EROSION AND COASTAL ARCHAEOLOGY: EVALUATING THE THREAT AND PRIORITISING ACTION

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Archaeology and the coast

The coastal zone of Scotland, as in many other parts of the world, has always been a preferred location for human settlement and activity. Benefits of coastal settlement would have included a proximity to marine resources and material washed up on the beach; a transportation route by boat; and in some areas, fertile agricultural land. The result is a rich legacy of outstanding and diverse archaeological sites which span all periods and a wide range of functions. In Scotland, the shell middens of the first settlers lie adjacent to buried ecclesiastical buildings; and Iron Age forts overlook defensive structures constructed during the two World Wars.

Surveys of the archaeological heritage of Scotland's coast have demonstrated that the coastal zone is not only home to remains that had specific maritime-related functions but also contains many of the site types that are also found inland. Many of the "maritime" sites, such as boat noosts, (shelters for boats pulled out of the water at times of bad weather), were built deliberately close to the shore due to their function. Other site types, such as large Iron Age settlement mounds are also often found in coastal locations, although archaeologists are unaware of any direct functional relationship with the sea.

The favouring of the coastal zone has resulted in large numbers of sites and a detailed comparison of site densities at the coast and inland was undertaken for the Hebridean island of Barra (Branigan and Grattan 1998). Although the coastal zone made up just four per cent of the total area of the island, it contained 23% of all the recorded sites. The author concluded that "the coastal zone is archaeologically rich and was a preferred zone for at least some types of human activity in some periods in the past" (Branigan 2005, 68).

Some coastal sites are in remarkable states of preservation due to the circumstances of their abandonment and burial. This is particularly true in areas where sand has rapidly inundated sites and structures, burying walls that stand to almost full height and creating a stable protective burial environment. Two outstanding examples of such sites are the Neolithic settlement of Skara Brae in Orkney and the prehistoric and Norse remains at Jarlshof in Shetland.

Coastal erosion

Scotland has the second longest coastline of any country in Europe after Norway. A conservative estimate is that 12%, or 1300km of the Scottish coast is eroding. Although proportionally less, this is a greater distance than in any other part of the UK (Masselink and Russell 2007). Erosion is a natural process and the vulnerability of a stretch of coast is dependent upon a number of factors (Lees 2005), including the nature of the bedrock and the overlying sediments. Areas of soft sediment (for example, sand, gravel, mudflats, salt marshes and glacial tills) are particularly vulnerable. Wave attack is also a factor and damage caused by violent storms is proportional to the size and power of the waves. Exposed areas of coast that are not protected by offshore islands are often at greater risk as wind strength and the distance over which the wind can travel uninterrupted over the sea determine the height and power of the waves.

In areas of dune, the wind can also be destructive during periods of dry weather. Large volumes of sand can be moved by the wind, exposing archaeological remains built upon sand which can sink to the base of large craters created in the dunes. Aeolian erosion is more common where the vegetation cover has been broken and the sand is exposed. Over-grazing and burrowing animals can destabilise the vegetation cover, as can human activity such as cultivation, sand extraction and vehicle damage.

Erosion is already a pressing problem for many parts of the coast, but climate change predictions suggest that the problem may increase in the future, exacerbated by more frequent and more intense storms and by a rise in relative sea level. Rising sea levels will mean that the sea is able to penetrate further inland, especially during storm surges. This will be especially problematic for those stretches of coast where archaeological sites have been found to favour lower-lying ground. Surveys of parts of Shetland (Moore and Wilson 1998a, 1998b, 1999, 2001) noted that although much of the Shetland coast featured cliffs of hard igneous bedrock, the majority of archaeological sites were located on soft coastlines at an altitude of less than five meters (Wilson 2005, 39). This was also noted during the Ullapool to Lochinver Coastal Zone Assessment Survey, where 75 per cent of recorded sites were recorded below the ten meters contour (Long 2005, 93).

Rates of erosion

Erosion is not a steady event and local sedimentation and erosion patterns are complex and difficult to predict. A coastline can be stable, or even accreting, over a number of years, only to change drastically in a single storm. For example,

the effects of a storm that hit the Western Isles in January 2005 had a very localised effect. Although some stretches of coast remained relatively unchanged, neighbouring areas saw coastal retreat of up to 50m (see below).

