Chapter 26
Arch-Manche: Using Archaeological, Palaeoenvironmental, Historic and Artistic Resources in Coastal Management

Lauren Tidbury, Julie Satchell, and Garry Momber

Abstract The coast of the English Channel (La Manche) and the Southern North Sea is a dynamic environment. Coastal erosion, increased storm frequency, flooding and instability are all providing challenges for managing risks associated with these threats. Understanding the long-term development of the coast is vital in order to understand how the present situation has arisen. Archaeological and palaeoenvironmental data from submerged and prehistoric landscapes along the coastlines and sub-tidal fringes of the European Continental Shelf represent previously under-used coastal indicators that can be applied as tools to inform long-term patterns of coastal change. The preservation of organic material and traces of flora and fauna within submerged and intertidal sites provide detailed evidence of the past environment including plants, animals and insects, the types of soils and crucially whether it was dry, damp or wet, saline or brackish. Recording changes to these environments demonstrates the impact of rising or falling sea levels and relationships with coastal adaptation. This chapter presents the results of the Arch-Manche project, which used archaeological, palaeoenvironmental, historical and artistic resources to advance understanding of the scale and rate of long-term coastal change.

26.1 Introduction

Coastal managers face an ongoing battle to moderate impacts from the sea in the face of a changing climate and pressures from human uses of the coastal zone. The challenges that lie ahead are forecast to increase while pressure on limited resources is also likely to increase. This paper explores the value of under-used coastal indicators that can be applied as tools to inform on long-term patterns of coastal change. This work forms part of the 'Archaeology, Art and Coastal Heritage—Tools to Support Coastal Management and Climate Change Planning across the Channel Regional Sea" (Arch-Manche) project. The project aims to advance understanding of the scale and rate of long-term coastal change using sources of evidence including archaeology, palaeoenvironmental data, works of art, historic maps, charts and photographs (see also Karle and Goldhammer, Chap. 15 for a similar approach).

Traditionally, coastal engineers, planners and decision-makers have rarely studied long-term changes to the coast. However, the roots of coastal instability often relate to progressive geomorphological evolution that dates back thousands of years. Evidence from coastal, submerged and intertidal sites can be used to model the position of past coastlines, understand the rate of past sea level change

L. Tidbury (✉)
Museum of London Archaeology, Mortimer Wheeler House, 46 Eagle Wharf Road, London N1 7ED, UK
e-mail: LTidbury@mola.org.uk

J. Satchell • G. Momber
Maritime Archaeology Trust, National Oceanography Centre, Empress Dock, Southampton SO14 3ZH, UK
e-mail: julie.satchell@maritimearchaeologytrust.org; garry.momber@maritimearchaeologytrust.org

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and map coastal erosion. Early archaeological evidence can demonstrate how people were impacted by coastal change in the past and how populations reacted to some large-scale landscape and climatic changes (Van de Noort 2013). Coastal zones have often been favoured for human occupation, and marine resources in particular are thought to have played a key role in the settlement patterns of hunter-gatherers from an early period (Bell and Warren 2013, p. 31). Much of this evidence, now submerged in the Channel and southern North Sea, has been investigated and analysed during the project in order to reconstruct past landscapes and to model changes over time.

Various palaeogeographical models exist for the English Channel and North Sea region (including Shennan et al. 2000; Brooks et al. 2011; Sturt et al. 2013) and this work has stressed the importance of these once inhabited landscapes, now submerged, in terms of what can be learnt about the rate of change in the Holocene and the impact on human populations (Sturt et al. 2013 p. 3964). The Arch-Manche project focusses on a number of case study areas in the Channel and the southern North Sea and aims to highlight the importance of such data in terms of coastal management and how an understanding of past change can help with planning for the future. The project looked at archaeological and palaeoenvironmental data ranging from the Palaeolithic to WWII, located in the marine, intertidal and coastal zones. However, it was clear that submerged prehistoric land surfaces have the highest potential to inform on long-term coastal change. Many of those investigated as part of the project contain long stratified and dated sequences which can demonstrate a record of the changing environment, with some spanning a series of geomorphological events.

