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Assessment of Coastal Erosion and Landsliding for the Funding of Coastal Risk Management Projects

GUIDANCE NOTES

EA National Coastal Team

December 2010

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Assessment of Coastal Erosion and Landsliding for the Funding of Coastal Risk Management Projects

Statement of use

This document provides guidance on the assessment of coastal erosion and landsliding for the funding of coastal risk management projects under the Coast Protection Act 1949.

Dissemination status

Publicly available

Principal readership

Representatives of maritime local authorities, consulting engineers, EA coastal engineers, assessment boards of approving bodies.

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- p20 Scarborough Borough Council
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Background

The purpose of these notes is to provide guidance on the assessment of coastal erosion, cliff instability and coastal landslides in England and Wales for the funding of coastal erosion risk management projects, particularly with respect to applications for grant in aid under the Coast Protection Act 1949. The notes are essentially an outline and clarification of existing guidance from Defra and the EA (see Box 3). In all cliff systems there are many interrelated factors which contribute to coastal instability and erosion in addition to the action of the sea (for example, cliff-face weathering and the presence of groundwater).

The coastline of England and Wales faces significant threats arising from coastal erosion, cliff instability and landsliding. Damage and loss of land, property and infrastructure is widespread, particularly along the soft rock coastlines of eastern and southern England. Out of an estimated total of 6,251 km of coastline in England and Wales, 3,327 km (53%) are cliffs subject to instability and erosion (NCERM database). There are some 865 km of protection works to reduce the impacts of coastal erosion and cliff instability (Futurecoast cliffs database). However, a significant proportion of these works are either ineffective in terms of preventing cliff recession, or are approaching the end of their useful life. Coastal erosion problems may be particularly severe where development has taken place close to unstable and retreating cliff tops, or upon coastal landslide systems which are subject to ongoing ground movement or landslide reactivation under adverse conditions.

The management of coastal erosion risk will be an increasingly significant issue for the foreseeable future, due to the effects of climate change. Climate change impacts on the coastline are expected to increase the rates of erosion and the frequency of landslide activity, through continuing sea level rise and changing weather patterns, for example increasing winter rainfall totals and a greater intensity of rainfall events.

Funding

Coastal erosion risk management work, comprising both the investigation of coastal erosion problems and physical protection works, is funded and undertaken, principally, by the following types of organisation:

- private land-owners, estates and coastal industries;
- transport authorities such as highways authorities and Network Rail;
- local authorities, using their own funds;
- local authorities, using grant in aid funding from central government, via the Environment Agency.

The principal route for local authorities to gain funding to carry out coastal risk management work has been through the Coast Protection Act 1949. In theory, it may be possible to attract funding for coastal instability and erosion problems through other routes, such as the Land Drainage Act 1991. However, the Coast Protection Act 1949 has proved to be the most widely used and practical Instrument to undertake investigations and to carry out coast protection and stabilisation works in the national interest.

Existing funding arrangements under the Coast Protection Act 1949

In recent years there has been debate about how funding for protection works involving coastal landslides should be addressed. Assessments for grant in aid funding under the Coast Protection Act 1949, have recognised that coastal retreat is often due to a combination of different processes in addition to erosion by direct wave action, and that these influences may be impossible to separate. Thus many of the major protection schemes which have received grant in aid funding nationally over the last 20 years have included components of slope strengthening and drainage in addition to toe protection against wave action.

Whilst many schemes receiving grant in aid have included provision of drainage, for example to lower groundwater levels to assist in landslide stabilisation, other projects have been unsuccessful in securing grant where it has been deemed that drainage issues are unrelated to the normal processes of coastal cliff recession.

It has also been recognised that coastal erosion risk does not necessarily stop once the toe of the cliff is protected from wave action by, for example, a seawall, and several grant in aided schemes have involved works to stabilise cliffs behind established seawalls. This has acknowledged the fact that unless these works are undertaken, risks may be posed to the coastal defence structure from landsliding occurring behind the defence itself.