Gauging past rates of erosion can be difficult and is usually only possible by referring to fixed points. These can either be grid points established for monitoring purposes or features such as walls, fence lines or buildings. Desk-based surveys are a useful way of determining rates of coastal change, and in Britain this can be done by comparing historic Ordnance Survey maps with aerial photographs. Although there are recognised problems with this approach (Hansom *et al.,* 2011), such studies can provide an indication of how much land may have been lost. A survey of the dunes of Tiree found that some beaches, such as Traigh Thodhrasdail, had retreated by 100m in 100 years (Dawson 1999, 5).

This approach has also been used to determine rates of coastal change in proximity to archaeological sites. A survey of the eroding limekiln at Boddin, Angus on the east coast of Scotland showed that coastal processes had led to significant changes in the shape of the promontory that the monument is built upon (Hambly *et al.,* 2010). A Geographical Information System (GIS) was used to compare the First Edition Ordnance Survey map (1865) with a modern map depicting the present position of the base and top of the cliff. This indicated that the west coast of the headland had suffered heavy erosion, shown on the ground by the partial collapse of the limekiln (Figure 1); the exposure of the former road leading down to the limekiln in the coastal section; and the destruction of a small fishing harbour to the north.

Figure 1. Laser scanning at the eroding Boddin Point limekiln, Angus (copyright Joanna Hambly).

Aerial photographs can also be used, and a series of three images taken of the coast of Baile Sear, North Uist, showed that very little change occurred between 1946 and 1992, despite there being a perception that erosion was rapid. This belief was partly due to frequent remains found eroding from the dunes, which prompted an archaeological evaluation excavation (Barber 2003). A third image, taken immediately after the storm in 2005, revealed that up to fifty metres of the coast had been lost overnight, totally destroying the partially excavated archaeological site (Dawson forthcoming).

Historic photographs can also be used to show coastal change over a period of time. A survey of the Fethaland Fishing Station (Dawson 2011) included the comparison of old photographs with modern images showing the same view. The Shetland Archives, Lerwick, has a large collection of images, including photographs taken by J. D. Rattar in the 1890s. Copies were laminated and taken into the field so that the exact view could be replicated and a comparison showed that although the underlying geology could be thought of as "hard", it was prone to collapse. For example, the cliff at the north end of the Wester Wick (Figures 2 and 3) changed significantly after the original image was taken in the 1890s.

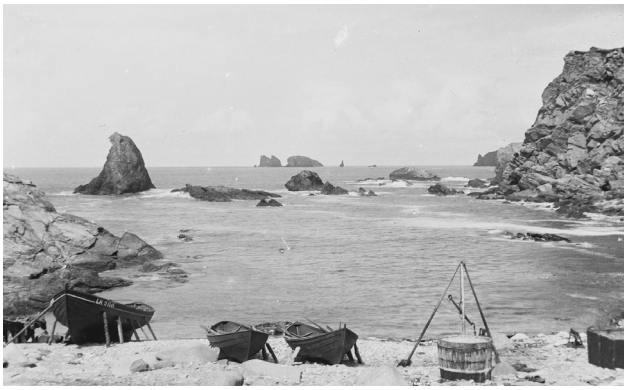

Figure 2. Photograph of the Wester Ayre, Fethaland, Shetland taken at the end of the nineteenth century (J. D. Rattar, copyright Shetland Museum).

Figure 3. Same view as Figure 2, taken in 2010. Note that the profile of the cliffs has changed due to erosion (copyright Tom Dawson).

The images also gave an indication of when structures had collapsed due to erosion. For example, a building that local tradition asserts was used to store salt at the fishing station is today ruinous; the same building is shown as almost complete on an image taken in the 1920s (Figures 4 and 5).

Managing the problem

People managing various assets within the coastal zone have different, and sometimes competing, priorities when devising plans for areas threatened by erosion. The four main options usually available to coastal managers are:

- Hold the line

Construct coastal defences to protect areas of coastline.

- Managed realignment

Breach existing sea defences in order to create a buffer zone of submerged, low-lying land that dissipates wave energy and can help reduce the power of storm surges.

- Advance the line

Construct defences out at sea, for example, across the mouth of a bay.

- No active intervention (sometimes referred to as "do nothing")

An approach that allows land to be eroded.

Figure 4. Photograph of one of the buildings of the Fethaland Fishing Station, Northmavine, Shetland, taken in the 1920s (L. G. Scott, copyright Shetland Museum).

Figure 5. Same view as Figure 4, taken in 2010. Much of the building has collapsed due to erosion below one corner (copyright Tom Dawson).

