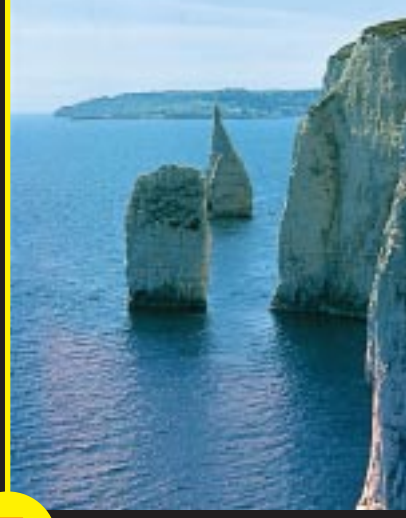
The Earth in our hands

- how geoscientists serve and protect the public



7 COASTAL EROSION

About these briefings

The Earth is a dynamic planet. It is active and productive, offering humanity enormous opportunities. However, living on it also presents us with many dangers; some of our own making.

In our interaction with the Earth, geoscientists are in the front line. They seek and find the raw materials we use for agriculture, roads, buildings, energy, water supply and all the industries that provide wealth and health.

Geoscientists help society understand natural hazards and mitigate their effects. Such dangers include floods, landslips, volcanic eruptions and earthquakes.

Geoscientists also help to minimise hazards we have created (or made worse) by our activities. These include subsidence, and the disposal of waste.

With their unique understanding of the immensely long time spans over which Earth processes operate, geoscientists help communities world-wide to learn how to use the planet's resources safely, wisely, and sustainably.

This series of information sheets is dedicated to bringing this role to public attention.

Further information

http://www.bgs.ac.uk/programmes/envhaz/cggci/home.html Description of key strategic research on coastal issues being undertaken by the British Geological Survey

http://www.wwf-uk.org/news type "coastal erosion" into search box for up to date information and useful introduction to the coastal erosion and the threat to Britain's east coast.

http://www.coastalwight.gov.uk Isle of Wight coastal management, climate change and landslide studies

http://www.scopac.org.uk Coastal defence initiatives along the central south coast of England

http://www.environment-agency.gov.uk Environments Agency site with links to environment groups, newsletters and news releases

http://www.curdev.hull.ac.uk/html/coastal_erosion_resources.htm web site aimed at schools in the Hull area and along the Holderness coast with links and photographs of local sites of coastal erosion and a few useful links worldwide

http://www.rdg.ac.uk/~waa5/ecifm/protected_areas.htm University of Reading web site with good glossary and explanation of protected land areas, acronyms, and designated bodies, with useful links

http://www.bgs.ac.uk Holiday guides to coastal regions in the UK

http://www.geographyshop.org.uk/catsec.html Geographical Association Classic Landform Guides include coasts of East Dorset, West Dorset, Gower, North Devon, South Devon, North Norfolk, Sussex, Antrim, Morecambe Bay

http://www.haznet.org/text/erosion.html A good introduction to coastal erosion with links to US research sites and nationwide projects

http://www.environment.about.com/newsissues/environment/cs/coastalerosion/ Useful site for environmental issues, with links to more than 700 environmental web sites. Predominantly US-based, it includes a teachers' guide to coastal erosion and worldwide articles and book reviews.

The Earth in our hands

Published by
The Geological Society of London
Burlington House
Piccadilly
LONDON W1J 0BG
Tel: +44 (0)20 7434 9944
Fax: +44 (0)20 7439 8975
Email: enquiries@geolsoc.org.uk
Web site: www.geolsoc.org.uk

Further copies are available on request (preferably by email). Individual copies are free, and will be posted anywhere without charge. Multiple copies attract both charge and postage. Please contact the Society if you wish to order more than one copy. All leaflets in this series can now be downloaded free as colour PDFs from www.geolsoc.org.uk.

Series Editor: Ted Nield
Written by: Cally Oldershaw
Photos by: Ted Nield

The Geological Society gratefully acknowledges the assistance of its External Relations Committee (Chair, Dr Hazel Rymer) and the following scientists, who (in a personal capacity) read and commented on earlier drafts of this briefing.

