Impacts of Climate Change on Cultural Heritage in the UK and Ireland

Davies, M.H[1]., Dunlop, C[2]., Firth, A[3]., Jay, H[4]., & Whitewright, J[5].

[1]Historic Environment Scotland, Longmore House, Salisbury Place, Edinburgh, EH9 1SH

[2]Department of Agriculture, Environment & Rural Affairs, Cromac Avenue, Gasworks Business Park, Malone Lower, Belfast, BT7 2JA

[3]Historic England, Cannon Bridge House, Dowgate Hill, London, EC4R 2YA

[4]National Trust, Kemble Drive, Swindon, SN2 2NA

[5]Royal Commission on the Ancient and Historical Monuments of Wales, Crown Buildings Plascrug, Llanon, SY23 1NJ

KEY FACTS

What is already happening?

- Climate change can exacerbate the natural rates of decay. These damaging impacts of climate change have already been observed at a range of heritage assets.
- Many coastal heritage assets in the UK are currently at risk from coastal processes and flooding, but climate change is increasing this risk. These include sites managed as visitor attractions as well as other designated and undesignated heritage assets, the majority of which are in private ownership.

What could happen in the future?

- Heritage assets located in the coastal zone will be subjected to enhanced rates of erosion, increased flooding and changes in weathering patterns as a direct result of climate change. The erosion processes that in some cases result in loss will inevitably result in new discoveries being made as well.
- Submerged sites will be adversely affected by changes in ocean pH, temperature and circulation patterns.

SUPPORTING EVIDENCE

Introduction

The term ‘cultural heritage’ encompasses a range of different facets. For the purpose of this review, it focuses on tangible heritage, the physical remnants of the past that we can still see today, from discrete heritage assets to the broader historic environment, which is the physical evidence of millennia of human activity. The archaeological record specifically is an important ‘store’ of paleoenvironmental data and provides a crucial long-term perspective on human vulnerability to changing environmental conditions

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(Jackson et al., 2017) on a scale that other disciplines are often unable to achieve.

What is already happening?

Changes in ocean temperatures, sea-level rise, coastal erosion, ocean acidification (Willems and Schaik, 2017), and altering patterns of extreme weather events are influenced by climate change and all can impact cultural heritage underwater, in the tidal zone and on land (Croft, 2013). Additional impacts relate primarily to changing weather patterns and include building-fabric degradation in response to changing rainfall patterns, air temperature and wind patterns (Sabbioni et al., 2008). Of course, our built heritage has always been exposed to the natural processes of decay brought about by the climate to which they are exposed. Climate change, as experienced today, is a threat multiplier and potentially exacerbates the natural rates of decay that are expected. These damaging impacts of climate change have already been observed on a range of heritage assets, and the way in which the historic environment is being conserved, preserved, managed and researched, in light of these new challenges, needs to be adapted accordingly.

Impacts of climate change on cultural heritage

Impacts of sea-temperature change on heritage assets

Between 1984 and 2014, coastal water temperatures around the UK increased at an average rate of 0.28 °C/decade (Hughes et al., 2017). Warming seas have a variety of impacts on heritage assets, both direct and indirect. Indirectly, lead to more moisture in the atmosphere which in turn increases the likelihood of extreme weather, meaning that rates of erosion experienced on the coastline may change to the detriment of coastal heritage (Dunkley 2017, 220-221; Gregory et al 2022, 1401). Sea temperatures directly control the geographic range and abundance of species, with warmer waters around the UK allowing for migration of new and invasive species. Studies in ecology on wreck sites have highlighted the migration of invasive species to the UK in recent years. Reflecting broader patterns in wood-boring bivalves in European coastal waters (Gregory et al. 2022), a study carried out by Bournemouth University for Historic England identified the presence of Blacktip shipworm (*Lyrodus pedicellatus*) on wrecks along the south coast, in Hampshire and Cornwall. These worms are thought to have migrated from southern latitudes as a result of rising sea temperatures. Significantly, this baseline research, completed in June 2014, records that the reported northern limit of *L. pedicellatus* by 1980 was at 40° N but by 2007 had extended to 50° N. Records from the time of the Historic England research place *L. pedicellatus* around 51° N (Palma, 2014). A further study undertaken for Historic Scotland, limited to four wreck sites in Scottish waters, confirmed evidence for shipworm species considered to be locally established wood-boring communities. There was some evidence that archaeological wood may be particularly attractive to marine boring-molluscs. The Historic Scotland project provided very minimal evidence for *Teredo navalis* and *L. pedicellatus* and not enough to state that they are as established as they are around the English coasts (Palma, 2016).