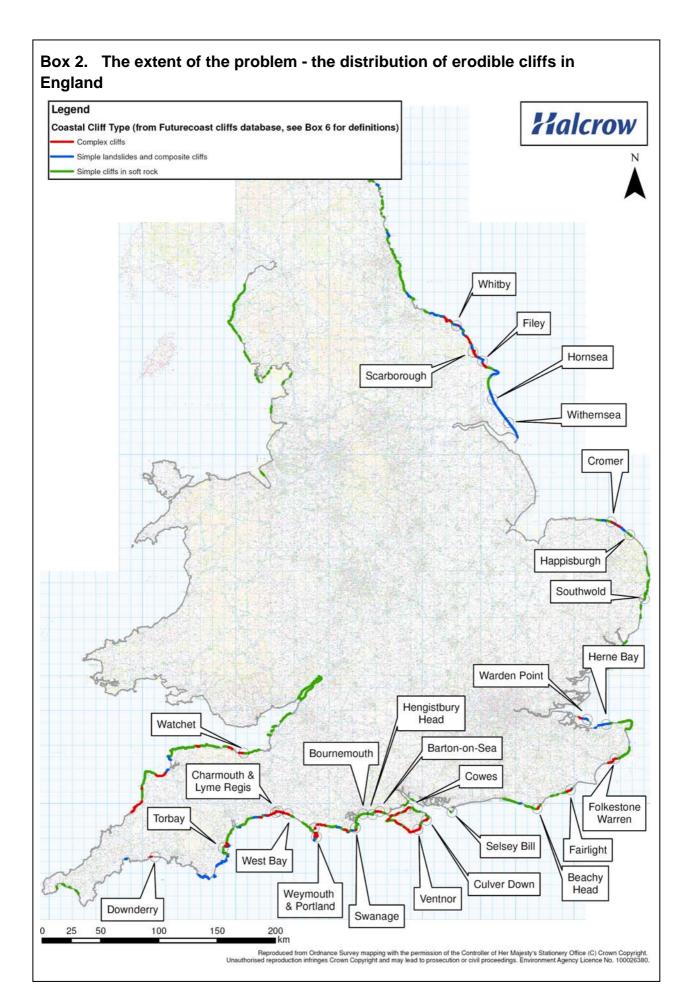
Grant in aid has also been given under the Act to assist with studies and investigations of coastal erosion risk problems.

In addition to receiving grant in aid funding from central government, coast protection projects have often been supported with funds from other sources, including contributions from local authorities and from organisations benefiting from the work, such as utility companies and highways authorities.

Box 1. Definitions

(For further explanation of these terms, see the publications listed in the references.)

Cliff	A vertical face or (usually steep) slope. Most cliffs on the coast have been formed by erosion by the sea.	
Coast protection	Coastal erosion risk management involving physical protection. This may include measures for stabilising landslides.	
Coastal erosion	The detachment of material, transport through the cliff system, deposition on the foreshore and its removal by wave action. The definition encompasses any one, or all, of these elements, and does not require direct wave action on the base of the cliff.	
Coastal erosion risk management	Activity to identify and manage the risks and consequences of coastal erosion and encroachment from the sea.	
Erosion by the sea	For the purposes of these guidance notes, identical in meaning to coastal erosion.	
Groundwater	Water present within geological materials below the ground surface. Groundwater pressures and seepage erosion are often contributory factors in coastal erosion processes.	
Instability	Essentially synonymous with landsliding, but may also be used to describe initial ground movements prior to the onset of fully- developed landsliding, or the potential for ground movements to occur in the future.	
Landslide	The failure of a mass of rock or soil under gravity, often an important part of coastal erosion processes.	
Landslide system	A system consisting of several interrelated landslides or mass movement processes.	
Recession	The landward retreat of the cliff profile (from cliff base to cliff top) in response to the coastal erosion processes (often including landsliding.)	
Sea cliff	The most seaward cliff face within a landslide system.	
Slope stabilisation	Engineering work to improve the stability of a slope, typically with the aim of preventing landslide movement in order to protect assets.	
Soft cliff	Cliffs formed of geological materials which have low resistance to erosion, such as clays and sands.	



