Historic England

Climate Change Adaptation Report

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SUMMARY

The statutory requirement on Government Agencies to provide a report on climate change adaptation, as part of the National Adaptation Plan (NAP), arises from the Climate Change Act 2008. However, we should not see contributing as an imposed additional task, but rather an opportunity to think differently and review existing practices and processes. Many adaptations provide benefits that go beyond providing resilience to climate change related impacts.

Our climate is changing and organisations need to adapt to these changes, to become more resilient to the challenges and to make the most of the opportunities. There is international recognition of the importance of preparedness for climate change in the heritage sector, with a number of UNESCO publications; and Historic England's own publication record reflects a long-standing consideration of the impacts of a changing climate upon England's heritage.

This report considers the impacts of the changing climate upon Historic England as an organisation: both in its management of personnel, facilities and equipment and with regard to its role as champion of England's heritage. It identifies key risks and opportunities based upon looking at how our organisation has been affected by weather-related impacts in the past, how the climate is projected to change in the future, and what impact this will have on our work. It then outlines how Historic England can begin to adapt to the future challenges of a changing climate.

In summary, this report discusses twelve risks relating to heritage advice, and five risks relating to organisational operations as well as eight opportunities for furthering Historic England's key function as champion of England's heritage. To begin to address these risks, and make the most of these opportunities, the report recommends the following adaptive measures:

1. Maintain a 'watching brief' on climate change projections and their associated environmental impacts;

2. Support measures to increase workforce resilience;

3. Support measures to increase resilience in the historic environment;

4. Embed climate change adaptation and environmental risk management within projects and practices;

5. Promote the positive role the historic environment can play in informing responses to climate change and associated environmental risks;

6. Develop an approach for dealing with inevitable change, including loss;

7. Support the English Heritage Trust in addressing climate change impacts.

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FRONT COVER IMAGE
East Lyng and Isle of Athelney, Somerset Levels during winter flooding 2014. Photo by Damian Grady 09.01.2014 ©Historic England Archive

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1. INTRODUCTION

This section gives the context for this report.

The climate is changing and these changes are already impacting upon many areas of our lives. As the Government recognised with the Climate Change Act 2008, there is a need for us to understand the risks presented by this changing climate and how we can adapt to minimise the impact of those risks.

As well as setting out requirements for undertaking a national Climate Change Risk Assessment[1], the Climate Change Act 2008 also introduced the National Adaptation Programme, which sets out what Government, businesses and society are doing to better adapt to climate change[2]. Contributions to this (ARP adaptation reports) can be requested by Government from certain organisations, under the Adaptation Reporting Power established by the Act.

ARP[3] adaptation reports should contain:

- a summary of the statutory and other functions of the organisation
- an assessment of current and future risks presented by climate change to the organisation and its functions
- a programme of measures to address the risks, including policies and practices that are already being implemented.

The first round of ARP reports were completed in 2011[4], and subsequently the Government invited additional organisations, including English Heritage, to participate in the second round, and produce a report for the National Adaptation Programme (due for publication in 2018). This invitation noted that English Heritage and the Church of England were establishing a wider 'Historic Environment Climate Change Adaptation Group' to define areas of consensus in the historic environment sector[5]. At the time of the invitation, however, a process had begun at English heritage to implement a 'new model' that saw the parent body (the Historic Buildings and Monuments Commission for England) split its organisation into two. One part becoming the English Heritage Trust (a charity responsible for the conservation and public enjoyment of the National Heritage Collection); the other part continuing the Commission's responsibilities for preserving England's wider historic environment and being renamed Historic England. Historic England, therefore, inherited the commitment to produce an adaptation report[6].

This document is a report of Historic England's approach to adapting to climate change. It is intended that it will continue to be developed by embedding the adaptations set out in Section 7 (below) within existing and developing corporate strategies. This is a condensed

[1] The first UK Climate Change Risk Assessment (CCRA) was completed in 2012. Work on the second is underway with the UKCCRA2 due for publication in 2017. Historic England has responded to consultation on these.
[2] The first NAP was published in 2013 and will be revised every 5 years with NAP2 due 2018. A progress report on the NAP by the Committee on Climate Change was published in 2015.
[3] Adaptation Reporting Power
[4] Analysis of first round reports was produced by Cranfield University (2012).
[5] The Historic Environment Adaptation Working Group is coordinated by Historic England and the Church of England and meets every 6 months. It currently includes representatives from across the sector and across the UK including National Trust, CADW, Historic Environment Scotland, Churches Trust, Heritage 2020, National Park Authorities, National Association of AONB, Natural England, Environment Agency.
[6] NOTE: Throughout this report, unless otherwise specified, "Historic England" should be taken to mean both the current body, and the body previously known as English Heritage, which undertook the same functions

version of a larger piece of work with associated appendices, which have not been included in this concise report.

2. HISTORIC ENGLAND – STRUCTURE, ROLES AND RESPONSIBILITIES

Historic England - officially the Historic Buildings and Monuments Commission for England – is the government's independent expert advisory service for the English historic environment. It champions historic places and helps people to understand and care for them, now and for the future, by giving constructive advice to local authorities, owners and the public.

Structure

Structurally, Historic England is an executive non-departmental public body with powers and responsibilities that are principally set out in the National Heritage Act 1983. Key roles include contributions to the planning system; designation; record keeping; conservation advice to Government, the general public, and the heritage sector; research to support all of these activities; and grant-giving.

Historic England is sponsored by the Department for Culture, Media and Sport (DCMS), and reports to Parliament through the Secretary of State for Culture, Media and Sport; but it also works closely with other Government departments, including the Department for Environment Food and Rural Affairs (Defra) and the Department for Communities and Local Government (CLG). Work is overseen by a Chair and a board of up to sixteen Commissioners selected by the Government.

The aims and objectives for Historic England are set out in the Three Year Corporate Plan (2016-19)[7].

Historic England licenses a charity (English Heritage Trust) to look after the majority of historic sites in Government control (the 'National Heritage Collection').

Staff resource and facilities

Historic England employs around 900 staff across 11 offices; a significant and growing number of this workforce are homeworkers. National offices are sited in London, Swindon and Portsmouth, with the following local offices each covering a particular geographical area: London, South East, South West, East Midlands, West Midlands, East of England, North East, North West and Yorkshire. The distribution of staff and premises means Historic England has an interest in, or responsibility for, a range of building types and locations that may variously be impacted by environmental risks such as flooding, water ingress or overheating.

Roles and responsibilities

Planning: Historic England advises Government on law and policy developments and called-in planning applications where appropriate; it advises on marine and coastal

[7] https://historicengland.org.uk/about/what-we-do/corporate-strategy/

developments; it is a statutory consultee to Local Planning Authorities for certain applications[8]; it advises on national infrastructure projects.

Designation: Historic England administers applications for, and advises the Secretary of State for Culture Media and Sport on, the designation of listed buildings, scheduled monuments and protected wreck sites, as well as certificates of immunity from listing; it is the decision-maker for new entries and amendments to the Register of Parks and Gardens and the Register of Battlefields; it administers National Heritage List for England [9].

Record keeping: Historic England annually compiles the Heritage at Risk Register, which is an official statistic[10]; it holds the largest public archive for the historic environment containing over 10 million photographs, documents, plans and reports relating to the historic environment of England; it is responsible for keeping the Historic Environment Record for Greater London.

Conservation Advice: Historic England advises on dealing with historic sites facing risk; it advises government, the general public, and the heritage sector on best practice; it disseminates best practice guidance; it collaborates with and advises other organisations.

Research: Historic England funds and undertakes research to support the protection and management of the historic environment, and to foster its wider understanding and enjoyment; it works with partners[11] to maximise research impacts.

Grant-giving: Historic England administers a number of grant schemes concerned with the protection and promotion of the historic environment, including research, repair and maintenance [12].