Impacts of sea-level rise and coastal erosion on heritage assets

Numerous studies have consistently estimated that the average rate of regional sea-level rise (SLR) around the UK observed by tide gauge records, has been between 1 and 2 mm per year. When vertical land movement is also included, this rate is increased for the south of England and decreased for some parts of Scotland and Northern Ireland. These results are consistent with the globally averaged figure from tide gauge records of 1.7 mm per year between 1901 and 2010 (see accompanying MCCIP sea-level rise paper, Horsburgh et al., 2020). Rates of SLR are highly variable, with data showing that certain parts of the UK are now experiencing more-rapid rates of change. In Scotland, for example, over the last 20 years SLR measured at Scottish ports have exhibited a rate of increase of 3 mm/year; this is faster than the twentieth-century average (Hansom et al., 2017; Rennie and Hansom, 2011). Rising sea levels can increase the severity of extreme sea-level events, such as exceptionally high tides, storm surges and severe weather events (Horsburgh and Lowe, 2013).

Combined, the impacts of SLR present an increasingly growing threat on coastal heritage. Increased rates of coastal flooding and erosion as a result of SLR can potentially destroy coastal heritage gradually over decades, as well as cause catastrophic loss in single events (Hunt, 2011). Dynamic Coast, a major Scottish Government project assessing coastal change, mapped the changing position of Scotland's 'soft' coastline in 1890, 1970 and today, alongside future projections. The results show that 46% of the soft coast is eroding, at an average rate of 0.43m per year (Rennie et al., 2021a), with half of selected coastal cultural heritage assets lying behind unprotected soft coast (Muir et al, 2021, 13-14)

The cultural heritage sector's response to these threats is well established, and has often taken a 'community-focused' approach to quantifying and recording eroding coastal heritage assets. Scottish Coastal Archaeology and the Problem of Erosion (SCAPE, https://scapetrust.org/), Coastal and Intertidal Zone Archaeological Network (CITiZAN, England, https://citizan.org.uk/) and Arfordir ('Coastline', Wales, now complete: https://www.dyfedarchaeology.org.uk/wp/discovery/projects/arfordir/) are three examples of organisations and collaborative projects that have empowered local communities and volunteers to record vulnerable coastal heritage before it is lost to the sea. Through combining specialised skills in recording and surveying at-risk heritage assets, with the power and enthusiasm of local communities, thousands of heritage assets around the UK's coastline have been recorded.

Between 2012 and 2016 SCAPE, grant-aided by Historic Environment Scotland and its predecessor Historic Scotland (HS) recruited, trained and supported over 500 volunteers to conduct a national survey of 'at-risk' coastal archaeology in Scotland. The aim of this survey was to update heritage data collected as part of Coastal Zone Assessment Surveys (CZAS) carried out for HS between 1996 and 2010. The overall goal was to identify the most 'at-risk' coastal heritage sites in Scotland. The review concluded that 31 sites required urgent action, including emergency excavation of archaeological deposits at immediate threat of being lost, and a further 114 remained vulnerable to the impacts of coastal process and extreme weather events (Hambly, 2017).

Impacts of ocean acidification on heritage

'Atmospheric levels of CO2 have increased from pre-industrial values of 280−300 ppm (Betts et al., 2016) to concentrations of 410 ppm in 2019, higher than at any time in at least two million years (IPCC, 2023). Oceans and seas play a crucial role in mitigating climate change by absorbing CO_2 emissions, removing 25−30% of CO_2 added to the atmosphere; this however causes acidification of the oceans. A more acidic ocean can negatively impact submerged metal structures and shipwrecks, lowering their preservation potential (Williamson et al., 2017; Willems and Schaik, 2017). However, the relationship between acidification and the processes affecting metal shipwrecks can be complex, increasing corrosion whilst simultaneously encouraging the growth of calcareous deposits (concretion) that inhibit corrosion. Moreover, corrosion is only one of the factors affecting the survival of metal shipwrecks: the combination of processes affecting similar sites in similar contexts can result in widely different outcomes (Gregory et al., 2022). To further illustrate the complexity of relationships between heritage and the changing chemistry of seawater driven by climate change, Gregory et al. (2022) note that decreasing oxygen solubility due to higher water temperatures is advantageous for the preservation of underwater cultural heritage, yet unsustainable for the marine environment as a whole.

