ISSN 1476-1580

North West Geography

Volume 24, Number 2, 2024

Back to the future: the story of, and lessons from, the managed realignment of Hesketh Out Marsh

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Introduction

In the face of escalating global challenges such as climate change, more frequent extreme weather events and sea level rise, coastal regions are particularly vulnerable to the impacts of flooding and erosion. About 40% of the world's population lives within 100 km of the coast (United Nations, 2007) and more than 600 million people (~10%) live less than 10 metres above sea level (C40 Cities Climate Leadership Group, 2022; Adger *et al.*, 2005). In England and Wales, in 2020, over 5.3 million people lived in coastal towns (Office for National Statistics, 2020). As climate change accelerates, coastal communities, especially those with low coastlines, are at great risk of flooding and erosion. It is estimated that almost 30% of homes within 200 metres of these vulnerable worldwide coastlines will suffer serious loss due to erosion over the next fifty years (Rangel-Buitrago *et al.*, 2018). This forecast emphasises the urgent need for comprehensive coastal management strategies to mitigate the effects of flooding and erosion and protect affected communities. From implementing measures to stabilise the coastline to exploring options for managed realignment, proactive planning is essential to meet the challenges ahead. By prioritising resilience and adaptation, coastal regions can seek to minimise the potential issues caused by erosion-related asset loss in the coming decades. Resilience and adaptation are contested concepts (Masselink and Lazarus, 2019) so, for the scope of this paper we will use the IPCC definition of resilience and adaptation (Field *et al.*, 2012). Resilience is defined as:

> "The ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions." (Field *et al.*, 2012, p.3).

Adaptation is defined as:

> "In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate." (Field *et al.*, 2012, p.3).

This paper provides an overview of the history of the Ribble Estuary in relation to coastal management, focusing on the use of Nature-based Solutions (NbS) at Hesketh Out Marsh. NbS are gaining increasing attention as a response to widespread human-created and naturally occurring challenges for human activity. The definition and use of the term NbS continues to evolve, but here we can use the definition provided by the European Commission:

> "Solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions." (European Commission, n.d.).

The use of a historical approach helps to emphasise that there has been a tension between human intervention in the Ribble Estuary and unintended consequences. From the 17th century onwards, humans began to profoundly alter the environment of the Ribble Estuary to prioritise human needs, without appropriate assessment of the environmental impacts and consequences. In contrast to this approach, NbS leverage natural processes and systems, often involving living organisms, to address environmental, social, and economic challenges. Unlike traditional engineered solutions, these living systems are constantly evolving, adapting to changes in their environment (Moosavi, 2022). Hesketh Out Marsh is an example of the implementation of NbS that recognise the importance of natural processes and seek to protect some of this space by limiting some of the human activity. Hesketh Out Marsh is also a case study of the project 'Resilient Coasts: Optimising Co-Benefit Solutions' (Co-Opt) which partly informed this work.

This article is based on a rapid evidence review of various sources, including websites, scientific papers, archival documents, online articles, and reports. The inclusion of grey literature was essential for obtaining localized information not available in traditional scholarly publications (white literature). Whilst it is important to note that a limitation of grey literature lies in its varying quality, as it does not undergo the same rigorous peer-review process that characterizes white literature, there is a growing recognition of the need for public policy literature reviews to engage with grey literature in order to avoid biases within academia and present a more rounded overview of the arguments (e.g. Paez, 2017). This is intended to provide a stronger evidence base for setting out the experience of Hesketh Out Marsh from which wider lessons can be learned.

Decision-making processes in coastal management

Decision-making processes concerning coastal management often prioritise short-term protection over long-term sustainability and resilience. This is due to processes being heavily influenced by economic factors and political expedience, often following an action-reaction pattern, as noted by Rangel-Buitrago *et al.* (2015, 2018). Moreover, the approach frequently is based on cost-benefit analyses to assess the feasibility and viability of various management strategies, as highlighted by Cooper & McKenna (2008).

Indeed, hard engineering solutions such as seawalls, groynes, and revetments have been used extensively to defend coastal areas from flooding and erosion (Morris *et al.*, 2018). Although these structures are designed to provide immediate protection and they can also last for many years, they have other effects such as disruption of natural sediment supply, transport and processes and accelerated soil erosion downstream of the structure, which are not always factored into the design (Martin *et al.*, 2005; Gracia *et al.*, 2018; Foti *et al.*, 2020; Morris *et al.*, 2020) and can inhibit resilience downstream. Furthermore, these structures are often expensive to build and maintain, and some have limited effectiveness against extreme weather events, including those exacerbated by climate change (Morris *et al.*, 2020). It is essential to recognise the limitations of purely economic considerations and to incorporate wider environmental and social impacts into decision-making processes. Balancing economic concerns with environmental integrity and community well-being is critical to the development of effective and equitable coastal flooding and erosion protection strategies.

Although still a small fraction of the situation compared to traditional grey coastal protection measures, there is a shift towards more sustainable coastal adaptation strategies that consider the incorporation of nature and natural elements in the system management, considering short and long-term scenarios and multiple benefits beyond flood and erosion protection (Powell *et al.*, 2019). These approaches recognise the interconnectedness of coastal systems and aim to work with nature rather than against it. They can also provide additional benefits to the whole socio-ecological coastal system (the human and natural elements of the system being studied and the interactions between them) in terms of ecosystem services, improved flooding and erosion control, recreation and habitat conservation (Powell *et al.*, 2019). Examples of NbS include beach nourishment, dune restoration and managed realignment. While most of these strategies require a longer-term planning compared to hard engineered coastal defences, they offer numerous benefits beyond reducing flood and erosion risk (Watkin *et al.*, 2019; Boano *et al.*, 2020; Giordano *et al.*, 2020; Lackey *et al.*, 2021). Some of the benefits of more sustainable coastal management approaches are enhanced resilience of the system, restoration of coastal habitats that have seriously declined over recent decades, recreational and aesthetic value. This is not to overstate the ease of implementation, NbS still have challenges and responses are emerging and evolving (Nelson *et al.*, 2020).

