding under the Land Drainage Act 1991 (HM Government, 1991a) and the Water Act 1989 (HM Government, 1989) to enable information to be gathered on coastal processes and develop plans to defend from the sea (HM Government, 1995). The Environment Agency took over the roles of the National Rivers Authority and HM Inspectorate of Pollution and waste regulation authorities.
Shoreline Management Plans (First Generation) or SMP1	1995	Provides the first national guidance on the preparation of shoreline management plans, taking a time horizon of 50 years (MAFF et al., 1995).
Automatic Voice Messaging System	1996	Delivered pre-warnings of floods to those who signed up to the service (HM Government, 2021). Changed in 2006 to a new national system (Hansard, 2008)
Easter 1998 floods review	1998	After significant inland flooding, key recommendations (that also affected coastal areas) included improved planning, warnings, improved defences and better co-ordination of the emergency services (Bye and Horner, 1998).
Countryside and Rights of Way Act 2000	2000	Rights of way (extended to the coast – also see Marine and Coastal Access Act. (HM Government, 2009a, HM Government, 2000).
EU Water Framework Directive 2000 (2000/60/EC)	2000	Uniform approach to improvement and standards on: quality of drinking water, including getting prices right; cleaner waters with ‘good status’; river basin management; water protection and pollution (European Union, 2000).
Lessons learnt from Autumn 2000 floods	2001	Although largely affecting inland flood locations, the recommendations impacted the way coastal floods are managed. This included improved forecasting and early warning, clearer division of responsibilities for different sources of flooding, clearer database of ownership of assets, flood risk information to be made clear when buying a home, improved flood preparedness, emergency planning and investment in flood defences (Environment Agency, 2001).
EU Recommendation on Integrated Coastal Zone Management	2002	This built on European Commission (1999). Guidance on delivering ICZM including principles of coastal planning and management (European Union, 2002), ‘despite increasing deterioration of … our European coastal zones, coastal planning activities or development decisions still take place in a sectoral, fragmented, way leading to inefficient use of resources, conflicting claims on space and missed opportunities for more sustainable coastal development’ (European Commission, 2022)

Flood Insurance Statement of Principles	2002	Association of British Insurers (ABI) (Insurance Times, 2002) agreed a Statement of Principles about flood insurance with the then government, to commit the insurance industry to provide flood insurance for domestic properties and small businesses 'for as many customers as possible' (Edmonds, 2017). A revised statement started in 2008 (HM Government, 2008a) and was replaced by FloodRe in 2013 (Flood Re, 2022).
Civil Contingencies Act 2004	2004	Civil Contingencies Act: (i) removes obligations in the Civil Defence Act 1939 and 1948 and empowers Local Authorities to act locally on hazard management; (ii) creates two types of local disaster responder (emergency services and supporting services) including local authorities, emergency services, health, the Environment Agency, and utilities, transport, health and safety services; (iii) creates Local Resilience Areas and Local Resilience Forums to manage local risks (HM Government, 2004).
Foresight future flooding and erosion reports	2004	Commissioned report targeted to those in policy in central and regional Government, the private sector and others to ensure a vision for the future, and to ensure those strategies are in place now. It evaluated the drivers of flooding and erosion, risks, responses and key choices for policy makers over the next 100 years (Government Office for Science, 2004).
Making Space for Water	2005	Response to the Foresight reports (Government Office for Science, 2004). Integrated, holistic approach to catchment and shoreline management over the next 20 year period in England; practical implementation including risk management, planning, rural issues, coastal issues, drainage; linking fluvial, erosion and coastal flood risk (DEFRA, 2005).
Scotland and north of England floods	2005	A storm on 11th January 2015 over northern Scotland moving towards Scandinavia resulted in 5 deaths, transport disruption and significant erosion (Haigh et al., 2017).
Improved flood forecasting service	2006	The National Flood Forecasting Service adopted the Delft-FEWS (Flood Early Warning System) flood forecasting system (Werner et al., 2009; Pilling et al., 2016).
Planning Policy Statement 25: Development and Flood Risk Practice Guide	2006	Planning Policy Statement 25 (PPS25) Development and Flood Risk, including subsequent updates (Department for Communities and Local Government, 2009) sets out the UK central government's approach to land use development, taking account of flood risk.
Marine Works (Environmental Impact Assessment) Regulations 2007	2007	Environmental Impact Assessments for regulated activity. Identifying, predicting, mitigating, monitoring potential environmental impacts with development, including flood and erosion infrastructure projects (HM Government, 2007).
EU Directive on the assessment and management of flood risks (2007/60/EC)	2007	Commits to undertaking flood risk assessments, mapping flood hazards and risks and establishing flood management plans (European Union, 2007).
Provision of flood insurance: revised Statement of Principles	2008	Continued commitment for the government and insurance industry to work together to enable the insurance market to provide flood insurance for homes and businesses (HM Government, 2008a).
Pitt Review 2008	2008	Lessons learnt from 2007 pluvial and fluvial floods (Pitt, 2008) that also had important lessons for coastal flooding as: at times insufficient preparation, lack of information during flood emergencies. Recommended: improve quality of flood warnings, strengthen technical capability of Environment Agency and councils; learn from abroad. The government responded in a number of progress reports, the last being in 2012 (DEFRA, 2012b).
Future Water	2008	The government publishes its water strategy for England, including a vision for river and coastal flooding. This aims to ensure flood and erosion risk management contributes to sustainable development and protect economic assets. Holistic management, realisation of risks and the increased emphasis on resilience (HM Government, 2008b).

Climate Change Act 2008	2008	Responding to climate change and preparing for climate change risks (HM Government, 2008c). Established the Climate Change Committee to pursue progress on managing climate risks.
Planning Act 2008	2008	Development plans must consider mitigation and adaptation to climate change. Planning covers infrastructure associated with flood defence (HM Government, 2008d).
National Risk Register	2008	Outlines the key risks that could affect the UK and considers measures to increase resilience. Periodically updated (HM Government, 2020a; House of Lords Library, 2020).
EU Birds Directive (Council Directive 2009/147/EC)	2009	Conservation of bird species and sustainable development. Long-term protection and management of natural resources to reduce commercial/other interests exploiting species (European Union, 2009).
UK Coastal Monitoring and Forecasting	2009	After the Environment Agency took over the responsibility of flood warnings, the Storm Tide Warning Service was renamed the UK Coastal Monitoring and Forecasting, better reflecting its wider services now offered (Environment Agency, 2009a). The service, provided by the Met Office and funded by the Environment Agency, operates automated tide gauges, has 24 hour coverage and provides negative surge warnings for shipping. Partners also include the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) and the National Oceanography Centre (NOC) (Met Office, 2022).
Flood Forecasting Centre	2009	Partnership between the Met Office and Environment Agency to provide a national forecasting and alert service (Environment Agency, 2009a; HM Government, 2022a) in response to the Pitt Review (Pitt, 2008). The Centre set up regular flood guidance statements (Flood Forecasting Centre, 2021).
National assessment of flood risk in England	2009	The Environment Agency's strategic overview of flood risk in England, including the causes of flooding and how to tackle risk. Includes consideration of strategy and policy, planning and development and the severity of risk (Environment Agency, 2009b).
Appraisal of flood and coastal erosion risk management	2009	Principles that guide decision making, including a wider consideration of risk management and adaptation, rather than protection, ensure value for money, better social and environmental outcomes whilst taking a risk based approach to shoreline management (DEFRA, 2009).
Flood and coastal risk management: Long Term Investment Strategy 2009, plus long term investment scenarios (LTIS)	2009	Scenario of future economic risk. 50-year view (scenarios) and economic assessment of flood and coastal erosion risk management, taking account of climate change, development on flood plains and how these are managed, future costs and benefits. Major updates in 2014 and 2019, with a minor update in 2021 (Environment Agency, 2019b).
Marine and Coastal Access Act, 2009	2009	Management of marine and coastal areas. Creation of the Marine Management Organisation to help with sustainable development on the UK's marine area. Opening up the coast known as the English Coastal Route by creating a long distance route (except military lands) for recreation by foot or ferry. Regulation and co-ordination of marine activities (HM Government, 2009a).
The Flood Risk Regulations 2009	2009	Sets out provisions for flood risk assessments and flood risk management plans (HM Government, 2009b).
Shoreline Management Plans (Second Generation) or SMP2	Late 2000s / early 2010s	Updated coastal management priorities. Recognised current SMPs reinforced the status quo and policy changes not taking place at rates initially envisaged. Four main policy options agreed, for three epochs over 100-year timescale, including allowing transitions between epochs (DEFRA, 2006a, 2006b).
Flood and Water Management Act 2010	2010	Flood and erosion risk management strategies. Addresses needs identified in the Pitt Review (Pitt, 2008). A plan to manage and measure flood and erosion risk in an integrated way, including costs and benefits. Where a national agency (Environment Agency and from 2013 Natural Resources Wales) or local flood authorities develops, carries out, maintains, applies and monitors a strategy for flood and erosion risk management. Establishment of Regional Flood and Coastal Committees in England and Wales to carry out flood and coastal erosion risk management functions in place of regional flood defence committees (HM Government, 2010).