Impacts of climate change mitigation and adaptation on heritage

Mitigation and adaptation responses to climate change also present challenges in the management of heritage. Underwater, potential impacts come via increased emphasis on the construction of offshore renewable energy infrastructure on the seabed and within the inter-tidal zone; all have the potential to damage cultural heritage (McNeary and Westley, 2013, 48-49). On the coast, adaptation responses ranging from managed realignment to upgrading or construction of new sea defences present further risks to heritage attributable to climate change (Cooper and Firth, 2020).

What could happen in the future?

The impacts of climate change over the next century will present serious challenges for our cultural heritage (Fatoric and Seekamp, 2017). The identified destructive or problematic impacts are numerous. For coastal cultural heritage this includes increased erosion rates and an increased probability of coastal flooding. Secondary impacts to onshore sites include changes in weathering (i.e. driven by wind, rain and temperature), while fully submerged sites may be affected by changes to seawater properties (pH, temperature) and hydrodynamic regimes.

The relationship between rising sea levels and the frequency of coastal floods is clear in that the probability of flood events will increase (Hansom et al., 2017). The IPCC AR5 has projected global sea-level to rise for the period 2081 to 2100, compared to 1986 to 2005, of 0.29 to 0.82 m. On a more-local scale, the expected SLR is likely to be different. For example, projections for the year 2100 (relative to the 1981−2000 average) carry considerable uncertainty. For London, the central estimate sea level projection for the year 2100 ranges from 0.45−0.78m, depending on the emissions scenario. Similar ranges of the central estimate at 2100 for other cities are: Cardiff 0.43−0.76m; Edinburgh 0.23−0.54m; Belfast 0.26−0.58m (Horsburgh et al., 2020).

For heritage assets situated on the coast this means the future is uncertain. Those sites that have hard defences, such as sea walls, in place will likely need increasingly regular maintenance and adaptation measures to allow them to remain effective. Such defences are not the preferred solution for managing future risk at coastal heritage assets as they often cause or exacerbate damage in adjacent areas, alongside being costly to install and of high visual impact. Adaptation responses, therefore, need to consider the wider landscape context with community and nature-based solutions offer most often providing the best outcomes in terms of respecting and benefiting natural and cultural aspects of landscape (HES & NatureScot 2019; Rennie et al 2021a;b).

For some assets, it may be appropriate to explore options including transformation and decline (Penrose & Bartolini 2022), accepting that some loss of coastal and marine heritage assets is inevitable.. However, instead of viewing this as a failure, it can be seen as an opportunity to learn about the past in a way that would not have otherwise been possible. There have been, and will continue to be, many remarkable discoveries made as a result of coastal erosion. For example, the presence of Mesolithic communities in the Western Isles of Scotland was first confirmed archaeologically through serendipitous access to deep deposits exposed as a result of coastal erosion in 2001 (Gregory et al., 2005).

Supporting case studies

Skara Brae

Skara Brae in Orkney is the best-preserved Neolithic settlement in Western Europe and forms part of the 'Heart of Neolithic Orkney' World Heritage Site (WHS), as well as being a scheduled monument and a property in the care of Historic Environment Scotland (HES). It was uncovered by a series of winter storms in 1850. In the 1920s a hard coastal defence was built to protect the site from further coastal erosion and this has been augmented at intervals, with repair and improvements ongoing. Aerial imagery clearly demonstrates that without this defence, part of the site may have already been lost to coastal erosion; however, it is likely that the sea wall is contributing to increased rates of erosion along the unprotected erodible coast on either end of the protected area (Rennie et al., 2017). Since 2010, HES has undertaken regular digital monitoring to inform understanding of change processes, by capturing millimetric-scale accurate digital scans of the site and surrounding coastline (see Figure 9). A pilot of the Climate Vulnerability Index assessed the Outstanding University Value (OUV) vulnerability of the WHS as a whole as High, with Precipitation Change, Sea Level Change, and Storm Intensity and Frequency identified as the three most relevant climate drivers. The overall community vulnerability was assessed as Moderate, due to the high adaptative capacity of the community (Day et al., 2019). Analysis of coastal processes in a case study produced as part of Dynamic Coast found that erosion continues to threaten the site and that it will increase in extent and rate in future with climate change. A dual approach to conservation and maintenance has been proposed, involving managed retreat combined with defence improvements and nature-based measures (Rennie et al., 2021).