Methodology

The work underpinning this paper was undertaken as a response to part of the "Resilient Coasts: Optimising Co-Benefit Solutions" (CoOpt) project, which the authors are currently involved in. CoOpt seeks to understand, explore and deliver a new integrated and interdisciplinary system-based framework to support the required transition from hard 'grey' defences to softer 'green' solutions in coastal and shoreline management. As part of the CoOpt project Hesketh Out Marsh was selected as one of four key case studies (one is in Wales and two in Scotland). The primary goal of the project is to identify and implement sustainable coastal management practices that deliver multiple co-benefits, such as enhancing biodiversity, improving flood resilience, and supporting local communities.

During the project, it became evident that historical information about the site would have been beneficial in enhancing our understanding of the local context, contextualizing the data collected thus far, and informing future activities. To address this, a rapid evidence review

was conducted using the keywords: Hesketh Out Marsh, Hesketh Bank, and Ribble Estuary through both Google Scholar and Google. Not all documents retrieved were utilized, as some were not relevant to the scope of this study. Additionally, certain photographs and materials were not available in digital format; therefore, photographs were taken of original documents held at the SMBC library.

The paper is based on this rapid evidence review, using a variety of sources including scientific papers, websites, and grey literature like reports and online articles. Grey literature was important for accessing localized information not found in traditional scholarly publications. While grey literature lacks the rigorous peer-review process of white literature, it's increasingly recognized in public policy reviews to avoid academic biases and offer a more comprehensive perspective (Paez, 2017). The goal of this paper is to create a stronger evidence base for understanding the experiences at Hesketh Our Marsh and deriving broader lessons.

A short history of the Ribble Estuary

The Ribble Estuary, in north-west England (Figure 1), is an important estuarine ecosystem, supporting a variety of habitats and species. Since the early 1800s, the Ribble Estuary has been heavily modified by a variety of engineering works to improve and secure navigation to the harbour at Preston. For a full explanation and image about the changes in the shape of the Ribble Estuary between 1737 and 1967 see Van Der Wal *et al.* (2002).

Between 1840 and 1847, training walls were constructed within the inner estuary. These walls, designed to direct the flow of rivers over sandy or muddy coastlines, help stabilize and deepen channels, aiding in navigation, flood control, erosion prevention, and water quality improvement. However, they can also disrupt longshore drift, leading to coastal erosion. From the 1880s to the early 1900s, a wide and deep channel to the Irish Sea was developed, followed by the construction of retaining walls between 1932 and 1937, which were later extended seaward (Figure 2). These modifications restricted flow in the main channel, increasing flood dominance on both sides. The estuary's natural tendency to accumulate sediment intensified, with new sediment sources emerging post-1900 due to dune erosion at Formby and the disposal of dredged material from the Mersey near the Ribble inlet. In the 20th century,

Figure 1: Map of the Ribble estuary. © Crown copyright and database rights 2024 Ordnance Survey (AC0000851941).

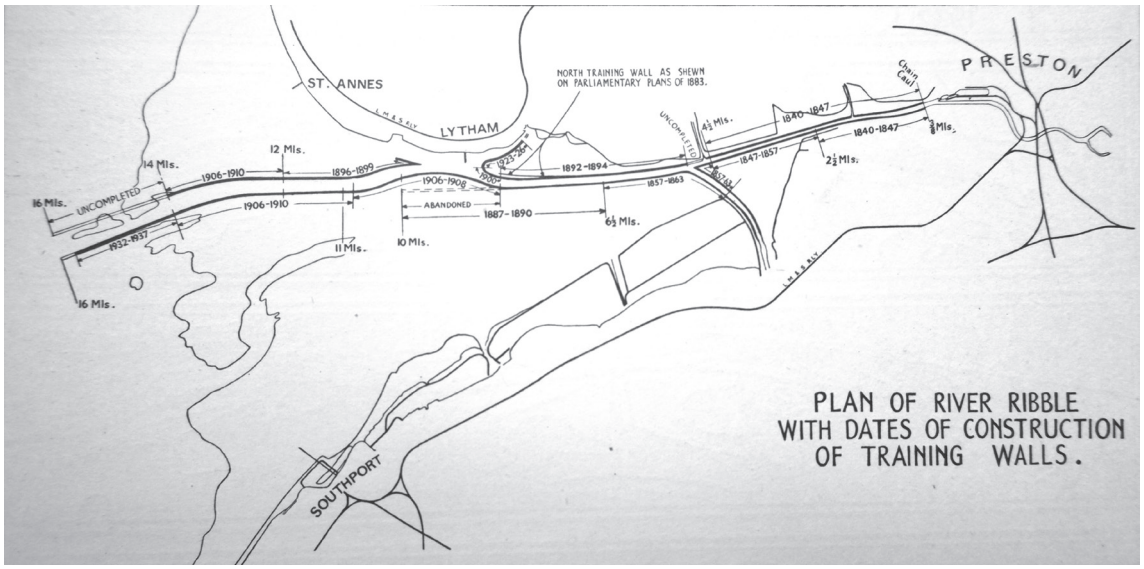
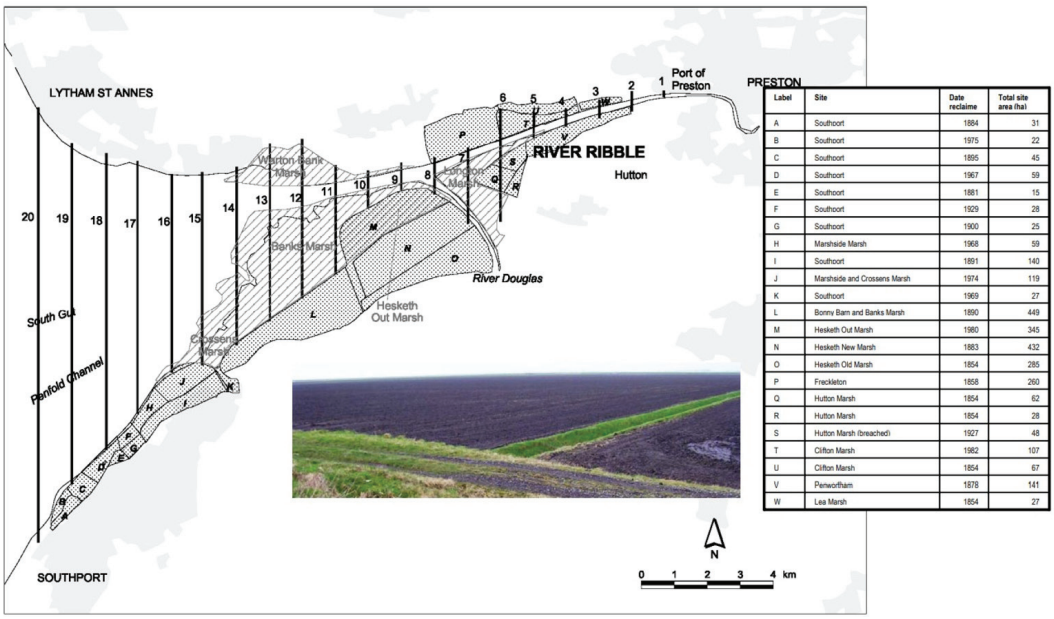