The case studies included a variety of coastal frontages faced with different challenges in terms of management, physical conditions and available data resources. Project partners in the UK, France, Belgium and the Netherlands employed a variety of research and fieldwork techniques involving in-depth, inter-disciplinary investigations (Momber et al. 2014). The work aimed to determine sea level in relation to the coast at particular times, identify resources showing specific measurable change, and model coastal change through time. This chapter demonstrates the methodology used and presents some of the results from case studies on the English south coast at Langstone Harbour and the western Solent (Fig. 26.1).

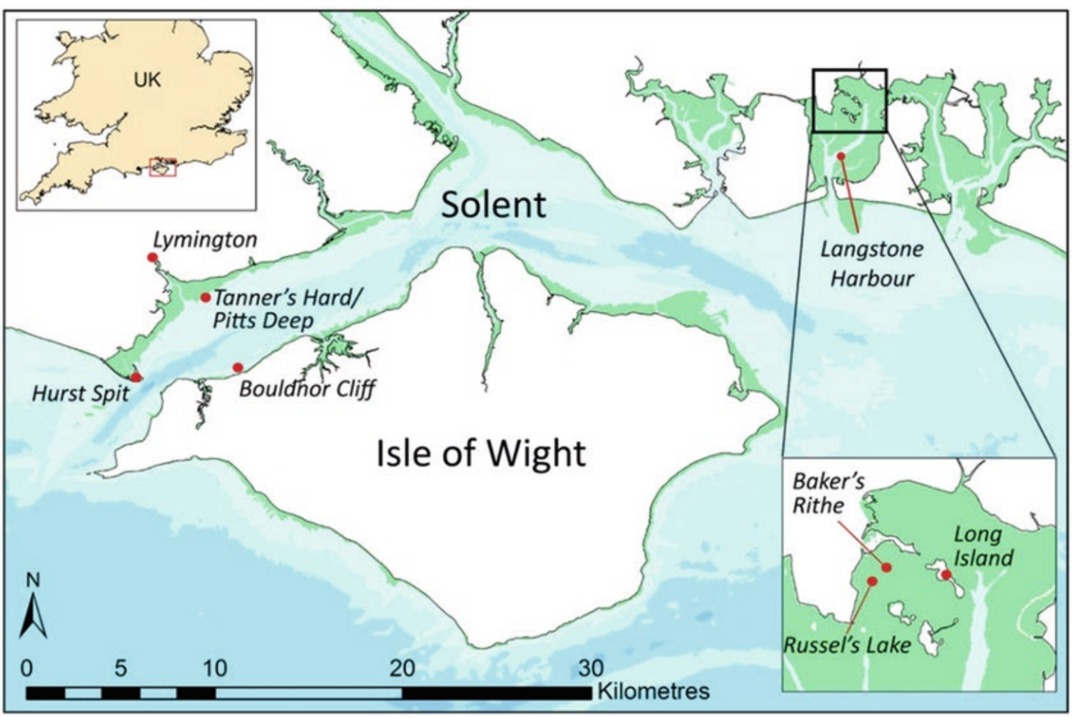

Fig. 26.1 Map of the Solent showing key sites mentioned in the text from the western Solent and Langstone Harbour. The *green shading* indicates the extent of the intertidal zone exposed between high and low tide

26.2 Methodology

A large amount of data was assessed as part of the project, and the process of extracting information from archaeological and palaeoenvironmental sources has involved a phased approach to work. This included initial desk-based assessment, ranking of sites, features and samples, and collection of primary field data using a range of field investigations.

26.2.1 Desk-Based Assessment

An initial desk-based survey identified areas of the coastline which have archaeological or palaeoenvironmental information that can help tell the story of past change, including monuments, fish traps, shipwrecks and submerged landscapes. A ranking system was developed in order to provide a relative value on the potential of each site to provide scientific information beneficial to practical decision-making in the long-term management and protection of the coastline. Particular importance was attached to information concerning the past behaviour of the coastline and to chronological information concerning the nature, scale and pace of sea level rise and coastal change.