John Rees
Tim Collins
Robin McInnes
Janet Hooke

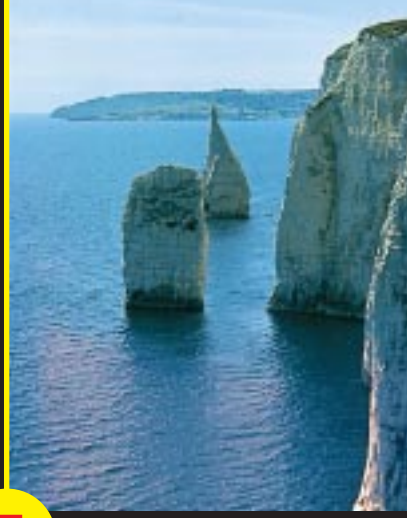
August 2001

The Geological Society of London is a Registered Charity, No. 210161

The Geological Society

The Earth in our hands

- how geoscientists serve and protect the public



7 COASTAL EROSION

The UK coast: a major asset

The UK has more than 6000km of coastline. Ports, harbours, marine industries, power generation and beaches are essential to manufacturing, trade, recreation, fishing and tourism. In addition, many parts of our coastline are important wildlife sanctuaries or breeding grounds. Over the last 30 years these attractions have drawn more people and industries to the coast.

- Many of our major cities and industrial port complexes are concentrated along coasts and major estuaries.
- Coastal and marine-related industries and services are estimated to contribute almost 5% of UK GDP (equivalent to an annual turnover of £51 billion)
- Such industries support almost one million jobs (nearly 4% of total employment); almost a quarter in the tourist industry.
- About 45% (£6.2 billion) of the total amount spent by UK residents on tourism in 1994 was on coastal holidays.

200,000 tonnes of chalk fell at Beachy Head in January 2001.

The Geological Society

Coastal change

Coastal erosion, or coastal instability, threatens property and businesses and puts people living near cliffs and shorelines at risk. The great concentration of national resources in coastal zones makes it imperative that coastal change is well understood. The character and shape of the coastline is controlled by many factors including:

Geology

- The nature of rock or sediment type, onshore and offshore
- Structures within the rocks or sediments such as bedding, joints or faults
- Position of the water table in coastal cliffs or slopes
- Rate of sediment supply to coastal areas from areas of coastal erosion or rivers
- Changes in the Earth's crust

Climatic and oceanographic processes

- Waves, largely influenced by wind and by water depth
- Tides
- Rates of relative sea-level change
- Rainfall
- Frequency and intensity of storms

Human intervention:

- Coastal constructions, such as harbours
- Aggregate extraction, such as beach mining
- Creation of flood and coastal defences against erosion
- Coastal reclamation, drainage (damming rivers or otherwise modifying their flows)

The nature of coastal change at any one place or time results from combinations of the factors described above. Coasts are subject to almost continuous change, and can either erode (retreat) or build seawards (accrete).

IPR/20-7C British Geological Survey. © NERC. All rights reserved

One person was killed as this landslide at Nefyn, North Wales swept a parked car into the sea.

Their position has been constantly changing over many thousands of years. At the peak of the last glaciation, about 18,000 years ago when Britain was connected to the main European landmass, our coasts were (in most instances) far removed from their present position.

Since about 6000 years ago, when sea-level stabilised after the last glaciation, many of our coasts have been dominantly erosional. For instance, the sites of many historic settlements now lie many kilometres seawards of the present coast (such as the ancient settlements now underwater off Humberside - Fig. 1).

Such examples show that the changes we see in our coasts, such as those caused by coastal erosion, are not the exception but the rule. It is only because most people see coasts as broadly stable over the human life span that they do not recognise that coastal change is constant and that - over the long-term - commonly inevitable.