[8] https://www.gov.uk/government/publications/arrangements-for-handling-heritage-applications-direction-2015 and https://www.gov.uk/government/publications/the-conservation-areas-direction-2015
[9] National Heritage List for England https://www.historicengland.org.uk/listing/the-list/
[10] https://historicengland.org.uk/advice/heritage-at-risk/search-register/ This includes registered parks, gardens and battlefields, listed buildings, protected wrecks, scheduled monuments and conservation areas.
[11] E.g. research councils and academic institutions.
[12]This includes repair grants intended to reduce Heritage At Risk https://historicengland.org.uk/services-skills/grants/our-grant-schemes/repair-grants/, grants for management agreements for vulnerable monuments https://historicengland.org.uk/services-skills/grants/our-grant-schemes/management-agreements/ and grants to underwrite urgent works notices https://historicengland.org.uk/services-skills/grants/our-grant-schemes/grants-to-underwrite-urgent-works/

Table 1: Summary of Historic England's Corporate Aims and their relevance to climate change

Corporate Aim	**Climate Change relevance**
Aim 1 Champion England's historic environment	HE[13] can make the most of its historical perspective to inform debates relating to climate change risks and adaptations. Heritage has a positive role to play in communicating change and adaptation but we also need to ensure heritage is included in consideration of climate change risks, opportunities and adaptations.
Aim 2 Identify and protect England's special historic buildings and places	Climate change affects how and why heritage is at risk. As the impacts of climate change are more keenly felt, certain environmental risks to heritage will be exacerbated and Historic England will be called upon to help.
Aim 3 Promote change that safeguards historic buildings and places	Climate change adaptation is at the heart of sustainable development. Heritage can contribute through constructive conservation: integrated policies that include and recognise the value of the historic environment in maintaining the culturally distinctive identity of places and landscapes through the adaptive changes needed to address climate change, as well as learning from the past.
Aim 4 Help those who care for historic buildings and places, including owners, local authorities, communities and volunteers	For those who care for our heritage, the changing climate is already presenting new challenges such as increased and new flood risks, increased and more intense rainfall, and changing flora and fauna (including pests & diseases). Providing support and information to enable them to respond to these challenges is essential to achieving Aim 4.
Aim 5 Engage with the whole community to foster the widest possible sense of ownership of our national inheritance of buildings and places	Climate change presents risks and opportunities for all sorts of heritage. There are opportunities for wider engagement; for instance, in recording heritage that will be lost and in assessing the risks and the impacts of climate change.
Aim 6 Support the work of the English Heritage Trust in managing and safeguarding the national Heritage Collection of buildings and monuments to achieve financial self sufficiency	The national Heritage Collection is subject to the risks and opportunities that result from a changing climate. We are in a good position to support the English Heritage Trust in this regard.
Aim 7 Work Effectively, efficiently and transparently	Climate change as a multiplier of environmental risks is an important consideration in future planning for Historic England, and should be clearly identified as such. These risks affect not just the specialist services that we offer but also the facilities we use and the people we employ.

[13] Historic England

3. HISTORIC ENGLAND AND CLIMATE CHANGE

In the 2016-2019 Corporate Plan Historic England identifies that it will '*enhance understanding of the risks to heritage and identify opportunities to avoid or reduce them*'[14]. Climate change is a significant risk to heritage.

Historic England has a long history of commitment to considering the impacts of climate change on the historic environment. Most recently the first Historic England Corporate Plan identified '*an urgent need to stimulate prosperity, to provide new housing, to renew infrastructure and to respond to climate change. Historic places can often be adapted to meet these changes in ways that enhance rather than detract from their inherited character and identity*'[15]. Recognition of the impact of climate change upon the historic environment can be seen in earlier iterations of the Corporate Strategy, and other initiatives and projects over the past two decades (both in-house projects and externally commissioned research). A summary of these can be found in Appendix I and a list of relevant Historic England publications in Appendix II.

Overall, since 2008, there has been a shift in Historic England's engagement with climate change and related issues from an emphasis on sustainability and mitigation towards a balance with adaptation. Besides the results of the *Rapid Coastal Zone Assessment Surveys*, the *Coastal Estate Risk Assessment* [16](Hunt 2011) and *Inland Estate Risk Assessment*[17] both assessed risk for flooding and erosion at English Heritage's properties and could feed into long-term management strategies. *Flooding and Historic Buildings* (first published in 2010 and revised in 2015) is more focused on adaptation than previous iterations. It includes sections on 'Establishing Flood Risk' and 'Being Prepared for Flooding', describing adaptation measures such as temporary and demountable, and also permanent, structures which can result in increased resilience, besides providing advice on dealing with the impacts of floods.

[14] 'Our Work in 2016-17' in *Historic England Three Year Corporate Plan 2016-201: page 13*
[15] *Historic England Corporate Plan 2015-2018*. Page 14.
[16] Hunt, A. 2011 *English Heritage Coastal Estate Risk Assessment*.
[17] Pearson, T. 2013. *Flooding and the English Heritage Inland Estate. Flood Risk Assessment.*

4. REVIEW OF PAST WEATHER IMPACTS AND LESSONS LEARNT

Experiences of past weather events were gathered and reviewed to better understand the relationship between Historic England's business and the likely future environmental impacts caused by a changing climate. Initially, only significant weather events over the past five years were considered, but this was broadened to include all significant events where there was evidence for impacts upon the historic environment and Historic England. In addition to individual weather 'events', trends in weather patterns that have affected the Historic England's work were recorded. Evidence was compiled concerning the impact of past weather events on Historic England's work.

The key lessons learnt are presented here.

Personnel and facilities

Disruption to staff

Certain events (e.g. floods, sudden cold spells, storms, and heat waves) impact upon staff ability to travel to work: not only to offices, but also to sites or meetings. Increased pressure upon those communications and IT systems that suport home working has been observed during these times, on some occasions causing those systems to fail.

Extremes of temperature can affect staff working conditions, both in office environments and when working in the field.

Damage to buildings

Storms and flooding, in particular, pose a threat to buildings housing offices, equipment, and archives. In some instances, this has led to rethinking where material could or should be stored and what equipment might facilitate moving it should a need to do so become apparent.

Particularly vulnerable are archives and IT equipment, where climatic stability is important for conservation and operation.

Damage to equipment

Extremes of temperature and humidity, and damage to buildings, can pose a challenge. Both archive and IT equipment need stable temperatures, but extremes of external temperature put pressure on the equipment that maintains these conditions; in hot weather, this has proven particularly challenging and instances of air conditioning failure have occurred.

Care needs to be taken as to where sensitive equipment and archive material is stored: in which buildings and whereabouts within those buildings.

Heritage work

Disruption to fieldwork

Extremes in weather can be especially disruptive to fieldwork, presenting challenging conditions not just in terms of staff wellbeing but also for the practicalities of survey, excavation and investigation.

Drought conditions have presented opportunities to identify new archaeological sites because previously unseen crop marks can present themselves, but can also make excavation, particularly of waterlogged sites challenging. Extremely wet conditions can affect the ability to undertake some types of survey work as well as being challenging for excavation, particularly on slow draining geologies (e.g. clay).

Weather unpredictability is an emerging theme in planning fieldwork, particularly in the marine environment, with reports of increasing numbers of occasions where planned fieldwork could not be undertaken, or had to be rescheduled, due to bad weather conditions. For instance fieldwork on the Royal Anne Galley wreck, off Old Lizard Point, Cornwall, had to be postponed for several successive years due to inclement weather over this particularly exposed dive site.

Calls on specialist advice

Extreme events such as flooding can lead to increases not only in casework for staff in regional offices but also to centrally based expertise. An example is the response to the floods of 2009 which affected much of the UK, but with Cumbria particularly badly affected. Questions arose about whether historic bridges posed a flood risk[18] to which HE had to respond from a national perspective[19].

These sorts of events also trigger increased calls on data. For instance following the flooding of winter 2015/16, staff in the north west regional office coordinated data on flood impact upon Listed Buildings. After flood events there is an increase in requests from insurance companies for data regarding listed properties in flood areas.