National flood and coastal erosion risk management (FCERM) strategy for England	2011	Report setting up the aims, roles, responsibilities and funding for flood and coastal risk management in England (Environment Agency, 2011). Later withdrawn due to the new FCERM strategy (Environment Agency, 2020a).
Flood and coastal erosion risk management: Development of a national strategy for Wales	2011	Development of strategy to manage flood and coastal erosion risk in Wales (Llywodraeth Cymru, 2011). Includes embedding sustainable development that promotes wellbeing whilst addressing the needs of the economy and environment. Reduces impacts, raises awareness, promotes a sustained response and prioritises investment.
Flood and Coastal Resilience Partnership Funding 2011	2011	Wider availability of funding for flood and coastal defences schemes, through sources other than central government's Grant-in-Aid. Has allowed more schemes to be funded, especially where they benefit more than households (DEFRA, 2011).
UK Marine Policy Statement 2011	2011	Framework for preparing marine plans. Contributing to sustainable development in marine areas, particularly social and economic. Includes the coast, marine ecosystems, heritage and habitats. High level policy context to demonstrate how Marine Plans will be developed, implemented, monitored and amended (HM Government et al., 2011).
Pathfinder projects	2011	Commissioned in 2011 to test new and innovative approaches to planning for and managing coastal change (DEFRA, 2012a). Opened up the possibilities of planning and a wider range of options other than defences to manage and plan for coastal change.
Formalised coastal monitoring begins	2011	Building from local and regional monitoring schemes, the National Network of Regional Coastal Monitoring Programme of England developed and joined up six regional monitoring programmes to provide evidence base underpinning FCERM. First strategic long-term evidence base becomes available to underpin 'sound coastal management and engineering decisions' (National Network of Regional Coastal Monitoring Programmes, 2019). In Wales, the Wales Coastal Monitoring Centre delivers a cost effective monitoring programme for the Welsh Risk Management Authorities (Wales Coastal Monitoring Centre, 2021).
National Planning Policy Framework 2012	2012	Sets out the government's planning policies. Local plans should be proactive in adapting to long-term flood risk and climate change, to ensure resilient communities and infrastructure. Steer development to lower risk areas. Avoid building in the highest flood risk areas, where this has to be done, plans should not increase vulnerability, adaptation measures should manage risk throughout its lifetime, and not increase flood risk elsewhere. Safeguarding land from development to cope with future flood risk. Introduces Coastal Change Management Areas that will experience significant coastal change in the next 100 years, so that this can be incorporated into local plans. Updated in 2018, 2019 and 2021 (Ministry of Housing, Communities & Local Government, 2012).
Coastal Communities Fund	2012	Transformation of coasts through investment. Focus on regeneration (e.g. for an economic benefit ratio of 1:8), such as bringing heritage and community assets back into economic use. Multiple rounds of funding with £229 million awarded in the UK, with £182 million in England (Department for Levelling Up, Housing and Communities & Ministry of Housing, Communities and Local Government, 2022b). Funding round (5) 2018, to invest in coastal communities and boost jobs, skills and local businesses through sustainable growth.
National Coastal Erosion Risk Mapping	2012	Coastal erosion for England and Wales published in 2011/12, built over a six year period. Sets out potential erosion from Shoreline Management Plans across three epochs up to 100 years in the future. Further developed and more accessible, such as through searchable tools so that the risk can be communicated better to the public (Rogers et al., 2014; HM Government, 2022b; Natural Resources Wales, 2022). Periodically updated.
Climate Change Risk Assessment	2012	Following recommendations in (HM Government, 2008c), it identifies the risks and opportunities of climate change, plus the main priorities for adaptation are identified. Targeted for the whole UK and devolved administrations. Updated every five years (HM Government, 2012a) most recently in 2022 (HM Government, 2022c), along with adaptation reporting and National Adaptation Programme (DEFRA, 2018).
East and west coast of England and Welsh floods	2013 -2014	A storm over northern Scotland on 5-6 December 2013 moving towards Scandinavia, resulting in overtopping and breaching of defences. 700,000 livestock died. 2,800 properties and agricultural land flooded. Transport disruption and significant erosion (Haigh et al., 2017). This event was part of a series of storms across winter 2013-2014. This was the wettest UK winter on record (since records began in 1910), and the stormiest for the UK and Ireland (Matthews et al., 2014). Persistent heavy rainfall, strong winds, high tides and storm surge conditions severely impacted many parts of the UK. Multiple simultaneous fluvial, fluvial, groundwater and coastal flooding. Exceptional duration of flooding from late December 2013 until late February 2014 (Muchan et al., 2015). On 5 - 6

		December 2013 the highest east coast flood since 1953 occurred, with higher water levels in some locations, but with much lower impacts due to warnings, preparedness and better defences (Wadey et al., 2015; Haigh et al., 2017).
Formation of Natural Resources Wales	2013	Formation of Natural Resources Wales, representing the merging of the Environment Agency, Countryside Council for Wales and Forestry Commission Wales to advise, regulate and designate environmental issues or areas (HM Government, 2012b; Natural Resources Wales, 2022).
Water Act 2014	2014	Provision of flood insurance and Regional Flood and Coastal Committees; establishment of the Flood Reinsurance scheme; and banding of flood risks (HM Government, 2014). Water industry: mapping, regulation, and the provision of flood insurance for households, internal drainage boards and Regional Flood and Coastal Committees (the latter is amended in other earlier Acts relating to flood and coastal erosion risk management).
Wales Coastal Flooding Review	2014	Review investigating the impacts, lessons learnt and key recommendations from the 2013/14 storms (Natural Resources Wales, 2022).
Flood Risk Management Plans	2015	Set out how communities, stakeholders and other organisations manage flood risk, inland, surface water and on the coast. Ran from 2015 to 2021 with updates every six years (Environment Agency, 2016).
Environment (Wales) Act 2016	2016	Care for natural resources and biodiversity and be responsible for climate change. Established a Flood and Coastal Erosion Committee from the Flood and Water Management Act (HM Government, 2010), responsibilities of the Water Resources Act (HM Government, 1991b), Environment Act (HM Government, 1995), Marine and Coastal Access Act (HM Government, 2009a) and the Water Act (HM Government, 2014).
Flood Re	2016	Joint initiative between the UK Government and insurers, aiming to make flood cover of household insurance policies more affordable. Flood Re accepts flood risk from an insurance company through a premium based on council tax bands, plus collects a levy from every insurer offering insurance (Flood Re, 2022). It replaces the ABI Statement of Principles (Insurance Times, 2002; HM Government, 2008a). Flood Re runs until 2039.
National Flood Resilience Review 2016	2016	Reviewing resilience to flooding. Review of causes, infrastructure at risk, protection and improving resilience to flood events (HM Government, 2016).
Marine Pioneer Programme	2017	Pioneering new approaches (including natural capital) to the management of the marine environment (HM Government, 2018a)
Government's 25 Year Environment Plan	2017	Improving the environment, within a generation. Emphasis on risk management, mostly through forms of protection and reducing exposure through the planning / development process, increasing resilience plus natural and sustainable solutions (HM Government, 2018b)
Managing the coast in a changing climate	2018	Quantified the trajectory for coastal defences with current rules. Noted that lengths of defended coast in England today will likely be decommissioned by the 2080s -- 'for 149km-185km of England's coastline it will not be cost beneficial to protect or adapt as currently planned by England's coastal authorities' and 'A further 1,460km of the coastline designated as 'hold the line' to the end of the century (29% of the total English coastline) has benefit-cost-ratios below current thresholds'. Removal of defences is most common for erosion cases (Committee on Climate Change, 2018).
Coastal Change Management Areas	2019	With limited uptake (Kirby et al., 2021) since their introduction in 2012 (Ministry of Housing, Communities & Local Government, 2012), the report encourages greater uptake to realise sustainable solutions to coastal change (Royal Haskoning DHV, 2019)
Shoreline Management Plans Refresh	2019-ongoing, anticipated in 2024	Reviews Shoreline Management Plans 2. Updates SMPs with more deliverable policies (Environment Agency, 2020b).
Flood and Coastal Erosion Risk Management Strategy for England	2020	Plan to 2100 to prepare England to be resilient to flooding, through working with social, economic and infrastructural partners; investing in safer locations; ensuring the public understands flood and coastal change risks, their responsibilities and how to take action (Environment Agency, 2020a). Supported by a strategy roadmap to help delivery outcomes (Environment Agency, 2022c) and Policy Statement (HM Government, 2020b).

