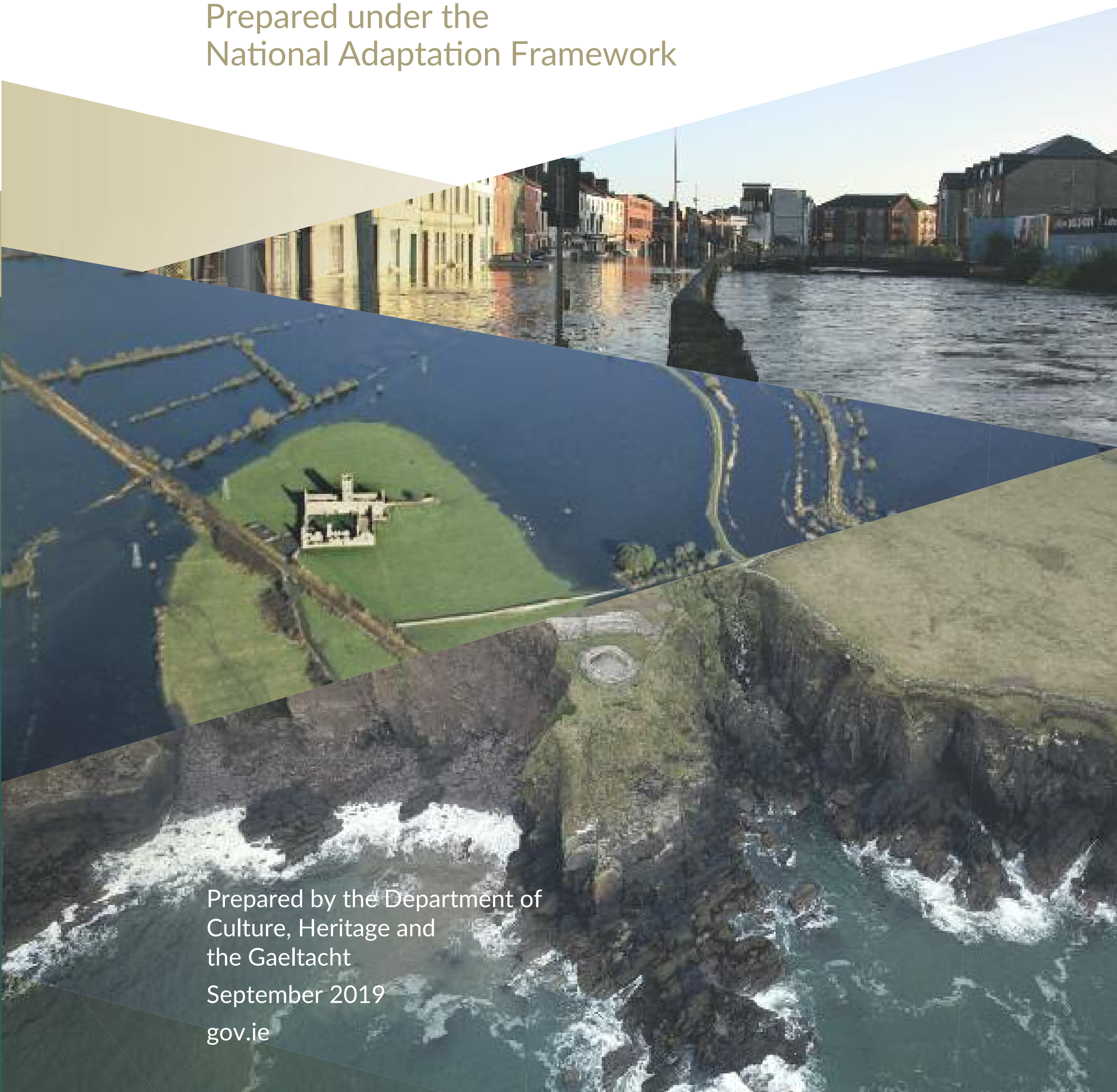
Rialtas na hÉireann
Government of Ireland

Built & Archaeological Heritage

Climate Change Sectoral Adaptation Plan

Prepared under the
National Adaptation Framework



Prepared by the Department of
Culture, Heritage and
the Gaeltacht

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An Roinn Cultúir,
Oidhreachta agus Gaeltachta
Department of Culture,
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Prepared for the Department of Culture, Heritage and the Gaeltacht
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Minister's Foreword

Our historic buildings and archaeological sites and monuments across the state have stood for centuries, if not for millennia. Yet there can be no denying the risk extreme weather events and climate change pose to them.

Hotter and drier summers, warmer and wetter winters, the increased frequency of extreme weather events and rising sea levels may result in structural damage to monuments and historic buildings, structures being undermined by coastal erosion, exposure and erosion of archaeological sites and flooding of historic urban areas.

My department is addressing the effects of climate change on our heritage and it is important that the public informs this process. The responsibility to identify where damage may be likely, to assist in repair and to build resilience will rest with many stakeholders in the years to come – both across local and central government and within communities who cherish their heritage.

This plan presents a number of case studies which illustrate the impacts of climate change on Ireland's heritage. A number of goals are also identified, with corresponding objectives and actions to meet those goals. It is hoped that they will enable us to better address those impacts together.

We stand ready to lead in meeting our responsibility to protect and conserve our unique heritage informed by the opinion of those who also care for it.

Josepha Madigan, T.D.
Minister for Culture, Heritage and the Gaeltacht

Executive Summary

In May 2019, the Irish government became the second country in the world to declare a climate emergency. The global climate has already warmed by between 0.8°C and 1.2°C since 1900 and, while we must act to reduce greenhouse-gas emissions and avoid exceeding an increase of 1.5°C, some climate-change impacts are already inevitable (Intergovernmental Panel on Climate Change (IPCC), 2018). The Climate Action and Low Carbon Development Act 2015 established the requirement for a National Adaptation Framework (NAF). The 2019 NAF will be composed of 12 sectoral plans, of which built and archaeological heritage is one. All the plans have been written according to the Sectoral Planning Guidelines for Climate Change Adaptation produced by the Department of Communications, Climate Action and Environment (DCCAE, 2018a). These guidelines detail a six-step process which has been used as a framework for drafting this plan and is also reflected in its structure. The plan has been informed by existing research and has incorporated consultation with experts, stakeholders and the public throughout its production. It has also closely considered published plans from other sectors in order to promote consistency within the NAF and to ensure cross-cutting issues are highlighted.

Heritage in Ireland ranges from the many modest sites of local and regional importance to those of national and global significance. It includes private homes, commercial and public buildings, national monuments, underwater and buried archaeology and the physical and cultural settings of all of these. This plan considers not only those structures and sites that have been statutorily listed, but all man-made assets that have historical, aesthetic and cultural value, even though they may not be officially protected. It does not consider natural heritage because this is within the remit of the biodiversity adaptation plan.

Studies of the climate record in Ireland clearly show that the long-term prevailing weather conditions (i.e. the climate) are changing (Dwyer, 2012). The last century was characterised by an upward trend in temperatures, resulting in warmer, wetter winters and hotter, drier summers, accompanied by an increase in extreme weather events. This pattern is likely to continue. In the marine environment, we can expect rising sea levels and an increase in storm surge, temperature and acidification.

The direct effects of climate change on heritage may be immediate or cumulative. Damage from catastrophic weather events such as floods and storms is likely to increase at the same time as slow-onset environmental-deterioration mechanisms. The way these effects manifest will vary according to the sensitivity of the heritage and its level of exposure. In addition, there will be indirect impacts arising from societal responses to climate change in terms of both adaptation (e.g. changes in land use) and mitigation (e.g. the retrofitting of historic buildings to reduce energy consumption). Of the many potential impacts, those identified as priorities for adaptation planning are flooding (inland and coastal), storm damage, coastal erosion, soil movement (landslip or erosion), changing burial-preservation conditions, pests and mould, wildfires and maladaptation.

The adaptation strategy and accompanying action plan presented in this document aim to:

- Build adaptive capacity within the sector
- Reduce the vulnerability of built and archaeological heritage to climate change
- Identify and capitalise on the various potential opportunities for the sector

The goals outlined are commensurate with the five-year term of this plan, but also create a longer-term strategic vision. While the actions arising from them focus on the priority factors, many capacity-building measures will address a broad range of issues.

The five adaptation goals for built and archaeological heritage in Ireland are:

1. To improve understanding of each heritage resource and its vulnerability to climate change
2. To develop and mainstream sustainable policies and plans for climate-change adaptation of built and archaeological heritage
3. To conserve Ireland's heritage for future generations
4. To communicate and transfer knowledge
5. To exploit the opportunities for built and archaeological heritage to demonstrate value and secure resources

In order to achieve these goals, specific actions have been proposed. The plan's success will be largely contingent on the degree to which these are implemented. A monitoring strategy has been developed to track the implementation of planned actions. Progress will be measured against selected indicators, which will help to identify problems and inform improvements to the adaptation plan as part of an iterative process. Monitoring mechanisms include both internal and external oversight. Stakeholders are a vital part of the review methodology, building on the participation and sharing of good practice that have been integral to the creation of this plan.

Note to Readers

This plan is for anyone with an interest or involvement in climate-change adaptation and Ireland's cultural heritage, from public organisations to private individuals and community groups.

The plan can be read from cover to cover or dipped into for specific information. For example, if you are interested in a broad overview of how climate change may affect cultural heritage in Ireland, we suggest you read Section 2: Climate Impact Screening and then consult the case studies in Section 4: Priority Impact Assessment for more detail. If you are interested in how stakeholders participated in the formulation of the plan, we suggest you read Section 3: Prioritisation and the consultation details published as a separate volume on the Department's website.

If you would like to know what adaptation goals, objectives and actions have been developed and how these intersect with other sectoral plans, we suggest you read Section 5: Developing the Adaptation Plan. Finally, if you want to know how this plan will be put into action, we suggest you read Section 6: Implementation, Evaluation and Review.

Introduction

Under the Climate Action and Low Carbon Development Act 2015, the Minister for the DCCAE must submit to government a series of successive National Mitigation Plans and NAFs. This mandate is preceded by an adaptation strategy set out by the European Union (EU) in the 2009 white paper *Adapting to Climate Change: Towards a European Framework for Action*, which encourages member states to develop their national climate-change adaptation frameworks based on a two-phase process. The first phase focuses on the identification of national vulnerabilities to climate change and the second phase, which we are now in, involves the development of sectoral and local-authority climate-change adaptation plans.[1] The inclusion of built and archaeological heritage as one of the 12 sectors covered within Ireland's NAF fits within this policy context.

The United Nations Framework Convention on Climate Change (UNFCCC) Paris Agreement drafted in 2015 joined all signatories into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects, establishing a collective goal of enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change (Article 7.1). Cultural heritage – embracing historic fabric, buried archaeology, cultural landscapes and traditional ways of life – frequently includes particularly vulnerable places and people. While at-risk heritage needs the attention of adaptation strategists, the sector has much to offer in return. The possible contribution of cultural heritage to climate-change adaptation is in fact acknowledged within the Paris Agreement itself, where it states that adaptation action should be based on and guided by the best available science and, as appropriate, traditional knowledge, knowledge of indigenous peoples and local knowledge systems (Article 7.5). Enhancing adaptive capacity, strengthening resilience and reducing vulnerability of heritage thus contributes to wider societal adaptation.

[1] Under the NAF, each local authority is required to make and approve a local adaptation strategy by 30 September 2019, following procedures that closely resemble those for the sectoral plans.

1 Preparing the ground

1.1 Methodology

This adaptation plan for built and archaeological heritage has been written according to the *Sectoral Planning Guidelines for Climate Change Adaptation* produced by the DCCAE (DCCAE, 2018a). These guidelines detail a six-step methodology for creating an adaptation plan:

1. Preparing the Ground
2. Climate Impact Screening
3. Prioritisation
4. Priority Impact Assessment
5. Develop your Plan
6. Implement, Evaluate and Review

These six steps have been used as a framework for drafting the plan and are also reflected in the structure of this document. The methodology is intended to be iterative (Figure 1), with the plan being reviewed and improved as experience and understanding increase.

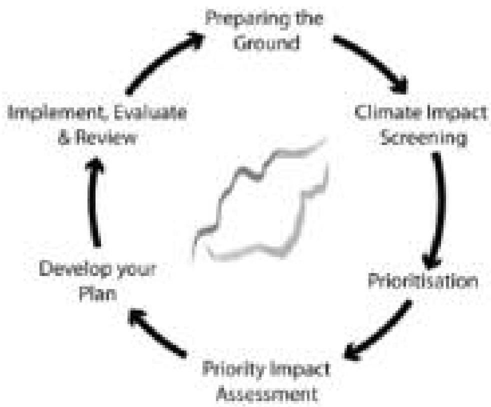

Figure 1. The six-step adaptation process (DCCAE, 2018a)

The plan has been informed by existing research, including a background report commissioned by the Department of Culture, Heritage and the Gaeltacht (DCHG) (Daly, 2017) and climate-change projections for Ireland (Nolan, 2015). In order to add robustness and to ensure relevance in an Irish context, the project has incorporated consultation with experts, stakeholders and the public throughout the process of its creation. Details of the consultation are published as a separate volume on the Department's website www.chg.gov.ie/heritage/climate-change.

Individuals and organisations were consulted during the development of the Climate Change Sectoral Adaptation Plan (CCSAP) for built and archaeological heritage through one or more of the consultation processes:

- The three Climate Change Advisory Group (CCAG) meetings, attended by a group of experts representing local authorities, non-governmental heritage organisations, professional bodies and other key stakeholders convened by the DCHG to advise on climate-change adaptation
- The two stakeholder workshops organised by the team to focus on prioritising climate-change impacts
- A series of meetings with individual organisations and bodies that will likely have a strategic interest in the implementation of the adaptation plan

Follow-up consultation on the proposed adaptation goals, objectives and actions was also carried out with all of the above via an online survey from March to May 2019. Public consultation of the entire plan occurred from 15 May to 14 June 2019. Details of the consultation are published as a separate volume on the Department's website www.chg.gov.ie/heritage/climate-change.