Ranking methodologies were also developed for historical resources in order to assess their reliability. Such resources can provide important information for studying coastal development, for example, maps can be georeferenced and digitised to reconstruct former shorelines. However, the quality and detail can vary dramatically, and it was therefore necessary to evaluate these resources in terms of accuracy and reliability prior to using them for coastal research, using methods based on work carried out by Jongepier et al. (2016) and McInnes (2008).

In areas of coastal instability, archaeological and palaeoenvironmental sites have a particular role to play in establishing proven histories of localised change in coastal geomorphology and shoreline positions. These are particularly valuable in sectors subject to landslide movement and other coastal changes. Thus the ranking criteria sought to identify those sites that might best offer evidence for measuring the magnitude and rate of coastal change. Data were ranked according to the following criteria:

- Does the site contain evidence of changes in sea level?
- Does the site provide evidence of environmental change?
- Does the site contain archaeological material from different cultures/time-periods, showing evidence of temporal continuity?

The ranking did not place particular archaeological value on sites but was used to highlight the potential of a site to inform coastal managers of past changes to the coastline. The data was integrated into the project database and GIS to facilitate analysis and visualisation of areas of high potential. Although the process of ranking was subjective, it has revealed areas and environments where questions concerning the links between past and present coastal behaviour can be positively pursued.

This study has demonstrated that certain types of site and deposit can gain consistently positive scores for their potential to inform on coastal change. Some of these sites represent single or short-lived episodes. These might include a shipwreck or a prehistoric camp site. Sites of this kind can occur at a particular height, location or time that is pertinent to the understanding of shoreline-change. Other sites can offer a broader range or sequence of chronological and environmental information. They include biostratigraphical evidence such as pollen records in peat deposits, diatoms in stratified marine sediments and plant macro-fossils in river valley alluvium.

Fig. 26.2 *Left*: Auger survey off long island. *Right*: Marine seismic survey, Langstone Harbour

26.2.2 Fieldwork

The project employed a variety of fieldwork techniques to carry out detailed research on significant sites and areas of the coastline. This involved in-depth, inter-disciplinary research including fieldwork, scientific dating and analysis. The methods varied depending on the specific environment and the type of information being targeted, and included:

- Diving archaeological investigation
- Intertidal survey
- Archaeological excavation
- Geophysical and geotechnical sources

Here we discuss two case studies. The prehistoric landscape of Langstone Harbour was investigated using intertidal and marine seismic surveys (Fig. 26.2). Here the focus was on the islands present in the north of the harbour, which are known to be the last vestiges of the prehistoric landscape prior to inundation, as well as the main channels in the harbour. Six of the 14 case-study sites were subject to detailed field investigation, and full details can be found in the project technical report (Satchell and Tidbury 2014).

In the western Solent, the fieldwork included survey and sampling of submerged landscapes. Evidence from sites and deposits in this area provide high resolution data on the development of the Solent as a river, including coastal and climate change and human responses to this, which inform on current change and vulnerabilities.

26.3 Results

26.3.1 Langstone Harbour

Langstone Harbour is located between Portsmouth Harbour to the west and Chichester Harbour to the east (Fig. 26.1). The site was selected as a case study area due to its rich and diverse archaeological record and its history of archaeological investigation, in particular a large multi-disciplinary project carried out over a 5-year-period in the 1990s (Allen and Gardiner 2000). The project revealed intermittent human activity commencing in the Mesolithic and adapting, at various times, to a rising sea-level and changes in areas of mudflats and saltmarsh.

Langstone Harbour today includes an area of around 1900 ha, of which 1700 ha are exposed at low tide, demonstrating the shallow nature of the harbour. Peat deposits in the Broom Channel at a depth of between −10.5 and −12 m OD (Ordnance Datum, equivalent to Mean Sea Level) were discovered within cores related to a housing development (Mottershed 1976). But other than these, the main evidence for the development of the harbour comes from work associated with the Langstone Harbour Archaeology project undertaken in the 1990s. Of particular relevance are two radiocarbon dates obtained from submerged tree remains embedded within peat deposits from the Baker's Rithe and Russel's Lake areas between the islands. From the former a peat deposit at −1 m OD provided a date of 2310–1950 cal BC (R-24993/2, 3735 ± 60 BP), and from the latter at −0.5 m OD a date of 3350–2910 cal BC (R-24993/1, 4431 ± 70 BP) (Allen and Gardiner 2000, pp 88–90), indicating the nature of changes that have occurred since the Neolithic and early Bronze Age period.