Figure 2: Development of the Ribble training walls from 1840 to 1937. Source: Barron (1938) (document held at SMBC archive) (p.257).

sediment build-up in the navigation channel became a major issue, especially at Preston Docks and Salter's Bank in the outer estuary. Dredging peaked in the early 1960s and ceased shortly before Preston Harbour's closure in 1981, leading to the movement of Salter's Bank, which blocked the seaward end of the navigation channel, causing dike breaches and increased ebb currents on the south side of the estuary (Barron, 1938). The estuary's banks and channels remain highly dynamic, with sand extraction ongoing since the 1960s. Although this ceased at Horse Bank in 2005, it continues at Lytham, with permission granted by the Borough Council in 1989 and set to expire in 2049. Since 1854, land has been progressively reclaimed for agricultural and commercial purposes, particularly on the southern bank of the Ribble Estuary, to enable the development of the town of Southport (Figure 3) (Fellows and Shirres, 2017). Due to the good quality of the soil, estuarine areas have often been reclaimed for agricultural use. The land is drained and often a private defence wall is built to protect the field from encroaching water. In the 18th and 19th centuries, the Ribble



Label	Site	Date reclaime	Total site area (ha)
A	Southport	1884	31
B	Southport	1975	22
C	Southport	1895	45
D	Southport	1967	59
E	Southport	1881	15
F	Southport	1929	28
G	Southport	1900	25
H	Marshside Marsh	1968	59
I	Southport	1891	140
J	Marshside and Crossens Marsh	1974	119
K	Southport	1969	27
L	Bonny Barn and Banks Marsh	1890	449
M	Hesketh Out Marsh	1980	345
N	Hesketh New Marsh	1883	432
O	Hesketh Old Marsh	1854	285
P	Freckleton	1858	260
Q	Hutton Marsh	1854	62
R	Hutton Marsh	1854	28
S	Hutton Marsh (breached)	1927	48
T	Clifton Marsh	1982	107
U	Clifton Marsh	1854	67
V	Penwortham	1878	141
W	Lea Marsh	1854	27

Figure 3: History of land reclamation in the Ribble Estuary. The vertical lines represent the locations of the transects at 1 km intervals used in the Pontee study to analyse the geomorphological shape of the estuary. Image taken from Pontee (2005, p.5).

estuary was famous for its salmon. In 1867, around 18,000 salmon were caught in the river. From 1880 the number of salmon caught declined until in the 1930s it was reported that the fish caught above the Calder were unsaleable for food due to water pollution (Barron, 1938).

Nature Conservation area

In 1979, following pressure from local groups and national conservation organisations, Banks Marsh (Figure 3) was acquired for conservation purposes with the help of a government grant of nearly £1.75 million. At this time the Nature Conservancy Council, now Natural England, was given responsibility for 2,182 hectares of the estuary to be managed as a National Nature Reserve. Today, the Ribble Estuary is generally recognised as an important nature reserve with extensive sand and mud flats and salt marshes. Behind the embankments along the estuary there are areas of coastal grazing marsh. Large parts of the estuary have been designated as a nature reserve at both national (e.g. Site of Special Scientific Interest, National Nature Reserve, Marine Conservation Zone) and international level (Special Protection Area, Ramsar Site and Special Area of Conservation), primarily because they harbour internationally important waterfowl population (Figures 4 & 5). Almost 250,000 birds regularly winter in the Ribble Estuary, making it the third most important wetland for birds in the UK.

Flood history

The Ribble catchment spans over 750 square miles and encompasses more than 3,479 miles (5,600 kilometres) of waterways (Ribble River Trust, n.d.). This catchment area contains several villages, extensive rural areas and some main urban areas (e.g. Preston; Figure 6). Large areas of the lower catchment area of the Ribble Estuary are low-lying river floodplain, which increase their likelihood to be impacted by flood events. In fact:

> "The Ribble catchment has a history of flooding; 40 significant events having been recorded since 1600. The most significant was in 1866 when flooding occurred on the Ribble, Calder and the Darwen, when newspapers recorded widespread flooding of businesses and properties. More recently in 1995, 38 properties were