Published plans from the other sectors have also been closely considered in order to aid consistency within the NAF and to ensure cross-cutting issues are highlighted.

1.2 Built and Archaeological Heritage Sector Profile

1.2.1 Overview of Ireland's Heritage

This section provides an overview of the built and archaeological heritage in Ireland to which this adaptation plan applies. The built and archaeological heritage of Ireland ranges from the many modest sites of local and regional importance to those of national and global significance, such as Ireland's two World Heritage Sites, Brú na Bóinne and Sceilg Mhichíl. These heritage sites include, but are not limited to, megalithic tombs and prehistoric settlements, forts and enclosures, early churches and round towers, medieval monasteries, castles and fortified structures.

The architecture of Ireland includes a great variety of styles and ages, be it the vernacular and traditional buildings of the Irish countryside, the country houses and demesnes of the great estates, Georgian townhouses, squares and urban developments, our industrial heritage or our grand public buildings. The coastal zones of Ireland contain coastal fortifications, stone quays, piers and weirs, seafaring infrastructure, historic warehouse buildings, historic shipwrecks and other underwater cultural heritage. The introduction of railway lines during the Victorian era has left behind a legacy of transport infrastructure in the form of bridges, railway stations and associated structures, including hotels. We have a wealth of fine public buildings in our capital, other cities and regional towns that include hospitals, courthouses, town halls, schools, banks, churches, monasteries, convents and other religious structures. More recently, contemporary buildings and landscapes of the modern movement represent Ireland's response to international architectural styles.

This section also provides an overview of the resources available to assist local authorities and other agencies in assessing the vulnerability of local heritage sites and in planning for their protection. To accurately evaluate the vulnerability of individual heritage properties, condition surveys, risk assessments and ongoing monitoring where necessary will need to be planned, resourced and managed by the building owners and the relevant organisations.

There are various levels of protection for structures and sites in the National Monuments Acts and the Planning and Development Acts. Both seek to provide for proper and sustainable planning while protecting and preserving our inherited building stock for generations to come. However, heritage constitutes more than appears on the various lists and surveys and much of it remains in private ownership. Adaptation planning for the heritage sector must therefore encompass the historic environment in a holistic sense, taking account of what may be deemed valuable by future generations.

1.2.2 Built Heritage

Built heritage includes all buildings, structures and urban settlements, both vernacular and architect designed, that are of historic, aesthetic, social or technical interest. These sites may include associated curtilage, outbuildings and designed landscapes. Built heritage may also include buildings and structures in a ruinous or dilapidated state. Indeed, these would be particularly vulnerable to the effects of climate change.

Built heritage includes protected and unprotected buildings and sites of potential value. Recorded sites, including national monuments in state ownership or guardianship, are listed in the Record of Monuments and Places (RMP), which was given statutory standing under the National Monuments (Amendment) Act 1994. The National Inventory of Architectural Heritage (NIAH) is a state record established under the provisions of the Architectural Heritage (National Inventory) and Historic Monuments (Miscellaneous Provisions) Act 1999. Its function is to identify, record and evaluate the built heritage of Ireland uniformly and consistently as an aid to its future protection and conservation. Properties listed on the NIAH are not statutorily protected. However, it is seen as a significant resource for the identification of structures and sites that should be placed in the Record of Protected Structures (RPS), which is managed by local authorities. A collection of buildings and sites of historic, architectural or cultural value can also be protected as part of an Architectural Conservation Area (ACA). ACAs are designated by local authorities.

With reference to the types of built heritage identified by the NIAH, the following themes emerge: domestic, religious, infrastructural, governmental and social. A selection of historic buildings which fall under each theme are listed below:

- **Domestic:** apartments, castles, coach houses, country houses, farmhouses and complexes, gate lodges, houses (various types), hunting/fishing lodges, lighthouse-keepers' houses, lock-keepers' houses, townhouses, workers' houses
- **Religious:** abbeys, almshouses, bell towers, bishops' palaces, cathedrals, church/parish halls, chapels, churches and outbuildings, convents, friaries, graveyards, manses, mausoleums, monasteries, rectories/glebes/vicarages/curates' houses
- **Infrastructural:** aqueducts, boathouses, bridges, bus stations, canals, footbridges, harbours/docks/ports, lighthouses, locks,

piers/jetties, quays/wharfs, railway stations, signal towers, train/locomotive sheds, tunnels, viaducts
- **Governmental:** barracks, batteries, coastguard stations, constabulary barracks, courthouses, custom houses, garda stations, hospitals, Martello towers, monuments, nurses' homes, officers' houses, orphanages, prisons and support buildings, town/county halls, schools, watchtowers, water towers, workhouses
- **Social:** banks and financial institutions, cinemas, colleges, commercial buildings and shops, community centres, handball alleys, market buildings, masonic lodges, mills, public houses, universities

The cultural value of built heritage extends beyond the bricks and mortar to the decorative interiors, soft furnishings, artworks, literary works and artefacts housed inside. The early eighteenth-century Marsh's Library in Dublin, for instance, still holds on its shelves much of the original collection donated to the library by Archbishop Narcissus Marsh, as well as 387 books of which only a single copy remains in the world. The National Library of Ireland likewise holds precious manuscripts that date back 1,000 years in its collection. The National Museum of Ireland (NMI) is the repository for archaeological artefacts from prehistoric through to more recent times that are emblematic of the Irish people and their greatest achievements in history. Given the value of our museums' collections, specific strategies will need to be developed to protect them at short notice against changing climatic conditions and severe weather events.

1.2.3 Archaeological Heritage

Archaeological heritage includes all the material remains of past societies and cultures, both above and below ground (preserved in soil and peat) and also underwater. The Archaeological Survey of Ireland (ASI) was established as a branch of the National Monuments Service (NMS) to create an inventory of known archaeological monuments in Ireland, which are logged and displayed in the Historic Environment Viewer as the SMR. To date, the ASI has recorded 142,891 sites excluding redundant or duplicate listings. The following map (Figure 2) depicts the location and concentration of archaeological heritage in Ireland (Clutterbuck, 2015).

As the map demonstrates, the existence of above- and below-ground archaeological heritage is spread relatively evenly across the country, with a slightly higher density in the west. This heritage ranges in significance from sites of local interest and value to the two iconic UNESCO World Heritage Sites of Brú na Bóinne (inscribed in 1993) and Sceilg Mhichíl (inscribed in 1996). Drought conditions during the summer of 2018 led to the discovery of a significant number and variety of previously unknown sites around Brú na Bóinne (DCHG, 2018).

The rich organic environment of the waterlogged bogs and peatlands of Ireland preserve untold numbers of artefacts – environmental and human remains from past centuries, including trackways, roads, hunting platforms, settlement activity, votive offerings, preserved bog butter, hoards of valuable objects and bog bodies. Limited tillage in the poorer farming land of the west of Ireland and the uplands has also helped to preserve a far higher level of upstanding and below-ground monuments than elsewhere.

Urban archaeological remains are frequently composed of deep sequential layers and building foundations (one over another) that have accumulated over time. Many Irish coastal cities were founded after the Viking invasions of the eighth and ninth centuries and remains from this time and subsequent periods are still being discovered, even as the cities continue to be transformed. In some of our oldest coastal towns preservation can be extremely good, owing to the waterlogging of organic deposits.

As archaeological finds are not limited to land, the Underwater Archaeology Unit of the NMS was established in 2000 to assess and record the locations of underwater cultural heritage from Ireland's tidal, sub-tidal and freshwater environments. Wrecks over 100 years old and any archaeological artefacts found underwater, irrespective of age, are protected under Section 3 of the National Monuments (Amendment) Act 1987. To date, over 18,000 shipwrecks have been recorded by the Underwater Archaeology Unit. However, it is estimated that, given the island's long maritime history from prehistoric to modern times, the true number could be closer to 30,000.
Documented underwater heritage in Irish waters

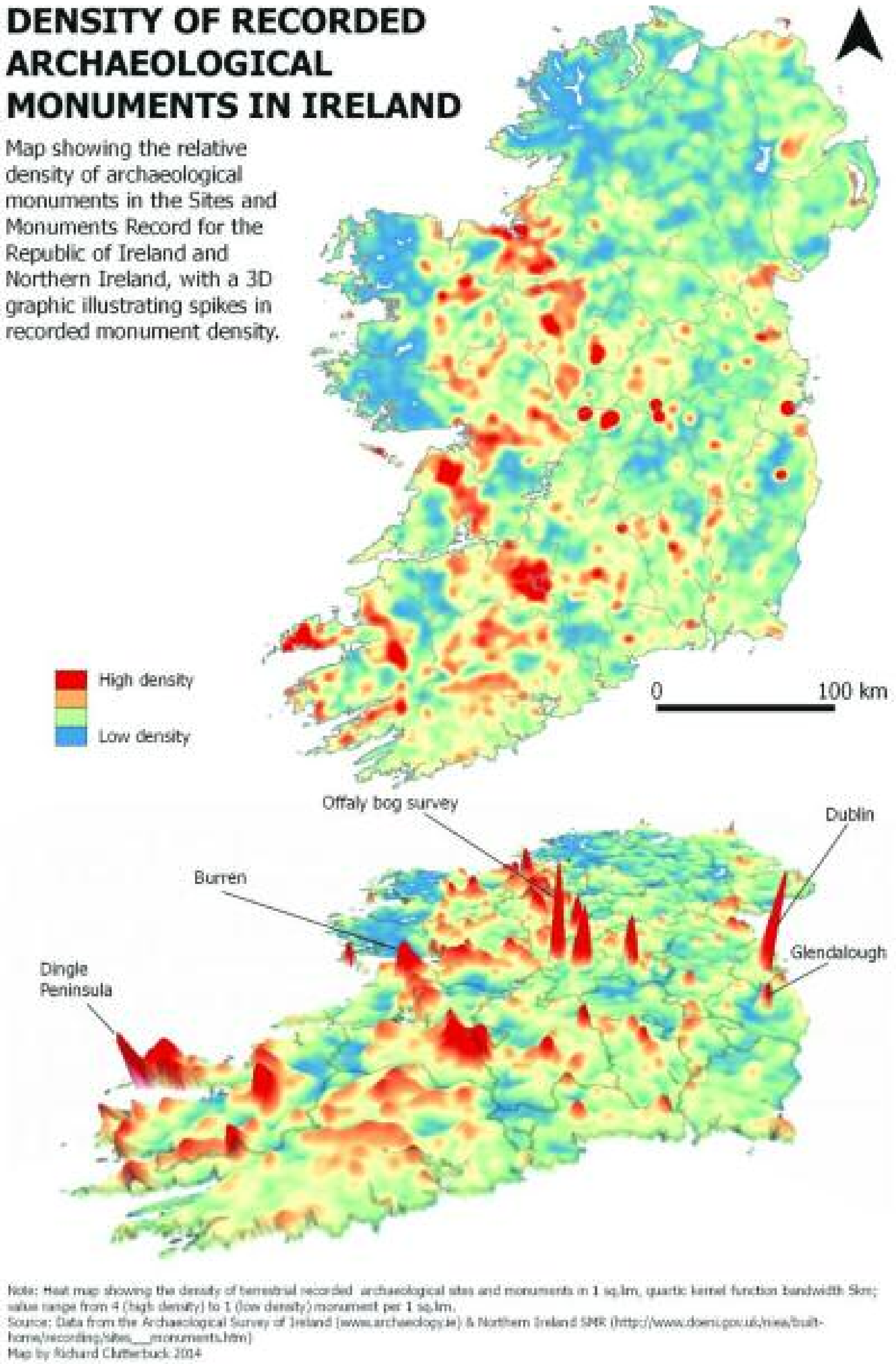

Figure 2. Map showing the location and density of archaeological heritage in Ireland

(including inland waters) includes: traditional logboats; timber framed, hide-covered craft such as currachs; medieval plank-built boats, coastal and oceangoing ships; as well as submerged archaeology, including subsurface materials near sites such as crannógs.[2] The remains of approximately 1,800 military wrecks relating to World War I and World War II, including submarines, troopships and aircraft, are also to be found off Ireland's coast, indicative of events in Ireland's more recent history.

1.2.4 Heritage Records, Databases and Online Mapping Systems

The government has plans to update and centralise all heritage and built-environment datasets (Goal 1.a–b). However, for the time being, further information can be found in the following databases and online mapping systems. Information on Ireland's social and cultural heritage can also be found through the Digital Repository of Ireland.[3]

1.2.4.1 Historic Environment Viewer

All heritage properties and sites recorded by the Department of Culture, Heritage and the Gaeltacht through the NIAH and the ASI have been mapped in the interactive Historic Environment Viewer, which maps the location of each site, provides a short summary of its historic value (if available) and allows viewers to explore nearby sites of interest.

1.2.4.2 Heritagemaps.ie

https://www.heritagemaps.ie/

Buildings on the RPS are included on heritagemaps.ie, developed and maintained by the Heritage Council (HC, 2019). Heritagemaps.ie is an ongoing initiative which brings together and makes public datasets on many aspects of heritage – built, natural and cultural, including collections. These datasets are collected at national level or by local authorities. It should be noted that the RPS of the planning authorities must be consulted to establish whether or not a structure is protected.

1.2.4.3 Wreck Viewer

https://www.archaeology.ie/underwater-archaeology/wreck-viewer

The known location for all wrecks around the coast of Ireland are included in the interactive Wreck Viewer and all known and potential locations for wrecks in Ireland's coastal, offshore and inland waterways are included in the Wreck Inventory of Ireland Database (WIID), both managed by the NMS (DCHG, 2018). Wrecks with known locations account for 22% of the total number of wrecks documented in the WIID, equalling approximately 3,960 wrecks. To date, 3,555 wrecks with known locations have been mapped in the Wreck Viewer by ship name, type, number and wreck date (DCHG, 2018).