During auger work related to the excavation of the Langstone log boat in 2002, a substantial peat deposit was encountered at a depth of around −2 m OD off the north-west coast of Long Island. This peat remained undated until recently, but its substantial thickness of up to 2 m indicated that it was likely to be a different peat from those identified during the Langstone Harbour Project (Allen and Gardiner 2000; Scaife 2003). In 2012 this area was re-visited and the palaeochannel was tracked through hand augering along a transect south-west of the previous survey. Due to the difficulties of hand augering in the intertidal zone, the deepest core reached just −2.3 m OD. A sample from a wood horizon at −0.8 m OD located within the peat layer was sent for radiocarbon dating and was dated to 1660–1650 cal BC (Beta 344585).

In order to track the buried palaeochannels, a marine seismic survey was conducted in the harbour using a parametric echosounder. The survey was conducted at high water between the islands in the north of the harbour, focussing on the area of the auger survey and around the location of the submerged forests at Baker's Rithe and Russel's Lake. The survey was also conducted in the main channels of the harbour.

Between the islands the survey profiles revealed in high detail a network of channels and a number of features on the seabed which could relate to timber remains. These were outside of the known location of the submerged forests at Baker's Rithe and Russel's Lake, suggesting that the submerged forest could have been more widespread than originally presumed (Evangelinos et al. 2014, p 4).

Previous work in the harbour suggested that the area was dominated by a steep valley in the Mesolithic following the course of the present day Langstone Channel (Allen and Gardiner 2000 p 203). A network of profiles was recorded in the Channel including large palaeochannels (Fig. 26.3; Evangelinos et al. 2014, p 10).

A 4-D model of the topographical and environmental change in Langstone Harbour was constructed based on the results from the geoarchaeological data analysis including boreholes, sediment analysis, radiocarbon dating, the results of seismic survey and the data from the 1990s Langstone Harbour Project (Fig. 26.4). The model was produced using a CesiumWebGL cross-platform. Significant stages in the development of Langstone Harbour begin with a transition from a down-cut ravine with fresh water streams to a silted river valley, infilled by organic material, which became established during the Late Mesolithic/Early Neolithic. During the Bronze Age the area developed towards a more predominantly marine environment made up of salt marsh and tidal rivers. Fully marine conditions did not characterise the channels within the harbour until after 800 BC. There then followed periods of stasis and episodes of both accelerated erosion and deposition. The harbour was then altered significantly by anthropogenic processes in the post-Medieval period, particularly through land reclamation in the area of Farlington Marshes. These dynamic episodes show a relationship with concurrent changes in relative sea-level and shifts in local currents and the tidal system (Allen and Gardiner 2000, pp 186–198).

