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Planning for long-term coastal change: Experiences from England and Wales

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ABSTRACT

England and Wales has a long history of recognising coastal change, where coastal morphology adjusts in response to changing patterns of erosion and accretion, especially in the vicinity of ports and reclamations in estuaries. The long history of responses to coastal change can be linked to the history of coastal engineering, the wider development of coastal management; and most recently shoreline management, as a policy framework for managing flood and erosion risks on changing coasts. Coastal change is ongoing and long-term so that management is necessarily a process and effective delivery requires an adequate monitoring programme to inform management decisions. Monitoring also enables adaptive and flexible solutions to be implemented that take account of the inherent uncertainties such as future climate, promoting well adapted rather than mal-adapted outcomes. Given the current concerns about accelerated rates of sea-level rise and climate change this paper considers the development of both shoreline management and the supporting national monitoring programme in England to assess whether the SMP process remains useful in these circumstances. The lessons and experience are widely transferable.

1. Introduction

The United Kingdom[1] (Fig. 1) has a varied and dynamic coastline and a long history of coastal change and responding to this. The soft cliff coasts such as Holderness and East Anglia have retreated for thousands of years (Boyle, 1889; Wingfield and Evans, 1998). In contrast, the 'silting' and loss of the many of the historic Cinque ports in southeast England around the 15th Century illustrates significant accretion in coastal lowlands, quite likely aided by human agency (Ward, 1916). Active land claim has occurred since Roman times, and more extensively since the medieval period (French, 2001). Hence the Royal Commission on Afforestation and Coastal Erosion in 1911 found a net gain of land in England and Wales. Recent EU legislation, especially the Habitats Directive, has constrained land claim and when it must happen, compensation (i.e. habitat creation) is often required. Since the 19th century, erosion has been widely countered by hard engineering measures, although developments in coastal process understanding have meant that alternatives, such as beach nourishment and recycling schemes have routinely been considered over the last 40 years (e.g., Hanson et al., 2002). In addition, the need to maintain existing hard defences is increasingly questioned within shoreline management processes and national policy assessments because of the recognised need for a less constrained shoreline; as set out in the 'Making Space for Water' initiative (Defra, 2005) and the more recent 'Making Space for Nature' review (Lawton et al, 2010). Hence, significant lengths of defences could be abandoned in the coming decades.

This implies that current concerns about increasing rates of sea-level rise (SLR) and climate change are important drivers which need to be carefully considered within coastal management and especially shoreline management. However, this has to be done in the broader context of the system dynamics. One simple conceptual approach is to consider the *Source-Pathways-Receptor* (*S-P-R*) Model (Sayers et al., 2002; Thorne et al, 2007; Narayan et al., 2012). Coastal flood systems have the following distinct components:

- Relative SLR, surges and waves as sources; and
- Coastal landforms (and their associated morphodynamics) as pathways.

The receptors are the features impacted, such as eroded cliffs, flooded coastal plains, their land use, etc. The inter-relationship to

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[1] The United Kingdom includes England and the devolved administrations of Scotland, Wales and Northern Ireland, and coastal management and policy is distinct at the level of these four countries.

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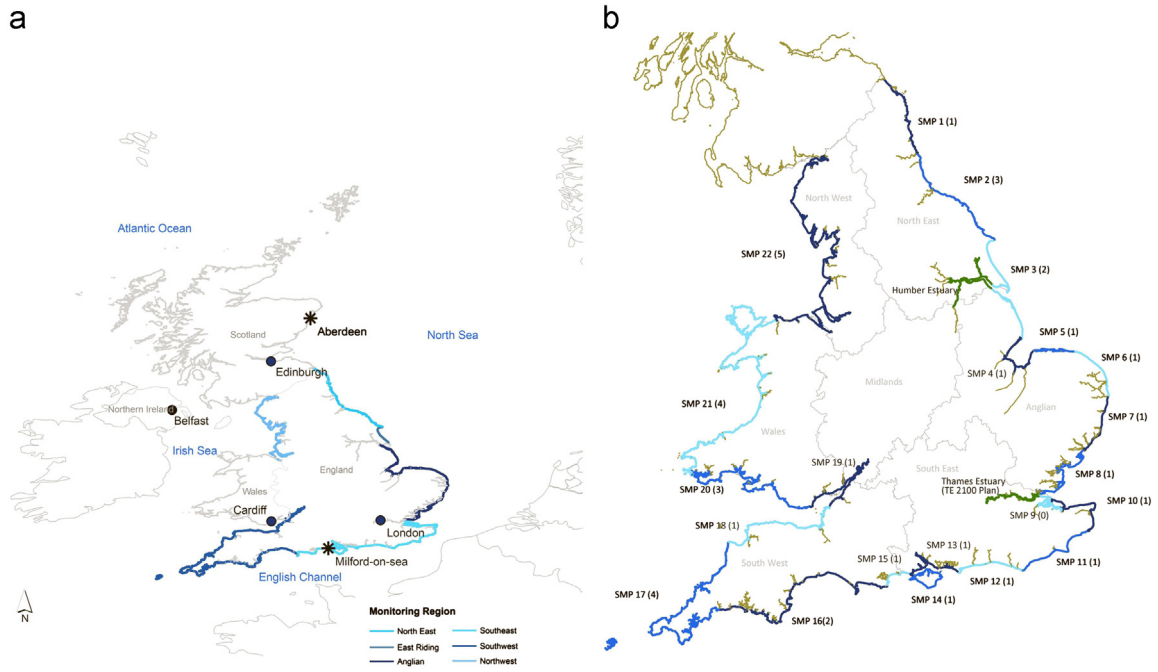