Box 3.	Coastal Erosion Risk Management Framework

Responsibilities	Key Policy Documents, Guidance Documents and Data
Department for Environment, Food and Rural Affairs (Defra) Sets national strategy for coastal risk management.	Defra policy statement on the appraisal of flood and coastal erosion risk management, 2009. Defra - adapting to coastal change: developing a policy framework, 2010. Defra - risk assessment of coastal erosion project (RACE) 2006. Defra - Futurecoast cliffs database 2002.
Environment Agency (EA) Strategic overview of all flood and coastal erosion risk management. Grant in aided coastal risk management projects.	EA coastal strategic overview. Grant memorandum for coastal erosion. Flood and coastal defence project appraisal guidance. National coastal erosion risk mapping (NCERM).
Regional Coastal Groups	Shoreline Management Plans (SMPs). Regional coastal monitoring programmes.
Local Authority (Engineering) Investigates coastal erosion, plans and implements coastal risk management work.	Coastal Defence Strategy Plans. Consultants' reports on cliff instability and erosion investigations.
Local Authority (Planning) Assesses planning applications for coast protection works.	Local Development Frameworks. Planning Policy Guidance 14 - development on unstable land. Planning Policy Statement 25 - development and flood risk. Planning Policy Statement 25 Supplement: - development and coastal change.
Conservation bodies Assess proposals for coast protection works in terms of impacts on the natural environment and heritage.	Biodiversity Action Plan targets. Local conservation objectives.
Landowners Ongoing inspection and maintenance of property with the aim of minimising erosion and instability risk. May implement coastal risk management work in some cases.	McInnes, R. 2007. 'The Undercliff of the Isle of Wight. A guide to managing ground instability.' Centre for the Coastal Environment. Isle of Wight Council.
	General guidance documents
	Lee, E. M. and Clark A. R. 2002. 'Investigation and management of soft rock cliffs.' London. Thomas Telford.
	McInnes, R. 2008. 'Coastal risk management: a non-technical guide.' SCOPAC.

Principles – the nature of coastal erosion

Coastal erosion is a four stage process (Box 4) involving:

- detachment of particles or blocks of material from the cliff,
- the transport of this material through the cliff system,
- its deposition on the foreshore and
- its removal by wave action.

Coastal erosion may also involve the lowering of beaches and erosion of shore platforms.

Cliff recession is the landward retreat of the cliff (from cliff base to cliff top) as part of the erosion process.

At any one location there are usually many interrelated factors which contribute towards coastal erosion (Box 5), for example:

- geological structure
- material strength
- cliff angle
- groundwater pressures
- surface water drainage
- human effects.

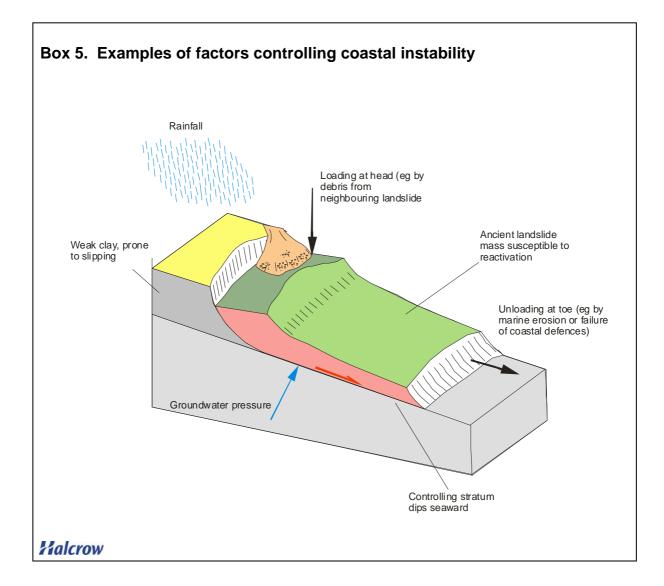
These factors define the way in which the cliff will behave, and a range of types of cliff system can be recognised on the basis of throughput and storage of material within the system (Box 6).