Key lessons learnt

Overall, the lessons learnt identified a benefit from joined-up forward planning, not only to minimise the impact of these events but also to maximise opportunities for positive engagement with the heritage and our work in promoting it for the benefit of future sustainable places. Lessons include:

- Good sharing of information – gives benefits both internally and externally.
- Preparedness- forward planning – is vital: there are great benefits in being proactive rather than reactive
- The most should be made of positive opportunities to promote Historic England's work

[18] Transport Committee Select Committee Announcement December 10th 2009. *The impact of flooding on bridges and other transport infrastructure in Cumbria*

[19] English Heritage response to Transport Committee Select Committee Announcement: *Representations on behalf of English Heritage in relation to the impact of flooding on bridges and other transport infrastructure in Cumbria*

- Robust support for flexible, home and mobile working makes for a more resilience workforce
- Flexibility needs to be built in to fieldwork projects, whether undertaken by Historic England's or commissioned from others
- It is important to 'future proof' all purchases and facilities

5. CLIMATE CHANGE IDENTIFIED FOR HISTORIC ENGLAND'S ADAPTATION PLANNING

While there is overwhelming evidence that the global climate is changing, and that human activity has and continues to play a key role in this change[20], exactly what this means for our future weather is less certain. A number of models have been developed which 'project' what our climate will be like into the future from an understanding of current climate and the variables affecting it. Work by the Met Office in the UK[21] and the IPCC globally, as well as others, has begun to identify trends that indicate what we might expect.

The models and data that inform these projects are constantly being refined and updated; however, while the precise details might change as we gain a greater understanding of the processes, the general trends these models have identified remain valid.

The climate changes that form the basis of this adaptation plan are principally based upon two key reports, the IPCC AR5 and the UKCP09. Previous work on climate change by Historic England has considered climate change as a multiplying factor with the potential to exacerbate or make more frequent certain scenarios[22].

The main climate changes that will impact upon Historic England's work are set out below:

Unpredictability:
Although the precise details may be uncertain it is clear that change is already occurring and will continue to occur. Inevitably, this means a departure from the predictable seasonal weather patterns of the past. This increasing unpredictability impacts upon our ability to schedule weather dependent work.

Increased rate and patterns of coastal change:
Britain's coastline has always changed continually, but the rate of this change and where its greatest impacts will be are being affected by sea-level rise, changes to coastal currents, storm patterns and other climate change related factors.

Precipitation pattern changes:
Intense pluvial events, and persistent periods of rainfall on saturated or impermeable ground, can damage buildings, flood historic areas and landscapes, affect planting in designed landscapes, disrupt fieldwork, and exacerbate erosion. With a projected increase in winter precipitation of around 33%, these impacts will be felt ever more strongly. At the other extreme, drought (also projected to increase in frequency and intensity) can harm plants that make up designed and historic landscapes, and can affect the stability of buildings and other structures.

Temperature increase:
In the sea, temperature increase is affecting the conditions that have hitherto preserved a rich maritime heritage[23]. On land, it may lead to changing patterns of land use that could also present challenges for terrestrial heritage. Increasing temperatures also give rise to different flora and fauna, some of which may be harmful to elements of our heritage. This is likely to have a major impact on the plants in designed landscapes, particularly trees, affecting the appearance of our designed landscapes.

[20] IPCC 2014. *Climate Change 2014. Fifth Assessment report. Geneva, IPCC.*
[21] Jenkins *et al.* 2009
[22] e.g. English Heritage 2008a; Atkins 2013
[23] Changes to salinity, acidity and flora and fauna that can harm archaeological remains (Dunkley 2013)

New pests and diseases may attack archive materials. Buildings may also be attacked and traditional repair materials may become increasingly difficult to source.

Reduced water resources:
Desiccation of wetlands can have a dramatic effect on the preservation of waterlogged archaeological and palaeo-environmental material. The drying out of certain geologies (e.g. clay) can increase subsidence affecting historic structures.

6. RISKS AND OPPORTUNITIES

The impacts of a changing climate pose challenges and opportunities for the range of heritage assets within Historic England's interest, as well as for Historic England as an employer and a business, but they are complex and frequently interrelated.

Heritage assets will face multiple risks, and even new opportunities may themselves present risks (e.g. increased tourism due to more favourable weather can increase footfall and thus erosion for some monuments). New impacts will emerge as a consequence of measures taken to mitigate climate change, or adapt to it.

There are also risks and opportunities that relate to Historic England's functioning as an organisation and employer. The risks to and opportunities for the historic environment do not just affect the heritage sector, as highlighted by a recent publication from UNESCO. This examined the impact of climate change upon the historic environment, and on the tourist industry that depends upon it; one example explored was the potential impacts upon Stonehenge.

Risks and opportunities have been identified from previous work, through the workshops undertaken as part of the adaptation planning process and in light of the UK Climate Change Risk Assessment. Further detail of the risks and opportunities identified can be found in Appendix III. And an overview is presented in Table 2, where risks are separated into 'business risks' (affecting Historic England's Operations, personnel and facilities) and 'heritage risks' (affecting the historic environment).

Table 2. Climate change related risks and opportunities to/for Historic England and the Corporate Aims affected

Risk/Opportunity		Corporate Aims affected
Heritage Risk 1	Inadequate or insufficient information or experience preventing or impeding appropriate action	**ALL**
Heritage Risk 2	Damage to or loss of heritage assets	**Aims 1, 2 & 3**
Heritage Risk 3	Difficulties in planning/undertaking fieldwork	**Aims 2, 6 & 7**
Heritage Risk 4	Harm to heritage assets from maladaptation.	**Aims 3, 4 & 6**
Heritage Risk 5	Damage to reputation from inappropriate, inconsistent responses or failure to respond to climate change related impacts.	**ALL**
Heritage Risk 6	Harm to/loss of plants within designed and historic landscapes	**Aims 1, 2, 3 & 5**
Heritage Risk 7	Damage to buildings from poor/inadequate rainwater goods.	**Aims 1, 2, 3, 4 & 6**
Heritage Risk 8	Geological shrink and swell causes damage to historic structures.	**Aims 2, 4 & 6**
Heritage Risk 9	Damage to or loss of historic and archaeological collections and archives	**ALL**
Heritage Risk 10	Harm to heritage structures from frost fracture	**Aims 2, 4 & 6**
Heritage Risk 11	Harm to heritage assets from wildfire	**Aims 2, 4 & 6**
Heritage Risk 12	Damage to, loss of, or changes to visibility of maritime heritage due to changing depositional processes	**Aims 1, 2, 3, 4, 5 & 7**
Business Risk 1	Damage to Fort Cumberland office and facilities from coastal flooding	**Aims 1, 2, 3, 4 & 7**
Business Risk 2	Disruption to staff travel and ability to undertake work (esp. fieldwork.)	**ALL**
Business Risk 3	Damage to Historic England facilities and their contents from rainwater incursion.	**Aims 6 & 7**
Business Risk 4	Damage to Historic England facilities and their contents from flooding	**Aims 6 & 7**
Business Risk 5	Harm to staff from pests & diseases	**Aims 6 & 7**
Opportunity 1	Opportunity for new discoveries	**Aims 1, 2, 4, 5 & 7**
Opportunity 2	Learning from the past - the historic environment can inform integrated solutions	**Aims 1, 5, 6 & 7**
Opportunity 3	Making the case for heritage: advocacy for the positive role the historic environment can play	**Aims 1, 3, 4, 5 & 7**
Opportunity 4	Possibility of prolonged fieldwork season	**Aims 2, 6 & 7**
Opportunity 5	A role for heritage in helping to communicate change	**Aims 1, 5 & 7**
Opportunity 6	Increased opportunities for community engagement and broadening access to heritage	**Aims 1, 5 & 7**
Opportunity 7	Extended tourist season, increased interest in heritage	**Aims 1, 4, 5, 6 & 7**
Opportunity 8	Greater collaboration with existing and new partners for knowledge, expertise & data.	**ALL**

7. ADAPTATIONS

The historic environment is everywhere; it is what makes places culturally distinctive, and therefore contributes strongly to the identity of the people who use them. With care and understanding it can, and should, retain those vital cultural roles even as we are forced to adapt it to take account of climate change.

Within this context, this section presents the recommendations for adaptation for Historic England over the period 2016-2021.

Adaptation is about being flexible in order to be resilient; about planning for what is ahead without being constrained by future uncertainty. By its nature, it is an iterative and reflexive process. Some potential adaptations are things Historic England is already doing; others it could do differently or more effectively. Other adaptations proposed here are new.

The most effective way for Historic England to adapt to climate change is to embed consideration of current and future climate-related impacts into all strategic plans, processes and everyday practice[24].