Holding or advancing the line is often advocated when the cost of construction is justified by the value of the assets to be protected. However, in rural areas where there is no threatened infrastructure, it is more usual for the recommended action to be "no active intervention". In such cases, coastal erosion is regarded as a vital natural process rather than as a peril. Eroded material is recycled and birds, animals and plants that inhabit coastal zones are able to move or re-colonise recently eroded coasts. However, managers of cultural heritage assets in rural locations face a problem. Archaeological sites that have been damaged or destroyed by erosion cannot be replaced, yet very few are valued sufficiently to justify the construction of defences. It is therefore vital that cultural heritage managers devise strategies for prioritising work at threatened sites before they are lost.

In Scotland, the preparation of management plans and the undertaking of action at archaeological sites threatened by coastal erosion fall beyond the main remit of most Local Authorities. Historic Scotland has taken the lead in investigating the scale of the problem (Ashmore 1994; Barclay and Fojut 1995). Since 2000, they have been working in partnership with the SCAPE Trust (Scottish Coastal Archaeology and the Problem of Erosion).

Identifying what is at risk - Scotland's Coastal Zone Assessment Surveys

A formal programme of assessing the scale of the threat to the archaeological resource was initiated in Scotland in the 1990s. The Scottish Coastal Zone Assessment Surveys (CZAS) followed a similar methodology to surveys conducted in Wales (Davidson and Jones 2002, 19), and aimed to:

- assess the nature and extent of the archaeology,
- assess the nature of threats and the rate of erosion of both the coast and of archaeological sites,
- recommend appropriate management strategies.

The publication of Historic Scotland Archaeological Procedure Paper 4 (HSAPP4, Historic Scotland 1996) provided guidelines for Scottish surveys, noting differences to conventional archaeological area surveys. It stated that data was to be acquired rapidly and was to be used as a tool to "provide information and advice to policy makers on the scale of the threat to the built heritage from coastal erosion and to take the first steps towards developing national and regional priorities". The gathered information was to be used to inform "choices on what should be preserved, what should be recorded before destruction and what should be allowed to disappear without detailed recording" (Historic Scotland 1996, 2).

HSAPP4 defined the area to be surveyed as a zone that included the intertidal area and a buffer that extended up to 100m inland from the coast edge. In addition to obtaining data on archaeological sites, HSAPP4 specified the collection of information that would help calculate the stability of the coast. Data on hinterland geology, coastal geomorphology and the erosion class of the coast was to be presented on maps produced at a scale of 1:25,000 or 1:50,000. The erosion class of the coast was to be classified as eroding, accreting, stable or any combination of these states. It was recognised that there are problems in classifying the stability of the coast, as both erosion and deposition can be localised and can change rapidly from one status to the other. A storm may wash away loose sediment such as sand and cause the coast edge to retreat, but the change may only be temporary and wind and tidal action can replace the sediment within a relatively short period of time (Ramsay and Brampton 2000, 10). The recycled sediment can give an impression of stability whilst obscuring vulnerable or damaged sites exposed during a storm.

HSAPP4 specified the type and level of information to be collected for the site gazetteers, noting that descriptions were to be "merely enough to characterise the sites in terms of size; complexity; nature of their contents; and

relationships". If possible, period(s), archaeological potential, and an assessment of vulnerability to erosion were also to be given. Detailed site descriptions were to be included separately within the report, as well as a Summary and Recommendations section. Three examples of the terms to be used when recommending action for future work were provided: "Survey", "Monitor", "Nil" (Historic Scotland 1996, 13). Although no precise definition of the three terms was given, survey was taken to mean everything from the drawing of measured sketches to full excavation.

Review and prioritisation

Between 1996 and 2011, 28 Coastal Zone Assessment Surveys were completed, covering approximately 4700km (30% of the entire Scottish coast). In order to evaluate the information contained within the completed surveys, the SCAPE Trust reviewed the data (Dawson 2006, 2008). One finding of the review was that of the *c.* 11,500 sites recorded, 3768 (30%) carried a recommendation for further work. However, the majority of the recommendations had not been pursued, primarily because the large number of sites outstripped the resources available.

HSAPP4 did not specify was that surveyors should prioritise action during the coastal surveys. Reasons for not prioritising action included fears that the rapid nature of the surveys would result in problems over site recognition and that any attempt at prioritisation would be difficult due to the disparate site types encountered (Ashmore 2005, 4).