1.2.4.4 Flood Maps Viewer

https://www.floodinfo.ie

The Office of Public Works (OPW) maintains detailed flood maps and flood plans for Ireland and has undertaken a flood-risk assessment for 300 communities. These are now publicly available online through the interactive Flood Maps Viewer, which was developed to allow local authorities, communities and individuals to learn about their risk of flooding (OPW, 2018a). The Flood Maps Viewer provides information on the location and date of past floods and also maps the potential extent and probability (low, medium and high) of future fluvial and coastal flooding with reference to climate change. A variety of flood-hazard datasets can be layered on top of the base map. These include details of the mid-range and high-end potential flood risks for fluvial, pluvial and coastal flooding.

1.2.4.5 Myplan Viewer

https://myplan.ie/

The Department of Housing, Planning and Local Government (DHPLG) maintains a separate interactive mapping system called the Myplan Viewer (DHPLG, 2011). This system is primarily designed to be used by planning departments and therefore includes a variety of dataset layers, including datasets for NIAH properties, monuments on the SMR and datasets relating to natural heritage. The Myplan Viewer also includes some OPW Draft Flood Mapping layers. However, the information is derived from the preliminary flood-risk assessment completed by the OPW in 2012 and therefore is significantly less accurate than the information provided in the OPW's Flood Maps Viewer, which is based on the National Coastal Flood Risk Assessment and Management (CFRAM) programme of 2018.

[2] Crannógs are man-made islands situated in the shallow part of lakes that were in use from AD 400–1600. They were primarily built for defensive purposes, but some were also used by local chieftains as high-status sites. A decrease in lacustrian (lake) and riverine water levels due to increased temperatures and reduced levels of rain during summer months will also likely lead to the exposure of delicate subsurface materials near sites such as crannógs. This will allow greater access to these sites. With erosion and exposure, artefacts that have been hitherto well submerged, such as the eighth- or ninth-century Tully Lough Cross, discovered near a crannóg in County Roscommon (Kelly, 2007), could become vulnerable.

[3] It should be noted that there are some 1,600 recorded monuments and protected structures on the Coillte estate alone and a comparable, if not higher, number within private forest holdings. These are subject to the regulatory controls for forestry activities administered by the Forest Service of the Department of Agriculture, Food and the Marine (DAFM) (feedback received from the department during the public consultation).

2 Climate impact screening

2.1 Climatic Trends in Ireland

Studies of the climate record in Ireland clearly show that the long-term prevailing weather conditions (i.e. the climate) are changing (Dwyer, 2012). The last century was characterised by an upward trend in temperatures, resulting in warmer, wetter winters and hotter, drier summers, accompanied by an increase in extreme weather events. This pattern is likely to continue (Table 1) (Nolan, 2015; DCCAE, 2018b).

Climate projections for Ireland referenced within this plan have been based on the report *Ensemble of Regional Climate Model Projections for Ireland* (Nolan, 2015). In this study, climate simulations were run for a reference period (1981–2000) and a projection period (2040–2060). The difference between these two periods was then used to estimate how the Irish climate will change over the coming decades. The simulation was based on both medium–low-emission and high-emission scenarios from the IPCC. The medium–low-emission scenario represents a future where the global population takes drastic steps to reduce greenhouse gases, while the high-emission scenario represents a business-as-usual future, where little has been done to reduce emissions. For instance, compared to the 1981–2000 reference period, by 2040–2060 annual temperatures in Ireland are expected to have risen by 1–1.3°C in the medium–low-emission scenario but by 1.2–1.6°C in the high-emission scenario (Figure 3).

It is important to emphasise that many of the impacts of climate change on cultural heritage will be process driven and therefore require a fine-tuning of climate data, sometimes described as 'heritage climatology' (Brimblecombe, 2010). For example, the number of wet days where the temperature drops from above to below freezing reveals freeze-thaw action in a way that average winter temperature does not. Similarly, the incidence of relative humidity around certain key threshold values is fundamental to predicting deterioration mechanisms such as salt weathering, mould growth and corrosion. Careful analysis of the scientific data, combined with an awareness of the mechanisms that affect heritage, will therefore be essential for informed decision-making.

The effects that the projected changes in climate will have on built and archaeological heritage will depend on the vulnerability of each heritage resource. The degree of vulnerability to any hazard depends on exposure, sensitivity and adaptive capacity (resilience). Exposure to climate-change impacts will

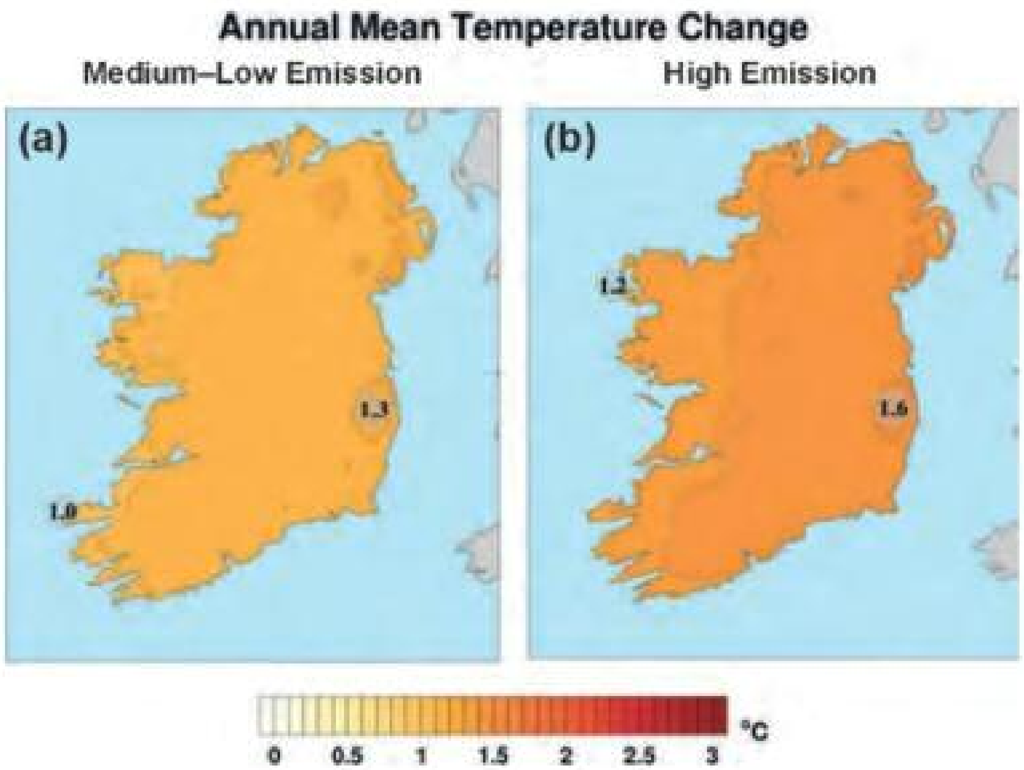

Figure 3. Projected rise in annual mean temperature by 2040–2060 for the (a) medium–low-emission and (b) high-emission scenarios as compared to the 1981–2000 reference period (Nolan, 2015)

Table 1. Summary of observed and projected climatic change (Nolan, 2015, 2019). Projections are for the medium-future period to be addressed by this strategy and represent a range of emission scenarios.[4]

OBSERVED IMPACTS	PROJECTED IMPACTS 2041–2060
Temperatures have increased by 0.8°C since 1900, an average of 0.07°C per decade	**Annual average temperatures will rise** by 1–1.6°C, with the largest increase in the east **Extreme high temperatures will increase** by up to 2.6°C (summer maximums) and up to 3.1°C (winter minimums)
The number of annual frost days has decreased	**The average number of frost days will decrease further** by 50% for the medium- to low-emission scenario and by 62% for the high-emission scenario
The growing season has extended, beginning one week earlier	**The growing season will extend further** by 35–40 days
Average rainfall has increased by ≈ 5% since the mid-twentieth century[5]	**Intense rainfall will increase** The number of 'very wet days' (≥30mm rain/day) will increase by ≈ 30% during winter months
Dry periods have become more frequent The likelihood of an extremely dry summer has doubled over the last century	**Summers will become drier** **Rainfall volume will reduce** by ≈ 20% (summer) **The number of dry periods** (i.e. periods of at least 5 consecutive days with <1mm rain) will increase by up to 40%
The temperature and acidity of the sea have increased Sea surface temperature is >1.0°C higher than in the mid-twentieth century and sea acidity is 30% higher globally	**Sea-surface temperatures will continue to rise** by 1.9°C (Irish Sea) by the end of the century; sea acidity will increase by 100–150% globally[6]
The sea level has risen by 2–3mm per year around the Irish coast since the 1990s; mean wave heights along the south-west coast have increased by 0.8m per decade[7]	**Sea levels will continue to rise** by up to 800mm by 2100 **Storm surge will increase** **Atlantic coastal retreat rates are likely to increase** from current 0.5–1m per year
The number and intensity of storms in the north Atlantic have increased by ≈ 3 per decade since 1950	**The intensity of storm activity will increase** in the north Atlantic and over Ireland **Extreme wind speeds will increase slightly,** particularly in winter
Relative humidity values have slightly increased in summer and decreased in winter in the period since 1961[8]	**Relative humidity is likely to increase,** especially during winter months **Relative humidity is likely to decrease in summer**, mainly in the south and east[9]

[4] The IPCC produced a range of low- to high-emission scenarios for climate models in order to cover the range of uncertainty regarding the degree to which societies will control greenhouse-gas emissions (and thus global temperature rise).
[5] Average annual national rainfall comparing the period 1981–2010 to the 30-year period 1961–1990.
[6] IPCC, 2007.
[7] OPW, 2015.
[8] Based on comparison of Met Éireann 30-year average winter and summer relative humidity values (1961–1990 and 1981–2010) from eight weather stations across Ireland.
[9] Nolan, 2019.

vary with location and aspect, while the sensitivity of heritage will generally be determined by its nature and condition (e.g. an unroofed tower house will be more vulnerable than an occupied thatched cottage). Although sensitivity and exposure are inherent, deliberate actions to increase adaptive capacity (e.g. through management and policy actions) can be undertaken in order to reduce vulnerability.

2.2 Vulnerability of Ireland's Built and Archaeological Heritage to Impacts of Climate Change

2.2.1 Overview of Potential Impacts and Vulnerabilities

The direct effects of climate change on heritage may be immediate or cumulative. Thus, damage from catastrophic events such as floods and storms are likely to increase at the same time as slow-onset environmental deterioration mechanisms. The way these impacts manifest will vary according to the sensitivity of the heritage and its exposure (Murphy and Ings, 2013). Exposure will alter with location and aspect, while sensitivity will be determined by the nature of the heritage resource (type, material) and its current condition. In addition, there will be indirect impacts related to societal responses to climate change in terms of both adaptation (e.g. changes in land use) and mitigation (e.g. the renovation or upgrading of historic buildings to reduce energy consumption).

2.2.2 Coastal Heritage

Many of the losses due to climate change are likely to occur at the coast (National Trust, 2005; Pearson, 2008). Coastal heritage includes land-based sites, intertidal sites and structures and underwater or submerged sites. The direct impacts include sea-level rise (SLR), increased frequency of storm events and greater wave energy, leading to flooding, coastal erosion and coastal squeeze (Kelly and Stack, 2009). Losses are likely to be highest on geologically soft coasts or in low-lying areas. Tidal influences are liable to be felt further upstream in river systems and could cause significant flooding in previously immune areas, including historic urban centres (Chapman, 2002; Murphy and Ings, 2013). Saline intrusion will compromise historic structures and archaeological deposits through physical and chemical reactions (Pearson and Williams, 1996; Chapman, 2002). Alterations in currents, increased storm activity and SLR may cause greater erosion impacts to underwater cultural heritage, while increased depth (due to SLR) and decreased visibility (due to turbidity) will inhibit documentation and excavation (Kelly and Stack, 2009; Dunkley, 2015). Preservation *in situ* for underwater archaeology will be compromised as both water temperature and acidity increase (Perez-Alvaro, 2016).

2.2.3 Architectural and Archaeological Heritage

The parameter of most concern to those managing historic buildings and archaeological monuments is rainfall. Increased frequency of wind-driven rain may result in an increase in abrasion and dissolution rates (Cassar, 2005). Higher rainfall and rising water levels will increase the moisture content of soils and potentially lead to weakened building foundations, subsidence, erosion and even landslide. Conversely, long, dry summers with lowered water tables may also damage building foundations (Berghäll and Pesu, 2008) and lead to an increased likelihood of wildfires and landslides, which could hamper emergency response and restrict access to sites. Flood waters may erode foundations and damage structural fabric and the heavy flotsam carried in floods has potential to cause mechanical damage to bridges and other historic infrastructure (Pospisil, 2013). Prolonged periods of wetness, especially if associated with winter warmth, have implications for a number of decay mechanisms, including salts and biological action (Bolton, 2007; Smith et al., 2004). Cumulative deterioration due to the mobilisation of salts is likely to increase in western Europe because of an increase in critical humidity fluctuations (Brimblecombe and Grossi, 2006; Grossi et al., 2011; Menéndez, 2016). Increased winter wetness may also lead to deeper penetration of salts (Smith et al., 2004; McCabe et al., 2010).

The temperature rise due to climate change is likely to be most severe in cities. Areas in Dublin with high building coverage have been found to be on average more than 4°C warmer at night than areas of Dublin with high vegetated coverage. This is due to the urban heat island (UHI) effect (Alexander and Mills, 2014). The UHI effect is likely to act as a risk multiplier, meaning that buildings in urban centres will be propelled more rapidly towards damaging temperature thresholds for microbiological and/or chemical decay mechanisms (Croft, 2013). Higher temperatures can provide conditions for established pest species to spread and increase in numbers (Croft, 2013), while invasive species such as termites may also become established. The EU-funded Climate for Culture research project used climate modelling and whole-building simulation tools to predict how climate change will affect historic interiors in Europe under different projected scenarios in the near (2021–2050) and far (2071–2100) future.[10] The project has predicted increased risks from chemical degradation mechanisms (paper and silk), mould growth and pests (such as moths and woodworm). Western Atlantic Europe is likely to see an increase in biodeterioration due to mould and pests as higher temperatures provide more hospitable environments for both.