This report has identified work already undertaken which, although prompted by other drivers, also serves to prepare us better for adapting to changing environmental conditions [25]. A key finding is that we need to improve how we flag such interfaces, to ensure that we improve our own and others' understanding of what we are already doing, and highlight where the gaps lie.

Historic England is committed to the following activities to facilitate adaptation to current and future climate change:

1. Maintain a 'watching brief' on climate change projections and their associated environmental impacts

1.1. Historic England should periodically review changes to climate change projections and risk assessments, and assess their impact upon Historic England's business in line with the National Adaptation Plan reporting cycle.

1.2. Historic England should communicate the impacts, risks, and opportunities of a changing climate on the historic environment to inform the UK Climate Change Risk Assessment, clarifying which aspects align with our core priorities and which are better served by sector responses.[26]

2. Support workforce resilience

2.1. Historic England should facilitate sharing of information between staff (across different teams and offices) in the aftermath of dealing with extreme weather events (e.g. experiences and lessons learnt with regard to flooding to increase preparedness).

[24] Recognised as the method preferred by the majority of businesses in EA commissioned report (Acclimatise, 2015).
[25] Reference to the relevant Appendices listing this material will be made in the final report submitted to DEFRA.
[26] Both of these reports operate on a 5 yearly cycle (latest reports due 2016).

2.2. Historic England should continue to build resilience and facilitate business continuity in the face of extreme weather events by: a) exploring different models of working, including mobile/remote/flexible working; and b) building flexibility into fieldwork to make programmes more resilient to changing conditions.

2.3. Historic England should improve preparedness by continuing to provide training and guidance to its workforce on climate change and associated impacts, risks (including health & safety), and opportunities. This will be pitched at a level appropriate to the operational requirements of individual teams.

3. Support resilience in the historic environment

3.1 Historic England should consider aspects of the historic environment which are vulnerable to climate change and seek to improve their resilience through targeted advice, advocacy and partnership working in alignment with delivering the Corporate Plan.

3.2 Historic England should promote the benefit of good site management and maintenance for increasing the resilience of the historic environment to changing environmental conditions; this includes making the case for investing in maintenance.

4. Embed climate change adaptation and environmental risk management within projects and practices

4.1 Historic England should include environmental risks in corporate risk management, business continuity and disaster planning

4.2 Historic England should consider how best to 'future proof' purchasing decisions, facility selection and specification in maintenance contracts.

4.3 Historic England should seek to better understand and audit which of the projects it undertakes (whether commissioned, partnership or internal) improves understanding of climate change impacts on the historic environment. In particular it should:

- Explore how to include environmental risk in its assessment of Heritage at Risk.
- Seek to understand the impact of environmental change on the sustainability of nationally important heritage.
- Begin to debate how to include consideration of climate change impacts in corporate policies and strategies, technical guidance and advice and strategic and development management planning advice, particularly where inevitable loss is a factor.

5. Promote the positive role the historic environment can play in informing responses to climate change and associated environmental risks

5.1 Historic England should seek opportunities to promote the positive role which the historic environment can play in responding to the challenges posed by climate change, and support or undertake research in these areas: promoting urban green

space as heritage value and role in urban heat island mitigation; promoting the 'long view' of land management impact on flood management and settlement pattern; promoting traditional building techniques for resilient construction; providing a context for coastal change.

5.2 Historic England should begin to explore the potential of the 'Ecosystem Services' approach as a way to present some of these positive contributions to a wider audience.

6. Develop an approach for dealing with inevitable change, including loss

6.1 Historic England should begin to develop a framework in which to begin discussing the management of inevitable change/loss of heritage assets, in particular affecting heritage assets at the coast.

7. Support English Heritage Trust in addressing climate change impacts

7.1 Historic England should offer support to the English Heritage Trust for climate change adaptation.

Table 3 presents a summary of adaptations, and the risks and opportunities they address (as identified in Section 6), relevant corporate aims, work and outcomes.

Table 3: Recommended adaptations, the risks and opportunities they address, Historic England work and outcomes

Adaptation	Risk/ opportunity addressed	Relevant Corporate Aims	Work through which this is delivered	Outcomes that can be monitored as a measure of success
1. Maintain a 'watching brief' on climate change projections and their associated environmental impacts	Heritage risks ALL Business risks ALL Opportunities 1, 8	3, 4, 6, 7	1.1 Review changes to climate change projections and risk assessments 1.2 Communicate impacts, risks and opportunities of a changing climate	• Input into NAP reporting cycle is maintained (5 yr). • Input into National Climate Change Risk Assessment (5 yr) • Briefing notes provided as necessary • Guidance is kept up to date and relevant
2. Support workforce resilience	Heritage risks 1, 3, 5, 9 Business risks 1, 2, 3, 4, 5 Opportunity 4	6, 7	2.1 Facilitate sharing of information between staff 2.2 Build resilience and facilitate business continuity 2.3 Improve preparedness through guidance & training	• Information shared within Historic England using a variety of (largely digital) methods. • Potential of technologies to deliver benefits is fully realised. • Climate Change Network used to raise awareness of the issues • Training provided where need identified • Impact of extreme weather upon operations is kept to a minimum

3. Support resilience of the historic environment	Heritage risks ALL Opportunities 2, 3, 5, 6, 8	1, 2, 3, 4, 5, 6	3.1 Target advice, advocacy and partnership working to improve resilience of areas of historic environment vulnerable to climate change 3.2 Improve the business case for investment in maintenance to increase resilience of historic buildings to changing weather patterns	• Authors consider impact of changing conditions when drafting advice (Climate Change Network support) • Partnership projects and campaigns to articulate how and why maintenance makes a difference are promoted. • Stories told about what works using a wide range of techniques. • HE's role in Historic Environment Adaptation Working Group maintained
4. Embed climate change adaptation and environmental risk management within projects and practices	Heritage risks ALL Business risks ALL Opportunities 3, 4	7	4.1 Include environmental risks in corporate risk management, business continuity & disaster planning 4.2 Consider how to' future proof' purchasing decisions, facility selection & maintenance 4.3 Better understand which projects fulfil a role in improving understanding of climate change impacts including: - explore inclusion of environmental risk in Heritage At Risk - impact of environmental change on sustainability of nationally important heritage - how to include consideration of climate change impacts in policies, strategies, guidance & advice	• Consideration of resilience to extreme weather events (including heavy rainfall) is factored into the procurement of facilities and their maintenance. • HE carry out, commission or facilitate dedicated research projects and support partnership work that considers climate change impact and associated environmental risks. • Simple mechanisms are created to help audit projects that contribute to furthering this understanding (whether or not it is their primary goal) - facilitating future reporting of climate change adaptation.

5. Promote the positive role the historic environment can play in informing responses to climate change and associated environmental risks	Heritage risks 2, 4, 5, 12; Opportunities 1, 2, 3, 5, 6, 7, 8.	1, 6	5.1 Seek opportunities for promoting positive role historic environment can play in responding to climate change and support research in these areas 5.2 Explore potential of Ecosystem Services to present positive contributions to a wider audience	• Opportunities for the public to help us understand and monitor what is at risk, where and why, are created and facilitated (Scalable) • A wider range of audiences and partners are aware of the positive role the historic environment can play (from volunteers to planners and environmental managers) • A greater awareness of the historic environment amongst those working with climate related impacts
6. Develop an approach for dealing with inevitable change, including loss	Heritage risks 1, 2, 5, 6, 7, 8, 10, 11, 12 Opportunities 1, 6, 8	2, 3, 5, 6, 7	6.1 Facilitate public discussion of the challenges & choices for the historic environment with respect to the impact of climate change	• Positive opportunities created by change and loss are identified and promoted. • A greater range of people and organisations are engaged in heritage. • Support for volunteering to record vulnerable assets
7. Support English Heritage Trust (EHT) in addressing climate change impacts	Risks in so far as they relate to shared services ALL Opportunities, 3, 4, 7, 8.	6	7.1. Offer support to the English Heritage Trust for climate change adaptation	• EHT are included within the Historic Environment Adaptation Working Group • named climate change contact(s) in EHT to aid with liaison and communications (ideally one for collections and one for properties) • Expertise, information and lessons learnt shared with EHT as requested

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government-policy-climate-change-adaptation/2010-to-2015-government-policy-climate-change-adaptation Accessed 16/3/16
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APPENDIX I: SUMMARY OF HISTORIC ENGLAND'S CLIMATE CHANGE WORK 1997-2016