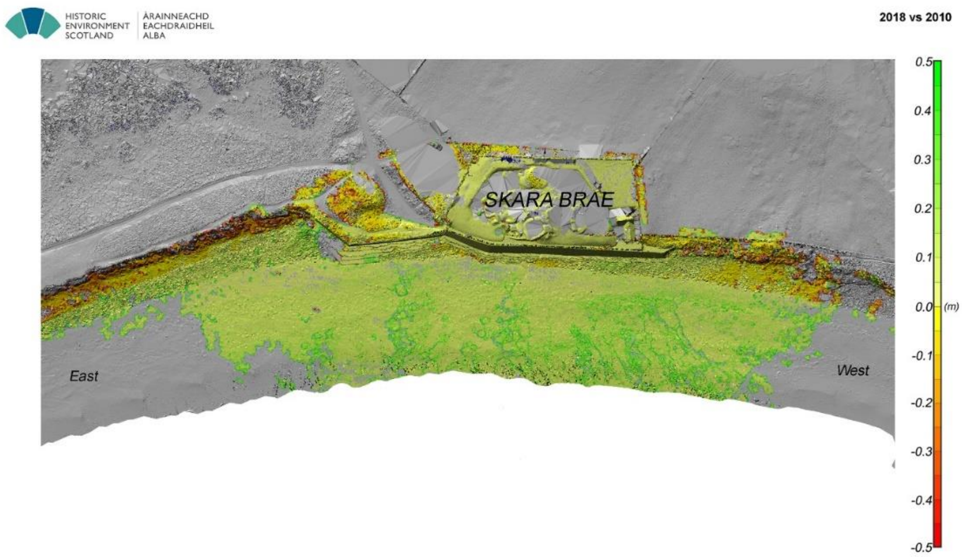


Figure 1. A deviation map created from laser scans of Skara Brae, its sea wall and environs, comparing data from 2010 and 2018 to identify coastal change and current vulnerabilities (Copyright Historic Environment Scotland)

CHERISH

CHERISH[1] was a 6½ -year (2017–2023) EU funded Ireland−Wales project, coordinated by the Royal Commission on the Ancient and Historical Monuments of Wales (RCAHMW). It was a cross-disciplinary project aimed at raising awareness and understanding of the past, present and near-future impacts of climate change, storminess and extreme weather events on the rich cultural heritage of the sea and coast. It linked land and sea and employed a variety of techniques and methods to study some of the most iconic and remote coastal locations in Ireland and Wales. These ranged from terrestrial and aerial laser scanning, geophysical survey and seabed mapping, through to palaeo-environmental sampling, excavation and shipwreck monitoring.

Rather than trying to map and understand every archaeological site within its study area, the CHERISH project focused on a series of case study sites to demonstrate the application of different techniques as a means to better understand the sites under study, and the environmental changes impacting upon them. Shipwrecks – both offshore and inter-tidal, prehistoric coastal settlements, industrial-era buildings, and prehistoric submerged forests and peat deposits have all been included within the project. This in turn has allowed well-informed baseline information to be generated for the chosen sites, with subsequent monitoring across the lifetime of the project to further assess the feasibility of the techniques employed, and the results generated.

One of the main outcomes of the project is the publication of a series of guidance documents[2] detailing the use of each technique, suitable site-types for application, expected data outcomes, relative effectiveness and economic costs compared to other methods, and ease of application. It is envisaged that this will make undertaking similar work, focused at understanding the impact of climate change, more effective, and encourage accessibility to data collection from a broad range of groups through clear explanation of which technique might be best suited for their needs. The lessons learned and methodologies developed during the CHERISH project are being implemented by the RCAHMW on a growing number of sites within the intertidal zone and coastal margin, evaluated as being at risk to impact from climate change, across Wales.

[1] https://cherishproject.eu/en/
[2] http://cherishproject.eu/en/resources/reports/sharing-our-practice/

Figure 2. Dinas Dinlle, an Iron Age hillfort owned by the National Trust is subject to significant erosion along its seaward side and one of the study sites selected as part of the CHERISH project (Crown Copyright: RCAHMW and CHERISH).