Buried archaeological deposits survive in conditions that inhibit deterioration mechanisms (Cronyn, 1990). Even minor alterations to the burial environment can lead to the deterioration and even destruction of subsurface remains. Anaerobic environments, associated with excellent conservation of waterlogged artefacts and palaeological evidence, are especially vulnerable to changes in water levels (Chapman, 2002). Hotter, drier summers with consequent drying of soils and parching of vegetation will lead to an increased incidence of fires at unmanaged archaeological sites (Croft, 2013). Bog-bursts are likely to be more frequent as dry periods are followed by heavy rainfall (Sweeney *et al.*, 2008) and, as with fluvial erosion or scouring by pluvial flooding, could result in complete loss of deposits (Kincey *et al.*, 2008; Howard *et al.*, 2008).[11] Increased storm activity could also damage sites where the soils are light and sandy, the archaeology is close to the surface, or windthrow of trees is a risk (Riksantikvaren, 2010).[12] Changes in agricultural practices due to a predicted shift towards arable farming raise the threat of indirect effects, such as an increase in plough damage or the removal of traditional field boundaries (Sweeney *et al.*, 2003; Powell *et al.*, 2012). Large-scale renewable energy developments may compromise archaeology, maritime and terrestrial, as well as affecting historic landscapes (Flatman, 2012). Increased sea temperatures will result in the preponderance of marine borers and other invasive species into areas not previously populated, with consequential impacts on the underwater cultural heritage (Gregory *et al.*, 2012).

2.2.4 Cultural Landscapes

Cultural landscapes such as parks and gardens and archaeological clusters are at risk from increasing pests and diseases as well as droughts, wildfires and windthrow (Pearson, 2008; Powell et al., 2012; Croft, 2013). Changes may also occur through gradual ecosystem responses such as plant distribution, the loss and/or gain of species and altered growing seasons (Sweeney et al., 2002; Australian National University, 2009). Alterations in natural landscape characteristics will also impact indirectly on material cultural heritage by disturbing the 'sense of place' and on intangible culture, which expresses landscape through art, poetry and music:[13]

> *People go to places to feel things, experience things, get a sense of place. Those feelings are difficult to put into words… with Irish music you express some of those feelings… that feeling you get when you look at the scene is right there in the music (Sweeney* et al.*, 2008).*[14]

[10] Grant agreement no. 226973. See https://www.climateforculture.eu/.
[11] Bog-bursts occur as a result of intense rainfall and oversaturation of peatlands and can cause localised landslides.
[12] Windthrow (also known as tree throw or blowdown) refers to the uprooting or damage caused to trees by intense winds.
[13] The National Landscape Strategy for Ireland 2015–2025 recognises that landscapes embody cultural values and outlines relevant principles and policy objectives.
[14] Traditional musician Martin Hayes.

2.2.5 Opportunities

The discovery of new archaeological sites as a result of erosion (from storms, intense rainfall and SLR) and summer dry periods (crop-marks) is likely to accelerate with climate change. However, eroding material will rapidly decompose after exposure unless it is found and conserved. This offers both an opportunity and a challenge to archaeologists (Riksantikvaren, 2010). Hotter, drier summers are also likely to lead to an increase in tourism and recreational demand on heritage sites (Morgan et al., 2016). Although this presents conservation issues, it may also offer a possible revenue stream for adaptation actions. Visitor numbers, patterns of visitor access to sites and the conservation and management pressures that result are all likely to alter with climate change.

Table 2. Potential impacts of climate change on built and archaeological heritage in Ireland

Climate Stimuli and Impacts	Sectoral Consequences – Built Heritage		Sectoral Consequences – Archaeology	
Higher temperatures Hotter summers Warmer winters Prolonged dry periods Longer growing season Altered microbiological activity Accelerated rate of chemical reactions Ocean acidification	DIRECT			
	Challenges Increased microbiological growth/changes in species Increased urban pollution effects, chemical processes of deterioration (summer) Increased thermal weathering Increased risk of fires Loss/gain of plant species	**Opportunities** Reduction in freeze-thaw weathering	**Challenges** Accelerated deterioration Desiccation of organics Change in vegetation cover Deterioration of peatlands Increased risk of fires Increased microbiological growth/changes in species	**Opportunities** Discovery of sites (crop marks)
	INDIRECT			
	Challenges Maladaptation of occupied buildings Changing land use (agriculture and renewables)	**Opportunities** Increased recreational use	**Challenges** Changing land use (agriculture and renewables)	**Opportunities** Increased recreational use
Extreme precipitation and storms Flooding Increased water flow Altered water tables Change in humidity cycles Increase in penetration of water and time of wetness Changes in soil chemistry Deterioration of water quality	DIRECT			
	Challenges Surface erosion, abrasion and salt weathering Microbiological growth Rising damp Subsidence/landslip Changes in surface deposition, washing of pollutants, soiling Physical damage, loss and collapse Windthrow Dispersal		**Challenges** Landslide, bogslide and rock fall Erosion Silting Pollution/contamination Windthrow Altered preservation conditions Collapse/subsidence	**Opportunities** Discovery through erosion
	INDIRECT			
	Challenges Damage to flood defences		**Challenges** Damage to flood and drainage works	
SLR and storm surge Coastal erosion Coastal flooding Increased wave heights Saline intrusion Wind-transported salts Wind-driven sand	DIRECT			
	Challenges Mechanical erosion and salt weathering Sand blasting Erosion of foundations Physical damage, loss and collapse Rising damp accompanied by salts		**Challenges** Saline intrusion (soils and water table) Altered preservation conditions Erosion and exposure (sand dunes, underwater and intertidal) Submersion/inundation (marine, intertidal) Sedimentation (intertidal, marine)	**Opportunities** Discovery of sites
	INDIRECT			
	Challenges Maladaptation (leading to damage of coastal defences) Reputational loss (where losses are severe and public confidence in the heritage sector is reduced)		**Challenges** Maladaptation (leading to damage of coastal defences) Reputational loss (where losses are severe and public confidence in the heritage sector is reduced)	

3 Prioritisation

3.1 Overview of the Prioritisation Process

The climate impact screening undertaken in Step 2 of the Sectoral Planning Guidelines for Climate Change Adaptation provides an overview of projected climate change and its potential effects on built and archaeological heritage. For this step it was necessary to decide which of the many potential impacts identified should be considered as priorities for adaptation planning. This prioritisation exercise was undertaken in two phases.

Table 3. Secondary sources utilised for preliminary priority-setting

AGENCY	SOURCE	PRIORITIES
Historic Environment Scotland	A geographic information system (GIS)-based risk assessment of properties owned by Historic Environment Scotland, *A Climate Change Risk Assessment*, mapped six impacts identified as being of key concern (Harkin *et al.*, 2018)	Flooding – fluvial Flooding – pluvial Flooding – groundwater Flooding – coastal Coastal erosion Slope instability
Historic Environment Group Wales	A national risk-assessment exercise resulted in the publication of *Climate Change and the Historic Environment of Wales: A Summary of Potential Impacts* and the identification of five key risks for the historic environment (Powell et al., 2012; Murphy and Ings, 2013)	Flooding SLR Desiccation and erosion of wetlands/peats Storms and high winds Migration and invasion of species and pests
Historic England	*Key Messages*, the Atkins report for English Heritage, drew together existing knowledge on environmental threats to heritage and outlined six priority areas (Croft, 2013)	Inland water inundation (all types of flooding and ingress) Coastal processes (erosion, flooding, marine issues) Extremes of wetting and drying on soil hydrology (buried archaeology) Pests and diseases Fire (peatland and moorland) UHIs

Phase 1. Based on secondary research, a preliminary identification of priority impacts was made. The published climate-change risk analyses undertaken by heritage agencies in Britain were particularly useful in this task (Table 3). Although not specific to Ireland, the many parallels in climate and heritage materials make the results relevant for a first-phase assessment (Powell et al., 2012; Croft, 2013; Harkin et al., 2018). A trawl of Irish newspapers for instances of reported climate-related damage to heritage, conducted as part of the background report, was also utilised (Daly, 2017).

Phase 2. In January two expert-stakeholder workshops were held in Dublin and Ballinasloe to gather information on how climate-change impacts were being experienced within the sector and to establish whether the initial prioritisation accurately reflected current concerns (see Appendix V: Stakeholder Workshop Reports). More than 100 participants attended over the two days. After a series of presentations outlining the adaptation-planning process, climate projections and potential impacts on heritage, the participants engaged in guided group discussion.[15]

Workshop participants were first asked to discuss any impacts on the built and/or archaeological heritage in their region that they believed may be due to climate

[15] The participants were given an overview of all potential impacts based on Step 2 of the *Sectoral Planning Guidelines for Climate Change Adaptation*. To ensure that any opinions from the workshop were the participants' own, no suggestion of prioritisation was provided.

change. Second, they were asked to identify the main vulnerabilities, as they saw them, of Ireland's built and archaeological heritage to the impacts of future climate change. Participants were also asked to pick three to four of the named impacts which were of key concern to them. This provided some degree of qualitative ranking.

3.2 Priorities

The two-phase process described above led to the development of a final list of priority impacts for the sector (Table 4). In general, workshop participants' concerns matched closely the literature-based list of prioritised impacts already produced. There were two notable exceptions, however. Firstly, workshop participants did not highlight the impact of increased wildfires. This is possibly because wildfires are currently very uncommon in Ireland and have not so far caused significant damage to built heritage, although gorse fires do regularly have low-grade impacts on archaeological heritage. Climate projections suggest that wildfires will increase due to hotter, drier summers, and the current low level of awareness and preparation for such events means that they could be highly damaging. For these reasons fire was kept on the final list of priority impacts. Secondly, the impact of maladaptation was not addressed by the UK studies but surfaced as a major concern during stakeholder consultations and was added to the final list. The set of priorities that emerged from this desktop research and consultation process will need to be kept under review and updated as a more detailed understanding of climate-change risks and impacts evolves.

Table 4. Priority impacts list

PRIORITY IMPACT	CLIMATIC FACTOR	HERITAGE AFFECTED
Flooding – inland (fluvial, pluvial and groundwater)	Rainfall	All (highest risk for buildings and collections)
Flooding – coastal	SLR and storm surge	All
Storm damage	Wind and rain	All (highest risk for buildings and landscapes)
Coastal erosion	SLR and storm surge	All (highest risk for buildings and archaeology)
Soil movement (landslip/erosion)	Intense rainfall, long dry periods, storms	All
Changing burial-preservation conditions (e.g. desiccation, saline intrusion, acidification)	Long dry periods, SLR, temperature rise	Archaeology
Pests and mould (mould/invasive species/ increase in microbiological activity)	Warmer, wetter winters	All (highest risk for buildings, collections and landscapes)
Fire (wildfires)	Hotter, drier summer periods	Archaeology, landscapes and rural buildings
Maladaptation (e.g. energy renovation of historic buildings; flood and coastal defences)	Temperature rise, SLR, rainfall	All (highest risk for buildings and archaeology)

4 Priority impact assessment

4.1 Introduction to Case Studies

Following a preliminary prioritisation based on research and stakeholder feedback (Step 3 of the Sectoral Planning Guidelines for Climate Change Adaptation), this section examines some of the key impacts with reference to illustrative heritage examples. These case studies are not exhaustive but should be taken as indicative of climate-change impacts that may be felt across the country. Although the list of priority impacts includes fire, maladaptation and changes in burial-preservation conditions, there was insufficient heritage-related data on these issues to build informative case studies. In recognition of this lack of data, recording and research to ensure a baseline understanding have been included as actions in the adaptation plan (Goal 1.h, i; Goal 3.g; Goal 4.g).[16] Further research is also needed on the effect of multiple factors on a single heritage site, e.g. SLR and storms causing coastal flooding and damage (Goal 3.b; Goal 4.d–f). The following case studies aim to demonstrate how climate change has already affected built and archaeological heritage and what the response has been. In selecting these individual examples, efforts were made to ensure a variety of heritage types (national monuments, a small town, a city, local infrastructure and archaeology) and geographic spread (Figure 4).