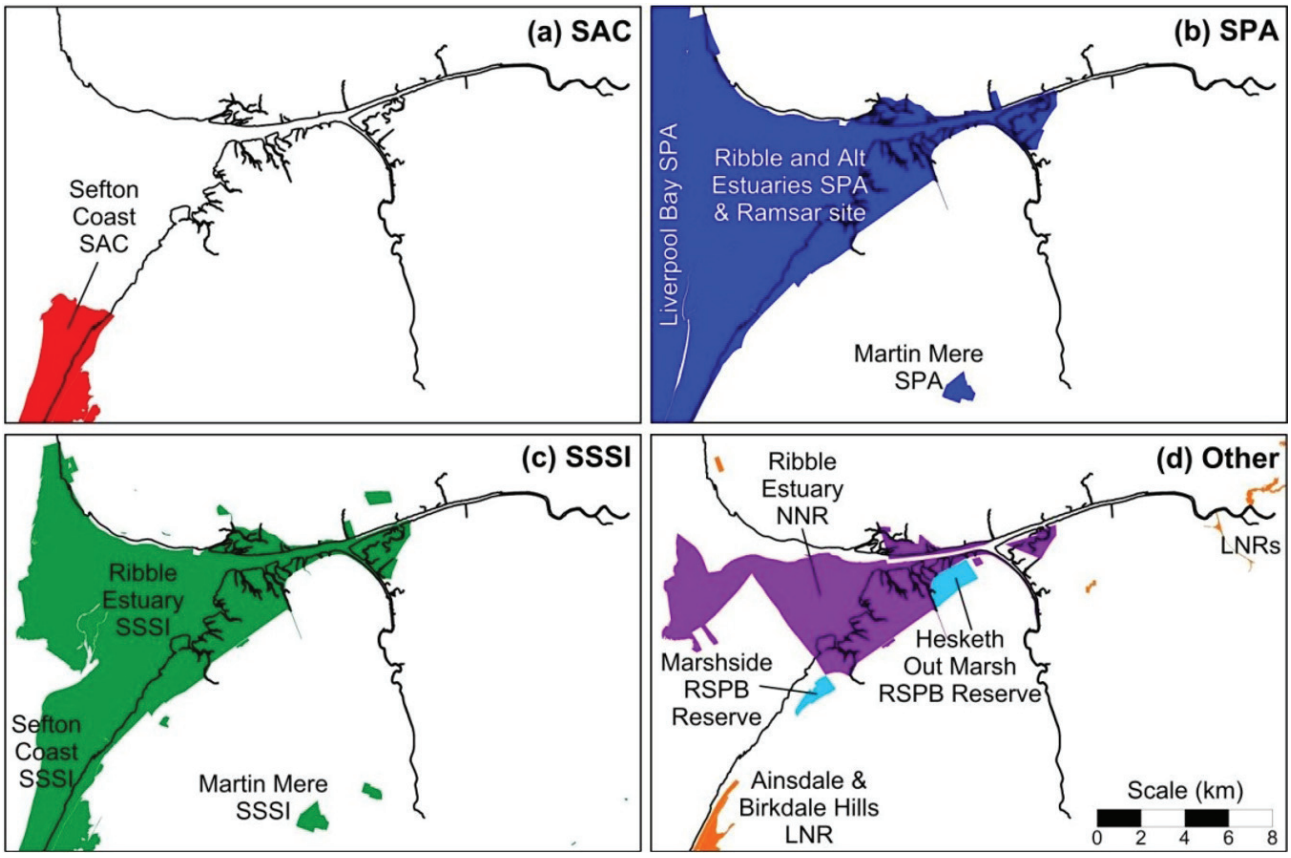


Figure 4. Nature conservation designations and reserves in and around the Ribble Estuary. SAC (Special Area of Conservation), SPA (Special Protection Area), Ramsar site, (Joyce et al., 2020), SSSI (Site of Special Scientific Interest) (Natural England, 2013), NNR (National Nature Reserve) (Natural England, 2009), LNR (Local Nature Reserve) (Natural England and Department for Environment, Food & Rural Affairs, 2014), RSPB (Royal Society for the Protection of Birds) . Image taken from Halcrow Group Ltd (2013, p.6).

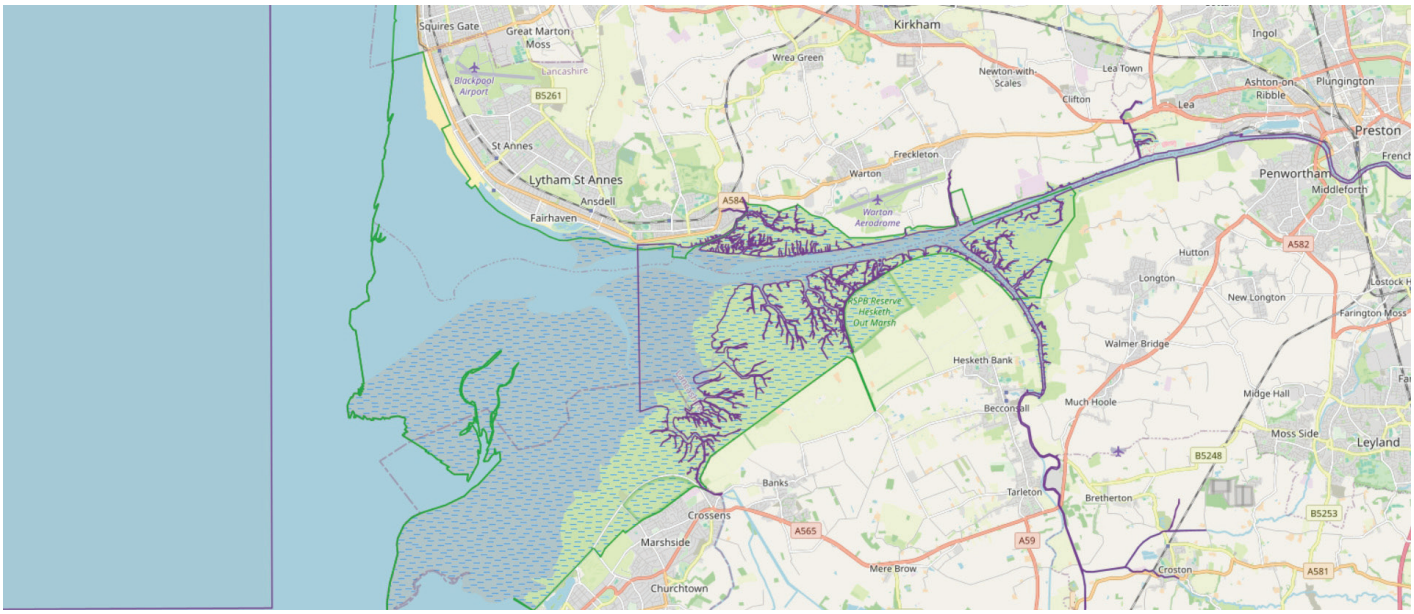


Figure 5. Marine Conservation Zone (MCZ) (Department for Environment, Food & Rural Affairs, JNCC and Natural England, 2013), in the Ribble estuary indicated with a purple boundary and Special Protection Area (SPA) (NatureScot, n.d.) with a green boundary. Map developed with JNCC Marine Protected Area Mapper (jncc.gov.uk, n.d). JNCC accepts no liability for the use of this data or for any further analysis or interpretation of the data.

> flooded in Preston, Walton le Dale and Ribchester and a similar event in 2000 also flooded Padiham, Barrowford and Blackburn affecting 33 properties. In 2002 the Calder and Darwen flooded affecting 18 residential and 40 commercial properties around Blackburn and Burnley." (Environment Agency, 2009, p.6).