Historic Environment Scotland Climate Change Risk Assessment

In January 2018 Historic Environment Scotland (HES) published the first phase of its climate change risk assessment project. This phase detailed the risk to its 300+ Properties in Care from natural hazards, such as flooding and coastal erosion. The project was carried out in partnership with the British Geological Survey and the Scottish Environment Protection Agency. Of the 352 sites analysed, they found that 31 were at high or very high risk of coastal flooding, and 24 sites at a high or very high risk of coastal erosion. With many of HES sites situated on the coast these results were expected (for example, Tantallon Castle, Figure 3). HES now plans to refine the results of this assessment through measures like incorporating the UKCP18 climate change projections into the assessment, ground-truthing the data and carrying out more in-depth desk-based studies of the properties to understand how the environmental conditions impacting their properties have changed in the past.

Figure 3. Tantallon Castle, a property in care of Historic Environment Scotland, overlooking the Firth of Forth. Sites like this, situated in strategic, easily defendable positions in the landscape exemplify the reasons why people chose to build in certain parts of the landscape that are today vulnerable to the impacts of climate change (copyright Historic Environment Scotland).

Coastal Conservation Appeal

English Heritage is the charitable trust set up in 2015 to manage the national heritage collection of historic sites in England that are in public ownership. In September 2022, English Heritage launched a major fundraising appeal to protect coastal heritage from the effects of erosion and flooding, identifying the six coastal castles in its care most at risk from rising tides, due to their exposed locations and the fragility of the rocks upon which they sit. The six sites identified are Tintagel Castle, Cornwall; Piel Castle, Cumbria; Bayard's Cove Fort, Devon; Garrison Walls, Scilly; Calshot Castle, Hampshire; and Hurst Castle, Hampshire. The appeal underlined the degree to which climate change, through rising sea levels and more regular storms, is accelerating the issues faced by coastal heritage, creating huge challenges for heritage organisations like English Heritage. In particular, the partial collapse of the East Battery at Hurst Castle in February 2021 had served as a devastating reminder of the power of the sea and the risks faced by coastal heritage. The damaged section of Hurst Castle had to be stabilised with 22,000 tonnes of shingle and rock armour, though it was acknowledged that there is no quick fix to the complex issues facing the castle, including sea level rise and climate change. Hurst Castle has been added to the 2022 World Monuments Watch[3], which is a list maintained by the World Monuments Fund to spotlight 25 heritage sites of extraordinary significance that are facing pressing challenges.

[3] https://www.wmf.org/2022watch

Figure 4. Hurst Castle showing collapsed portion of east wing and extent of stabilisation measures (copyright English Heritage).

Seaford Head

Historic England has been funding a collaborative project at Seaford Head, East Sussex, where Downland meets the sea in a 90m clay-capped chalk cliff (Figure 5). Seaford Head is a scheduled monument: a Bronze Age bowl barrow and Iron Age hillfort point to the importance of the coast in prehistory, whilst Second World War features reflect its recent history. In 2021, major cliff collapses caused significant damage to the scheduled monument; such collapses are expected to increase in frequency and severity with predicted rises in rainfall and storm events related to climate change. In response, Historic England worked with the South Downs National Park Authority (SDNPA), Archaeology South-East (UCL), Seaford Town Council, the National Trust and other stakeholders to carry out desk-based, aerial, topographic and geophysical investigations to record the monument and open up conversations with the public about heritage loss linked to landscape change.

Figure 5. Seaford Head Iron Age Hillfort showing encroachment of cliff (copyright Historic England).

Coastal Heritage Resources Mapping Project (Northern Ireland)

Between 2021 and 2022 a full coastal LiDAR, orthophoto and infrared survey of Northern Ireland was commissioned by the Department of Agriculture, Environment and Rural Affairs (DAERA) Marine & Fisheries Division. This data is being used to develop the evidence base for coastal adaptation and will be used to inform future management plans. Working in conjunction with Department for Communities (DfC) Historic Environment Division, DAERA are analysing this data to create a detailed coastal heritage resources map which will show which heritage assets are currently at risk from climate change. It will also allow for the creation of a detailed heritage asset constraints buffer for future coastal management decisions. As the LiDAR survey is to be repeated on a 3-4 year cycle the change to these coastal heritage assets will be regularly monitored and the effects of climate change on them assessed.