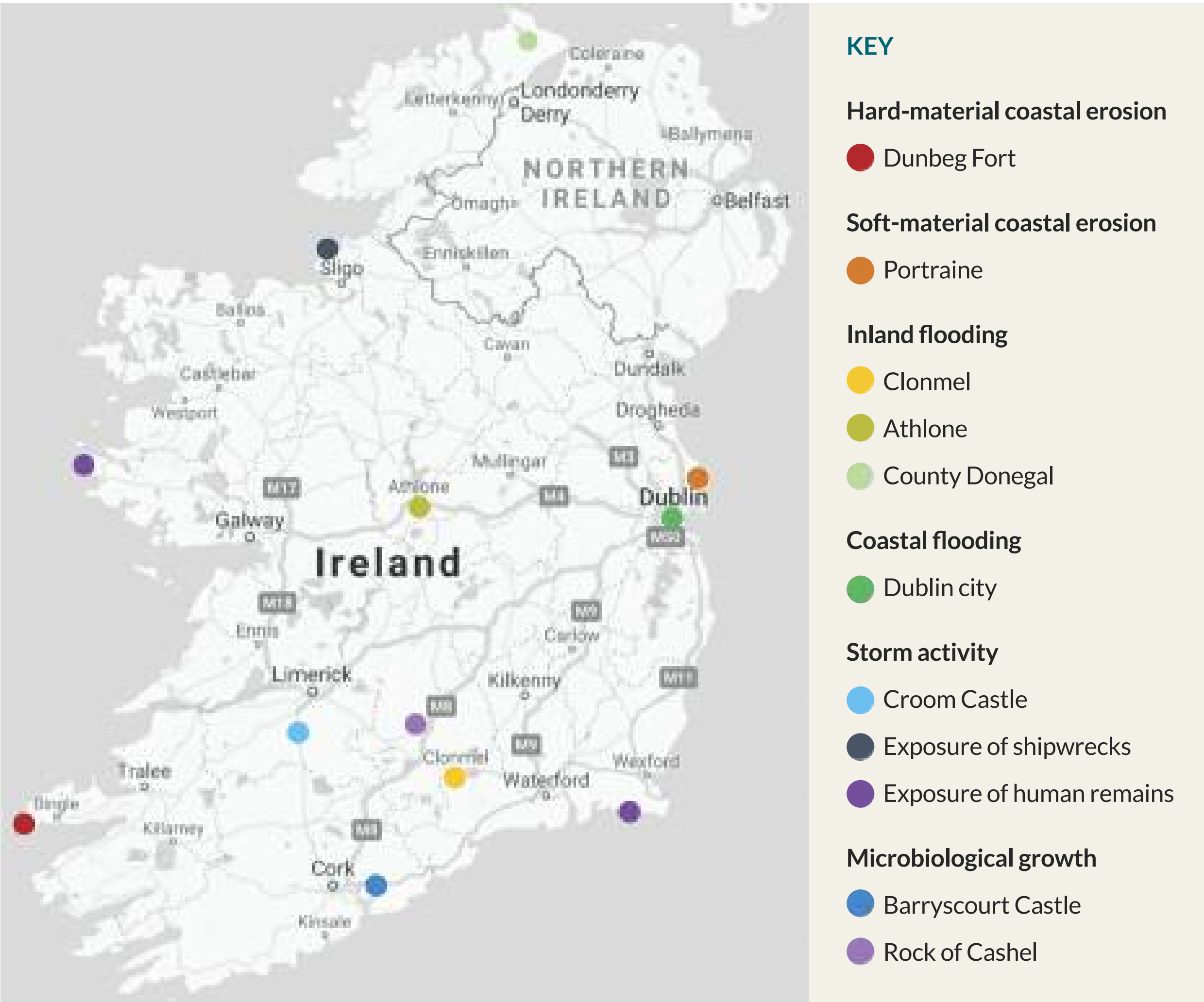

Figure 4. Location of sites selected to illustrate the impacts of climate change on built and archaeological heritage in Ireland (Google Maps, 2019b)

16 Goals, objectives and actions (represented by letters a–j) referenced here are detailed in Section 5.1: Adaptation Goals and Objectives.

4.2 Coastal Erosion

4.2.1 Environmental Causes and Effects

Ireland has a long coastline in relation to its overall area, approximately 7,400km (+/- 5%). The irregular headland and bay configuration of Ireland's coastline provides over 3,000km of rock-dominated coasts in the south-western, western and northern regions of Ireland. The eastern and south-eastern coasts generally consist of unconsolidated Quaternary glaciogenic sediments and have fewer rock exposures. Sedimentary areas such as large bays and estuaries are present along the west coast (Devoy, 2008).

Coastal regions of Ireland have always been subject to environmental changes. Storm surge, strong waves and tidal actions, as well as intense, repetitive rainfall, all cause coastal erosion.

- Strong waves attack the base of cliffs, leading to cliff collapse
- Strong waves and tidal action move and deposit on the foreshore materials which are eventually removed by waves
- Prolonged heavy rainfall triggers landslips

These processes result in a destabilisation of cliff systems, which, although localised, can be catastrophic. Coasts are also subject to shoreline erosion, where beaches and sedimentary areas are washed away – either gradually, by waves and tidal action, or abruptly, during storms. This results in a retreat of shoreline. Affected areas can be extensive (Croft, 2013).

The west and south-west coasts of Ireland are exposed to eastward-moving storms and wave energy from the north Atlantic. Coastal erosion in these regions is often caused by storm events and storm surge (significant deep-water wave height can reach 15–20m). The impact of storms and wave energy on the eastern and south-eastern coasts is relatively less severe; it is gradual erosion that occurs more commonly in these regions (Devoy, 2008).

4.2.2 Impact of Climate-Change Projections

Climate Ireland (CI) projections for the middle of this century (2041–2060) indicate a decrease in the overall number of cyclones, although it is projected that the intensity of storm activities in the north Atlantic and over Ireland will increase and that the tracks of intense storms from the Arctic regions will extend further south over Ireland (Nolan, 2015). This implies that Ireland will experience more intense storm surge, which will lead to increased coastal erosion.

Mid-century projections indicate that Ireland will experience more extreme precipitation events, with an increase in the frequency of heavy rainfall (over 20–30mm per day) by approximately 20%, with especially wet weather in autumn and winter (Nolan, 2015). Coastal erosion induced by heavy-rain events is therefore also expected to increase.

The Irish Coastal Protection Strategy Study (ICPSS) has modelled the position of the coastline in 2030 and 2050. These projections indicate that under 'normal' climate conditions the erosion lines of the Irish coasts would, to varying extents, continue to move inland (Figure 5). The studies do not consider the impacts of climate change, however, and with some areas already exceeding erosion levels projected for 2020, the model might be an overly optimistic view of future erosion patterns (Casey, 2019).

4.2.3 Case Study 1 – Dunbeg Fort, County Kerry[17]

Dunbeg Fort serves as an illustrative example of catastrophic hard-material coastal erosion along the south-west coast of Ireland.

The Dunbeg prehistoric promontory fort and medieval habitation site is situated on a sheer cliff edge overlooking Dingle Bay at the base of Mount Eagle in the townland of Fahan, Dingle, County Kerry (Figure 6). Dunbeg Fort is a national monument in state care and the OPW is responsible for its maintenance and conservation. It is one of a number of heritage sites on the Dingle Peninsula and receives several thousand visitors each year.

[17] National monument no. 177; SMR no. KE052-270.

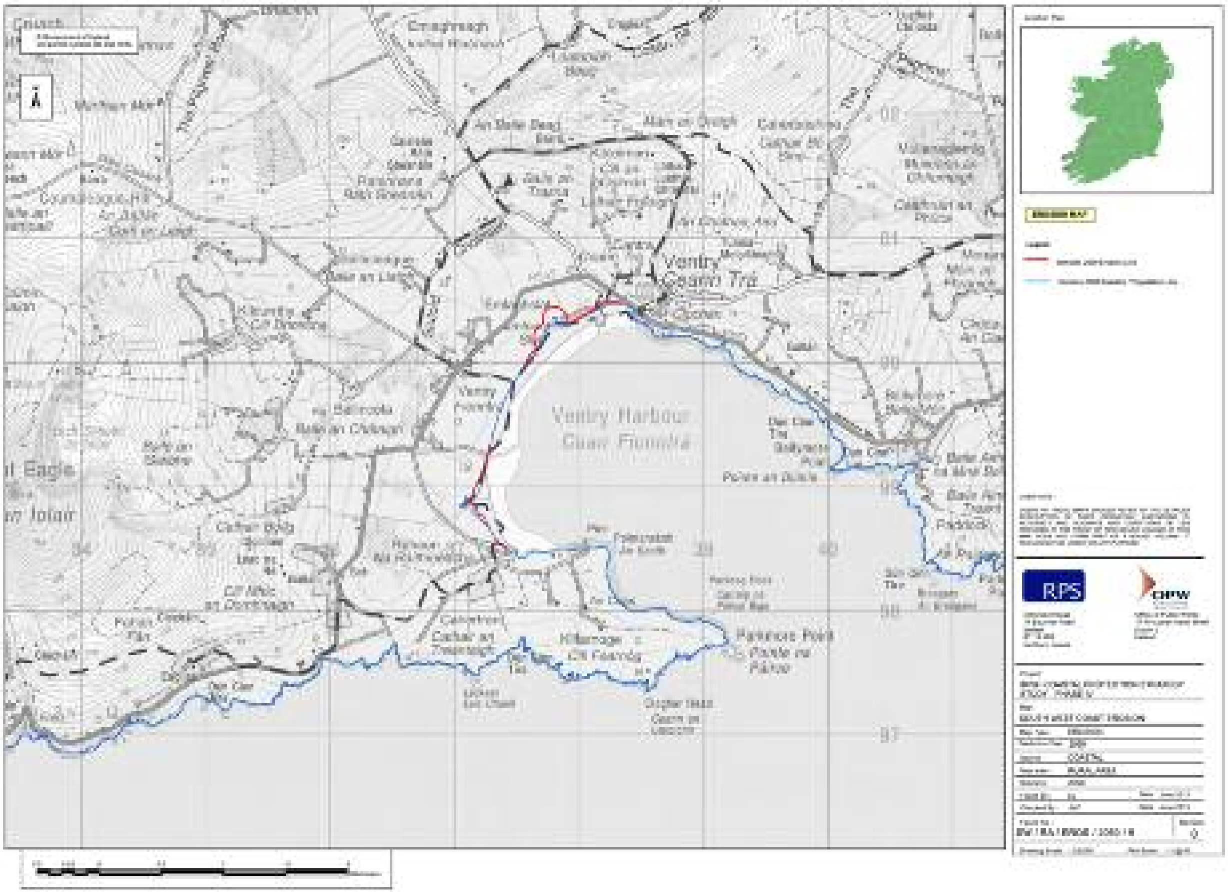

Figure 5. One of the south-west coastal-erosion maps for Dingle in County Kerry, extracted from ICPSS. The blue baseline/vegetation line was drawn in 2000. The red line is the predicated erosion line for 2050 (OPW, 2013a).

Figure 6. Dunbeg Fort, County Kerry (OPW)

The site has suffered extensive coastal erosion since the mid-nineteenth century, with a marked increase in erosion rates over the past decade. In January 2014, a storm caused a substantial portion of the western edge of the cliff to collapse into the sea. Between December 2017 and January 2018, further extreme weather brought by Storm Eleanor caused a 10m section of the internal drystone rampart, including the entranceway, to fall into the sea (RTÉ, 2018) (Figure 7).

The stability of the western limits of the site has been undermined by this ongoing coastal erosion. Full site-safety assessments have been carried out by the OPW to understand the scale of damage, the potential for further erosion and the danger of the fort eventually being lost. Coastal strengthening is not deemed to be an effective solution and is anyhow not feasible because of dangerous cliff conditions. The OPW has undertaken drainage works to redirect rainwater, which had also been contributing to damage, away from the fort. Fencing and access strategies were explored to enable safe

Figure 7. A 3D survey of Dunbeg Fort, mapping erosion from June 2017 (red line) through April 2018 (blue line). The green line indicates the coastline in 1898 (CHERISH, 2017, 2018).

access to what remains of the site. The site reopened to the public in 2019 with limited and controlled access along its eastern extent. Site monitoring, scheduled safety appraisal and post-weather event assessment now form part of the management strategy for the site.

There has been long-standing concern regarding the damage and potential loss of Dunbeg Fort due to coastal erosion. In 1977, archaeological excavations were carried out to record the site before more of it was lost.[18] As OPW conservation works are carried out, particularly following recent storm damage, continued archaeological investigation and monitoring is also being undertaken by the NMS. In 2017, under the Irish-Welsh Climate, Heritage and Environments of Reefs, Islands and Headlands (CHERISH) research project,[19] the site was modelled using 3D-imaging software. The project aims to set a baseline against which future change can be measured and to raise awareness of the impact climate change can have on coastal heritage (Goal 1.1).

4.2.4 Case Study 2 – Portraine, County Dublin

Portraine (or Portrane) is a seaside settlement located in Fingal, County Dublin. The undulating low-lying landscape constitutes a unique marine and estuarine environment (Courtney and Goucher, 2007). The eastern edge of Portraine is comprised of beaches and sedimentary areas and is particularly vulnerable to natural erosion. The coastline there is eroding because of strong waves and tidal action brought by major storms. Some sections have receded by as much as 20m over the past six years (Hutton, 2018). The earliest evidence of human activity on the Donabate/Portraine Peninsula dates to the Mesolithic period (7000–4000 BC) and the landscape has continued to attract human settlement over the ensuing millennia (Courtney and Goucher, 2007). A number of religious and vernacular heritage properties and sites lie within 1km of the Portraine shoreline, including burial remains, a graveyard, a cottage, a tower house and a Martello tower, all of which are recorded on the SMR (Figure 8).

Affected local communities have been expressing their concerns through the Fingal Coastal Liaison Group.[20] In November 2018, Fingal County Council installed a 250m-long, 6m-wide erosion-defence sea wall made of concrete blocks as a short-term emergency solution to slow down the increasingly rapid erosion of the coastline (Hutton, 2018) (Figure 9).[21]

4.2.5 Sectoral Consequences and Possible Actions

Coastal erosion around Dunbeg Fort and Portraine illustrate the potential impact that increased coastal erosion will have on heritage located along hard and soft coastlines. In general, the sector will need to prepare for the following:

- Increased structural damage, including either

[18] The report of the excavation, Barry, T., Archaeological Excavations at Dunbeg Promontory Fort, County Kerry, 1977, was published in 1981.

[19] CHERISH is a five-year EU-funded Ireland–Wales project undertaken in collaboration by: the Royal Commission on the Ancient and Historical Monuments of Wales; the Discovery Programme: Centre for Archaeology and Innovation Ireland; Aberystwyth University: Department of Geography and Earth Sciences; and Geological Survey Ireland (GSI).

[20] The Fingal Coastal Liaison Group was established in 2016 in response to ongoing concerns in relation to coastal erosion and coastal flooding in Fingal. The group is made up of county councillors, council officials and community members from each of the affected areas. Details of the Fingal Coastal Liaison Group are available at http://www.fingalcoco.ie/planning-and-buildings/fingalcoastalliaisongroup/.

[21] Interim emergency measures were implemented by Fingal County Council with the assistance of the OPW and the National Parks and Wildlife Service.