The biggest coastal disaster in the area discussed in this paper was in 1720, when the area from Crossens (Figure 8) to Hesketh Bank and Tarleton were flooded. The sea banks broke, nine people lost their life, 47 houses were carried away by the tidal flood and cattle, sheep and crops were lost (Cotterall, 1985).

Shoreline Management Plans

To manage the complex challenges of coastal erosion, flood risk, habitat conservation and sustainable development in the Ribble Estuary, Shoreline Management Plans (SMPs) have been developed in collaboration with local authorities, environmental organisations, and stakeholders (Environment Agency, n.d.; Halcrow Group Limited, 2010). The Ribble Estuary is one of the 22 SMPs and covers the coast for North Wales and North West England from Great Ormes Head to the Scottish border. More specifically, the Ribble Estuary forms most of Sub Cell 11b. SMPs are non-statutory documents that are designed to manage coastal erosion and flooding while balancing the needs of nature, communities, and infrastructure. These plans are essential for ensuring long-term sustainability in coastal areas and are developed through a strategic approach that considers environmental, social, and economic factors. SMPs in the UK balance the needs for nature, communities, and infrastructure by taking a strategic and evidence-based approach to coastal management. They prioritize sustainable solutions that protect both natural environments and human settlements, all while involving local communities in decision-making processes (Environment Agency, 2024). They make recommendations on the most appropriate approach to managing coastal flood and coastal erosion risk in the short (0–20 years), medium (20–50 years) and long (50–100 years) term. One of the four options for managing flood and erosion risk that is set out in the SMPs is managed realignment (alongside hold the line, no active intervention and advance the line). The adoption of managed realignment and other NbS in coastal and flood management faces several significant challenges, primarily due to discrepancies between the timescales of planning and funding. NbS require long-term strategic planning and a period for natural processes to fully develop and deliver their intended environmental, social, and economic benefits. However, funding decisions in this sector are often driven by short-term priorities or are based purely on immediate risk assessments, leading to a preference for hard-engineered solutions. In high-risk areas, where the threat of flooding or coastal erosion is immediate, there is a tendency to favour hard engineering approaches, such as seawalls or flood

Figure 6: Map of Ribble catchment area with main tributaries. Map produced by Ribble Rivers Trust. Contains Ordnance Survey data © Crown copyright and database right 2024.; © Environment Agency copyright and / or database rights 2024. All rights reserved. Contains public sector information licensed under the Open Government Licence v3.0.

barriers, due to their ability to be implemented quickly and provide visible, immediate protection. While these solutions may offer rapid risk mitigation, they do not always address the underlying environmental issues and can sometimes lead to long-term negative impacts on ecosystems and biodiversity. By contrast, NbS, such as wetland restoration or the use of natural floodplains, require time not only for implementation but also for natural systems to evolve and mature in order to realize their full benefits. This often includes enhanced ecosystem services, such as improved water quality, increased biodiversity, carbon sequestration, and more sustainable flood and erosion control. The success of these solutions depends on patience and forward-thinking policy-making, which can be at odds with the immediate needs of high-risk regions or the short-term focus of many funding mechanisms. Addressing this disconnect between long-term ecological benefits and short-term decision-making is critical for the wider adoption of NbS. Strategic investment frameworks that prioritize resilience and sustainability, rather than short-term risk reduction alone, are essential to support the transition towards more holistic and environmentally integrated approaches to coastal and flood management (Stojanovic & Meschini, 2023).

Hesketh Bank

The earliest mention of the village of Hesketh dates back to the 13th century. It was once a fishing village and became a popular seaside resort due to its location at the mouth of the river.

The town was hit by severe flooding in 1720 and 1833, causing devastating loss of life and properties, so in 1860 the inner bank at Hesketh Bank was built, known locally as 'Old Bank' (Figure 7). Between 1880 and 1884 another sea bank of similar length was constructed further out in the estuary. The northern half of the land has been reclaimed from the Ribble since 1834, mainly by the Ribble Navigation Company (Cotterall, 1985).