Date	English Heritage/Historic England Project/initiative
1997	After the Storms published looking at the longer term impact of the 1987 great storm[27].
	EH/RCHME publication of England's Coastal Heritage identifying future sea level rise as a major threat to England's coastal archaeological resource. The recommendations led directly to the Rapid Coastal Zones Archaeological Survey programme
1998	EH commissioned the first in a series of rapid coastal archaeological surveys in order to allow us to respond to government policy on coastal defence in the face of climate change.
2000	EH published guidance on protecting historic churches from lightning[28], augmented in 2003 with guidance on protecting historic buildings from electrical surges
2002	EH commissioned a scoping study on the implications of climate change for the historic environment by University College London. Published in 2005, this served to illustrate possible approaches to future research (Cassar 2005)[29].
	EH published Building Regulations and Historic Buildings an interim guidance note on the application of Part L of the Building Regulations
	With a wide range of partners EH co-funded the UK Climate Impacts Programme (UKCIP) to undertake a study of the potential impacts of climate change on UK gardens, garden plants and the garden industry[30].
2003	EH published Coastal Defence and the Historic Environment on the coastal defence policy for the historic environment, augmented in 2006 with more detailed guidance on shoreline management planning.
2004	EH arranged for the Carbon Trust to undertake a number of assessments of their energy use.
	EH published 1st edition of Flooding and Historic Buildings covering flood protection and damage
	EH published 2nd edition of Building Regulations and Historic Buildings
2005	EH published the first in a series of guidance notes on renewable energy technologies, sustainability and heritage. This now includes wind energy, biomass crops, micro-generation technologies and water management.
	EH Research strategy published for 2005-2010 Discovering the Past: Shaping the Future
2006	EH published Sustainable Development Strategy and Sustainable Development Action Plan

[27] https://historicengland.org.uk/images-books/publications/after-the-storms/
[28] https://content.historicengland.org.uk/images-books/publications/lightning-protection-for-churches/lightning-protection-for-churches.pdf/
[29] http://discovery.ucl.ac.uk/2082/1/2082.pdf
[30] UKCIP 2002 *Gardening in the global greenhouse* https://content.historicengland.org.uk/images-books/publications/gardening-global-greenhouse/gardening-global-greenhouse-summary.pdf/

	EH published initial policy statement Climate Change and the Historic Environment
	EH published Biomass Energy and the Historic Environment
	EH commissioned a study of the implications of climate change on World Heritage Sites, as part of the UK Government contribution to the UNESCO Experts' meeting on climate change (World Heritage Centre 2007).
	EH published Shoreline Management Plan Review and the Historic Environment
	Government Historic Estates Unit 10th Annual conservation seminar Be Prepared! Emergency Planning for Historic Buildings & Collections
2007	EH published guidance for home owners on energy conservation in traditional buildings together with interim guidance on Energy Performance Certificates, Home Information Packs, understanding SAP ratings for historic and traditional homes, advice for Domestic Energy Assessors, all building on previously published technical advice regarding compliance with Part L of the Building Regulations.
	As research partners with the Engineering and Physical Sciences Research Council (EPSRC) and UKCIP, HE co-sponsored the publication of the Engineering Historic Futures which focuses on responses to flood damaged historic buildings[31]
	Government Historic Estates Unit 11th Annual conservation seminar Cutting Down on Carbon: Improving the energy efficiency of historic buildings
	EH published Micro Wind Generation and Traditional Building
2008	EH published 2nd edition of Climate Change and the Historic Environment[32].
	EH launched a website, 'Climate Change and Your Home', to provide the general public with information about how traditionally constructed buildings are likely to respond to climate change and how any necessary adaptations, including energy saving measures, might be made.
	EH launched a research project, 'Hearth and Home', to measure the energy use and embodied energy of a group of Victorian terraced homes and to lead to enhanced advice on the cost-effectiveness of various energy-saving measures.
	EH hosted 'Inventing the Future: Buildings in a Changing Climate', a summit for invited representatives from government, industry and academia to look at buildings in light of climate change adaptation.
2009	EH organised a training course 'Climate Change and the Historic Environment' at Oxford University Department for Continuing Education (repeated 2010).
2010	EH organised a training course in 'Flooding and the Historic Environment' at Oxford University Department for Continuing Education
	EH initiated the English Heritage Coastal Estate Risk Assessment[33].

[31] Cassar and Hawkins 2007.
[32] https://historicengland.org.uk/images-books/publications/climate-change-and-the-historic-environment/

	EH published 2nd edition of Flooding & Historic Buildings
	EH published Energy Efficiency and Historic Buildings
2011	EH established the National Heritage Protection Plan for 2011-14 which incorporated climate-related activities and projects
	EH contributed to the development of the UK Climate Change Risk Assessment (published on 26/1/12), at workshops and by direct communication with Defra.
	EH published Solar Electric Panels and slates on Listed Places of Worship
	EH published series of 13 guidance notes on upgrading the thermal performance of building elements
2012	EH contributed to development of the National Adaptation Programme at workshops and by direct contact with Defra, and responded positively to Defra's invitation to submit an adaptation report.
	EH appointed Climate Change Officer within Historic Environment Intelligence Team (role currently included within more general 'Environmental Impacts' portfolio).
	EH Climate Change Network was established, to provide expert advice on prioritising and procuring research and formulating responses to address climate change issues.
2013	EH published initial thoughts on the potential effects of oceanic change on the management and curation of underwater archaeological remains[34]
	English Heritage Estate and Inland Flood Risk Assessment published
	EH Research into the thermal performance of traditional brick walls published
2014	The future Historic England committed to undertake an Adaptation Report as part of the second round of ARP. As part of this commitment the cross sector Historic Environment Adaptation Working Group was established, coordinated by Historic England and Church of England
	EH Research into use of external wall insulation on traditional buildings in the North West of England published
	Practical Building Conservation Building Environment volume published EH/Ashgate
2015	Historic England contribute to Climate Change Risk Assessment 2 and the Flood Resilience Review
2016	Historic England produce Climate Change Adaptation Report

[33] Hunt, A. 2011.

[34] https://heritagecalling.com/2013/09/12/oceanic-climate-change-and-underwater-archaeology/

APPENDIX II: PUBLICATIONS RELATED TO CLIMATE AND SUSTAINABILITY PRODUCED BY ENGLISH HERITAGE/HISTORIC ENGLAND

Advice and guidance

Traditional windows their care, repair and upgrading Historic England, April 2016

Energy Efficiency and Historic Buildings: Insulating pitched roofs at rafter level. Historic England, April 2016

Energy Efficiency and Historic Buildings: Insulating pitched roofs at ceiling level. Historic England, April 2016

Energy Efficiency and Historic Buildings: Insulating flat roofs. Historic England, April 2016

Energy Efficiency and Historic Buildings: Insulating dormer windows. Historic England, April 2016

Energy Efficiency and Historic Buildings: Open fires, chimneys and flues. Historic England, April 2016

Energy Efficiency and Historic Buildings: Insulating solid walls. Historic England, April 2016

Energy Efficiency and Historic Buildings: Insulating thatched roofs. Historic England, April 2016

Energy Efficiency and Historic Buildings: Insulating timber framed walls. Historic England, April 2016

Energy Efficiency and Historic Buildings: Insulating early cavity walls. Historic England, April 2016

Energy Efficiency and Historic Buildings: Draught-proofing windows and doors. Historic England, April 2016

Energy Efficiency and Historic Buildings: Secondary glazing for windows. Historic England, April 2016

Energy Efficiency and Historic Buildings: Insulating suspended timber floors. Historic England, April 2016

Energy Efficiency and Historic Buildings: Insulating solid ground floors. Historic England, April 2016

Energy Efficiency and Historic Buildings: Energy Performance Certificates. Historic England, May 2015

Energy Efficiency and Historic Buildings: Advice for Domestic Energy Assessors and Green Deal Advisors. Historic England May 2015

Flooding and Historic Buildings (3rd edition) Historic England, April 2015

Micro-Hydroelectric Power and the Historic Environment. English Heritage 2014

Energy Efficiency in Traditional Buildings, Heat pumps. English Heritage, 2013

Landscape Advice Note: Historic parks and gardens and changes to reservoir safety. English Heritage, with the National Trust and Environment Agency, September 2013