Despite this, the high number of sites carrying recommendations meant that it was difficult for coastal heritage managers to make choices about where to allocate available resources. In 2010, SCAPE undertook a project on behalf of Historic Scotland to develop a system for prioritising sites recorded within the CZAS that required urgent or immediate action (Dawson 2010). A methodology was developed that was repeatable and transparent, and that would allow others to review the recommendations. The key to the system was the project database, linked to a Geographical Information System. The GIS allowed archaeological information to be correlated with physical information relating to the vulnerability of the coast edge. Thus, each site could be "scored" on both its archaeological importance and its risk of damage or loss from erosion. Combining these scores enabled the level of priority of each site to be established.

Methodology

The prioritisation project followed a staged approach (Figure 6). The first step was to construct the database from the thousands of records contained within the 28 published reports. This involved digitising the data from all surveys prior to 2001 as these had been published as paper reports only. The individual databases were combined to create one master database that contained 11,439 records, each of which was checked for errors.

The second stage was the standardisation of the data. As many different terms had been used for defining sites, ascribing dates and recording other information, it was difficult to compare results from one survey to the next. Additional fields were added to the database to allow inputting of standardised descriptions. At the third stage, all site records that included a recommendation for further action were isolated. In general, all site records that had a recommendation of "Nil" were stripped out of the database, although a small number of exceptional sites were also included in the short list.

At Stage 4, the remaining sites were assigned to broad classes (based upon the site type and description). The aim of assigning a class to a site record was to allow similar monuments to be compared and considered together. For example, sites described as either a "stone pier" or a "stone jetty" were assigned to the same class. The classes used were defined during the project and reflected the types of site within the database rather than using classes contained in existing archaeological thesauri, such as the RCAHMS (Royal Commission on the Ancient and Historical Monuments of Scotland) Scottish thesaurus of monument types (Casey 2009). This was because site descriptions were often vague and so special classes were needed.

At Stage 5, the classes were ranked into one of five groups, based on relative importance or value. Site classes falling within a higher group were considered either to be more important or to have more potential than those falling within lower groups, although the difference in degree was not specified and could be minimal. The relative importance between site classes within one group and the next immediately above or below should be considered slight, but the difference between a group two places above or below is more significant.

A number of factors were taken into account when creating the classes and assigning these to groups. These reflected some of the criteria used when considering legal protection for archaeological sites in the UK. For example, the site's *period* and *rarity* were assessed, using the information contained within the database records. *Condition* was taken into account, and a "post-medieval building with walls higher than a metre" was assigned to a group above a "post-medieval building with walls lower than one metre". Similarly, *group value* was considered, and a complex of World War I or II remains in good condition was grouped higher than isolated WW I or II remains in similar condition. In some cases, it was necessary to consider the site's *potential*, especially when a record was ambiguous. For example, a wall of unknown date or function seen eroding from a coastal section was placed in a class (stonework/wall eroding from section: not dated, possibly modern) that belonged to a higher group than an eroding wall that was definitely part of a nineteenth century field boundary. *Fragility* and *vulnerability* were also assessed, but at Stage 6 (see below).

At Review Stage 1, lists of classes and groups were distributed to Historic Scotland, the Local Authority Archaeologists and the directors of The SCAPE Trust and the feedback led to a number of refinements.

At Stage 6, the threat posed by erosion to each site was assessed. Only vulnerability to coastal and aeolian erosion was considered in the analysis, and threats from animals,