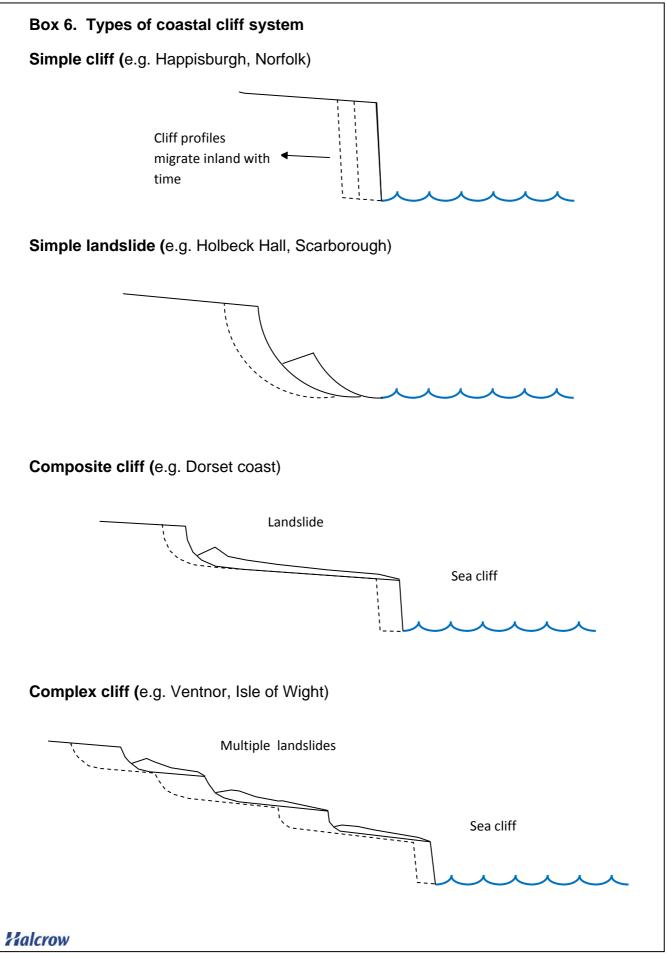
Wave action is only one part of a relatively complex multistage process. It prevents debris from building up on the foreshore, which if allowed to accumulate in the long-term would give support to the cliff and may ultimately lead to its stabilisation.

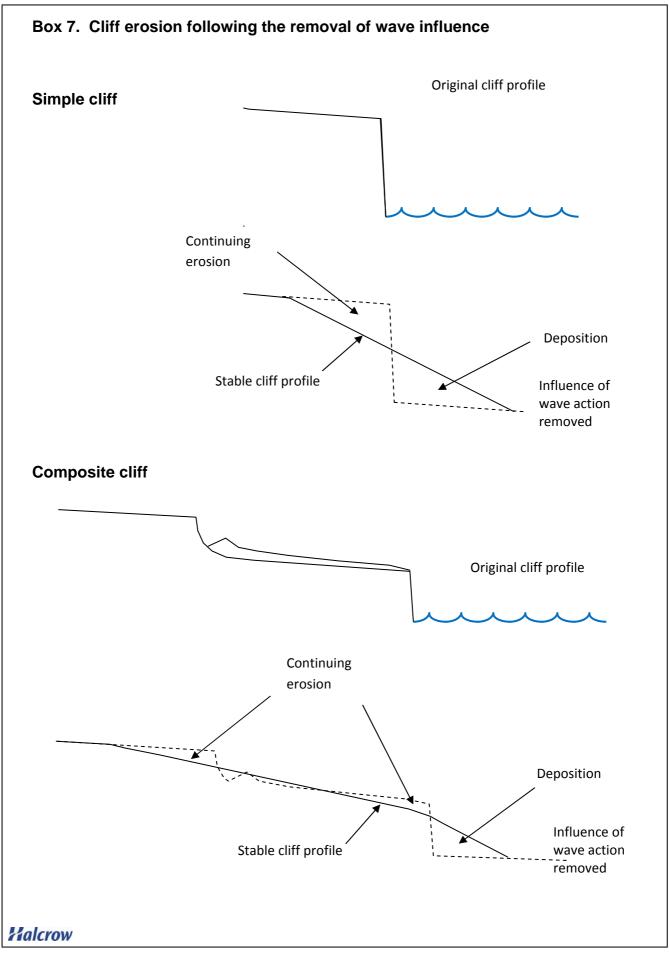
If wave action is prevented, this does not necessarily stop a continuation of erosion, weathering and instability higher up in the cliff system and the further landward retreat of the cliff top, which may progress until the cliff reaches an ultimate stable angle (Box 7). These processes may also pose a risk to coastal defence structures if not addressed. The timescale required for the cliff system to move back to its ultimate stable state depends upon the characteristics of the individual cliff, but may range from tens of years through to hundreds, or even thousands, of years. The effects of wave action may be prevented or reduced by constructing a seawall or rock revetment at the toe of the cliff system (Box 8). In such cases, erosion may continue above the sea wall with the debris overriding the wall and being washed away by the sea. In this situation, the sea is effectively still having a direct influence on the behaviour of the cliff system by removing debris and preventing it from establishing slope support at the toe.