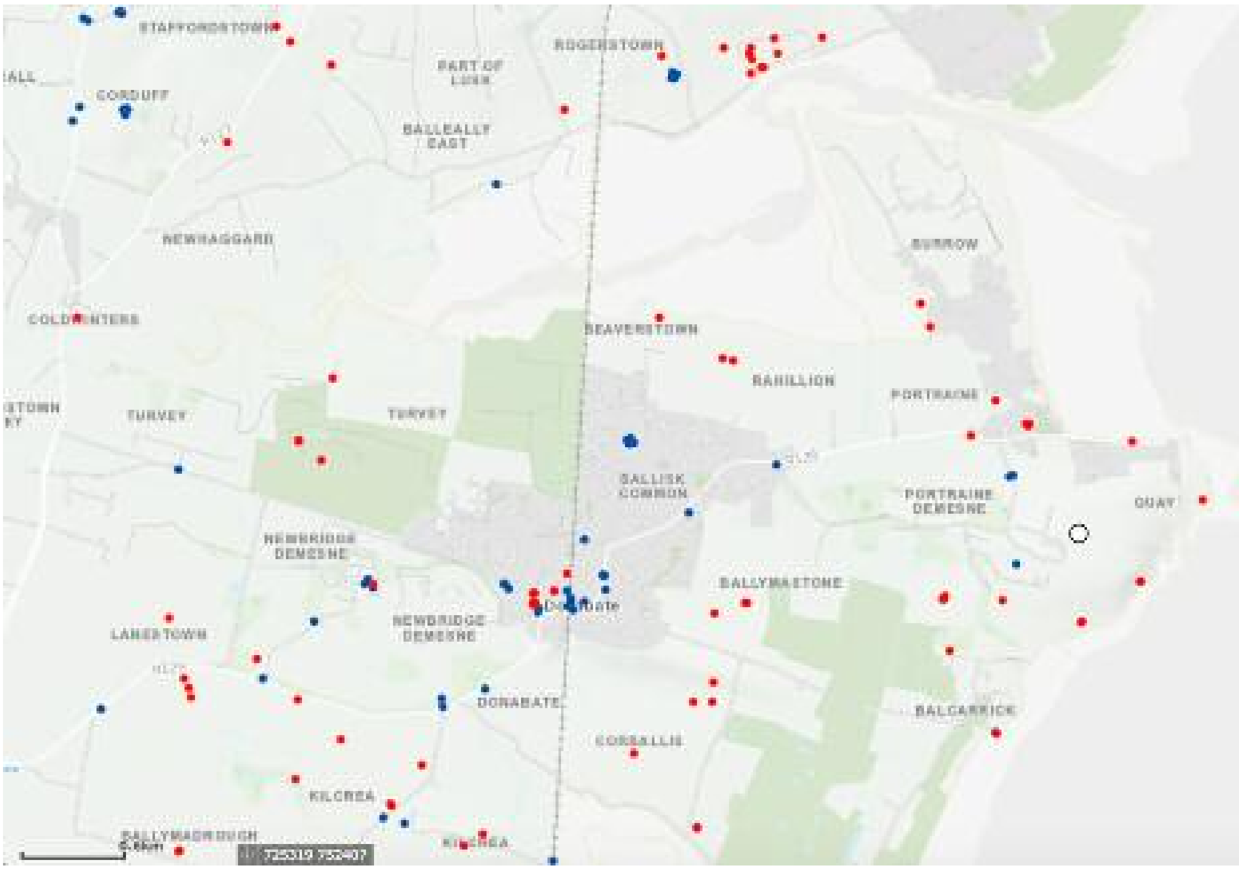

Figure 8. Heritage on the SMR (red dots) and the NIAH (blue dots) on the Donabate/Portraine Peninsula (Department of Culture, Heritage and the Gaeltacht)

Figure 9. Dwellings in Portraine on the brink of falling into the sea because of coastal erosion (left); €500,000 worth of concrete blocks installed as a short-term solution to coastal erosion in Portraine (right) (Comerford, 2018)

partial or complete loss of built and archaeological heritage
- Potential closure of heritage sites, leading to a loss of heritage value and tourism revenue
- Health and safety risks posed by sudden coastal-erosion incidents

While it is anticipated that coastal erosion will continue to have direct negative impacts on the built and archaeological heritage located along the coastal areas of Ireland, there is a general consensus among heritage specialists that, for the majority of sites where loss is inevitable, resources should be focussed on documenting and recording rather than on expensive preventative measures. There is therefore an urgent requirement to develop a risk register and establish priorities in order to guide how resources should be used – both for recording and, where feasible, for implementing cost-effective and environmentally sustainable preventative measures (Goal 1.2; Goal 3.2).

Geological Survey Ireland (GSI) has a new coastal-vulnerability mapping initiative, the first phase of which will run from 2019 through 2020 and will map coastal areas from north County Louth to County Wexford. The impact of SLR will be assessed against several indicators, including geomorphology, cliff type, coastline orientation, regional coastal slope, tidal range, significant wave height, relative SLR and long-term shoreline erosion and accretion rates (GSI, 2019). Once complete, the Coastal Vulnerability Index will provide a visual graded representation of areas vulnerable to SLR and will allow local authorities and communities to concentrate adaptation measures in those areas.

While hard-coastal-defence measures are usually visually intrusive and costly, they are often effective as emergency short-term solutions to coastal erosion. However, soft coastal-defence measures such as the preservation of coastal dunes could be considered as sustainable and affordable ways to achieve the long-term stabilisation of coastal regions.

4.3 Inland Flooding

4.3.1 Environmental Causes and Effects

Ireland has over 73,000km of rivers, streams and tributaries. The Shannon is the country's longest and largest river (by river flow) (Environmental Protection Agency (EPA), 2018). These waterways flow through every county in Ireland, meaning that the country as a whole is widely exposed to river-related flood hazards.

Ireland receives large amounts of precipitation, with north-Atlantic storms frequently traversing the country. Intense rainfall events are the major cause of inland flooding and storm activity often brings heavy precipitation.

Large amounts of rain over an extended period will cause waterways, storm-water drainage systems and the ground to exceed their holding capacity, leading to different types of threats.

- Fluvial flooding occurs when rivers and streams break their banks and water flows out onto adjacent low-lying areas. Flash flooding, when a high velocity of water occurs suddenly with little or no notice, can be particularly dangerous and destructive.
- Pluvial flooding occurs when water-drainage systems and/or the ground are unable to absorb rainfall. This leads to overland flow and ponding in low-lying areas. Pluvial flooding usually occurs rapidly after intense rainfall but can be short-lived. The flood water often dissipates quickly into natural or man-made drainage systems.
- Groundwater flooding occurs when prolonged precipitation causes a rise in groundwater levels until the water flows out over the surface. Groundwater flooding is a slow process but can last for a prolonged period because it is related to rising water-table levels (unlike pluvial flooding, which is caused by falling rain).

The area affected by fluvial and pluvial flooding depends on several factors, including the depth of riverbanks, size of catchment areas, permeability of soil and underlying rock, and the capacity of natural and man-made drainage systems to store the flood water. Groundwater flooding, on the other hand, often occurs at a local scale and is subject to geological composition and tidal variations (OPW, n.d.b).

Figure 10. Projected fluvial flood events (green areas) in Ireland based on a high-emission future scenario (30% increase in rainfall and 1,000mm rise in sea level) (OPW, 2018a; Central Statistics Office, 2011)

4.3.2 Impact of Climate-Change Projections

The high-emission-scenario projections from CI for the middle of this century (2041–2060) indicate an increase in mean precipitation during the winter and a substantial decrease during the summer. Overall annual precipitation is projected to decrease by 8–10%. However, the projections suggest that the frequency of heavy precipitation (≥ 20mm/day) will increase by approximately 20% over the full year, especially during autumn and winter (Nolan, 2015). During autumn, precipitation is projected to increase most in the midlands and the south-west regions of Ireland, while in winter the greatest increase in precipitation is projected to occur in the midlands and along the south-east coast of Ireland.

Flood maps developed by the OPW indicate the extent to which specific areas of Ireland are exposed to a range of flood-event scenarios, with the potential effects of climate change taken into consideration. The areas affected by fluvial flood risks are widespread (Figure 10).


Figure 11. Aerial view of Clonmel (left) (Google Maps, 2019a); flooding in Clonmel in 2000 (right) (McCarthy, 2015)

4.3.3 Case Study 3 – Clonmel, County Tipperary

Clonmel is an example of an Irish town that grew considerably during the Anglo-Norman period, and its surviving walled defences date from the fourteenth century. Clonmel also contains numerous historic buildings, most notably the Main Guard Courthouse, which is a national monument.[22] Protected structures include St Mary's Church,[23] the Franciscan friary,[24] bridges, country houses and villas, as well as industrial heritage such as mills and warehouses (Tipperary County Council, 2013).

The River Suir has a vital role in the history of Clonmel, as the transport channel that made it an important commercial and industrial inland town in the late eighteenth century. In recent decades, however, Clonmel has been subject to regular and often severe fluvial flooding from the Suir and its tributaries, the Whitening Stream and the Auk Stream (OPW, 2013b) (Figure 11).[25]

The Clonmel Flood Relief Scheme was a collaborative project implemented in three phases from 2007 to 2013 (*Irish Times*, 2015).[26] Detailed surveys and impact assessments were carried out on heritage that might be affected by the project, including the Dry Bridge and the Old Bridge (Irish Archaeological Consultancy, n.d.). The Dry Bridge and a mill building were recorded and then demolished as part of the flood-relief works. The Dry Bridge[27] was replaced with an architecturally designed bridge and the Old Bridge[28] was reinforced under licence from the DCHG. The removal of existing structures was necessary as part of the flood-defence scheme, which underwent public consultation. Flood-defence walls have to date successfully contained flood water within the river channel. The permanent flood-defence walls are relatively low and do not significantly


Figure 12. Flood-defence walls that kept the river water from overflowing after prolonged and heavy rainfall in 2014 (left); demountable defences which can be raised prior to potential flooding and lowered during times of low risk to reduce the visual impact on the town. A flood-warning system was developed to monitor rainfall in the catchment area to make sure the defences are fully installed before a flood (right) (McCarthy, 2015; Mott MacDonald Ireland).

22 National monument no. 667; SMR no. TS083-019004.
23 SMR no. TS083-019001; NIAH no. 22117013.
24 SMR no. TS083-019003; NIAH no. 22117076.
25 Severe floods occurred in 1995, 1996, 1997, 2000, 2004 and 2008 and 2009.
26 The OPW worked with South Tipperary County Council, Clonmel Borough Council (now Tipperary County Council), Waterford County Council, the South Eastern Regional Fisheries Board and engineering consultants to develop and implement the scheme.
27 NIAH no. 22121006.
28 SMR no. TS083-019002; NIAH no. 22117113.

Figure 13. Denis Burke Park, which is located along the River Suir in the centre of Clonmel, is designed to store excess water as part of the flood-relief defence scheme (Kenneth Hennessy Architects, 2012)

impede visibility of the landscape. The demountable panels provide extra protection and are raised during times of high water levels (Figure 12). Blue-green infrastructure[29] was implemented to create flood-attenuation areas. These also serve as public amenities (Figure 13).

4.3.4 Case Study 4 – Athlone, Counties Westmeath and Roscommon

Athlone is a medieval town situated along the River Shannon and is the centre for industrial, agricultural and tourist activities in the midlands. Athlone's heritage includes castles, churches, vernacular dwellings, infrastructure and archaeology. The town has been subject to numerous instances of fluvial flooding from the River Shannon and its tributary, the River Al, most recently in 2009 and 2015. The OPW is working with Westmeath County Council, other local authorities and engineering consultants on a flood-alleviation scheme to be implemented in different phases (Athlone Flood Alleviation Scheme Project Team, 2019). The public and stakeholders are currently being consulted regarding the design of flood-defence works (Figure 14).[30]

4.3.5 Case Study 5 – County Donegal

North Atlantic Storm Gert brought extreme rainfall to County Donegal during 2017, with a record-breaking 77mm falling on 22 August (News Highland, 2018). Fluvial and flash flooding and landslides caused severe damage to buildings and infrastructure, including Buncrana Castle Bridge.[31] About 500 homes (Burns,

Figure 14. Flooding near Athlone town along the River Shannon (left) (Fitzsimons, 2018); implementation of a flood embankment (right) and flood-defence wall (below) on Brick Island in Athlone (Athlone Flood Alleviation Scheme Project Team, 2019)

Figure 15. Old Mill Bridge in Buncrana, County Donegal, was also destroyed in the floods caused by heavy precipitation in August 2017 (Maguire, 2017)

2017) and 145 bridges (Donegal County Council, 2019) suffered flood damage and almost 50 families were displaced (Maguire, 2017). Inishowen Peninsula was one of the worst-hit areas (Figure 15).

In the immediate aftermath of the storm, Donegal County Council carried out assessments of the damage and of the impact to the county's 1,500km road network (Maguire, 2017). The council identified the protected bridges affected by the floods by combining first-hand flood data with existing GIS (Goals 2.1 and 4.2).

29 Blue-green infrastructure is an interconnected network of natural and designed water-management systems.
30 The Athlone Flood Alleviation Scheme is still in development at the time of writing.
31 Buncrana Castle Bridge is listed on the NIAH (no. 40815003) and protected under the County Donegal Development Plan 2018–2024.

While some local roads were closed for up to ten months after the floods, the council was able to minimise the loss of historic infrastructure in the post-flood clean-up. Most of the repair works carried out were of minimal intervention and aimed at halting further deterioration. Local communities also contributed and cooperated with the council during the recovery works (Goal 4.3).

4.3.6 Sectoral Consequences and Possible Actions

The situations in Clonmel, Athlone and County Donegal illustrate the potential impacts that increased inland flooding will bring to the heritage sector.