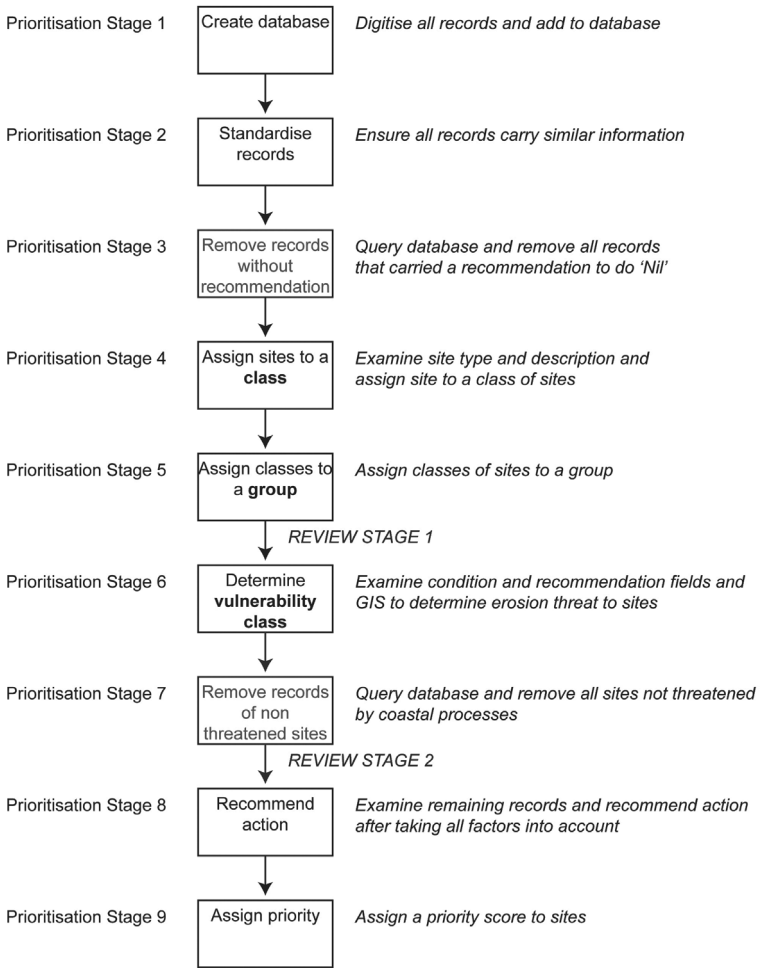

Figure 6. Stages of the Prioritisation Project.

agriculture or recreation were excluded. Five vulnerability classes were defined with Erosion Class 1 being most vulnerable and 5 being the least vulnerable (Figure 7).

Vulnera-bility Class	Description
1	Any distance from coast edge, definitely eroding (either coastal or aeolian erosion)
2	Any distance from coast edge, at risk of erosion (record not specific but possibility that site is vulnerable)
3	Within ten meters of coast edge or in dunes - stable, but may erode in future
4	Within ten meters of the coast edge or in dunes - stable and unlikely to erode
5	More than ten meters from the coast edge and stable

Figure 7. Definition of vulnerability classes.

The vulnerability class was initially assigned using a combination of the written description within the site record; the proximity of the site to the coast edge; and the description of the physical nature of the site's setting. The GIS was used to capture all sites falling within 50m inland of the coast edge and to correlate these with the erosion class, geology; and geomorphology. Sites in the intertidal zone were regarded as being at high risk, and were assigned to one of the more vulnerable erosion classes, depending upon the material from which the site was constructed.

At Stage 7, the database was queried to isolate sites at risk of damage from coastal processes. At Review Stage 2, copies of the shortlists of threatened sites were distributed to the relevant Local Authority Archaeologists. They were asked for comments about the assessment of the relative importance of each site and this process saw many sites being assigned to different classes or groups.

At Stage 8, a series of recommended actions were assigned to each site. The list comprised:

- Visit
- Desk based assessment
- Survey
- Monitor
- Excavate
- Management plan
- Nil

After selecting an action from the list, the recommendation could be defined further. After the first recommendation was made, there was the option of adding second and third actions and a staged approach was adopted, with the one action needing to be completed before the subsequent action. After the completion of each action, the project database is updated, which may result in subsequent actions being modified. In most cases, the first action recommended was "Visit" as it was recognised that the highly dynamic nature of the coast means that the condition of sites may have changed since the original survey. For example, a site may carry the following series of recommended actions: Visit [Check condition]; Survey [Combined survey to characterise site]; Excavation [Targeted: vulnerable areas]. However, the initial visit may show that the site has been destroyed by erosion, meaning that subsequent actions are no longer necessary. Updates to the database may also lead to the class and group of the site changing.

The final stage of the process was to prioritise the sites. This was done by assessing both the group and the vulnerability class of the sites. Sites that were in both a higher group and a higher vulnerability class were considered a higher priority. Action at sites was assigned to one of five priority levels as follows:

- Priority 1. Action needed urgently
- Priority 2. Action highly desirable
- Priority 3. Medium priority, either due to the nature of the site; lower threat; or lack of information
- Priority 4. Low priority
- Priority 5. No action required

Next steps

As a result of the prioritisation process, over 320 sites were categorised as Priority 1 or 2 and a further 620 were classed as Priority 3. This is still a large number of sites, but provides a starting point for coastal managers and other stakeholders to begin to address the issue in their areas.