Links of Noltland

Links of Noltland occupies some four hectares of sand dunes and coastal machair in Westray, Orkney (Figure 6). The area is subject to severe wind erosion and the dune system has been deflating since at least the 1980s. This erosion has led to the exposure of extensive and very well-preserved archaeological remains of Neolithic, Bronze Age and Early Iron Age date. Several interventions (monitoring, assessment, excavation and landscape consolidation) have been carried out since the late 1970s. The most extensive investigations commenced in 2006. Notable discoveries include the ‘Westray Wife’ – a carved stone figurine and the earliest human representation known from Scotland; a near-complete subterranean Neolithic house complex containing two further figurines and numerous carved stones; a Neolithic carved stone ball, found in situ inside a house, and a near-complete subterranean Bronze Age ritual structure, interpreted as a sauna. In 2011, HES initiated an extensive programme of landscape conservation and grass planting to attempt to reconsolidate the dune system and allow this form of natural protection to re-establish itself. This has involved remodelling the dune scape to reduce wind speeds locally, and thereby reduce aeolian erosion rates, as well as planting marram and lyme grasses to stabilise and encourage the growth of new dunes. Recent inspections confirm that these measures have been effective, and the area has been recolonised by vegetation (Moore and Wilson, 2011; Ainslie 2017; S. Watt pers. comm.).

Figure 6. Aerial view of Links of Noltland showing its exposed setting, and area of exposed dune system now extending inland.

The paddle-steamer ALBION (1837), Albion Sands, Pembrokeshire.

The archaeological remains of the Bristol-built paddle-steamer *Albion* are located within the inter-tidal zone at Albion Sands (named after the ship) in Pembrokeshire. The ship was wrecked in April 1837 when it was deliberately run ashore after striking a rock while on its regular route from Dublin to Bristol. At mid-to-low tide one of the crankshafts is visible, protruding vertically above the sand and/or sea. Other parts of the ship still survive in-situ and are visible when the distribution of sand across the beach allows it, by lowering the sand levels on the site itself. The major storms in the winter of 2013/14 scoured the site, exposing a large amount of previously unseen wooden hull, iron machinery, and the framework of the paddle wheel attached to the surviving crankshaft.

The site has been monitored by the RCAHMW on a regular basis since 2017 as part of the CHERISH project (above). This has resulted in the installation of permanent survey markers to allow the effective use of high-precision GNSS (Global Navigation Satellite System) to record the location of any extant structural and mechanical remains visible during monitoring visits.

Where possible, detailed records have been taken of exposed remains, and a geophysical survey has been undertaken to attempt to establish the buried extent of the archaeological material. A particular challenge to working at the site is the high degree of variability in sand-levels which can fluctuate dramatically, even between spring-tide cycles. This has been partially overcome through working closely with local people who have a deeper knowledge of the beach, and of the history of the site, and are able to visit on a frequent (weekly) basis.

The archaeological and historical investigation that has been undertaken on the *Albion*, in conjunction with local residents, has allowed a much better understanding of the original wrecking process and subsequent site-formation to be developed. Regular monitoring visits have allowed a greater extent of the site to be recorded, in more detail, than previously. This in turn has raised the overall archaeological significance of the site by demonstrating the extent of surviving archaeological material. Challenges remain in being able to understand the external factors – wind, tide, storms – acting on a wider scale, which result in localised short-term alterations to sand levels and site exposure.

The National Trust – Adapting to climate change at the coast

The National Trust is Britain's largest coastal landowner, caring for nearly 800 miles of dramatic, diverse and ever-changing coastline around England, Wales and Northern Ireland. Through their Shifting Shores (Dyke 2015) policy the Trust has made a commitment to working with, rather than against, natural processes, wherever possible. This involves working closely with communities, acting across boundaries and joining forces with partners and people, innovating and having the courage to try out new ideas and aspiring to have a healthy coastline, shaped by natural forces.