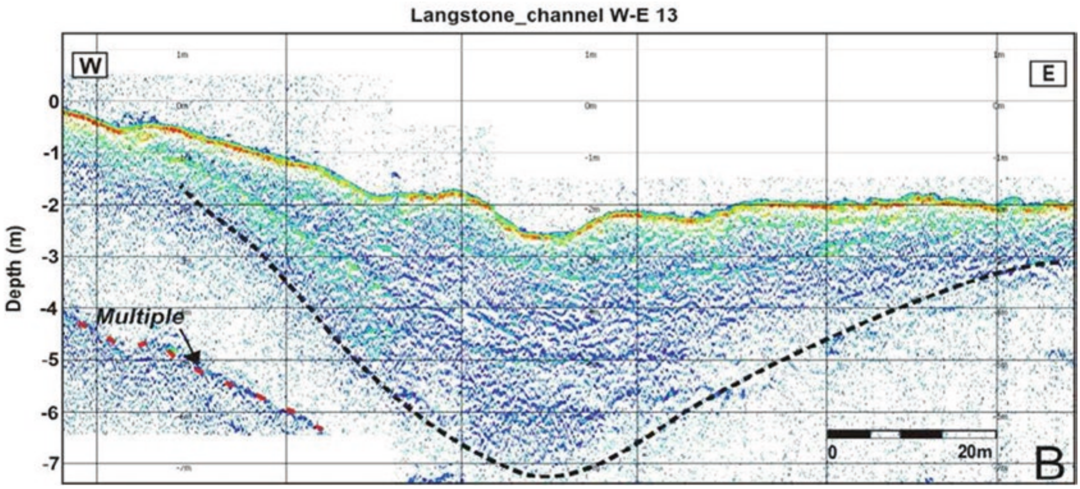

Fig. 26.3 Seismic profile in Langstone Channel showing a large buried palaeochannel (From Evangelinos et al. 2014, p 10)

26.3.2 Western Solent

The western Solent has been completely reconfigured over the last 8000 years by geomorphological changes and rising sea levels. The process has not finished and a stable equilibrium has yet to be reached. It demonstrates how the long-term evolution of a coastline can influence present and future patterns of change with important implications for ongoing management policies. Bouldnor Cliff and the wider landscape of the western Solent was chosen as a case study as it contains a long sequence of stratified prehistoric landscapes including Mesolithic occupation evidence (Momber et al. 2011).

Fieldwork was focused on the prehistoric and landscape features at Bouldnor Cliff, Tanners Hard and Hurst Spit (see Fig. 26.1) and included:

- Monitoring landscapes—many of the sites have been subject to previous survey and historic datum points were relocated to calibrate erosion over the past 10–15 years.
- Sampling landscapes—sediment samples were collected from Bouldnor Cliff and Hurst Spit to assess palaeoenvironmental changes and for radiocarbon dating.
- Excavation—an evaluation trench measuring 1 × 2 m was excavated at Bouldnor Cliff and lithic material and palaeoenvironmental samples were collected.
- Rescue artefacts—artefacts exposed through erosion were recovered from the seabed before they were lost.

Sediment archives are well preserved in this area, particularly at the site of Bouldnor, and the analysis of diatoms and formanifera together with analysis of bathymetry has revealed a sequence of events that saw final inundation by the sea around 6000 cal BC (Momber 2014, p 203). This was followed by the deposition of brackish estuarine sediments, which served to protect the palaeolandscape. Evidence suggests that the sea entered the system via the River Yar, and by 4500 cal BC rising sea levels eroded the barrier to the east of the basin, and breached the western barrier about 2000 years later. This formed the Solent, which changed from a sedimentary sink in the estuary to the new Solent channel cutting across the infill deposits and removing most of them (Fig. 26.5). Some of these deposits remain in sheltered areas to the north and south, including Bouldnor Cliff, although they are still subject to ongoing erosion (Momber et al. 2011).

The formation of the Solent dramatically remodelled the seabed by reshaping and transforming the submerged palaeolandscape. First, estuarine deposits covered and protected earlier land surfaces,