National Strategy for Flood and Coastal Erosion Risk in Wales	2020	Reducing risk of flooding to homes and businesses. Includes guidance on natural flood management and investments (Llywodraeth Cymru, 2020a). Published alongside the strategic national assessment to ensure environment, technical and economic effects have also been considered (Llywodraeth Cymru, 2020b).
Flood and Coastal Resilience Innovation Programme, including the Coastal Transition Accelerator Programme	2021-2027	From Committee on Climate Change, (2018) and other evidence, DEFRA funding has been granted for 25 projects trialling different approaches to improve resilience, tailored to local communities, including those on the coast, plus other programmes. Total investment £200 million (Environment Agency and DEFRA, 2022; DEFRA et al., 2022).
Critical national infrastructure in an age of climate change	2022	Assessed the risk of climate change of critical national infrastructure, pressing the urgent need to adapt to ensure the impact of hazards and their wider cascading effects on society are reduced through greater formal collaboration to build greater resilience (House of Commons et al., 2022).

Supplementary Table 5. Regions where policy units are subject to managed realignment and withdrawal of maintenance (i.e. HTL or MR to NAI). See Figure 1 of main manuscript. Units that are mixed policy are excluded (Smith, 2014). Numbers may not add up to 100% due to rounding.

Region	**Policy units (number, % of total)**	**Length (km, % of total**	**Managed realignment units (Epoch) (Units by number, % of regional coastline)**			**Withdrawal of maintenance units (Epoch) (Units by number, % of regional coastline)**	
			1	**2**	**3**	**2**	**3**
Anglian	223, 11%	898, 12%	39, 12%	55, 17%	48, 16%	8, 2%	5, 1%
North east	215, 11%	579, 8%	30, 10%	33, 11%	33, 12%	5, 1%	5, 1%
North west	220, 11%	927, 13%	25, 14%	47, 30%	47, 29%	4, 2%	4, 3%
South east	237, 12%	1016, 14%	14, 10%	20, 16%	28, 28%	4, 1%	6, 3%
South west	666, 33%	2398, 33%	65, 6%	115, 10%	95, 10%	16, 2%	21, 3%
Wales	437, 22%	1511, 21%	70, 16%	105, 20%	120, 21%	15, 3%	22, 4%

Supplementary Table 6. Questions asked to delegates in the national workshop (group feedback occurred after each theme).

Theme	**Questions**
Transitions	What are the coastal transitions you are aware of? What were the key points within the transitions that led to change? Of the coastal transitions you are aware of, what do you think worked well and what didn't in the process of transition?
SMPs	What indicators / data / information do you see used in SMPs currently? What indicators / data / information would you want to see underpinning SMPs?
Future	What does an acceptable future transition look like?

Supplementary Table 7. Questions asked to delegates in the regional workshops (group feedback occurred after each theme).

Theme	**Questions**
Reflections in practice	What are your reflections on the implementation of the four SMP options today? How does shoreline management planning relate to wider flood and erosion management and related issues today? What and how do external pressures (social, demographic physical, climatic, politics etc.) influence shoreline management planning today?
Future challenges	Future challenges on the coast: What might happen to: Rural coasts? Semi-urban coasts? Urban coasts? How might shoreline management planning alter with climate change? How do we get to long term sustainable shoreline management plans (that are resilient under multiple futures) from today?

Supplementary Table 8. End of meeting questionnaire for the national workshop.

Theme	**Questions**
Feedback and final session thoughts	What did you enjoy about today's session? What worked well? What did not work well? Is there anything more about coastal transitions that you would like to say, but did not have time to today?
Challenge and change	What is your personal biggest challenge in delivering the SMPs now and in the future? If you could change one thing in the SMP process, what would that be?

Supplementary Table 9. End of meeting questionnaire for the regional workshops. Questions were expanded based on feedback from the national workshop questionnaire.

Theme	**Questions**
Feedback and final session thoughts	What did you enjoy about today's session? What worked well? What did not work well? Is there anything more than you would like to add about the discussions today, that you have not had a chance to say or write on a post-it note?
Challenge and change	What is your personal biggest challenge in delivering the SMPs now and in the future? If you could change one thing in the SMP process, what would that be?
Addressing the challenges	Do you think there is sufficient communication and engagement with communities and business in the shoreline planning process? If not, why not, and how would you like the system improved? Do you think there is sufficient flexibility in central government finance to maintain and increase resilience in flood risk management and shoreline change? If not, why not, and how would you like the system improved? Do you think there is sufficient consistency in the way shoreline management and SMPs were created and how they are being enacted today? If not, why not, and how would you like the system improved? Do you think Shoreline Management Plans should be made statutory? If not, why not? If yes, what changes would you like to see before this happens? How would you make them statutory?

6 References

ABI (2014). Flood insurance: Protecting your home and making a claim. https://www.youtube.com/watch?v=WRE7U65x6nk [Accessed July 2022]

Altinay, Z., & Williams, N. (2019). Visuals as a method of coastal environmental communication. Ocean Coast. Manag. 178, 104809. doi: 10.1016/j.ocecoaman.2019.05.011

Alves, B., Angnuureng, D. B., Morand, P., & Almar, R. (2020). A review on coastal erosion and flooding risks and best management practices in West Africa: What has been done and should be done. J. Coast. Conserv. 24(3), 38. doi: 10.1007/s11852-020-00755-7

André, C., Boulet, D., Rey-Valette, H., & Rulleau, B. (2016). Protection by hard defence structures or relocation of assets exposed to coastal risks: Contributions and drawbacks of cost-benefit analysis for long-term adaptation choices to climate change. Ocean Coast. Manag. 134, 173–182. doi: 10.1016/j.ocecoaman.2016.10.003

André, C., Sauboua, P., Rey-Valette, H., & Schauner, G. (2015). Acceptabilité et mise en œuvre des politiques de relocalisation face aux risques littoraux: Perspectives issues d'une recherche en partenariat. VertigO, 15(1). doi: 10.4000/vertigo.16074 [translated into English via Google].