- Structural damage, partial loss or complete loss of built and archaeological heritage owing to velocity of streams and dynamic impact of floating objects
- Inaccessibility of flood-affected areas owing to damage to public roads and infrastructure
- Potential contamination of built and archaeological heritage and collections by flood water and deterioration in the drying-out phase (e.g. salts, microbiological activity)
- Potential loss of historic fabric during flood-prevention works, emergency response and post-flood recovery and rebuilding

As inland flooding will continue to cause direct negative impacts to built and archaeological heritage, there is a need to achieve better communication and cooperation between departments, authorities, agencies and stakeholders to reach a consensus on flood-prevention measures and to minimise negative impacts for heritage. Natural flood management may be a cost-effective and sustainable way to reduce flood risk (BBC News, 2007). For instance, *Forests and Water: Achieving Objectives under Ireland's River Basin Management Plan 2018–2021* highlights the role of woodlands and forests (together with shelter belts and hedgerows) as a natural means of flood attenuation, when applied strategically as part of a wider integrated catchment approach (Department of Agriculture, Food and the Marine (DAFM), 2018). It is important to consider the potential consequences of planting on archaeology and cultural-landscape character.

4.4 Coastal Flooding

4.4.1 Environmental Causes and Effects

Settlements in Ireland historically developed along river valleys, estuaries and the coasts, because of the relative ease of transport by water. Thus, there are many built and archaeological heritage sites located near waterways that could be threatened by increased coastal flooding. These include the cities of Dublin, Cork, Limerick and Galway.

Coastal flooding occurs when the sea level or wave heights rise above coastal land levels. Changes in wind direction and low atmospheric pressure during storms can force seawater to enter estuaries and harbours, causing the water levels to rise and the surrounding area to flood (OPW, n.d.b). Low-lying areas are particularly susceptible to coastal flooding and will be under greater threat as climate change causes sea levels to rise.

4.4.2 Impact of Climate-Change Projections

Global sea levels rose at an average rate of approximately 3mm per year between 1980 and 2010, and are projected to continue to rise at this rate or greater (Met Éireann, n.d.a). In addition, Ireland is likely to be subject to more intense storm surge, causing increased instances of coastal flooding. The OPW flood maps indicate that the coastal and estuarine regions in Counties Dublin, Louth, Cork, Kerry, Limerick, Galway and Donegal are at risk of increased coastal flooding (Figure 16).[32]

4.4.3 Case Study 6 – Dublin City

Located at the mouth of the River Liffey, Dublin is exposed to both riverine and coastal flood risks. The average sea level of Dublin Bay appears to be rising faster than previously forecasted. In the last two decades the level has risen annually by twice the global average, at 6–7mm per year (Codema, 2019). Major coastal flooding occurred in February 2002, October 2004 and January 2014 (Figure 17), caused by the three highest tides ever recorded in Dublin Port Station at Alexander Basin (OPW, n.d.a). The flooding during 2002 was the most severe –

[32] The Coastal Dataset for Evaluation of Climate Impact (CoDEC) project recently developed an approach to generate a sophisticated Europe-based dataset for tide, storm-surge and wave conditions. Such an approach could be applied on a local basis (e.g. to a coastal suburb) to predict future trends in coastal flooding (Murphy and Guerrini, 2019).

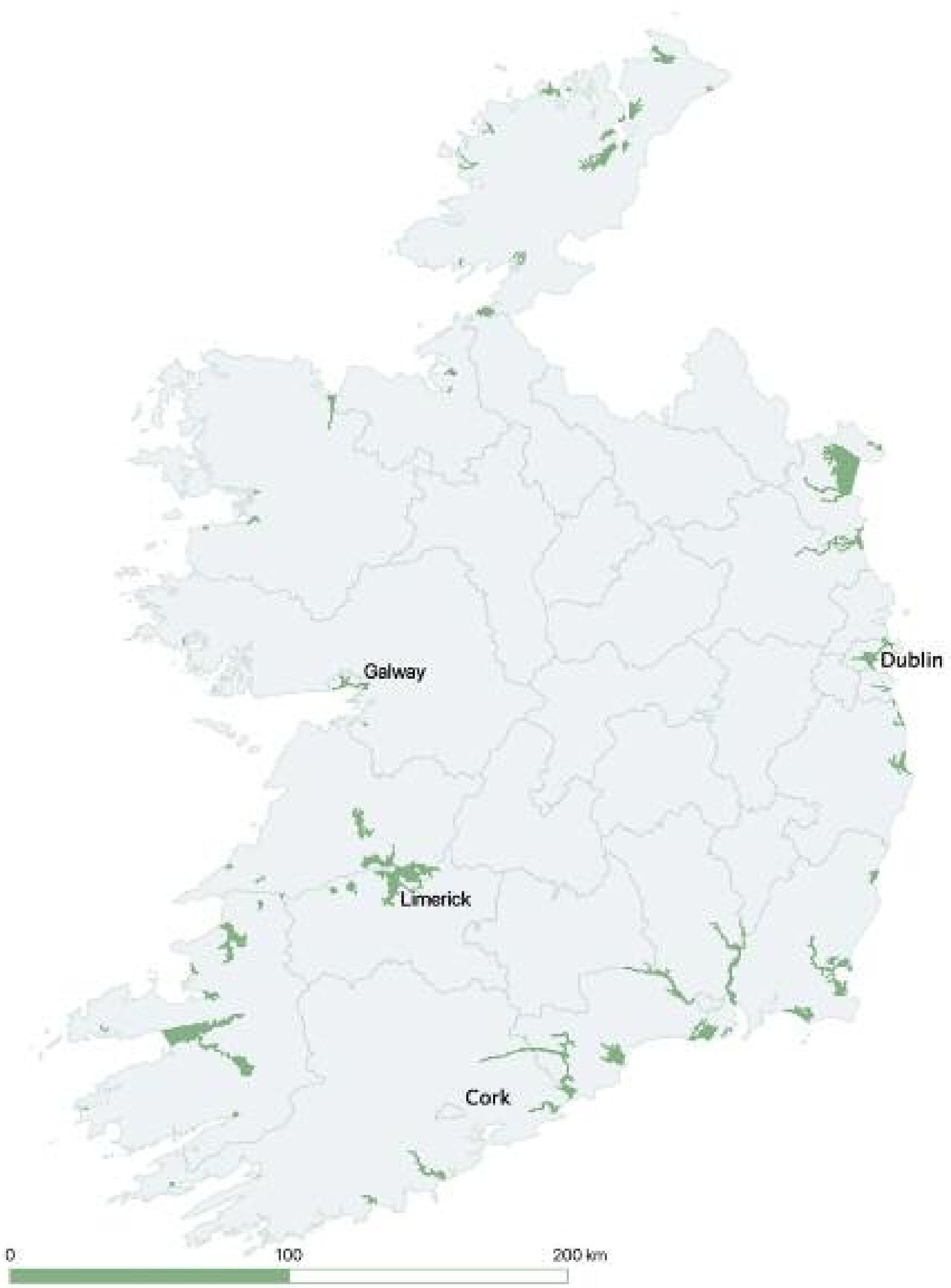

Figure 16. Projected coastal flood events (green areas) in Ireland based on a high-emission future scenario (30% increase in rainfall and 1,000mm rise in sea level) (OPW, 2018a; Central Statistics Office, 2011)

Figure 17. Seawater encroaching on the promenade at Clontarf, a coastal village of Dublin, during January 2014 (Humphreys, 2014)

seawater spilled over defences in the North Strand, East Wall, North Wall, Ringsend and Sandymount areas of the city. Over 1,200 properties were flooded (Codema, 2019) and more than 700 households lost power (RTÉ, 2002).

The OPW flood maps have been produced for both current and future climate scenarios. The potential extent of coastal flooding in Dublin under the OPW's mid-range (20% increase in rainfall and 500mm rise in sea level) and high-emission (30% increase in rainfall and 1,000mm rise in sea level) flood-risk scenarios are shown in Figure 18. A very large number of heritage properties and sites on the SMR and the RPS lie within the areas at risk of coastal flooding in the high-emission-scenario projections (Figure 19).

4.4.3.1 Climate Change Action Plan

The four Dublin area local authorities (Dublin City, South Dublin, Fingal and Dún Laoghaire-Rathdown) each prepared climate-change action plans in 2019. As with the sectoral plans, these action plans are subject to review and renewal every five years (Codema, 2019). The plans focus on five key action areas:

1. Energy and Buildings
2. Transport
3. Flood Resilience
4. Nature-Based Solutions
5. Resource Management

Across all four plans, nearly 100 short- and long-term actions have been identified to increase flood resilience through a range of flood-risk-management plans and flood-alleviation schemes.

4.4.3.2 Trinity College Dublin

Located at the heart of Dublin city, the main campus of Trinity College Dublin (TCD) is at risk of coastal flooding under both mid-range and high-emission scenarios (Figure 20). Severe coastal flooding could have adverse impacts on the campus buildings, structures and their interior furnishings and collections. Many are protected structures or listed on the SMR, such as Regent House,[35] the Dining Hall,[36]

Figure 18. Future coastal flood extents in Dublin city based on a mid-range-emission scenario (20% increase in rainfall and 500mm rise in sea level, top) and high-emission scenario (30% increase in rainfall and 1,000mm rise in sea level, bottom) (OPW, 2018a)

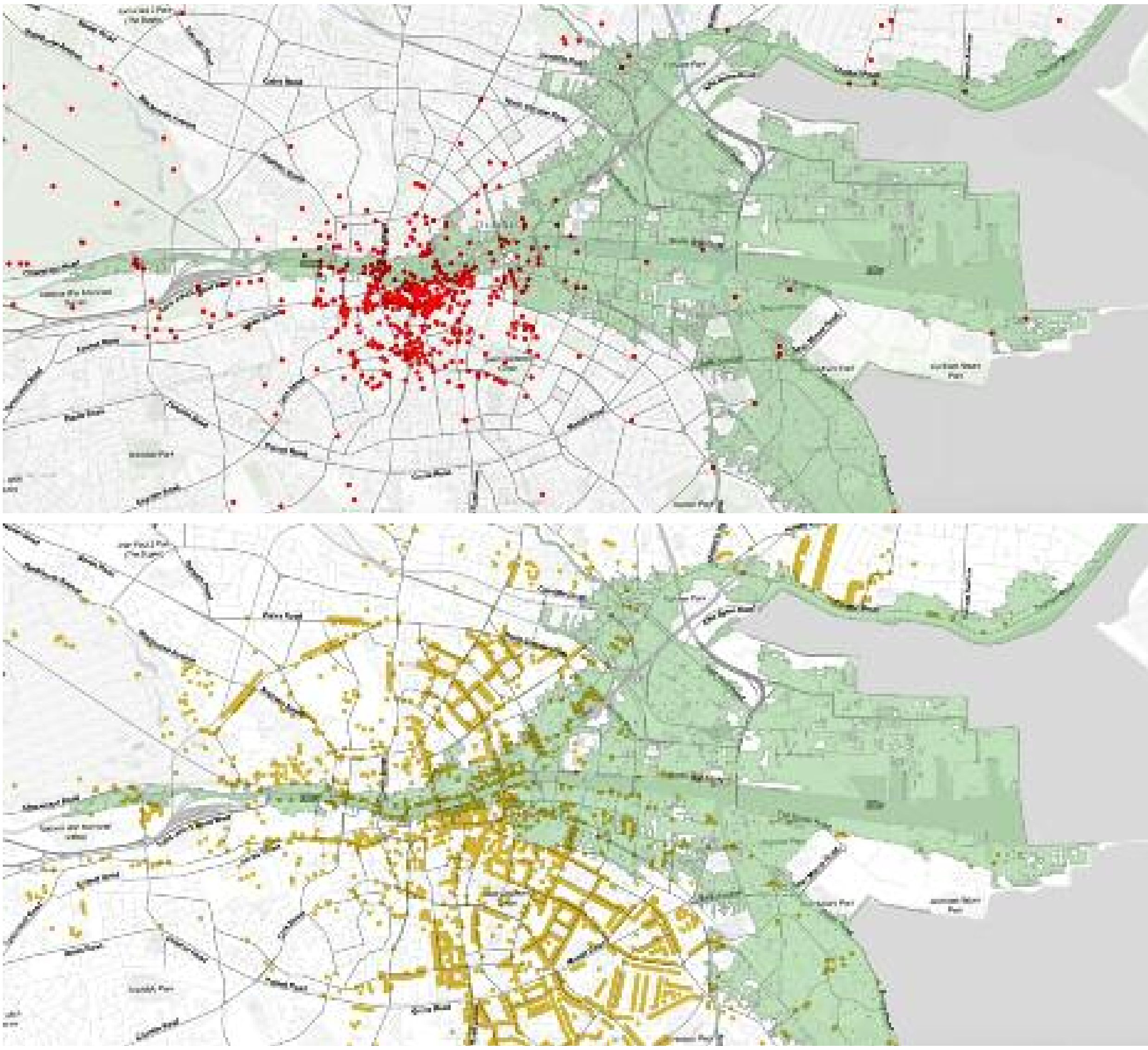

Figure 19. Heritage on the SMR (red dots; top) and the RPS (yellow dots; bottom).[33] Regions highlighted in solid green represent areas that are at risk of coastal flooding under the high-emission future scenario for Dublin (OPW, 2018a; DCHG).[34]

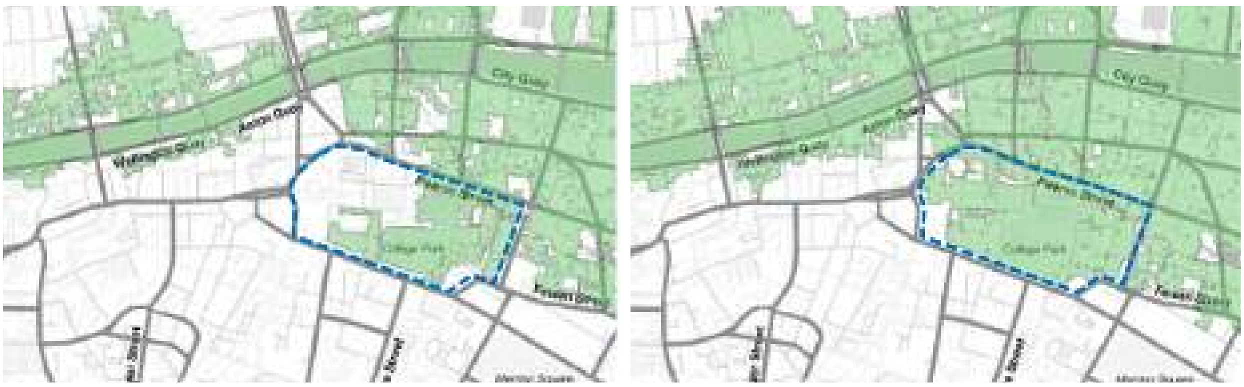

Figure 20. The main campus of TCD (blue dotted area) is at risk of coastal flooding under the mid-range-emission (20% increase in rainfall and 500mm rise in sea level; left) and high-emission scenarios (30% increase in rainfall and 1,000mm rise in sea level; right) (OPW, 2018a)

[33] Locations of heritage properties and sites are indicative only.