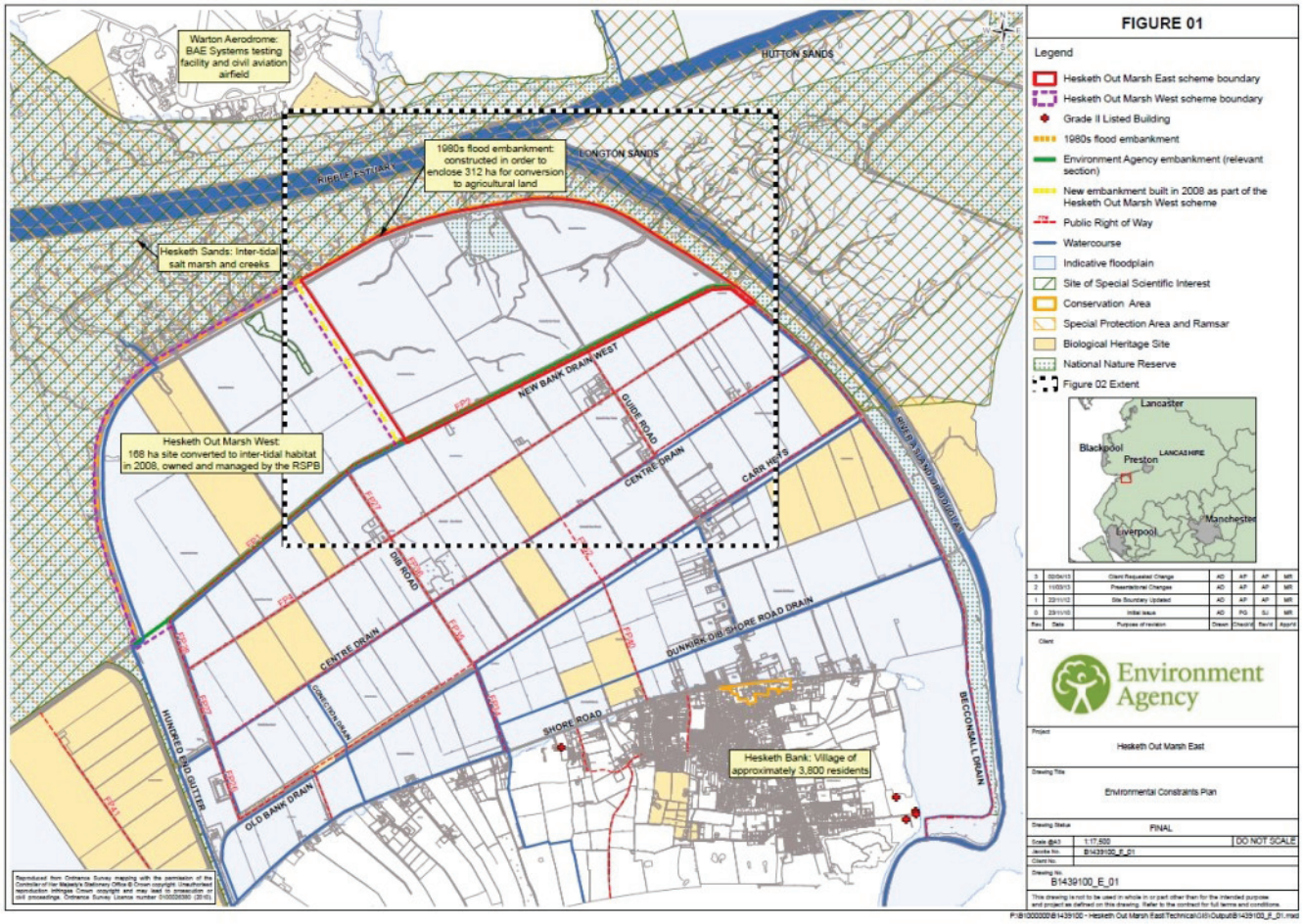


Figure 7: Map of Hesketh Out Marsh showing the west and east side of the managed realigned area. Image taken from Fellows and Shirres, (2017, p.2).

For many centuries, agriculture was the main occupation in the area, supported by the fertile soil, which consists mainly of black, heavy loam over clay and favours the cultivation of wheat, oats and potatoes. The agricultural viability of the area was enhanced after 1834 by the Ribble Navigation Company's land reclamation from the Ribble, increasing the area under cultivation to 2,394 acres according to historical records (Farrer, and Brownbill, 1911a & b).

The 1700s saw a shift towards shipping activities when sea-going vessels began to utilise the Douglas to transfer essential goods such as coal, bricks and slate from barges. The Parliament Act of 1720 was instrumental in improving the navigability of the River Douglas, reducing transport costs and increasing the market for Wigan's coal (Hesketh Bank Council, 2022). The strategic geographical location on the Ribble estuary facilitated the emergence of Hesketh Bank as a shipping hub and possibly a seaside resort, similar to Southport, in the Victorian era. The shipping sector flourished from the late 1700s to the 1800s, thanks to its location on the tidal Rivers Douglas and Ribble. However, this sector experienced a decline towards the end of the 19th century, challenged by competition from road and rail, so the economic focus shifted back to brickmaking and agriculture (Coyle, 2010).

The opening of brickworks in Hesketh Bank was made possible by the establishment of the railway, which utilised the area's boulder clay deposits for brick production. By the beginning of the 20th century, the brickworks had become a major local employer. The brickworks flourished after the Second World War due to modernisation measures, however the demand for bricks fell towards the end of the 20th century due to a change in the construction industry; the brickworks closed in 1970 (Fairhurst, 2019).

The conversion to a residential area following the closure of Hesketh Park railway station in 1964 meant a shift in the residential sector (Fairhurst, 2019). The area still retains its agricultural heritage, which is reflected in its designation as a small agricultural village. The population of the civil parish of Hesketh with Becconsall was 4,041 at the 2011 census (Hesketh with Becconsall, QPZM Local Stats, 2024). The communities in this area are at risk of flooding from both the Rivers Ribble and Douglas and from the sea. Protective measures in the tidal area of the Douglas (mainly earth embankments) reduce the risk in these villages. However, the flat topography means that the number of properties at risk could increase significantly during more extreme flood events, which are increasingly likely due to climate change (Fellows and Shirres, 2017). Coastal management in Hesketh Bank intersects with social and economic geography by protecting vital agricultural land, residential areas, and natural habitats, while also shaping how the community interacts with its environment. The social geography is influenced by flood risk, settlement patterns, and the protection of cultural heritage, whereas the economic geography is driven by the needs of agriculture, tourism, and ecosystem services. Coastal management efforts in this area aim to achieve a balance between protecting economic livelihoods and ensuring environmental sustainability, ultimately shaping the way land is used and developed in the face of natural hazards.

Hesketh Out Marsh

Hesketh Out Marsh between 1980s and 2006

Hesketh Out Marsh (Figures 8 & 9), located on the riverside of Hesketh Bank, is the focus of this paper as it is an example of the implementation of NbS , which recognise the importance of natural processes and seek to protect some of this space by limiting human activity. In fact, in this site managed realignment took place. In this approach, coastal protection measures like seawalls or dykes are removed to allow an area that was previously protected from flooding to be inundated by the sea. This flooding can then lead to the development of salt marsh ecosystems. The aim of the next sections is to provide a detailed overview of the steps that allowed the managed realignment to be implemented to facilitate the learning process to happen based on previous successful experiences.

The original saltmarsh was reclaimed from the estuary in the early 1980s by the construction of a private outer flood embankment and subsequently used as farmland. Since then, the land has been used to grow crops (including brassicas, lettuce, wheat, and potatoes) and for sheep and cattle grazing. Prior to 2000, the possibility of a managed realignment of the Ribble Estuary was considered. The Ribble Estuary Shoreline Management Plan identified five management units within which managed realignment was proposed as a strategic option for flood defence. This led to Halcrow consultants being commissioned by the Environment Agency in 2004 to assess the feasibility of managed realignment in the Ribble Estuary. Of the 11 potential sites suitable for a managed realignment in the estuary, Hesketh Out Marsh West (HOMW) was selected as the most feasible in the short term, as it had recently been reclaimed and was at a suitable elevation. Furthermore, this site was one of the most important sites internationally for wintering wildfowl. In fact, the Royal Society for the Protection of Birds (RSPB) was already in negotiations with the landowners of Hesketh Out Marsh West to acquire the