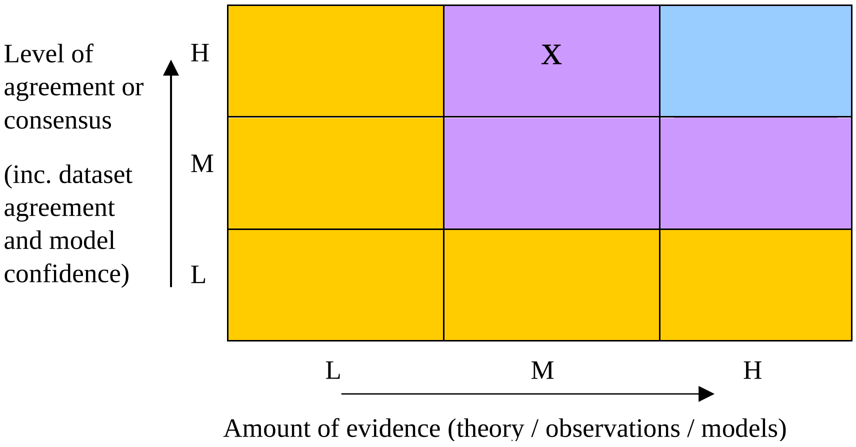
Work commissioned by the National Trust in 2008 highlighted the risks posed by coastal erosion and flooding to many of the Trust's important sites and recommended adaptive strategies, with 50% of National Trust properties identified at potential risk from moderate or extreme coastal erosion and 245 properties at risk from tidal flooding, coastal erosion and inundation. This prompted the development of coastal adaptation strategies for all high-risk sites, to enable well-informed decisions to be made on how to best manage those risks.

The National Trust (2022) is now building upon that earlier work to develop an up-to-date understanding of climate change impacts, taking account of a full range of hazards including slope failure, drought, flood, heat and humidity, and storms. Working with other heritage organisations, hazard maps have been produced, which illustrate projected changes in key hazards by the period 2060-2080, based on a worst-case climate change scenario. These are the first maps of their kind that have collated and plotted data in a way that will help the National Trust and other organisations identify the hazard level facing countryside locations, monuments and historical sites across England, Wales, Northern Ireland and Scotland. As part of this work, new mapping has been commissioned to assess the level and timing of risks to individual heritage features from coastal erosion and flooding, using the latest available national data sets.

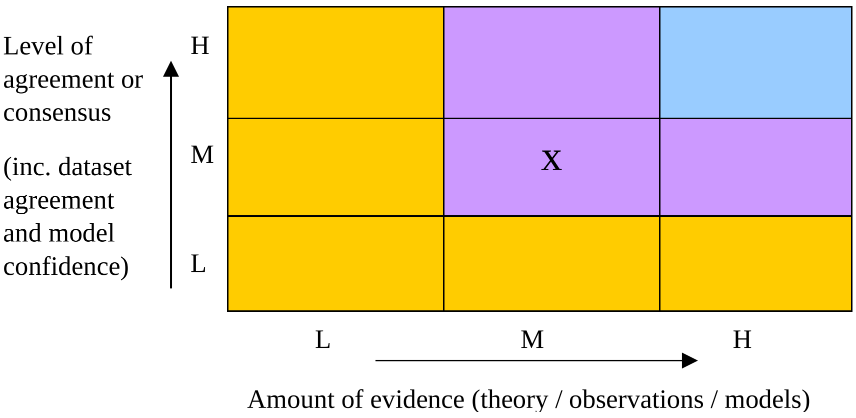
Combined, these new map products are being used by the National Trust to develop a national adaptation framework and to inform individual property adaptation action plans.

CONFIDENCE ASSESSMENT

What is already happening?



What could happen in the future?



Over the past 3 years there has been a marked increase in the amount of baseline data collected for the UK coastline. Various regional government heritage bodies and non-government heritage organisations have been analysing this data and providing initial assessments of the potential climate change impacts on the UK's coastal heritage assets. However, given the complex nature of coastal processes these surveys will need repeated over the next number of years to allow for a nuanced understanding of these impacts. Only through these repeat assessments will it be possible to quantify the effect of climate change on specific site locations and to provide an assessment of change, both negative (eg. erosion) and potentially positive (eg. accretion). This will then allow for projections of future impact/change and allow for development of appropriate adaptation. Baseline data for offshore, fully submerged heritage sites is lacking.

KEY CHALLENGES AND EMERGING ISSUES

1. Develop approaches to the management of cultural heritage assets that acknowledge the possibility of transformation and adaptive release as well as loss and decay of heritage assets due to climate change (see for example, DeSilvey, C. Venture et al, 2021; DeSilvey, C. et al., 2021)
2. Further develop long term monitoring to identify climate change impacts on cultural heritage assets (e.g. OA on ship decay; erosion rates).
3. Quantify the impact of multiple climate threats (storms, surge, flooding, wind driven rain) which cumulatively cause major damage to cultural heritage assets.

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