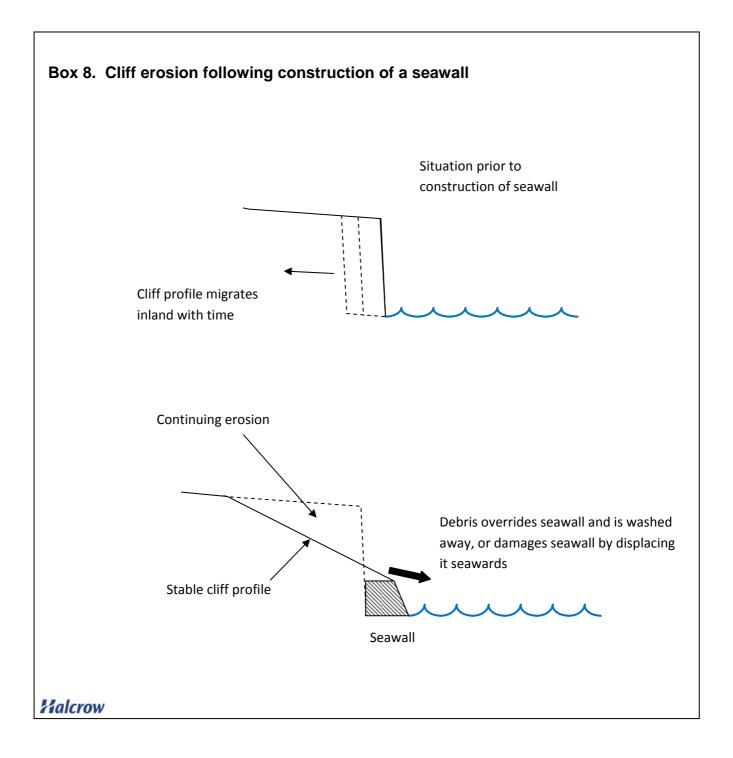


Modified from Lee and Clark (2002) - Investigation and management of soft rock cliffs.









Guidance in assessing coastal erosion

The Coast Protection Act 1949 states that,

'Subject to such conditions as the Treasury may determine, the Minister may make grants towards any expenditure incurred under the act by a coast protection authority...'

It also states that,

"protection" means protection against erosion or encroachment by the sea'

In order to make an assessment of which elements of a project may be eligible for grant under the Act, it is essential that the cliff system is well understood in terms of its erosion processes, instability and long-term behaviour. Hence adequate understanding must be established of coastal geomorphology and cliff behaviour to make a sound judgement on management options.

An essential requirement of the Act is that cliff recession must be associated with the sea. Instances of recession which may not be related to the sea may include, for example, erosion due to uncontrolled discharge of surface water drainage, or due to human effects such as inappropriate excavation for a development. Hence a fundamental link with the sea must be established.

A sea wall or similar defence structure under threat from landsliding, outflanking or scour due to wave action may be eligible for grant.

In principle, land that is currently unaffected by cliff recession, but will clearly become affected by the sea's influence in the future because, for example, of the effects of sea level rise or coastal change, may be considered for grant under the Act. However, in practice the urgency of funding the reduction of current at risk will need to balance against potential future needs. Economic discounting will, on balance, favour projects that provide substantial early benefits. Adaptation, rather than protection, measures are more likely to be an appropriate response to future risks that can clearly be foreseen in many cases.

The checklist in Box 9 and the flowchart in Box 10 may be used to assist in determining whether or not a project would be eligible for funding under the Coast Protection Act 1949. Proposals for investigations may be eligible for grant in aid where a reasonable case can be made for their inclusion.

It should be noted that even if a project appears to be eligible for grant in aid under the Coast Protection Act there is no guarantee that funding will be available. Any national funding which is available will be allocated on the basis of priority in terms of get the best value for money and meeting legal requirements.