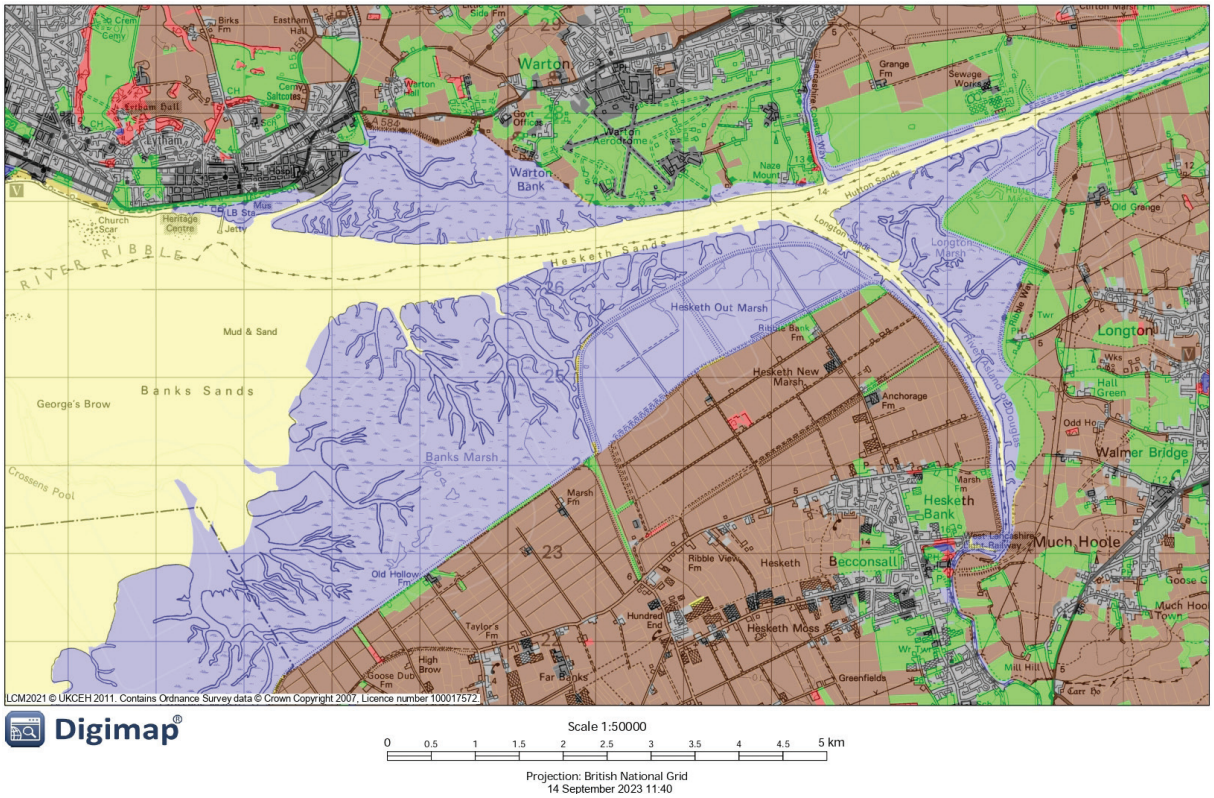


Figure 8: Map showing part of the Ribble estuary with a focus on Hesketh Out Marsh. Lilac = saltmarsh, yellow = littoral sediment and rock, brown = arable and horticulture, green = improved grassland, red = broadleaved woodland. Based upon Land Cover Map 2019 © UKCEH 2020. Contains Ordnance Survey data © Crown Copyright 2007, Licence number 100017572.

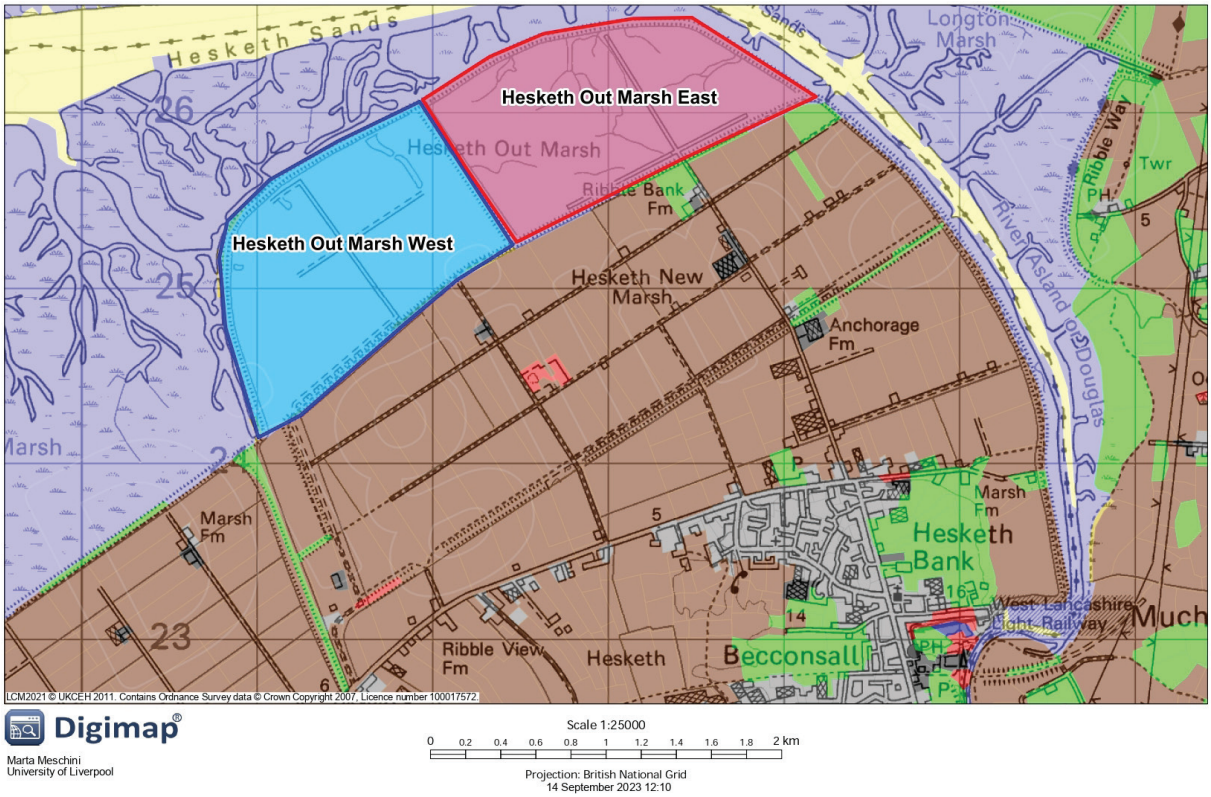


Figure 9: Map showing Hesketh Out Marsh West (blue area) and East (red area). Lilac = saltmarsh, yellow = littoral sediment and rock, brown = arable and horticulture, green = improved grassland, red = broadleaved woodland. Based upon Land Cover Map 2019 © UKCEH 2020. Contains Ordnance Survey data © Crown Copyright 2007, Licence number 100017572.

site on a long-term basis and manage it as a nature reserve. The landowner's willingness to negotiate the sale of the site confirmed the feasibility of this realignment.