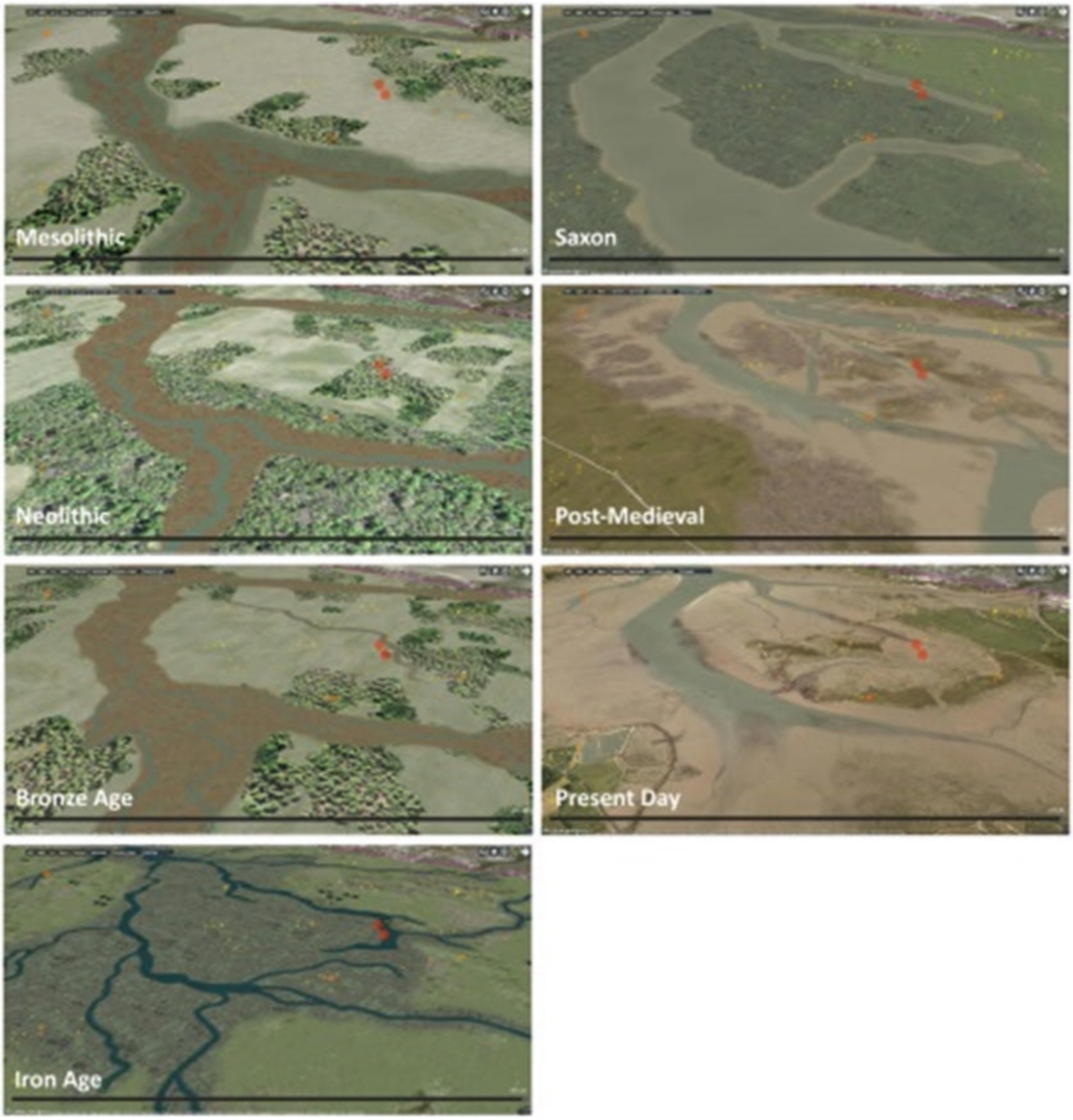

Fig. 26.4 Screenshots from the 4D model of Langstone Harbour showing the development of the harbour from the Mesolithic to the present day based on archaeological and palaeoenvironmental evidence. The *coloured dots* show the location of archaeological sites and features, the larger *red dots* are the Baker's Rithe and Russel's Lake submerged forests. The view is taken from the north-east corner of the harbour looking south-west

and secondly sea level rise overtopped hills to the east and west allowing a new channel to be formed perpendicular to the original drainage pattern (Fig. 26.5). This masked the previous north–south flowing river. The results show that the centre of the Solent Channel has been eroded and is now deeper than would otherwise have been the case, demonstrating that the palaeolandscape was quite different from what might have been concluded by relying solely on the morphology of the present-day seabed (Momber 2014, p 203). Moreover, the accumulation of fine-grained fluvial and marine silts in an oxygen-free environment has preserved detailed, well stratified and well preserved remains, demonstrating the nature, rate and scale of change, and the fact of ongoing erosion of the palaeolandscape.