Guiding Principles to aid preparation and assessment of submissions

- Cliff recession processes must have been properly investigated and be adequately understood to prepare eligible management options.
- A fundamental link with the sea must be established to allow a project to be considered for grant in aid under the Coast Protection Act 1949.
- There is a range of terminology applied to the cliff system behaviour such as 'Cliff recession', 'coastal erosion', 'erosion by the sea' and 'coastal landslides'. It is important to determine the appropriate process mechanisms and triggers, with the key principle being the link to the action of the sea.
- To secure asset design life, existing or proposed coast protection works may require complementary drainage or slope stabilisation to prevent landslides endangering their integrity.
- Contributions should be sought in line with the Environment Agency's Flood and Coastal Risk Management (FCRM) External Contributions Policy. There should be evidence that contributions are secured proportionate to the assets at risk.
- The EA Area Coastal Engineer should be consulted and involved at an early stage and throughout any investigations and works receiving grant under the Coast Protection Act.
- Grant would not be available where it has been deemed that drainage issues are unrelated to the normal processes of coastal cliff recession.

Box 9. A checklist for the assessment of coastal erosion

Description

Has the cliff system been investigated by specialists experienced in coastal geomorphology and cliff behaviour?

Typical elements of an investigation would include:

- historical research,
- geomorphological mapping,
- ground investigation,
- monitoring,
- interpretation of coastal process and cliff behaviour,
- prediction of future behaviour.

Is the cliff system well understood in terms of its erosion processes and long-term behaviour?

Is cliff recession associated with the sea, or has it been associated with the sea at some time in the past?

If the location is currently unaffected by cliff recession issues, could it become affected by the sea's influence at some time in the future, for example due to the effects of climate change and sea level rise? At what point in the future could this occur?

If a seawall or similar structure is present, is erosion or landsliding taking place on the slope above the wall, or does it have the potential to do so?

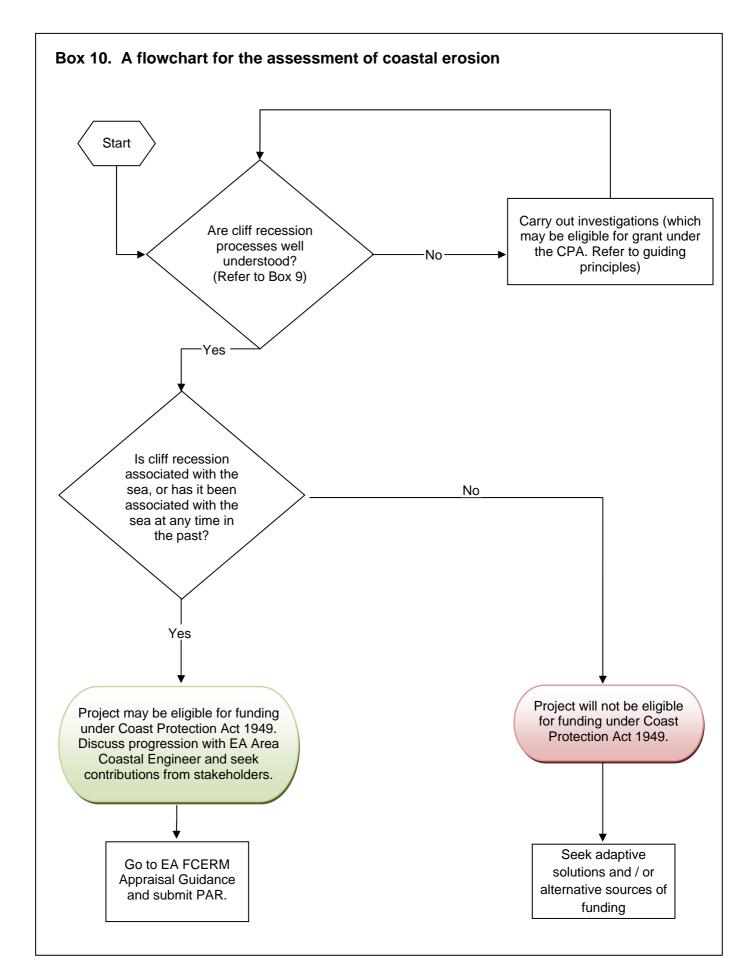
Does debris override the sea wall and get washed away by the sea, or may it have the potential to do so in the future?