Hesketh Out Marsh West (HOMW) (2006–2008)

In 2006, a partnership consisting of the RSPB (who bought the site), the Environment Agency (as statutory flood defence authority) and Lancaster City Council (who helped fund the purchase of the site) began the managed realignment of the site. The new intertidal habitats were needed to:

- compensate for the direct loss of 13 ha of Natura 2000 habitat in Morecambe (60 km north of the site) as part of an urgent flood alleviation programme by Lancaster City Council;
- compensate for historic and current losses elsewhere in the Ribble Estuary;
- contribute to the objectives of the National and Lancashire Biodiversity Action Plan (hub.jncc.gov.uk, n.d.; West Lancashire Borough Council, 2023).

At HOMW, RSPB worked with the Environment Agency and other organisations to restore the former system of saltmarshes, creeks and lagoons that existed on the site prior to land reclamation. Having first removed the original embankment inland, the Environment Agency then removed parts of the earlier (1980s) privately constructed sea wall. This allowed the tides to re-enter the nature reserve and recreate 168 hectares of salt marsh habitat. This first part of Hesketh Out Marsh was restored in 2008. The total cost of the first phase of Hesketh Out Marsh (completed in 2008) is not available, but the Environment Agency estimates that around £2 million was saved by using local soil for the shoreline improvement works.

Hesketh Out Marsh East (HOME) (2014–2017)

Over the following years, the RSPB worked in partnership with the Environment Agency and Natural England, and with funding from Lancaster City Council (LCC) (under the Lancashire Rural Recovery Action Plan), Biffaward and FCC Environment to purchase the remaining land from Hesketh Out Marsh East. A £1 million grant from the WREN Biodiversity Action Fund Land Purchase Programme enabled the RSPB to buy the land. This is a not-for-profit organisation that provides grants to communities living within 10 miles of an FCC Environment landfill site. The funds are provided by FCC Environment as part of a voluntary environmental tax credit programme, the Landfill Communities Fund. Work began in 2014 with the purchase of the first tranche of land and was completed in 2017 with the breaching of the outer embankment. The total cost of the second phase of the Hesketh Out Marsh managed realignment (completed in 2017) was £7.2 million, including expenditure by the Environment Agency (project management costs) and the RSPB (including land acquisition and land management costs funded by the RSPB and through grants from external sources). Funding from Biffaward and Natural England was used to provide facilities and services for visitors and for the cows and sheep grazing the marshes. This funding has also been used to research the changes that have occurred as a result of the realignment of the area.

Discussion and conclusion

Hesketh Out Marsh is now one of the largest managed realignment projects in the UK and one of the country's most important estuary habitats for birdlife. The entire land now belongs to the RSPB and is managed as a nature reserve. NbS work with nature to ensure space for nature limiting human activities while protecting human developments. For example, in the case of Hesketh Out Marsh, the neighbouring Warton airfield had to be considered when planning the realignment and the RSPB had to develop management plans for birds to ensure that the nature reserve did not impact on the airfield. With the completion of the Hesketh Out Marsh East realignment, a total of 322 hectares of land in front of the flood defence embankment has been converted to saltmarsh, which dissipates tidal energy and improves the resilience of the coastal defences. They also provide priority intertidal habitats (under the EU Habitats Directive) and biodiversity benefits for waterfowl, fish and invertebrates. The Hesketh Out Marsh project provides protection from 1 in 200 years flooding event for approximately 143 dwellings and 3 commercial buildings.

Hesketh Out Marsh is home to a variety of wildlife, including pink-footed geese and wigeons in winter and large flocks of wading birds such as redshanks and lapwings. There is a car park and viewing points along the public footpath on the southern edge of the reserve. Light, conservation grazing by cattle is required to maintain the salt marsh vegetation. This is organised by the RSPB with the help of tenants and/or grazing agreements.

Current challenges for the Hesketh Out Marsh area include siltation of the outfalls due to sediment movement in the estuary and challenges associated with the drainage system and new house development. Despite these current challenges, the managed realignment of Hesketh Out Marsh is an example of the successful implementation of NbS. The RSPB has a 5-year management plan for the area to ensure the good functioning of the reserve. However, especially for NbS, a long-term, systems-based approach is required

for these solutions to fully realise their expected benefits (Esteves, 2013). Ideally, long-term strategic planning is required to identify, prioritise, and exploit opportunities to implement a managed realignment. While nature-based solutions (NbS), like wetland restoration or managed realignment, offer long-term benefits such as improved biodiversity and sustainable flood control, their adoption is hindered by the short-term focus of funding and decision-making, especially in high-risk areas. These areas often prefer hard-engineered solutions like seawalls for immediate protection, even though such approaches can have long-term negative impacts on ecosystems. To promote NbS, there needs to be a shift toward long-term strategic planning and investment that prioritizes resilience and sustainability over short-term risk reduction. An important lesson for other similar projects in the future is the early involvement of the landowner. From conception to implementation, the Hesketh Out Marsh realignment took almost 20 years. As coastal regions continue to face escalating flood and erosion risks, exacerbated by global challenges such as climate change, the need for sustainable coastal management has never been more urgent. While hard engineering solutions may provide quick fixes, they often have significant drawbacks and can exacerbate long-term vulnerability. The transition to NbS and adaptive strategies not only increases coastal resilience, but also offers numerous benefits for ecosystems, communities, and economies. By taking a holistic and forward-looking approach to coastal management, there is an opportunity to create a more resilient and sustainable future for coastal regions worldwide.

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