Small Scale Solar Electric (Photovoltaics) Energy and Traditional Buildings. English Heritage, October 2011

Solar Electric (Photovoltaic) Panels and Slates on Listed Places of Worship. English Heritage May 2011

Energy Efficiency and Historic Buildings: Application of Part L of the Building Regulations to historic and traditional constructed buildings. English Heritage, March 2011

Micro Wind Generation and Traditional Buildings. English Heritage, October 2010

Small Scale Solar Thermal Energy and Traditional Buildings. English Heritage, 2008

Micro-generation in the Historic Environment. English Heritage, 2008

Climate Change and the Historic Environment. English Heritage, January 2008

Shoreline Management Plan Review and the Historic Environment: English Heritage Guidance. London: English Heritage, 2006

Biomass Energy and the Historic Environment. London: English Heritage, 2006

Wind Energy and the Historic Environment. London: English Heritage, 2005

Coastal Defence and the Historic Environment: English Heritage Guidance. English Heritage, 2003

Research reports:

A Retrofit of a Victorian Terrace House in New Bolsover: A Whole House Thermal Performance Assessment. English Heritage, 2015

Research into use of external wall insulation on traditional buildings in the North West of England NDM Heath for English Heritage, 2014

Research into the thermal performance of traditional brick walls; Glasgow Caledonian University for English Heritage, 2013

English Heritage Coastal Estate Risk Assessment. Research Department Report Series No. 68-2011. ISSN 1749-8775, 2011. This report assesses risk for flooding and erosion at EH's coastal properties.

Research into the thermal performance of traditional windows; Glasgow Caledonian University for English Heritage, 2009

After the Storms. London: English Heritage, 1997

English Heritage Rapid Coastal Zone Assessment Surveys. 46 reports have now been completed.

APPENDIX III: RISKS AND OPPORTUNITIES FOR HISTORIC ENGLAND

Inadequate information

Successful adaptation to the challenges and opportunities presented by a changing climate is very much dependent upon having access to up to date and relevant information, to inform understanding of the risks and opportunities, and to monitor the impact of any adaptations. There is a plethora of information on the historic environment but also relating to potential impacts upon it, some of this information is held by Historic England (e.g. the National Heritage List for England), and some by other organisations (e.g. Local Authorities, Environment Agency, Natural England). This information is also being constantly updated; how current the information used is will affect the utility and value of any impact assessments.

HERITAGE RISK 1: Inadequate or insufficient information preventing or impeding appropriate action

Loss of heritage

Climate change is accelerating the loss of cultural heritage in some places. Coastal heritage is particularly at risk. In some instances the loss is of heritage we are aware of, however there is also a huge amount we don't know that is at risk of loss, largely buried archaeological sites that have yet to be identified. While we cannot predict the location of all such sites as the funder of last resort for heritage of the 'utmost importance' we do have a vested interest in the archaeological potential of areas at risk of erosion or desiccation.

HERITAGE RISK 2: Damage or loss of heritage assets[35].

OPPORTUNITY 1: Opportunity for new discoveries

Unpredictability

The uncertainty surrounding future weather patterns and the increasing trend for unpredictability in current weather patterns poses a challenge for planning certain types of fieldwork and other outdoor activities which have traditionally been seasonal. Those working in the marine environment are already reporting increasing problems with unpredictable weather disrupting diving activity and terrestrial fieldwork is also facing similar challenges.

HERITAGE RISK 3.1: Difficulties in planning/undertaking fieldwork: unpredictable weather patterns

Maladaptation

In many instances poorly informed adaptations can be more harmful than the environmental threats they seek to protect against. This is particularly true for built heritage where adaptations that are not mindful of the way the building and their materials function can store up problems for the future, such as damp or overheating, or reduce the life of the structure.

HERITAGE RISK 4: Harm to heritage assets from maladaptation.

OPPORTUNITY 2: Learning from the past - the historic environment can inform integrated solutions

[35] over-arching risk encompassing HERITAGE Risks 1.1 to 1.9 above

Risk to our reputation

While many environmental risks may be beyond our control, how we respond to them is within our gift. For all of these risks that impact directly upon the historic environment there is an additional risk to Historic England associated with inaction or inappropriate action. As a publically funded body and champions of England's Heritage there is an expectation of us, from the public and the heritage sector, to respond to threats to heritage and take the lead in adapting and conserving it. If we are seen to fail to do this there is a risk to our reputation and credibility that could have disproportionate consequences for other areas of our work. While we are aware that we cannot 'save' all heritage at risk from coastal erosion, for instance, how we communicate our strategy for addressing that loss and facilitating *conservation* of those heritage assets is critical. Similarly, any inconsistency in how we apply our conservation approaches, for instance in response to flood defences or resilience measures, can have a negative impact on our reputation.

HERITAGE RISK 5: Damage to reputation from inappropriate, inconsistent response or failure to respond to climate change related impacts.

OPPORTUNITY 3: Making the case for heritage: advocacy for positive role the historic environment can play.

Coastal Flooding and Erosion

Rising sea levels are putting additional pressure on Britain's extensive coastline. Many coastal structures are also historic places, e.g. ports and harbours, piers, lighthouses. In those areas where coastal defences are to be strengthened or enhanced there can be an impact upon these historic features. Where defences are not being maintained then the loss of these historic structures may be inevitable. How we address that loss is a challenge.

In addition to the visible heritage of the coast there are many archaeological sites that may be partly or entirely hidden from view until they are exposed by scour, cliff collapse or erosion. Some of these we know about but others, such as the Palaeolithic footprints at Happisburgh[36] or 'Seahenge'[37] might be previously unknown but of considerable importance. How we deal with these new discoveries as well as damage to known sites and monuments presents a further challenge, but also opportunities such as increased engagement with communities in monitoring their stretches of coastline. Historic England's Fort Cumberland office and laboratories in Portsmouth (itself a Scheduled Monument) is at risk of, and has already experienced, coastal flooding.

HERITAGE RISK 2.1: Damage to or loss of heritage from coastal erosion and flooding

BUSINESS RISK 1: Damage to Fort Cumberland office and facilities from coastal flooding

OPPORTUNITY 1: Opportunity for new discoveries

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[36] Ashton N, Lewis SG, De Groote I, Duffy SM, Bates M, Bates R, et al. (2014) Hominin Footprints from Early Pleistocene Deposits at Happisburgh, UK. PLoS ONE 9(2): e88329. doi:10.1371/journal.pone.0088329

[37] Brennand, M. & M. Taylor. 2003 The Survey and Excavation of a Bronze Age Timber Circle at Holme-next-the-Sea, Norfolk, 1998–9 *Proceedings of the Prehistoric Society* 69

Precipitation

Precipitation patterns are projected to change with a likelihood of considerably increased winter precipitation, increased intensity in individual episodes and possibly more frequent periods of drought in some areas. Precipitation is connected to flooding, river flow, groundwater levels and other systems.

Increased precipitation

Too much rain can increase surface water run-off and therefore risk of flooding as drainage systems and waterlogged land fail to cope. For designed landscapes waterlogging can have a detrimental effect on plants. Prolonged periods of rainfall can affect fieldwork, waterlogged sites can affect geophysical survey results, archaeological excavation can be difficult or harmful to the archaeology and hazardous for the archaeologists and conservation work can also be affected.

Changing precipitation patterns

Indications are that we should expect increased frequency of periods of intense downpour. Very intense rainfall is problematic for a number of reasons. Rainwater goods on buildings may not cope, this may necessitate bigger guttering and downpipes but for some buildings with integrated rainwater systems (e.g. as seen in many 20th century structures, including some of those that are designated Heritage Assets) adaptation may be difficult without affecting the structure or physical appearance of the building. Intense rainfall can exacerbate erosion, both coastal and inland. It can also lead to flash flooding as underground drainage systems fail to cope and water falls to quickly to be absorbed into the ground. Erratic patterns in rainfall can make planning fieldwork increasingly challenging. For Historic England facilities water incursion can harm archives, IT equipment and make working conditions unpleasant or even unsafe.