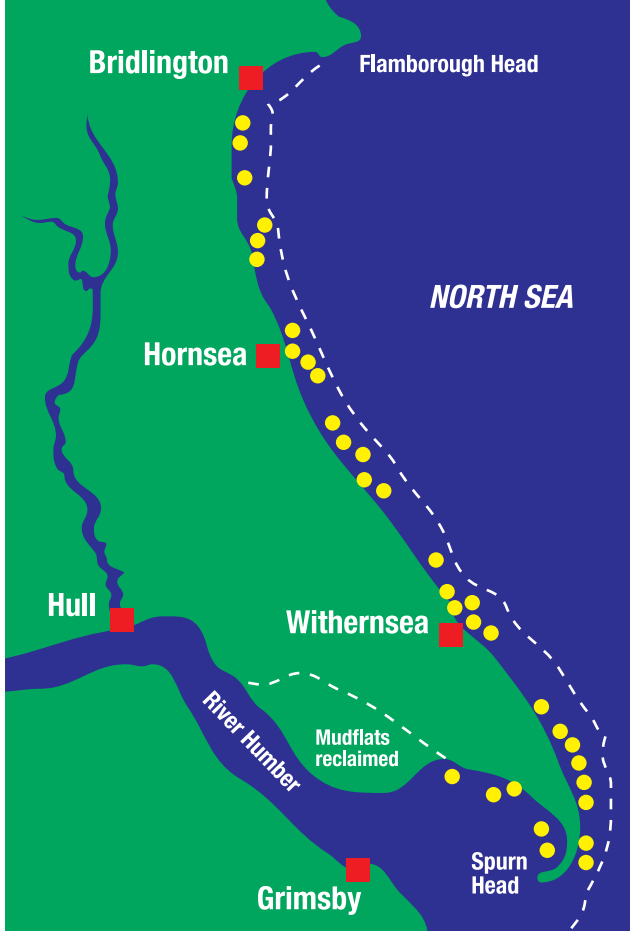


Fig. 1: Sketch map showing the loss of land and villages by marine erosion along the Holderness coast, Humberside, England. The broken line indicates the approximate position of the coast in Roman times; former settlements are shown by yellow dots. (After T. Sheppard)

Rates of change differ substantially over space and time. Although rates are generally slow on a human timescale and are governed by many cumulative events, occasionally earthquakes, other geological forces (see no. 6 in this series - *Tsunamis*) or storms can dramatically change coastlines within a few hours or minutes.

Some factors, such as periods of increased rainfall, storminess, or sea-level rise may increase rates of change. For instance, rain may weaken coastal cliffs or make them so heavy that they can no longer support their weight. The increased number of storms with heavy rainfall during the winter of 2000/01 led to increased numbers of landslides that caused dramatic coastal erosion (see no. 3 in this series, *Landslides*). For example:

- 27 December 2000. Nearly 2.5km of the 45m-high cliffs at Charmouth, Lyme Regis, Dorset, collapsed.
- 2 January 2001. One person was killed as landslides at Nefyn, North Wales swept a parked car into the sea.
- 26 January 2001. A section (almost 200m wide by 100m deep), of the White Cliffs of Dover near St Margaret's Bay, Kent collapsed yielding an estimated 200,000 tonnes of chalk rubble.
- 21 March 2001. The slope behind a hotel and flats on Shanklin seafront, Isle of Wight, failed.
- 3 April 2001. The Devil's Chimney (a chalk stack almost 70m high) collapsed at Beachy Head, East Sussex.
- 9 April 2001. Thousands of tonnes of debris falling from a cliff landed just short of a supermarket building near the Brighton Marina.

Some of these events damaged property and businesses. In any case, many councils face multi-million pound bills to repair damage and increase or improve coastal defences.

Coastal change and global warming

There is little doubt that rates of coastal change will escalate with enhanced rates of sea level rise and increasing storminess, both of which are associated with global warming. These changes are likely to have a significant impact on coastal populations and infrastructure.