Bale, D. (2018). £600,000 community hub now open for business in Norfolk village. https://www.northnorfolknews.co.uk/news/trimingham-gets-new-600-000-community-hub-village-hall-1622384 [Accessed July 2022]

Baxter, P. J. (2005). The east coast big flood, 31 January–1 February 1953: A summary of the human disaster. Phil. Trans. R. Soc. A: Mathematical, Phys. Eng. Sci. 363(1831), 1293–1312. doi: 10.1098/rsta.2005.1569

BBC (2022). Can protest songs really make a difference? https://www.bbc.co.uk/news/av/entertainment-arts-62086924 [Accessed July 2022]

Bird, D., Ling, M., & Haynes, K. (2012). Flooding Facebook—The use of social media during the Queensland and Victorian floods. The Aust. J. Emerg. Manag. 27(1), 27–33. doi: 10.3316/informit.046814266005608

Bolsen, T., Kingsland, J., & Palm, R. (2018). The impact of frames highlighting coastal flooding in the USA on climate change beliefs. Clim. Change, 147(1–2), 359–368. doi: 10.1007/s10584-018-2143-0

Burgess, K., Jay, H., & Hosking, A. (2004). Futurecoast: Predicting the future coastal evolution of England and Wales. J Coast. Conserv. 10(1/2), 65–71.

Bye, P., & Horner, M. (1998). Easter 1998 floods: Review. https://www.gov.uk/government/publications/easter-1998-floods-review [Accessed November 2022]

Bryne, J. P., & Grannis, J. (2012). "Coastal retreat measures" in eds. M. B. Gerrard & K. Fischer Kuh. The law of adaptation to climate change. 267-306.

Carapuço, M. M., Taborda, R., Silveira, T. M., & Andrade, C. (2017). Upstream public engagement on coastal issues: Audience response to a science-based exhibition. Ocean Coast. Manag. 144, 83–89. doi: 10.1016/j.ocecoaman.2017.04.008

CIRIA (2022a). Briefings. https://www.ciria.org/CIRIA/Resources/Briefings.aspx?hkey=f9c048bd-1e2c-476f-9903-514e1451dace [Accessed July 2022]

CIRIA (2022b). Free CIRIA downloads. https://www.ciria.org/CIRIA/Resources/Free_CIRIA_publications.aspx?hkey=622b85b3-7d21-4e59-8093-459571496a0a [Accessed July 2022]

City of Baton Rouge (2022). Code of Ordinances of the City of Baton Rouge, Louisiana and East Baton Rouge Parish, Louisiana. Codified through Ordinance No. 18539, passed June 15, 2022. (Supp. No. 96). Chapter 11—Blight elimination. Sec. 12.651—Definition of blight. https://library.municode.com/la/baton_rouge,_east_baton_rouge_parish/codes/code_of_ordinances?nodeId=10107 [Accessed July 2022]

Coleman, A. (2021). What do new planning proposals on flood and coastal change mean? https://www.rtpi.org.uk/blog/2021/april/what-do-new-planning-proposals-on-flood-and-coastal-change-mean/ [Accessed July 2022]

Commission of the European Communities. (2000). Communication from the Commission to the Council and the European Parliament on integrated coastal zone management: A strategy for Europe /* COM/2000/0547 final */. Brussels: Commission of the European Communities. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52000DC0547 [Accessed July 2022]

Committee on Climate Change (2018). Managing the coast in a changing climate. London: HM Government. https://www.theccc.org.uk/publication/managing-the-coast-in-a-changing-climate/ [Accessed November 2022]

Cooper, J. A. G., & McKenna, J. (2008). Social justice in coastal erosion management: The temporal and spatial dimensions. Geoforum. 39(1), 294–306. doi: 10.1016/j.geoforum.2007.06.007

Daniels, S., & Veale, L. (2014). Imagining coastal change: Reflections on making a film. Cultural Geogr. 21(3), 497–504. doi: 10.1177/1474474013503620

Dávila, O. G., Stithou, M., Pescaroli, G., Pietrantoni, L., Koundouri, P., Díaz-Simal, P., et al. (2014). Promoting resilient economies by exploring insurance potential for facing coastal flooding and erosion: Evidence from Italy, Spain, France and United Kingdom. Coast. Eng. 87, 183–192. doi: 10.1016/j.coastaleng.2013.12.007

Day, S. A., O'Riordan, T., Bryson, J., Frew, P., & Young, R. (2015). "Many stakeholders, multiple perspectives: Long-term planning for a future coast" in eds. R. J. Nicholls, R. J. Dawson, & S. A. Day. Broad scale coastal simulation: New techniques to understand and manage shorelines in the third millennium. Netherlands: Springer. doi: 10.1007/978-94-007-5258-0_12. 299-323

DEFRA (2005). Making space for water. London: DEFRA. http://jeremyshiers.com/downloads/ea/makingSpaceForWater.pdf [Accessed November 2022]

DEFRA (2006a). Shoreline management plan guidance. Volume 1: Aims and requirements. London: DEFRA. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69206/pb11726-smpg-vol1-060308.pdf [Accessed November 2022]

DEFRA (2006b). Shoreline management plan guidance Volume 2: Procedures. London: DEFRA. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69207/pb11726v2-smpg-vol2-060523.pdf [Accessed November 2022]

DEFRA (2009). Appraisal of flood and coastal erosion risk management. A Defra policy statement. London: DEFRA. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69419/pb13278-erosion-manage-090619.pdf [Accessed November 2022]

DEFRA (2011). Flood and Coastal Resilience Partnership Funding—An introductory guide. London: DEFRA. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/182524/flood-coastal-resilience-intro-guide.pdf [Accessed November 2022]

DEFRA (2012a). Coastal change Pathfinder review. Final Report. London: DEFRA. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69508/pb13720-coastal-pathfinder-review.pdf [Accessed November 2022]

DEFRA (2012b). The Government's response to Sir Michael Pitt's Review of the summer 2007 Floods. London: DEFRA. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69489/2012-01-31-pb13705-pitt-review-progress.pdf [Accessed November 2022]

DEFRA (2018). The National Adaptation Programme and the third strategy for climate adaptation reporting. London: DEFRA https://www.gov.uk/government/publications/climate-change-second-national-adaptation-programme-2018-to-2023 [Accessed November 2022]

DEFRA (2019). Call for evidence on flooding and coastal erosion. https://consult.defra.gov.uk/flooding/call-for-evidence-flooding-and-coastal-erosion/ [Accessed November 2022]

DEFRA (2020). Consultation outcome. Flood and coastal erosion: Call for evidence. London: DEFRA. https://www.gov.uk/government/consultations/flood-and-coastal-erosion-call-for-evidence [Accessed November 2022]

DEFRA, Environment Agency, & Pow, R. (2022). Communities to trial innovative ways of adapting to coastal erosion. https://www.gov.uk/government/news/communities-to-trial-innovative-ways-of-adapting-to-coastal-erosion#:~:text=Known%20as%20the%20Coastal%20Transition,be%20defended%20from%20coastal%20erosion [Accessed November 2022]

Department for Communities and Local Government (2009). Planning Policy Statement 25 Supplement: Development and coastal change practice guide. London: Department for Communities and Local Government. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/7771/1499049.pdf [Accessed November 2022]

Department for Levelling Up, Housing and Communities, & Ministry of Housing, Communities and Local Government (2022a). Guidance. Flood risk and coastal change. HM Government. https://www.gov.uk/guidance/flood-risk-and-coastal-change [Accessed November 2022

Department for Levelling Up, Housing and Communities, & Ministry of Housing, Communities and Local Government. (2022b). Coastal communities. HM Government. https://www.gov.uk/government/collections/coastal-communities

Dichmont, C. M., Dutra, L. X. C., Owens, R., Jebreen, E., Thompson, C., Deng, R. A., van Putten, E. I., et al. (2016). A generic method of engagement to elicit regional coastal management options. Ocean Coast. Manag. 124, 22–32. doi: 10.1016/j.ocecoaman.2016.02.003