Is the sea wall or structure itself at risk from landsliding, wave action or outflanking?

Are drainage/ groundwater issues part of the normal processes of coastal cliff recession?

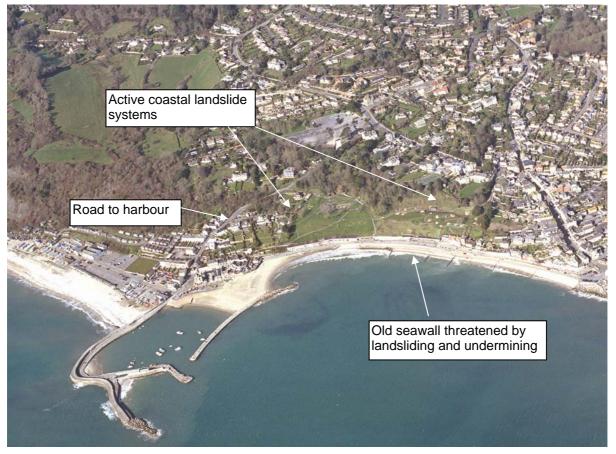
Has the coastal erosion problem been considered in the context of the coastal risk management framework, considering EA project appraisal guidance, grant memorandum, criteria for emergency works, Shoreline Management Plans, local plans etc. (see Box 3)?

Have the issues been discussed with the EA area coastal engineer?



Examples of schemes which have received grant in aid funding under the Coast Protection Act 1949

Lyme Regis Coast Protection Scheme, Phase 2



Lyme Regis has historically faced considerable challenges from coastal landsliding. The main seafront had a Victorian sea wall which was nearing the end of its useful life and was under threat from landsliding and undermining from the sea. Large coastal landslide systems, although protected from wave action at the toe by the sea wall, were continuing to expand inland through periodic landslide activity, threatening property and infrastructure. The coast protection project, which was completed in 2007, consisted of new seawalls and beach replenishment, together with extensive landslide stabilisation works including slope strengthening and drainage. The works were preceded by several years of preliminary studies and investigations to gain a good understanding of the cliff recession processes. Contributions were received from the Highway Authority and Utilities.

Basis for grant in aid – a seawall, properties and infrastructure under threat from continuing cliff recession processes, despite the toe of the cliff system being protected from wave action.

Holbeck Hall landslide stabilisation, Scarborough



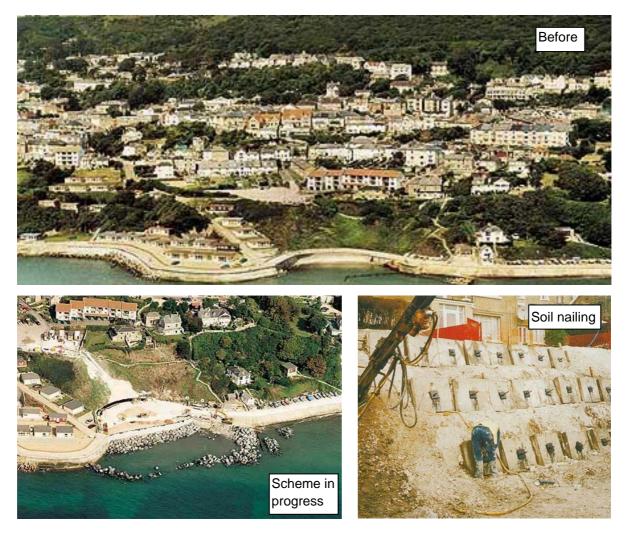




This famous landslide in Scarborough took place in June 1993, and quickly destroyed the Holbeck Hall Hotel which was situated at the top of the coastal cliff. Although the cliff was protected from direct wave action at the toe by a seawall, the structure was inadequate to prevent cliff failure and erosion and the landslide overrode the seawall onto the foreshore. Following a phase of investigation, the landslide stabilisation works included extensive slope regrading, drainage, landscaping and construction of a rock armour revetment around the landslide debris apron.