Drought

Just as too much rain is problematic, too little rain is also a risk. Drought can affect designed landscapes, not just during the period of drought but often for many years, even decades after, making veteran trees more susceptible to disease and less resilient to future climatic changes. Drought can lead to loss of groundcover on archaeological monuments, groundcover that prevents erosion of earthworks. Prolonged period of low rainfall can cause problem for buildings on certain geologies as the ground dries and shrinks leading to an increased risk of subsidence in certain areas. Conversely when the ground becomes waterlogged it can swell; clay rich ground is particularly susceptible to this shrink-swell action which the British Geological Survey have described as 'the most damaging geohazard in Britain today'[38].

HERITAGE RISK 2.2: Damage to or loss of heritage sites from erosion: as a results of intense rainfall or loss of groundcover due to drought.

HERITAGE RISK 3.2: Difficulties in planning/undertaking fieldwork: Waterlogging of sites affects geophysical survey results.

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[38] http://www.bgs.ac.uk/research/engineeringGeology/shallowGeohazardsAndRisks/whatisShrinkSwell.html 'What is Subsidence' BGS webpage. Accessed 24/3/16

HERITAGE RISK 3.3: Difficulties in planning/undertaking fieldwork: intense down pours/waterlogging makes archaeological excavation difficult, potentially harmful to archaeology or hazardous to archaeologists.
HERITAGE RISK 6.1: Harm to plants within designed and historic landscapes: detrimental effects from either waterlogging or drought.
HERITAGE RISK 7: Damage to buildings from poor/inadequate rainwater goods.
HERITAGE RISK 8: Geological shrink and swell causes damage to historic structures.
BUSINESS RISK 2: Disruption to staff travel and ability to undertake work (esp. fieldwork.)
BUSINESS RISK 3: Damage to Historic England facilities and their contents from rainwater incursion.
OPPORTUNITY 1: Opportunity for new discoveries (e.g. drought improving visibility of crop marks)

Flooding

Flooding is one the risks at the forefront of people's minds. Recent years have seen a series of devastating floods around the country and led to reconsideration as to how best to reduce flood risk and promote resilience. Flooding can occur as a consequence of rivers overtopping, surface water run off or coastal inundation, or a combination of all three; the first two of these are closely connected to increased rainfall. Historic buildings and structures can be damaged by flooding but often the greatest harm is from the adaptations that seek to make such structures and buildings resilient to flood. Ensuring our advice and guidance reaches the right people at the right time is a real challenge. The way that flood defence measures are undertaken can have a huge impact upon above and below ground heritage features, and recent discussion of implementing land management measure, such as increasing areas of tree planting, to reduce flood risk will have a huge impact on historic landscape character.

Flooding also presents an opportunity for historic environment experts to inform more integrated solutions which create culturally distinctive, resilient and sustainable places for the future.

HERITAGE RISK 2.3: Damage to or loss of heritage assets from flood defence measures
HERITAGE RISK 2.4: Damage to or loss of heritage assets from flooding
HERITAGE RISK 5: Damage to reputation from inappropriate, inconsistent responses or failure to respond to climate change related impacts.
HERITAGE RISK 6.1: Harm to plants within designed and historic landscapes: detrimental effects from either waterlogging or drought.
BUSINESS RISK 2: Disruption to staff travel and ability to undertake work (esp. fieldwork.)
BUSINESS RISK 4: Damage to Historic England premises and their contents from flooding
OPPORTUNITY 2: Learning from the past - the historic environment can inform integrated solutions

Land use changes

The changing climate will impact upon the way the landscape is used. We are already seeing significant proposed changes to land use in some areas as a consequence of flooding, such as increasing woodland planting[39]. Similarly as growing seasons are extended and different crops become suitable for different areas cropping patterns for arable land as well as the location of that arable land will change. These changes have an impact not only upon the heritage of the landscapes affected but also upon the character of the landscapes themselves. In addition to changes in rural land use the pressures from, for example, rising sea levels and increasing flood risk may shift those areas where settlement and other development is sited. This will impact upon the heritage within those places, although it may provide an opportunity for previously under-appreciated heritage to play a positive role in shaping the character of these areas. There are also opportunities for an understanding and analysis of historic land-use patterns to inform thinking about more resilient approaches to managing present and future landscape character e.g. as in the Lynher Valley Project (Cornwall)[40], and in the HEATH Project (west Cornwall)[41].
HERITAGE RISK 2.5: Damage to or loss of heritage assets from changing landscape use.
HERITAGE RISK 2.6: Damage to or loss of heritage assets from changing settlement patterns.
OPPORTUNITY 1: Opportunity for new discoveries (e.g. new sites revealed as land use changes)
OPPORTUNITY 2: Learning from the past - the historic environment can inform integrated solutions.

Pests and diseases
Warmer temperatures, milder wetter winters mean that flora and fauna are changing their ranges. This includes flora and fauna that may be harmful to plants and animals that maintain and make up our historic landscapes, harmful to the materials that constitute our built and buried heritage and harmful to the historic and archaeological collections and archives, and people.
HERITAGE RISK 2.7: Damage to or loss of heritage assets from pests and disease
HERITAGE RISK 6.2: Harm to plants within designed and historic landscapes: detrimental effects from pests and diseases.
HERITAGE RISK 9: Damage to or loss of historic and archaeological collections and archives
BUSINESS RISK 5: Harm to staff from pests and diseases

Soils
Climate change affects conditions below as well as above ground. In addition to the risk from shrink-swell in clay rich areas the national Climate Change Risk Assessment has identified a range of climate related risks affecting soil biota,

[39] http://www.forestry.gov.uk/fr/urgc-7qjdh7 Forestry Commission - Flood Alleviation. Accessed 24/3/16
[40] Herring, P. & Tapper, B. 2002. Lynher Valley Historic Landscape Characterisation Cornwall County Council
[41] Heathland: environment, agriculture, tourism and heritage Project. http://www.tHeritageeathproject.org.uk/heritage.html

organic matter, erosion and compaction[42]. Many of the impacts on soils are not necessarily related directly to climate change but may be a result of land use changes that might in turn be linked to climate change. Changes to soils will affect the preservation of archaeological resources contained within them. A good example of this is the desiccation of wetland areas, either as a consequence of precipitation changes or land use practices, which can have a significant impact upon preservation of archaeological sites and associated palaeoenvironmental information[43].
HERITAGE RISK 2.8: Damage to or loss of archaeological sites and palaeo-environmental information due to desiccation of wetlands

Less frequent cold spells
Warming of winter temperatures can be seen as a positive thing, decreasing the need for central heating, extending tourist seasons and fieldwork seasons. However, intermittent frosts can mean increased risk of damage to buildings and monuments from repeated freeze-thaw, particularly when accompanied by increased precipitation. Wet masonry and other building materials are more likely to be damaged by frost. Prolonged periods of cold weather are also important for certain species of plants as well as helping 'kill off' some pests and diseases. As winters become characterised by fewer and shorter cold spells pests and diseases may persist and some plant species may vanish from our parks, gardens and landscapes.
HERITAGE RISK 6.3: Harm to/loss of plants within designed and historic landscapes: range of species affected with increased maximum and minimum temperatures.
HERITAGE RISK 10: Harm to heritage structures from frost fracture
OPPORTUNITY 3: Possibility of prolonged fieldwork season

Wildfire
Prolonged periods of hot dry weather increase the risks of wildfire, however so do some land management regimes. Wildfire poses a risk to historic buildings and structures, landscapes and archaeological sites. While there are instances of wildfire also providing opportunity for new archaeological discoveries this is not without harm (e.g. Fylingdales, where fire revealed previously unknown archaeological sites but also caused harm to the palaeo-environmental record associated with them[44]).
HERITAGE RISK 11: Harm to heritage assets from wildfire
OPPORTUNITY 1: Opportunity for new discoveries

Marine changes
Climate change impacts upon the marine environment are principally: rising sea temperature, rising sea levels, increasing acidification, changing circulation and turbidity and sediment stability. Rising sea temperatures change the acidity of the water affecting not only what flora and fauna thrive and where (which can