Edmonds, T. (2017). Household flood insurance. Briefing paper. Number 06613. London: House of Commons Library. https://researchbriefings.files.parliament.uk/documents/SN06613/SN06613.pdf [Accessed November 2022

Environment Agency (2001). Lessons learned. Autumn 2000 floods. London: Environment Agency. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/292917/geho0301bmxo-e-e.pdf [Accessed November 2022]

Environment Agency (2009a). UK Coastal Monitoring and Forecasting (UKCMF) Service—Strategy for 2009 to 2019. Bristol: Environment Agency. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/292919/geho1009brfe-e-e.pdf [Accessed November 2022]

Environment Agency (2009b). Flooding in England: A national assessment of flood risk. Bristol: Environment Agency https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/292928/geho0609bqds-e-e.pdf [Accessed November 2022]

Environment Agency (2016). Flood risk management plans (FRMPs): 2015 to 2021. https://www.gov.uk/government/collections/flood-risk-management-plans-frmps-2015-to-2021 [Accessed November 2022]

Environment Agency (2019a). Draft national flood and coastal erosion risk management strategy for England. https://www.parliament.uk/business/committees/committees-a-z/commons-select/environment-food-and-rural-affairs-committee/inquiries/parliament-2017/coastal-flooding-and-adaptation-to-climate-change-17-19/ [Accessed June 2019]

Environment Agency (2019b). Long-term investment scenarios (LTIS) 2019. Bristol: Environment Agency. https://www.gov.uk/government/publications/flood-and-coastal-risk-management-in-england-long-term-investment [Accessed November 2022]

Environment Agency (2020a). National flood and coastal erosion risk management strategy for England. Bristol: Environment Agency. https://www.gov.uk/government/publications/national-flood-and-coastal-erosion-risk-management-strategy-for-england--2 [Accessed November 2022]

Environment Agency (2020b). Shoreline Management Plans. Supplementary guidance for their ongoing maintenance and delivery.

Environment Agency (2022a). Check for flooding in England. https://check-for-flooding.service.gov.uk/ [Accessed July 2022]

Environment Agency (2022b). Environment Agency. https://twitter.com/EnvAgency [Accessed July 2022]

Environment Agency (2022c). Flood and coastal erosion risk management strategy roadmap to 2026. Bristol: Environment Agency. https://www.gov.uk/government/publications/flood-and-coastal-erosion-risk-management-strategy-roadmap-to-2026 [Accessed November 2022]

Environment Agency & DEFRA (2022). Flood and coastal resilience innovation fund. https://www.gov.uk/guidance/flood-and-coastal-resilience-innovation-programme [Accessed July 2022]

Environment Agency & Flood and Coastal Erosion Risk Management Research and Development Programme (2019). Working together to adapt to a changing climate—Flood and coast (pilot project). Bristol: Environment Agency. https://www.gov.uk/flood-and-coastal-erosion-risk-management-research-reports/working-together-to-adapt-to-a-changing-climate-flood-and-coast [Accessed January 2023]

Environment, Food and Rural Affairs (2019). Coastal flooding and erosion, and adaptation to climate change: Interim Report. London: Parliament. https://publications.parliament.uk/pa/cm201919/cmselect/cmenvfru/56/5602.htm [Accessed November 2022]

European Commission (1999). Towards a European integrated coastal zone management (ICZM) strategy: General principles and policy options. Luxembourg: Office for Official Publications of the European Communities https://ec.europa.eu/environment/iczm/pdf/vol1.pdf [Accessed July 2022]

European Commission (2022). Our oceans, seas and coasts. Brussels: European Commission. https://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/index_en.htm [Accessed October 2022]

European Union (1992). Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. Brussels: European Union. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A31992L0043 [Accessed October 2022]

European Union (1994). Council Resolution of 6 May 1994 on a community strategy, for integrated coastal-zone management. (94/C 135 /02). Brussels: European Union. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31994Y0518%2801%29 [Accessed October 2022]

European Union. (2000). Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for community action in the field of water policy. Brussels: European Union. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32000L0060 [Accessed October 2022]

European Union (2002). Council Resolution of 25 February 1992 on the future Community policy concerning the European coastal zone. (92/C 59/01). Brussels: European Union. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31992Y0306%2801%29 [Accessed October 2022]

European Union (2007). Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks. Brussels: European Union. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32007L0060 [Accessed March 2023]

European Union (2009). Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds. Brussels: European Union. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32009L0147 [Accessed October 2022]

Fisher, K., & Cooper, G. (2021). Coastineers Learning. https://coastineers.co.uk/ [Accessed July 2022]

Flather, R.A. (2000). Existing operational oceanography. Coast. Eng. 41(1-3), 13-40. doi: 10.1016/S0378-3839(00)00025-9

Flood Forecasting Centre (2021). Flood Forecasting Centre: The first 10 years. https://www.gov.uk/government/news/flood-forecasting-centre-the-first-10-years [Accessed November 2022]

Flood Re (2022). How Flood Re works. https://www.floodre.co.uk/how-flood-re-works/ [Accessed July 2022]

Forkbeard Animations (2017). Changing coasts 2. A tremendous tale. https://vimeo.com/254485828 [Accessed July 2022]

French, P. W. (2004). The changing nature of, and approaches to, UK coastal management at the start of the twenty-first century. The Geogr. J. 170(2), 116–125. doi: 10.1111/j.0016-7398.2004.00113.x

Frew, P. (2012). Adapting to coastal change in north Norfolk, UK. Marit. Eng. 165(3), 131–138. doi: 10.1680/maen.2011.23

Geels, F. W. (2010). Ontologies, socio-technical transitions (to sustainability), and the multi-level perspective. Res. Policy. 39(4), 495–510. doi: 10.1016/j.respol.2010.01.022

Gerritsen, H. (2005). What happened in 1953? The big flood in the Netherlands in retrospect. Phil. Trans. R. Soc. A: Mathematical, Phys. Eng. Sci. 363(1831), 1271–1291. doi: 10.1098/rsta.2005.1568

Gilbert, S. & Horner, R. (1984). The Thames Barrier. London: Thomas Telford.

Government Office for Science (2004). Future flooding. Office of Science and Technology. London: Foresight Directorate https://www.gov.uk/government/publications/future-flooding [Accessed November 2022]

Haigh, I. D., Wadey, M. P., Gallop, S. L., Loehr, H., Nicholls, R. J., Horsburgh, K. et al. (2015). A user-friendly database of coastal flooding in the United Kingdom from 1915–2014. Sci Data, 2(1), 150021. doi: 10.1038/sdata.2015.21

Haigh, I. D., Ozsoy, O., Wadey, M. P., Nicholls, R. J., Gallop, S. L., Wahl, T., & Brown, J. M. (2017). An improved database of coastal flooding in the United Kingdom from 1915 to 2016. Sci Data 4(1), 170100. doi: 10.1038/sdata.2017.100

Hall, A. (2015). Plugging the gaps: The North Sea flood of 1953 and the creation of a national coastal warning system. J. Public Manag. Social Policy, 22(2), 8.

Happisburgh Village Website (2022). Timeline. http://happisburgh.org.uk/ccag/timeline/ [Accessed July 2022]

Hansard. (2008). Floods: Warnings. Volume 475: Debated on Thursday 8 May 2008. London: UK Parliament. https://hansard.parliament.uk/Commons/2008-05-08/debates/08050863000030/FloodsWarnings

Harley, M. D., Kinsela, M. A., Sánchez-García, E., & Vos, K. (2019). Shoreline change mapping using crowd-sourced smartphone images. Coast. Eng. 150, 175–189. doi: 10.1016/j.coastaleng.2019.04.003

Hart, J., & Blenkinsopp, C. (2020). Using citizen science to collect coastal monitoring data. J. Coast. Res. 95(SP1), 824. doi: 10.2112/SI95-160.1

Henderson, R. T. (2018). Sink or sell: Using real estate purchase options to facilitate coastal retreat. Vanderbilt Law Review. 71(2), 641.