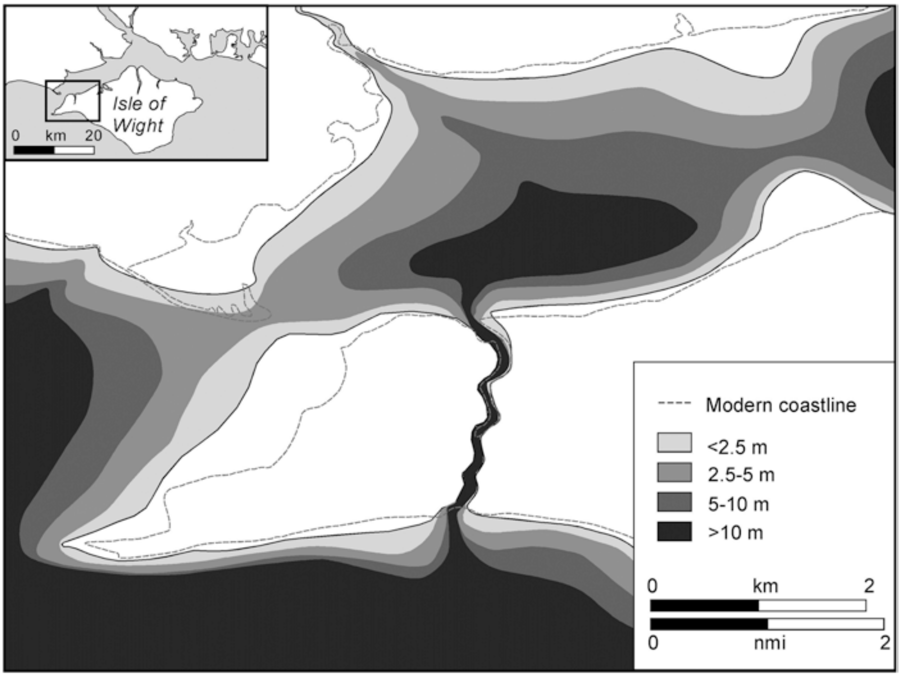

Fig. 26.5 Formation of the western Solent, showing the effects of progressive sea-level rise and shoreline retreat. At 6000 cal BC, sea level was around 10 m below OD and the Isle of Wight was connected to the mainland. At 4500 cal BC, sea level reached 5 m below OD opening up a channel to the east. Around 1500–2000 cal BC, sea level rise crossed the 2.5 m contour and a second channel opened to the west. The breaching of this final land link to the Isle of Wight transformed a salt marsh into a channel that would eventually extend over 10 km long and up to 60 m deep. The strong tidal currents introduced when the channel was formed continue to erode the Solent shoreline today. The land shown in white indicates an estimate of the coastline when sea-level approached the present level. The difference with the modern coastline reflects widening of the Solent channel by coastal erosion (and locally, shoreline progradation). Image re-drawn by Geoff Bailey from an original by Garry Momber

26.3.3 Lymington, North-West Solent

Alongside archaeological and palaeoenvironmental data, the project has also used historical resources including works of art, photographs, maps and charts to understand more recent change. This can be combined with the data from archaeological investigation to provide an understanding of coastal change both in the long and short term. A methodology was developed as part of the project to assess the reliability of historic maps and charts (Jongepier et al. 2016), and those which ranked more highly in terms of reliability were used to reconstruct past landscapes through digitisation and GIS-rectification.

Off Lymington in the north-west Solent, historic maps were used to assess the rate of saltmarsh and mudflat erosion (Fig. 26.6). The most reliable maps were georeferenced and the limit of the saltmarsh digitised demonstrating the rate of change from 1781 to the present day. Over a period of 153 years from the date of the first map (1781) to the second map (1934), the area witnessed around 500 m of regression of the saltmarsh. Over the next 57 years a further regression of 200–400 m took place, indicating an increased rate of change, and subsequently this accelerated more dramatically with salt-marsh erosion in just 22 years of up to 500 m in places. Clearly, the rate of erosion has dramatically increased in the last 100 years. The specific cause of saltmarsh regression is currently not well