[42] Climate Change Risk Assessment 2. 2016
[43] Geary, B. *et al.* 2010.Peatlands and the Historic Environment. Scientific Review.
[44] https://historicengland.org.uk/research/research-results/recent-research-results/yorkshire/fylingdales-moor/
http://archaeologydataservice.ac.uk/era/section/record_manage/rm_manage_fylingdales.jsf

pose its own threat to underwater cultural heritage e.g. shipworm[45]) but also the depositional environment of submarine and intertidal cultural heritage (e.g. increased risk of corrosion of metal cultural heritage). Changes to oceanic currents and increased turbidity can affect depositional processes and affect visibility. The winter storms of 2013/14 resulted in enormous volatility in near-shore sediment levels with serious consequences for the survival and stability of a number of protected wrecks. These storms undoubtedly had corresponding impacts on the wider marine historic environment dependent on sediment stability for its coherent survival.
HERITAGE RISK 2.9: Damage to or loss of maritime heritage due to changing ocean acidity
HERITAGE RISK 12: Damage to, loss of, or changes to visibility of maritime heritage due to changing depositional processes
OPPORTUNITY 1: Opportunity for new discoveries

Opportunities
New discoveries
Impacts such as coastal and fluvial processes and drought present real opportunities for new, particularly archaeological, discoveries. These discoveries can bring new challenges however, particularly when they are made as a result of erosion. For instance the opportunity to investigate the discovery may be very brief or hazardous. These new discoveries can also provide springboards for new research, for instance by identifying archaeologically interesting deposits in areas there this was previously unknown.
OPPORTUNITY 1: New discoveries as a consequence of environmental change

Advocacy and constructive conservation: providing context and learning from the past
Many impacts, from flooding to coastal change, can present opportunities to make the case for the historic environment and learn from the past. This can include the benefits from understanding the long term context for land management decisions and impacts, of traditional building techniques, of providing a context for coastal change, and of providing a positive community focus in difficult times, or simply making the most of an opportunity to share information about the past (e.g. archaeological mitigation ahead of flood alleviation schemes). Impacts such as urban heat island effect present opportunities to promote the importance of urban green spaces, parks and gardens.
OPPORTUNITY 2: Learning from the past - the historic environment can inform integrated solutions
OPPORTUNITY 4: Making the case for heritage: advocacy for positive role the historic environment can play
OPPORTUNITY 5: A role for heritage in helping to communicate change

[45] Dunkley, M. 2013. The potential effects of oceanic climate change on the management and curation of underwater archaeological remains. *The Archaeologist* 89, 60-62.

Reaching new audiences, doing things differently and citizen science
There are many opportunities for working with wider interest groups. The challenges presented by the impacts associated with Climate change present an opportunity for doing this differently. For instance community involvement in recording and monitoring the historic environment through projects such as CITiZAN[46] (recording coastal heritage). This can broaden interest and access to heritage.
OPPORTUNITY 6: Increased opportunities for community engagement and broadening access to heritage
OPPORTUNITY 7: Extended tourist season, increased interest in heritage

Better collaborative working
Addressing the challenges presented by climate change requires collaboration. There are real opportunities to work more closely with existing partners as well as forge new connections. This is not just about Historic England sharing knowledge and expertise but also about learning from other organisations and identifying and making the most of opportunities for data sharing/exchange with other agencies that could be beneficial for Historic England's work e.g. flood risk data, coastal and marine data.
OPPORTUNITY 8: Greater collaboration with existing and new partners for knowledge, expertise and data.

[46] The Coastal and Inter-Tidal Zone Archaeological Network is coordinated by Museum of London Archaeology with support from Crown Estate, Nautical Archaeological Society, Heritage Lottery Fund, Council for British Archaeology, National Trust, Historic England http://www.citizan.org.uk/

APPENDIX IV: ADAPTATIONS RECOMMENDED BY CLIMATE ADAPTATION WORKSHOPS

All the adaptations raised in the workshops are presented here. It is recognised that the most effective adaptations address several risks and opportunities, so the relevant risks and opportunities (see section 6) are identified.
The priority adaptations for Historic England extracted from the following are presented in section 7 of this report.

Resilience

- Embedding consideration of current and future climate change impacts in strategies and decisions.

Addresses all heritage and business risks and opportunities

- Incorporate climate related risks into corporate risk management.

Potentially addresses all heritage and business risks

- IT that supports flexible, remote and mobile working

Addresses business risks 1, 2

- 'Future proof' decisions on storage of IT equipment to avoid overheating/water damage

Addresses business risks 1, 3, 4

- Maintain and update staff skills relating to environmental impacts, potentially through collaboration with other organisations.

Potentially addresses all heritage risks and opportunities

- Improve mechanisms for sharing and updating climate change related information.

Addresses heritage risk 1 and opportunity 7

- Communicate any potentially hazardous conditions to staff.

Potentially addresses all business risks

- Support flexible, remote, and mobile working.

Potentially addresses all business risks

- 'Future Proof' decisions on facilities and equipment procurement by taking into account current and future climate change related impacts.

  Addresses business risks 1, 3, 4

- Continue to build in flexibility to fieldwork projects.

Addresses heritage risk 3

- Be prepared – proactive rather than reactive

Potentially addresses all heritage risks

Understanding and information

- Keep up to date with climate change projections and impacts and assess their impact upon the historic environment and our business.

Addresses heritage risk 1

- Maintain an organisation wide group to consider matters to do with climate change - Climate Change Network.

Potentially addresses all heritage and business risks and opportunities

- Clear strategic lead for coastal matters

Potentially addresses heritage risks 1, 2, 5, 12

- Collaboration with other public bodies to ensure access to up to date and relevant data sets (e.g. flood risk, landuse change)

Addresses heritage risk 1

- Mechanism for gathering and storing information regarding environmental impacts on sites – e.g. monitoring of coastal erosion, flood damage to structures, condition surveys

Addresses heritage risk 1, 2, 4, 5, 6, 7, 8, 10, 12

- Ensure IT systems can support any data processing/management proposed

Potentially addresses all heritage risks

Organisation

- Maintain foresight of risks and challenges for heritage.

Potentially addresses all heritage risks but especially 1, 5

- Develop a policy/guidance for heritage loss.

Addresses heritage risks 2, 5, opportunities 1 and potentially 6

- Promote positive role of heritage in future adaptation planning.

Addresses opportunities 2, 3, 5

Listing and Heritage at Risk

- Consider using information on current and future environmental impacts to guide strategies for reducing Heritage at Risk.

Addresses heritage risks2, 4, 5, 6, 7, 8, 10, 11, 12 and potentially opportunities 6, 8

- Consider how to address future environmental impacts on designated, and potentially designated, heritage assets.

Addresses heritage risks 2 and 5 and potentially opportunities 2, 3, 6, 7, 8

Projects and advice

- Clear, consistent guidance and advice internally and externally on adaptation of heritage assets to climate change.

Addresses heritage risks 2, 4, 5, 6, 7, 8, 10, 11, 12 and potentially opportunities 2, 3, 5, 6, 8

- Take climate change related impacts into consideration in future updates to 'Constructive Conservation' and 'Conservation Principles'.

Potentially addresses all heritage risks and opportunities 2, 3, 4, 5, 6, 7, 8

Communication

- Advocate the positive role of the historic environment in planning for adaptation to future climate change impacts – learning from the past e.g. land management and flood risk, coastal change, traditional building techniques.

Addresses heritage risks 4, 2 and opportunities 2, 3, 5, 8

- Improve internal information and knowledge sharing to facilitate more consistent and quicker responses.

Addresses heritage risks 1, 5

- Ecosystem services.

Addresses heritage risk 5 and opportunities 3, 7, 8

- Aim for proactive rather than reactive responses.

Addresses heritage risk 5 and opportunity 3, 5, 8

Collaboration

- Share experiences with other public Heritage organisations (e.g. CADW, Historic Environment Scotland).

Addresses heritage risk 1 and opportunity 8

- Stronger partnership working, including sharing data and expertise, collaborative research, training, with other bodies addressing climate related issues (e.g. Environment Agency, Natural England, British Geological Survey, Centre for Ecology and Hydrology, MET office).

Addresses heritage risk 1 and opportunity 8

- Seek partnerships for delivery of advice, training and guidance to extend our reach to relevant industries –e.g. engineering, construction, insurance, surveyors, land management, coastal.

Addresses heritage risk 1 and opportunities 3, 5, 8

- Citizen science

Addresses opportunities 6, 7, 8