HM Government (1862). Harbours Transfer Act 1862. London: HM Government. https://www.legislation.gov.uk/ukpga/Vict/25-26/69/contents [Accessed November 2022]

HM Government. (1948a). Civil Defence Act 1948. HM Government. https://www.legislation.gov.uk/ukpga/Geo6/12-13-14/5/contents/enacted [Accessed November 2022]

HM Government (1948b). Water Act 1948. London: HM Government. https://www.legislation.gov.uk/ukpga/Geo6/11-12/22/enacted [Accessed November 2022]

HM Government (1949). Coast Protection Act 1949. London: HM Government. https://www.legislation.gov.uk/ukpga/Geo6/12-13-14/74/contents [Accessed November 2022]

HM Government (1976). Land Drainage Act 1976. London: HM Government. https://www.legislation.gov.uk/ukpga/1976/70/part/I/enacted [Accessed November 2022]

HM Government (1989). Water Act 1989. London: HM Government. https://www.legislation.gov.uk/ukpga/1989/15/contents [Accessed November 2022]

HM Government (1990). Town and Country Planning Act 1990. London: HM Government. https://www.legislation.gov.uk/ukpga/1990/8/contents [Accessed November 2022]

HM Government (1991a). Land Drainage Act 1991. London: HM Government. https://www.legislation.gov.uk/ukpga/1991/59/contents [Accessed November 2022]

HM Government (1991b). Water Resources Act 1991. London: HM Government. https://www.legislation.gov.uk/ukpga/1991/57/section/1/enacted [Accessed November 2022]

HM Government (1995). Environment Act 1995. London: HM Government. https://www.legislation.gov.uk/ukpga/1995/25/contents [Accessed November 2022]

HM Government (1998). Memorandum submitted by the Association of Drainage Authorities (F19). London: HM Government. https://publications.parliament.uk/pa/cm199798/cmselect/cmagric/707/8042813.htm [Accessed November 2022]

HM Government (2000). Countryside and Rights of Way Act 2000. London: HM Government. https://www.legislation.gov.uk/ukpga/2000/37/contents [Accessed November 2022]

HM Government (2004). Civil Contingencies Act 2004. London: HM Government. https://www.legislation.gov.uk/ukpga/2004/36/contents [Accessed November 2022]

HM Government. (2007). The Marine Works (Environmental Impact Assessment) Regulations 2007. London: HM Government. https://www.legislation.gov.uk/uksi/2007/1518/contents/made [Accessed November 2022]

HM Government (2008a). Provision of flood insurance: Revised statement of principles. London: HM Government. https://www.gov.uk/government/publications/provision-of-flood-insurance-revised-statement-of-principles [Accessed November 2022]

HM Government (2008b). Future Water. The Government's water strategy for England. London: The Stationery Office. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69346/pb13562-future-water-080204.pdf [Accessed November 2022]

HM Government (2008c). Climate Change Act 2008. HM Government. https://www.legislation.gov.uk/ukpga/2008/27/contents [Accessed November 2022]

HM Government (2008d). Planning Act 2008. London: HM Government. https://www.legislation.gov.uk/ukpga/2008/29/contents [Accessed November 2022]

HM Government (2009a). Marine and Coastal Access Act 2009. London: HM Government. https://www.legislation.gov.uk/ukpga/2009/23/contents [Accessed November 2022]

HM Government (2009b). The Flood Risk Regulations 2009. London: HM Government. https://www.legislation.gov.uk/uksi/2009/3042/contents [Accessed November 2022]

HM Government. (2010). Flood and Water Management Act 2010. London: HM Government. https://www.legislation.gov.uk/ukpga/2010/29/contents [Accessed November 2022]

HM Government, Northern Ireland Executive, Scottish Government, & Welsh Assembly Government. (2011). UK Marine Policy Statement. London: The Stationery Office. https://www.gov.uk/government/publications/uk-marine-policy-statement [Accessed November 2022]

HM Government (2012a). UK climate change risk assessment: Government report 2012. London: The Stationery Office. https://www.gov.uk/government/publications/uk-climate-change-risk-assessment-government-report [Accessed November 2022]

HM Government (2012b). The Natural Resources Body for Wales (Establishment) Order 2012. London: HM Government. https://www.legislation.gov.uk/wsi/2012/1903/contents/made [Accessed November 2022]

HM Government (2014). Water Act 2014. London: HM Government. https://www.legislation.gov.uk/ukpga/2014/21/contents/enacted [Accessed November 2022]

HM Government (2016). National Flood Resilience Review. London: HM Government. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/551137/national-flood-resilience-review.pdf [Accessed November 2022]

HM Government (2018a). Marine pioneer. https://www.gov.uk/government/publications/marine-pioneer [Accessed November 2022]

HM Government (2018b). 25 Year Environment Plan. London: DEFRA. https://www.gov.uk/government/publications/25-year-environment-plan [Accessed November 2022]

HM Government (2020a). National Risk Register 2020. London: HM Government. https://www.gov.uk/government/publications/national-risk-register-2020 [Accessed November 2022]

HM Government (2020b). Flood and coastal erosion risk management. Policy Statement. London: HM Government. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/903705/flood-coastal-erosion-policy-statement.pdf [Accessed November 2022]

HM Government (2021). Improving dissemination of flood warnings. https://www.gov.uk/flood-and-coastal-erosion-risk-management-research-reports/improving-dissemination-of-flood-warnings [Accessed November 2022]

HM Government (2022a). About us. Flood Forecasting Centre. https://www.gov.uk/government/organisations/flood-forecasting-centre/about [Accessed November 2022]

HM Government (2022b). Check coastal erosion management in your area. https://www.gov.uk/check-coastal-erosion-management-in-your-area [Accessed November 2022]

HM Government (2022c). UK Climate Change Risk Assessment 2022. https://www.gov.uk/government/publications/uk-climate-change-risk-assessment-2022 [Accessed November 2022]

HM Government, Northern Ireland Executive, Scottish Government, & Welsh Assembly Government. (2011). UK Marine Policy Statement. London: The Stationery Office. https://www.gov.uk/government/publications/uk-marine-policy-statement [Accessed November 2022]

House of Commons, House of Lords & Joint Committee on the National Security Strategy. (2022). Readiness for storms ahead? Critical national infrastructure in an age of climate change. London: Parliamentary Copyright House of Commons. https://committees.parliament.uk/publications/30507/documents/175976/default/ [Accessed November 2022]

House of Lords Library (2020). The National Risk Register: Preparing for national emergencies. London: House of Lords. https://lordslibrary.parliament.uk/the-national-risk-register-preparing-for-national-emergencies/ [Accessed November 2022]

Hull City Council. (2022). Hull's Local Flood Risk Management Strategy 2022—2028. Hull: Hull City Council. https://www.hull.gov.uk/sites/hull/files/media/Editor%20-%20Council%20and%20democracy/Hull%27s_Local_Flood_Risk_Management_Strategy_2022_-_2028.pdf [Accessed November 2022]

Insurance Times (2002). ABI Statement of Principles for flood insurance. https://www.insurancetimes.co.uk/-abi-statement-of-principles-for-flood-insurance/1344783.article [Accessed November 2022]

Jude, S., Jones, A. P., Bateman, I. J., & Andrews, J. E. (2003). Developing techniques to visualise future coastal landscapes. https://www.researchgate.net/publication/241566525_Developing_Techniques_to_Visualise_Future_Coastal_Landscapes [Accessed July 2022]

Kalt, T. (2021). Jobs vs. climate justice? Contentious narratives of labor and climate movements in the coal transition in Germany. Environ. Politics 30(7), 1135–1154. doi: 10.1080/09644016.2021.1892979

Kirby, J. A., Masselink, G., Essex, S., Poate, T., & Scott, T. (2021). Coastal adaptation to climate change through zonation: A review of coastal change management areas (CCMAs) in England. Ocean & Coastal Manag. 215, 105950. doi: 10.1016/j.ocecoaman.2021.105950

Lambert, M.-L. (2013). GIZC et élévation du niveau marin: Vers une gestion innovante des littoraux vulnérables. VertigO, Hors-série 18. doi: 10.4000/vertigo.14331 [translated into English via Google].