Sea levels are expected to rise significantly over the next century, largely as a result of the melting of ice sheets and thermal expansion of the oceans. Global warming will also change ocean currents, world weather patterns, winds, coastal currents, waves and storms. The increase in the frequency and size of the latter, which have an enormous influence on coastal change and near-shore sediment transport, will have a major impact on the form of our coasts.

Predicting coastal change

Geological, archaeological and historical records are used to establish the nature of past coastal change. Monitoring of coastal change is also undertaken using a broad range of techniques including airborne laser ranging technology (LIDAR) and digital aerial photogrammetry. These techniques are used to determine coastal topography, coastal erosion, and shoreline position with high accuracy. The bathymetry of offshore areas is determined by several geophysical techniques including side-scan sonar or multi-beam surveys.

In the UK geoscientists are widely involved in projects that address past coastal change and monitor how coasts are changing today. The principal aim of many of these studies is to understand the natural processes that govern coastal change in order to predict the patterns and rates of future coastal evolution. A broad range of decision-makers, including coastal zone planners, government and authorities require accurate and well-researched information in managing the coastal zone.

Much of the impetus and funding for such research is derived from the Department for the Environment Food and Rural Affairs (DEFRA). Some agencies have particular responsibilities for monitoring particular aspects of coastal change. For instance the Environment Agency has responsibilities for flooding in England and Wales (see no. 2 in this series, *Flooding*). Three national agencies (English Nature, the Conservancy Council for Scotland and the Countryside Council for Wales) are responsible for preserving flora, fauna and geological features, including those along the coast. The best examples of wildlife habitats, geological features and landforms are designated as Sites of Special Scientific Interest (SSSI; there are about 6500 of these covering about 9% of the UK land area).

Many surveys are carried out by the Ordnance Survey, the Hydrographic Office or the British Geological Survey. Other monitoring schemes are run by other Government research institutes, universities and local government. Some funding for UK coastal projects is derived from the European Union.

Managing coastal change

Much of this research on coastal change forms the basis for integrated coastal zone management on a local, national and international level. In the UK Shoreline Management Plans (SMPs) are required for coastal management. Each of the SMPs is required to consider coastal change and issues such as sediment transport in the nearshore zone. Most SMPs consider distinct parts of the coast, such as complete estuaries or sections of coast in which near-shore sediment is largely 'contained' within a coastal cell, or behaves in a consistent manner.

SMPs broadly recommend, in scientific and technical terms, where:

- the process of erosion can be checked
- the line can be held
- 'managed retreat' of the coastline is the only option.

Such evaluation is important given the high costs of coastal defences, which can only escalate in future years. Currently about 44% of the English and Welsh coast is protected by some form of coastal defence. Difficult decisions will need to be made to determine how this percentage will change in response to the increased rates of coastal erosion caused by sea-level rise. These decisions cannot be made without widespread consultation and will need to balance the socio-economic needs of developers, landowners and residents with coastal protection and environmental groups. Furthermore, they will need to take aspects of European legislation (e.g. the Habitats Directive) that been incorporated into British law, into consideration.

Coastal managers have to consider not only which parts of the coast they should attempt to defend, but also which type of defence is most appropriate. Locally it will be best to defend coastal areas using traditional constructions, such as sea-walls, dykes, groynes and breakwaters. Such engineered 'hard' structures are expensive and may only result in enhanced coastal erosion on adjacent coasts.

The alternative approach is to work *with* natural processes and create 'soft' engineered solutions, e.g., by encouraging accumulation of sediments in selected areas. For example, sediments accumulating in estuarine salt marshes protect the estuaries and associated human infrastructure from erosion, storm surges and coastal flooding.

Whatever approach is used, no section of coast should be studied or managed in isolation. The whole picture must be understood, in regard to changes in the past, the present position and how any coastal management scheme will be affected by future changes. The best and most sustainable options probably lie in an integrated coastal zone management approach. These may contain multiple response strategies that can be modified for different socio-economic factors and environmental conditions, working with natural processes rather than against them. Geoscientists have a key role to play in providing the foundations for such management.