Fig. 1. (a) United Kingdom and surrounding seas, including the current regional monitoring boundaries and key locations. (b) The second generation SMPs in England and Wales, including the Humber and Thames estuaries. The number in brackets indicates how many first generation SMPs are covered by each second generation SMP.

these various factors needs to be considered, especially the interaction of marine transgression with sediment supply and demand, if we are to ensure effective management of coastal change.

This paper assesses the lessons from the long history of dealing with coastal change in England and Wales for responses to SLR and climate change. In particular, it considers the benefits of moving from a traditional local approach to the broader scale in shoreline management planning which addresses wider coastal processes. The paper is structured as follows. Section 2 considers the physical drivers of coastal change including climate and non-climate factors. Section 3 considers the issue of planning for resulting coastal change. This includes an overview of the development of shoreline management planning, the role of coastal monitoring, and a consideration of adaptation. Section 4 discusses the issues and draws out the lessons for shoreline management in the face of the accelerated rates of coastal change expected during the 21st Century.

2. Physical drivers of coastal change

UK coasts are changing due to a number of climate and non-climate drivers. These drivers are discussed in turn, including consideration of their historic and future magnitude and role.

2.1. Non-climate change drivers

Large parts of the east and south coast in the UK have a long-term trend of erosion related to regional gradients in longshore transport. This leads to regions of erosion where stabilising a shoreline will involve growing efforts over time, and there will be downdrift consequences in terms of sediment starvation. For example, Norfolk protrudes into the North Sea and for any direction of wave approach, longshore transport is driven to the south or east leading to chronic long-term erosion of the un-protected cliffs of up to 0.5–1.0 m/yr (e.g. Clayton, 1989; Dickson et al., 2007).

Sediment starvation is also an important issue. In the UK, little if any beach-grade sediment is provided to the coast by rivers, and the main sources are coastal and shallow seabed erosion. It has been argued that the availability of this sediment has naturally diminished over the Holocene as these sources were depleted, especially the seabed sources (Orford and Pethick, 2006). In addition to these natural trends, coastal protection of cliffs (as noted above) has greatly reduced the input of new sources of sediment, and much contemporary erosion may be in response to these artificial sediment budget changes (e.g., Clayton 1989; Nicholls et al., in press).

While not a physical driver, the increased value of developments on or close to the coast, means that the risk, being a product of likelihood and consequences, has increased substantially over the last 40–50 years. This also influences decisions on the level of adaptation investment.

2.2. Climate change

2.2.1. Sea-level change

Long-term measurements have shown that sea levels have been slowly rising around the UK for many decades (Woodworth, 1999; Woodworth et al., 2009). Hence, this issue has long received attention in both coastal engineering and management, preceding the concerns about human-induced climate change. For instance, rising mean and extreme sea levels were considered in the design of the Thames Barrier, completed in 1982 (Gilbert and Horner, 1984).

In terms of sea-level change as a driver of coastal change, it is important to evaluate relative sea-level change, which comprises both global and regional ocean changes and local uplift/subsidence components due to natural and anthropogenic processes. After the post-glacial SLR at the end of the last ice age, sea levels around the UK stabilized, or rose slowly. Uplift and subsidence also occurred, with northern Britain slowly rising and southern Britain slowly sinking (Shennan et al., 2012). This pattern continues, leading to small variations of 1–2 mm/yr in relative SLR around the UK (Table 1a).

Regional sea levels around the British Isles are estimated to have risen 1.4 mm/yr over the 20th Century (Lowe et al., 2009), and as a result relative SLR has occurred at all the sites of long-term sea-level measurement around the UK, including those in Scotland (e.g., Aberdeen). Looking to the 21st Century, the UK has developed a series of climate scenarios based on the global