Landmark Information Group (2022a). Know Your Flood Risk. Is your home really safe from flood? Find out and take action today. Free flood guides. Landmark Information Group. https://www.landmark.co.uk/products/know-your-flood-risk/ [Accessed July 2022]

Landmark Information Group (2022b). Know Your Flood Risk. https://twitter.com/flooduk?lang=en [Accessed July 2022]

Lawrence, J., Boston, J., Bell, R., Olufson, S., Kool, R., Hardcastle, M., et al. (2020). Implementing pre-emptive managed retreat: Constraints and novel insights. Curr. Climate Change Rep. 6(3), 66–80. doi: 10.1007/s40641-020-00161-z

Lawrence, J., Stephens, S., Blackett, P., Bell, R. G., & Priestley, R. (2021). Climate services transformed: Decision-making practice for the coast in a changing climate. Frontiers in Marine Sci. 8, 703902. doi: 10.3389/fmars.2021.703902

Leafe, R., Pethick, J., & Townend, I. (1998). Realizing the benefits of shoreline management. The Geogr. J. 164(3), 282. doi: 10.2307/3060617

Ledoux, L., Cornell, S., O'Riordan, T., Harvey, R., & Banyard, L. (2005). Towards sustainable flood and coastal management: Identifying drivers of, and obstacles to, managed realignment. Land Use Policy, 22(2), 129–144. doi: 10.1016/j.landusepol.2004.03.001

Lewis, M., Horsburgh, K., Bates, P., & Smith, R. (2011). Quantifying the uncertainty in future coastal flood risk estimates for the U.K. J. Coast. Res. 27(5), 870–881. doi: 10.2112/JCOASTRES-D-10-00147.1

Liverpool Victoria (2022). How you can protect your home from flooding. https://www.lv.com/home-insurance/how-to-protect-your-home-and-prepare-for-flooding [Accessed July 2022]

Llywodraeth Cymru (2011). Strategic Environmental Assessment. Statement of Environmental Particulars. Flood and Coastal Erosion Risk Management: Development of a National Strategy for Wales. Cardiff: Llywodraeth Cymru. https://gov.wales/sites/default/files/publications/2019-06/strategic-environmental-assessment.pdf [Accessed November 2022]

Llywodraeth Cymru (2020a). National strategy for flood and coastal erosion risk management in Wales: Strategic environmental assessment. Cardiff: Llywodraeth Cymru. https://gov.wales/national-strategy-flood-and-coastal-erosion-risk-management-wales-strategic-environmental [Accessed November 2022]

Llywodraeth Cymru (2020b). The national strategy for flood and coastal erosion risk management in Wales. Cardiff: Llywodraeth Cymru. https://gov.wales/national-strategy-flood-and-coastal-erosion-risk-management-wales [Accessed November 2022]

Macdonald, N., Chester, D., Sangster, H., Todd, B., & Hooke, J. (2012). The significance of Gilbert F. White's 1945 paper 'Human adjustment to floods' in the development of risk and hazard management. Prog. Phys. Geogr.: Earth and Environ. 36(1), 125–133. doi: 10.1177/0309133311414607

MAFF (1993). Strategy for flood and coastal defence in England and Wales. PB1471. MAFF.

MAFF, Welsh Office, Association of District Councils, English Nature, & National Rivers Authority (1995). Shoreline Management Plans: A guide for coastal defence authorities. Report No: PB2197. London: Ministry of Agriculture Fisheries & Food.

Martinez, G., Costas, S., & Ferreira, Ó. (2020). The role of culture for coastal disaster risk reduction measures: Empirical evidence from northern and southern Europe. Adv. Clim. Change Res. 11(4), 297–309. doi: 10.1016/j.accre.2020.11.001

Mcglashan, D. J. (2003). Managed relocation: An assessment of its feasibility as a coastal management option. Geogr. J. 169(1), 6–20. doi: 10.1111/1475-4959.04993

Matthews, T., Murphy, C., Wilby, R. L., & Harrigan, S. (2014). Stormiest winter on record for Ireland and UK. Nat. Clim. Change 4(9), 738–740. doi: 10.1038/nclimate2336

Met Office (2011). Saturday 31 January 1953 (East coast floods). https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/library-and-archive/library/publications/historical-weather-factsheets/eastcoastfloods31january1953.pdf [Accessed November 2022]

Met Office (2022). Flood Forecasting. Met Office. https://www.metoffice.gov.uk/services/government/environmental-hazard-resilience/floodforecasting

Ministry of Housing, Communities & Local Government (2012). National Planning Policy Framework. London: Ministry of Housing, Communities and Local Government. https://www.gov.uk/government/publications/national-planning-policy-framework--2

Motyka, J. & Brampton, A. (1993). Coastal management: Mapping of littoral cells. Report SR328. HR Wallingford.

Muchan, K., Lewis, M., Hannaford, J., & Parry, S. (2015). The winter storms of 2013/2014 in the UK: Hydrological responses and impacts. Weather. 70(2), 55–61. doi: 10.1002/wea.2469

National Network of Regional Coastal Monitoring Programmes (2019). Programme design. https://coastalmonitoring.org/programme_design/ [Accessed November 2022]

Natural Resources Wales (2022). National Coastal Erosion Risk Management. http://lle.gov.wales/catalogue/item/NCERM [Accessed November 2022]

Nettley, A., Desilvey, C., Anderson, K., Wetherelt, A., & Caseldine, C. (2014). Visualising sea-level rise at a coastal heritage site: Participatory process and creative communication. Landsc. Res. 39(6), 647–667. doi: 10.1080/01426397.2013.773965

Nicholls, R. J., Dawson, R. J., & Day (née Nicholson-Cole), S. (eds.). (2015). Broad scale coastal simulation: New techniques to understand and manage shorelines in the third millennium. Netherlands: Springer. doi: 10.1007/978-94-007-5258-0

Nicholls, R. J., Townend, I. H., Bradbury, A. P., Ramsbottom, D., & Day, S. A. (2013). Planning for long-term coastal change: Experiences from England and Wales. Ocean Eng. 71, 3–16. doi: 10.1016/j.oceaneng.2013.01.025

O'Neill, J., & Wentworth, J. (2021). POSTnote. Coastal Management. https://researchbriefings.files.parliament.uk/documents/POST-PN-0647/POST-PN-0647.pdf [Accessed July 2022]

Penning-Rowsell, E. C., Priest, S., Parker, D.J., Morris, J., Tunstall, S., Viavattene, C., & Owen, D. (2013) Flood and coastal erosion risk management: A manual for economic appraisal (The 'Multi-Coloured Manual'). London: Routledge.

Penning-Rowsell, E. C., Priest, S., & Johnson, C. (2014). The evolution of UK flood insurance: Incremental change over six decades. Int. J. Water Res. Dev. 30(4), 694–713. doi: 10.1080/07900627.2014.903166

Pilling, C., Dodds, V., Cranston, M., Price, D., Harrison, T., & How, A. (2016). "Flood forecasting—A national overview for Great Britain", in eds. T.E. Adams III and T.C. Pagano, Flood forecasting, a global perspective. Elsevier. doi: 10.1016/B978-0-12-801884-2.00009-8. 201–247

Pinto, A. M. F., Ferreira, F. A. F., Spahr, R. W., Sunderman, M. A., Govindan, K., & Meidutė-Kavaliauskienė, I. (2021). Analyzing blight impacts on urban areas: A multi-criteria approach. Land Use Policy, 108, 105661. doi: 1016/j.landusepol.2021.105661

Pitt, M. (2008). Lessons learnt from the 2007 floods. London: Cabinet Office. https://webarchive.nationalarchives.gov.uk/ukgwa/20100702215619/http://archive.cabinetoffice.gov.uk/pittreview/thepittreview/final_report.html [Accessed November 2022]

Pontee, N. I., & Morris, K. (2011). CoastRanger MS: A Tool for Improving Public Engagement. J. Coast. Res. 27(1), 18–25.