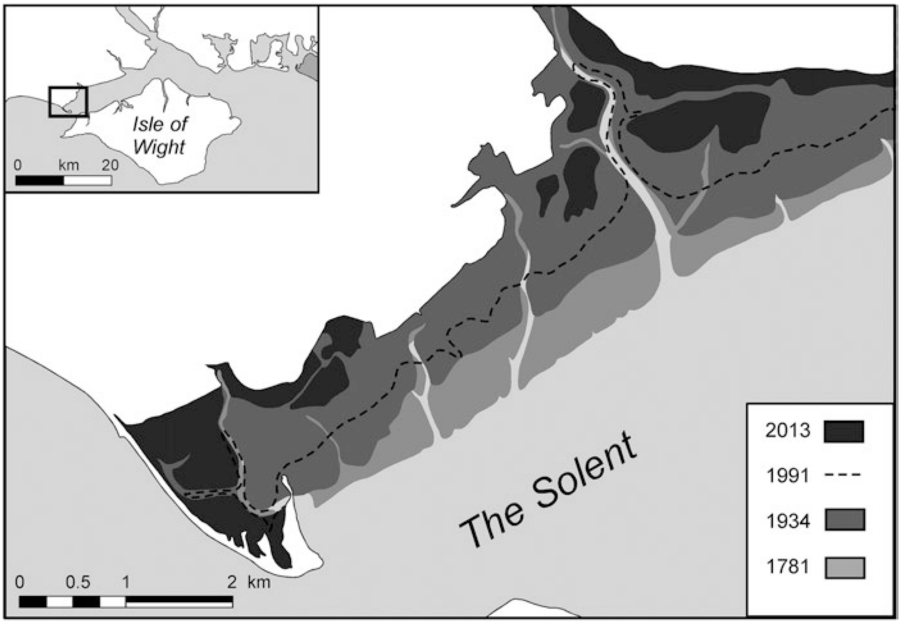

Fig. 26.6 Saltmarsh and mudflat regression in the north-west Solent based on historical map analysis (Image re-drawn by Geoff Bailey from an original by the Maritime Archaeology Trust)

understood, but is thought to result from a combination of factors including wave action, lack of sediment supply, dieback of vegetation, tidal currents and sea level change (NFDC 2014). These maps cannot provide an answer to the cause of erosion, but they can provide high resolution detail on the rate and scale of change from the eighteenth century onwards.

26.4 Conclusions

All those involved in coastal management have a requirement for high quality data and a thorough understanding of the physical processes at work around the coastlines of the Channel and the southern North Sea. An appreciation of the impacts of coastal evolution and processes is fundamental in order to understand and manage coastal frontages in the most effective way. Long-term coastal monitoring is increasingly recognised as an invaluable data source to support coastal risk management, as well as providing information to assist, for example, the efficient design and construction of coastal defence measures.

Over 3000 sites across the English Channel and southern North Sea regions were assessed as part of the Arch-Manche project. Six areas were selected for detailed fieldwork and investigation, and the results from two of these have been outlined here. Information from these sites provides data on the scale and rate of coastal change in these areas. Sites from the Mesolithic period demonstrate evidence of rapid sea level rise as thousands of kilometres of inhabited land were lost to the sea. Since current climate change models predict future rise in sea level, inundated Mesolithic sites are of particular relevance to coastal management (Gaffney et al. 2009). Archaeological research on such sites can also contribute new sea-level index points, providing valuable information to improve existing climate change models.

Palaeoenvironmental data provide evidence of past landscapes from early prehistoric times through to the present. Analysis reveals evidence of the environment including plants, animals and insects, the types of soils, and whether it was dry, damp or wet, saline or brackish. Recording changes to these environments demonstrates the impact of rising or falling sea levels and relationships with coastal adaptations. Humans have used the coastal zone for thousands of years. The position of settlements shows the proximity to coastal areas, while specific features like trackways to cross marshy areas show adaptations to marine environments, such as those found off the north coast of the Isle of Wight dating to the Neolithic (Tomalin et al. 2012). Studying the archaeological record can demonstrate how humans adapted to change, and in more recent times, how they effected change.

The project has also looked at coastal heritage and historical resources to understand more recent change to the coastlines of the Channel and North Sea regions. Using a combination of data sources allows for maximum amounts of information to be extracted.

This project has highlighted the potential of these various sources of data to contribute to understanding the rate and scale of past change, their value in contributing to informed decisions about future management, and the scope for more detailed analysis along the same lines and in different areas to further refine interpretation and assessment of future risk associated with climate and sea-level change.

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