SCAPE is currently working on a new project that seeks to engage local knowledge and public opinion to update and refine the Prioritisation Project database. The primary focus of the project are the Priority 1, 2 and 3 sites, however, information from all 11,500 sites recorded within the Coastal Zone Assessment Surveys are being made available on an interactive website and a phone app. Anyone will be able to explore the coastal heritage resource in their area and by selecting a site, will be able to edit, the information contained within the project database. The facility for the public to edit records is important, as their local knowledge will enhance records, providing information on aspects such as place names and local history that may have been unknown to the original survey teams of visiting archaeologists.

As well as editing original records, the project aims to recruit and train volunteers to carry out field visits to as many of the priority sites as possible and submit current condition surveys and photographs with which to update the CZAS records. The information will include measures of local and public site value. This type of information is often poorly captured in surveys carried out by professional heritage bodies.

Following validation, edits, updates and photographs submitted by the public will be added to (rather than replace) the original record. The updates will allow SCAPE to reassess sites, assigning them to new priority groups if necessary. The updated information may then be used to initiate projects at a number of the priority sites, with the focus being on those high priority sites that carry a high public or local value.

Conclusion

Recent work in Scotland has adopted a staged approach to the management of threatened coastal heritage. Much data has been collected, and currently efforts are focused on how to use this data in a practical way. The collection of data about eroding coastal sites is now being taken to a new level, bringing heritage professionals together with the public to manage a threatened resource. This is partly a response to the huge scale of the problem, both in terms of the length of the coast and the high numbers of threatened sites. However, the recognition that the public has a vital role to play in managing the coastal heritage resource is key, as it helps make management plans more sustainable, more relevant and more achievable. Although the model presented here has been developed in Scotland, it is transferable to coastlines everywhere.

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EROSION AND COASTAL ARCHAEOLOGY: EVALUATING THE THREAT AND PRIORITISING ACTION

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Keywords: *Coastal archaeology, erosion, Scotland, heritage management, mobile phone app, public archaeology*

Abstract
The archaeology of coastal regions is rich and varied, but is facing increasing pressures from natural processes. Regardless of how the climate may change in the future, many coastal archaeological sites are threatened by erosion now. In order to manage this resource, it is essential to identify both sites and vulnerable stretches of coast. This paper introduces the Scottish situation and discusses recent approaches taken in Scotland, where a methodology has been developed that is applicable to all coastal areas. The first stage of the approach has been to undertake desk-based and field surveys in order to identify what is at risk and to gauge its vulnerability. The next stage has been to produce and review recommended actions for vulnerable sites. Finally, a shortlist of sites has been produced that prioritises actions according to the importance and level of threat posed to individual sites. Looking ahead, a new project will seek to further refine this shortlist by harnessing public opinion and local knowledge in order to ensure that action is taken at sites valued both by archaeologists and the wider public.

ÉROSION ET ARCHÉOLOGIE CÔTIÈRE : ÉVALUATION DE LA MENACE ET CLASSEMENT DES ACTIONS PAR ORDRE DE PRIORITÉ

Tom DAWSON

Mots-clés : *Archéologie côtière, érosion, Écosse, gestion de patrimoine, application téléphone portable, archéologie publique*

Résumé
L'archéologie des régions côtières est riche et variée, mais elle fait face aux pressions croissantes des processus naturels. Indépendamment des variations probables du climat dans le futur, de nombreux sites archéologiques côtiers sont menacés par l'érosion actuelle. Pour gérer cette ressource, il est essentiel d'identifier à la fois les sites et les secteurs vulnérables de ces zones littorales. Cet article présente la situation écossaise et fait part des approches récentes adoptées en Écosse, où a été développée une méthodologie qui peut s'appliquer à tous les secteurs côtiers. La première étape de l'approche consistait à réaliser des études en laboratoire et des prospections sur le terrain afin d'identifier les sites à risque et de mesurer leur vulnérabilité. L'étape suivante a été de développer et de passer en revue des actions à recommander pour les sites vulnérables. Enfin, une liste réduite des sites a été dressée donnant priorité aux actions selon l'importance et le degré de menace sur chacun d'eux. À l'avenir, un nouveau projet visera à affiner davantage cette liste en exploitant l'opinion publique et les connaissances locales. Ceci permettra de mener des actions en fonction de l'évaluation tant des archéologues que d'un public plus large.