Pontee, N. I., & Parsons, A. (2010). A review of coastal risk management in the UK. Proc. Inst. Civil Eng. - Marit. Eng. 163(1), 31–42. doi: 10.1680/maen.2010.163.1.31

Revell, D., King, P., Giliam, J., Calil, J., Jenkins, S., Helmer, C. et al. (2021). A holistic framework for evaluating adaptation approaches to coastal hazards and sea level rise: A case study from Imperial Beach, California. Water. 13(9), 1324. doi: 10.3390/w13091324

Robert, S., & Schleyer-Lindenmann, A. (2021). How ready are we to cope with climate change? Extent of adaptation to sea level rise and coastal risks in local planning documents of southern France. Land Use Policy. 104, 105354. doi: 10.1016/j.landusepol.2021.105354

Rocle, N., Rey-Valette, H., Bertrand, F., Becu, N., Long, N., Bazart, C., Vye, D., Meur-Ferec, C., et al. (2020). Paving the way to coastal adaptation pathways: An interdisciplinary approach based on territorial archetypes. Environ. Sci. Policy, 110, 34–45. doi: 10.1016/j.envsci.2020.05.003

Rocle, N., & Salles, D. (2018). "Pioneers but not guinea pigs": Experimenting with climate change adaptation in French coastal areas. Policy Sci. 51(2), 231–247. doi: 10.1007/s11077-017-9279-z

Rogers, J., Allan, E., Hardiman, N., & Jeans, K. (2014). The national coastal erosion risk mapping project—from start to finish...and beyond. From sea to shore – meeting the challenges of the sea. ICE Publishing. 774–782. doi: 10.1680/fsts.59757.0774

Rouse, H., Blackett, P., Hume, T., Bell, R., Britton, R., & Dahm, J. (2013). Coastal Adaptation to Climate Change: A New Zealand story. J. Coast. Res, 165, 1957–1962. doi: 10.2112/SI65-331.1

Royal Commission on Coastal Erosion and Afforestation (1911). Royal Commission on Coast Erosion and Afforestation, Great Britain. London: His Majesty's Stationery Office.

Royal Haskoning DHV (2019). Coastal Change Management Areas: Opportunities for more sustainable solutions in areas subject to coastal change. Natural England Commissioned Reports, Number 275. Peterborough: Natural England. http://publications.naturalengland.org.uk/publication/6167783398440960 [Accessed November 2022]

RTPI (2021). Planning for coastal change. Part 1. https://www.rtpi.org.uk/planningforcoastalchange [Accessed July 2022]

Rulleau, B., & Rey-Valette, H. (2017). Forward planning to maintain the attractiveness of coastal areas: Choosing between seawalls and managed retreat. Environ. Sci. Policy, 72, 12–19. doi: 10.1016/j.envsci.2017.01.009

Rulleau, B., Rey-Valette, H., & Clément, V. (2017). Impact of justice and solidarity variables on the acceptability of managed realignment. Clim. Policy. 17(3), 361–377. doi: 10.1080/14693062.2015.1119097

Seddon, A. (2011). Fleeting Strands. https://ambroseseddon.com/portfolio/fleeting-strands/ [Accessed July 2022]

Skinner, C. (2020). Flash Flood!: A SeriousGeoGames activity combining science festivals, video games, and virtual reality with research data for communicating flood risk and geomorphology. Geosci. Comm. 3(1), 1–17. doi: 10.5194/gc-3-1-2020

Smith, S. (2014). Managed realignment and coastal abandonment in England and Wales and their representation in the second round of Shoreline Management Plans [MSc dissertation]. Southampton: University of Southampton.

The ClimateMusic Project (2021). What If We…? https://climatemusic.org/our-music/#what-if-we [Accessed July 2022]

The Flood Hub (2022a). Knowledge hub. https://thefloodhub.co.uk/knowledge-hub/ [Accessed July 2022]

The Flood Hub (2022b). KS2 Flooding Lessons. https://thefloodhub.co.uk/ks2-flooding-lessons/ [Accessed July 2022]

Thomas, M., Roberts, E., Pidgeon, N., & Henwood, K. (2021). "Using photographs in coastal research and engagement: Reflections on two case studies" in eds. M. Gustavsson, C. S. White, J. Phillipson, & K. Ounanian. Researching people and the sea. Cham: Palgrave Macmillan. doi: 10.1007/978-3-030-59601-9_9. 181–207

Topley, W. E. (1885). Rate of erosion of the sea-coasts of England and Wales and the influence of artificial abstraction of shingle or other material in that action. Rep. Br. Association Adv. of Sci. 404–407

Townend, I. H. (1991). The future of shoreline management. London: Sir William Halcrow & Partners/NRA Anglian Region.

Townend, I. H. (1992). "Shoreline management: A question of definition" in eds. M.G. Barrett, M.G. Coastal zone planning and management. London: Thomas Telford. 195–210.

Townend, I. H., Fleming, C. A., McLaren, P., & Hunter-Blaire, A. (1990). A regional study of coastal morphology. 22nd International Conference on Coastal Engineering. Virginia: American Society of Civil Engineers. 2589-2602.

Townend, B. I. H., French, J. R., Nicholls, R. J., Brown, S., Carpenter, S., Haigh, I. D., Hill, C. T., Lazarus, E., Penning-Rowsell, E. C., Thompson, C. E. L., & Tompkins, E. L. (2021). Operationalising coastal resilience to flood and erosion hazard: A demonstration for England. Sci. Total Environ. 783, 146880. doi: 10.1016/j.scitotenv.2021.146880

Townend, I. H., & McLaren, P. (1988). Anglian coastal management atlas. Swindon: Sir William Halcrow and Partners.

Turner, I. L., Harley, M. D., Hanslow, D. J., Kinsela, M. A., & Splinter, K. D. (2022). 'Coastal Management Guide - Managing Coastal Erosion': A STEM education resource for secondary school teachers. Cont. Shelf Res. 244, 104783. doi: 10.1016/j.csr.2022.104783

United Nations (1993). Report of the United Nations Conference on Environment and Development. Rio de Janeiro, 3-14 June 1992. United Nations. https://documents-dds-ny.un.org/doc/UNDOC/GEN/N92/836/55/PDF/N9283655.pdf?OpenElement [Accessed October 2022]

Wadey, M. P., Haigh, Ivan. D., Nicholls, R. J., Brown, J. M., Horsburgh, K., Carroll, B., Gallop, S. L., Mason, T., & Bradshaw, E. (2015). A comparison of the 31 January–1 February 1953 and 5–6 December 2013 coastal flood events around the UK. Frontiers Mar. Sci. 2. doi: 10.3389/fmars.2015.00084

Wales Coastal Monitoring Centre (2021). About WCMC. https://www.wcmc.wales/about [Accessed November 2022]

Waverley, J.A. (1954). Report of the departmental committee on coastal flooding. London: HMSO.

Werner, M., Cranston, M., Harrison, T., Whitfield, D., & Schellekens, J. (2009). Recent developments in operational flood forecasting in England, Wales and Scotland. Meteorol. Appl. 16(1), 13–22. doi: 10.1002/met.124

White, G. (1942). Human adjustment to floods: A geographical approach to the flood problem in the United States. Research Paper No. 29. [PhD thesis]. Chicago: University of Chicago. https://biotech.law.lsu.edu/climate/docs/Human_Adj_Floods_White.pdf [Accessed June 2022]

Woodruff, S. C., Mullin, M., & Roy, M. (2020). Is coastal adaptation a public good? The financing implications of good characteristics in coastal adaptation. J. Environ. Plan. Manag. 63(12), 2082–2101. doi: 10.1080/09640568.2019.1703656

Zia, R. (2022). Land and sea. https://www.rehanzia.net/land-and-sea/ [Accessed July 2022]