Basis for grant in aid - it was recognised that although there was a seawall at the toe, coastal erosion processes were continuing and landslide stabilisation works were required in order to prevent the landslide from expanding inland where there were further properties.

Wheeler's Bay, Ventnor Undercliff, Isle of Wight



Wheeler's Bay is located within the Ventnor Undercliff landslide complex on the eastern side of the town. The location had a long history of slope instability, which was aggravated by a succession of wet winters between 1995-1997. As a result, there was increasing concern that a major retrogressive failure could occur, with risks of loss of life, up to 100 residential properties, an important sewer pumping main and the seawall itself. The adopted solution, on technical, economical and environmental grounds comprised a combination of toe-weighting of the slope using chalk fill and by 'advancing the line', rock armourstone protection, soil nailing, drainage and provision of erosion-control geotextile matting.

Basis for grant in aid - a full consideration of cliff instability and erosion processes in a holistic manner identified major risks linked fundamentally with the sea.

Examples of schemes which would not be eligible for grant in aid funding under the Coast Protection Act 1949

Instability related to coastal erosion, but system not affected by wave action for over 200 years



Residential properties and industrial units in a coastal town are subject to periodic damage and occasional destruction due to debris run out from landslides of the coastal cliffs behind them.

Historical research, including the examination of old maps, indicated that:

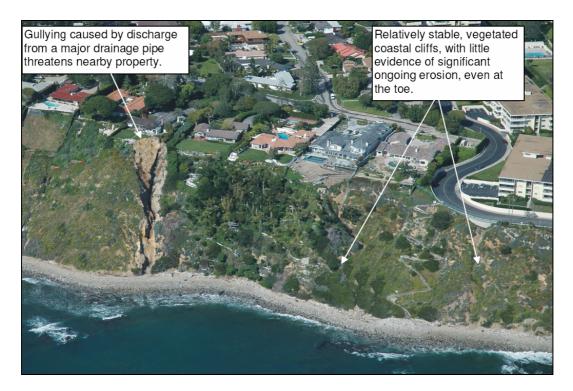
• high water mark was formerly much further inland than its present position, and the toe of the cliff corresponded to the original high water mark,

• a part of the town has been built upon beach material which had accumulated due to a combination of natural and artificial coastal changes over the last 250 years,

• hence the last time the toe of the cliff had been directly affected by wave action was around 1760.

Accretion and development have separated the cliff system from action by the sea and therefore cliff instability is not considered to be linked to the sea. Therefore this was not eligible for consideration for coast protection grant in aid.

Erosion caused by discharge of drainage



Cliff-top properties in this example were under threat due to the landward expansion of a gully on the cliff. A short investigation established that the gullying was due to the discharge of surface water from a major drainage pipe at the top of the cliff. The surrounding cliffs were relatively well vegetated and showed no signs of significant ongoing coastal erosion, even at the toe of the cliff just above high water mark. As the problems were caused by a drainage discharge issue rather than a normal process of coastal cliff recession, they were not eligible for grant aid under the Coast Protection Act and funding for investigations and works should be sought elsewhere.

Further reading

The following references have been used to assist in the preparation of these guidance notes, and are recommend as further reading:

Reference

Brunsden, D. and Lee, E.M. 2004. 'Behaviour of coastal landslide systems: and inter-disciplinary view. '*Zeitschrift fur Geomorphologie* Supplement Volume 134.

Lee, E.M. and Clark, A.R. 2002. 'Investigation and management of soft rock cliffs.' London. Thomas Telford.

McInnes, R. 2008. 'Coastal risk management: a non-technical guide.' SCOPAC.

McInnes, R. 2007. 'The Undercliff of the Isle of Wight. A guide to managing ground instability.' Centre for the Coastal Environment. Isle of Wight Council.

Environment Agency, 2009, Flood and Coastal Risk Management (FCRM) External Contributions Policy

Description

A comprehensive technical summary of cliff behaviour and recession processes. Contains an extensive list of further references.

An authoritative text book prepared as part of a Defra-funded research project.

A guide to coastal risk management generally, including flooding as well as erosion, aimed at a non-technical readership.

A guide to best practice in managing ground instability. Based on the Undercliff of the Isle of Wight, but of general application. Includes advice for landowners.

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