[34] Flood maps from the OPW and heritage maps from the Historic Environment Viewer contain records from the SMR of the National Monuments Service and records from the NIAH.

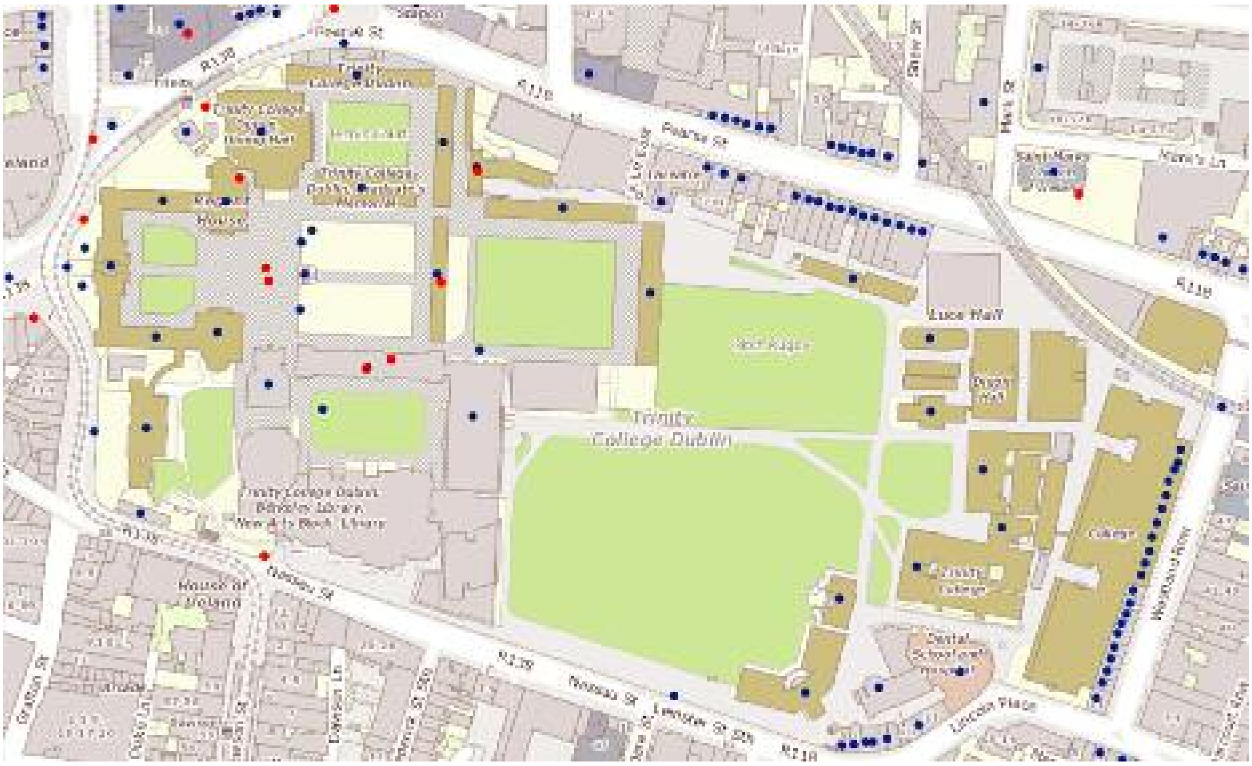

Figure 21. Heritage on the SMR (red dots) and RPS (blue dots) in the main campus of TCD (DCHG)

the Campanile,[37] the Provost's House[38] and the Old Library[39] (Dublin City Council, 2016) (Figure 21).

In addition to regular monitoring and maintenance of facilities such as its drainage systems, TCD has a comprehensive Emergency Response Plan to cope with natural disasters caused by flooding, extreme weather and fire, as well as emergency evacuation situations in the case of a gas leak, bomb threat etc. A 24-hour service is available for reporting emergency situations and alerting the relevant teams, who then cooperate with each other to ensure the safety of campus users and minimise adverse impacts on buildings and assets within the campus (TCD, 2016).

4.4.3.3 Galleries, Libraries, Archives and Museums (GLAM) Sector

In November 2009 the basement of the Lewis Glucksman Gallery at University College Cork was flooded with more than ten feet of water after the River Lee burst its banks (Roche, 2010). A total of 187 pieces of art were submerged in water (RTÉ, 2010).

That flooding incident brought up discussion within the GLAM sector on achieving better cooperation in disaster response. A National Disaster Response Scheme was established in 2010 to help galleries, libraries, archives and museums in Ireland respond more efficiently to water-related emergencies that may damage collections.[40] Disaster-response equipment and materials are held at the Collections Resource Centre of the NMI in County Dublin. Participating institutions can borrow these and replenish them after use. The Museum Standards Programme for Ireland, in which almost 60 institutions take part, requires participants to draw up a comprehensive disaster plan and provides training on the same. Ireland's Blue Shield Committee has also provided substantive disaster-planning training. However, given the number of historic buildings and cultural institutions (many containing important national collections) within the flood-risk area for Dublin and other urban areas, existing disaster-risk-response measures will need to be expanded and reinforced with additional training (Goal 2.3).

[35] Dublin City Council RPS ref. no. 1999; NIAH no. 50020376.
[36] Dublin City Council RPS ref. no. 1999; NIAH no. 50020378.
[37] Dublin City Council RPS ref. no. 2002; NIAH no. 50020386.
[38] Dublin City Council RPS ref. no. 3240; NIAH no. 50020381.
[39] SMR no. DU018-020180; Dublin City Council RPS ref. no. 2004; NIAH no. 50020389.
[40] See https://www.icriconservation.ie/news/national-disaster-response-scheme.

4.4.4 Sectoral Consequences and Possible Actions

While flood-management plans are currently in operation or under development to cope with the potential impacts of increased coastal flooding in the Dublin area, there is a need to raise awareness regarding heritage at risk. To minimise the damage to or loss of built and archaeological heritage due to coastal flooding, the potential impacts of climate change should be incorporated into conservation-management plans and intervention measures. Detailed and accessible baseline information on heritage would assist the identification and classification of risk. The integration of all heritage-site data as a layer within the OPW flood maps would help the identification process.

4.5 Storm Damage

4.5.1 Environmental Causes and Effects

Ireland is frequently exposed to storms from the north Atlantic. The 'Big Wind' in 1839 was the most devastating storm ever recorded (Bunbury, 2017). Recent notable storms of an extreme nature include Storm Darwin in 2014, Storm Ophelia in 2017 and Storm Emma (the so-called 'Beast from the East') in 2018.

4.5.2 Impact of Climate-Change Projections

CI projections for the middle of the century (2041–2060) indicate an increase in intensity of storm activity in the north Atlantic and over Ireland (Nolan, 2015), with associated extreme winds, heavier precipitation and more severe storm surge.

A range of instances of structural damage to heritage caused by storm-associated weather conditions were provided during stakeholder consultation workshops.[41] Recent examples include the collapse of Rathcannon Castle in County Limerick during Storm Ophelia in October 2017 and damage to Croom Castle, also in County Limerick, during Storm Darwin in February 2014. Strong winds can also cause windthrow of trees, altering landscape character and potentially damaging nearby structures and archaeological features. On 3 October 2013, a minor tornado delimbed and uprooted a number of trees within or near the cemetery of St Brendan's Cathedral in Clonfert, County Galway, causing damage to the enclosing walls of the historic graveyard and a number of graves and headstones within.[42] The NMS of the DCHG received almost 100 weather-related damage reports in 2014, predominantly relating to Storm Darwin. This number was five times greater than the reports received in previous and subsequent years. According to Appendix E of the DAFM's Forest Programme 2014–2020 Environmental Report, 52 standalone felling-licence applications by the Forest Service and a further 33 applications from Coillte were referred to the NMS of the DCHG between December 2013 and February 2014, owing to the presence of or proximity to a recorded monument (Davies, 2018).

4.5.3 Case Study 7 – Croom Castle, County Limerick

Croom Castle is an Anglo-Norman masonry fortification located on the west bank of the River Maigue, overlooking Croom village.[43] The earliest surviving features of the castle complex include the shell keep, dating from the thirteenth century, and the fifteenth-century tower house which was built into the east wall of the keep. The castle is recorded in the SMR and the RPS for County Limerick. It is in private ownership (O'Brien and Roche, 2014).

The east wall of the tower house collapsed during Storm Darwin, owing to the combination of heavy precipitation and strong winds, aided by vegetation growth which had undermined the stability of the castle walls (Figure 22).

The owners of the site notified Limerick County Council of the collapse; the council informed the NMS. The NMS carried out a site inspection to record the extent of the damage and to survey the medieval remains (Goal 3.3).

4.5.4 Case Study 8 – Exposure of 1588 Spanish Armada Wrecks, County Sligo

Extreme weather conditions can disturb and reveal marine and freshwater archaeology. Following a severe storm in April 2015, material from one of three Armada

[41] Details of the consultation are published as a separate volume on the Department's website www.chg.gov.ie/heritage/climate-change.
[42] Feedback received from the DAFM through the public consultation.
[43] SMR no. LI030-025005; County Limerick RPS reg. no. 1145 with ref. no. M30M(23); NIAH no. 21828001.

Figure 22. Croom Castle before (left) and after (right) Storm Darwin (O'Brien and Roche, 2014).

wrecks lost in the bay in 1588, that of La Juliana, washed up at Streedagh Strand, County Sligo (Figure 23) (DCHG, 2018).[44] The NMS carried out a detailed underwater survey and rescue excavation, to map the exposed remains on the seabed and recover any material under threat. Nine bronze cannons and several other items, including a carriage wheel and bronze cauldron, were recovered from the seabed and are now in the National Museum of Ireland undergoing conservation (Moore et al, 2015; Department of Culture, Heritage and the Gaeltacht, 2018).

Figure 23. Cannons from La Juliana (1570) exposed on the seabed at Streedagh in County Sligo following a storm in April 2015 (NMS, 2015)

4.5.5 Case Study 9 – Human Remains, Counties Wexford and Galway

In October 2017, ground disturbance caused by extreme weather during Storm Ophelia led to the exposure of human remains at Forlorn Point in the south of County Wexford. Following an initial inspection by the NMI and the removal of exposed remains of one individual, a rescue excavation was organised by the NMS. Excavation of a 4m by 4m area uncovered the truncated remains of a second individual. The skeletal remains were dated to the late medieval or post-medieval period and it was concluded that both were likely the victims of shipwreck or drowning.

There have been numerous other instances, especially on sandy shorelines, of human remains being uncovered through coastal erosion. In July 2015, human remains were discovered in the sand dunes on the north shore of Omey Island in County Galway.[45] The NMS carried out a limited rescue excavation and the site was listed in the SMR (Figure 24). The site has since been impacted upon by further phases of dune erosion, necessitating additional archaeological recording and the recovery of human remains.

4.5.6 Sectoral Consequences and Possible Actions

The collapse of Croom Castle and the exposure of archaeological remains on the shores at Forlorn Point and on Omey Island illustrate some of the impacts of storm activity which are likely to increase with climate change. The sector will therefore need to prepare for further damage and disruption including:

- Structural damage and the partial or complete loss of built and archaeological heritage
- Increasing pressure for government departments to respond to an escalating number of exposures of archaeological finds, including human remains

[44] Wreck no. 07023; La Juliana was an 860-tonne merchant vessel built in Mataró near Barcelona in 1570.
[45] SMR no. GA021-049.

Figure 24. Exposed skeleton remains at Forlorn Point, Kilmore Quay, County Wexford (left) (Tucker, 2017) and on Omey Island, County Galway (right) (NMS, 2015). Human remains continue to be exposed at this location after severe weather events.

In anticipation of increased extreme weather events with an archaeological impact, the NMS and the NMI are working closely to enable a rapid and efficient response to exposed ancient human remains and underwater archaeology.

The collapse of Croom Castle highlights the importance of carrying out protective measures to prepare heritage in private ownership for further extreme storm activity. Resilience-building activities might include:

- Conducting risk and vulnerability assessments for heritage with reference to the priority climate-change impacts (Goal 1.2)[46]
- Stabilising vulnerable structures (Goal 3.1)
- Undertaking structural surveys, digital recording and monitoring of vulnerable heritage (Goal 3.3)
- Conducting regular maintenance of heritage structures and sites and increasing funding to support the conservation of privately owned structures of historical importance (Goal 3.1)

4.6 Microbiological Growth

4.6.1 Environmental Causes and Effects

Growth of fungi and algae may cause surface damage and structural deterioration to historic buildings and archaeological remains. Changes in temperature and relative humidity affect the rate of microbiological growth. Intense and prolonged rainfall increases the moisture content in the air and, along with increased temperatures, creates favourable growing conditions for mould. Microbiological growth can be encouraged by rainwater ingress and by inappropriate thermal-efficiency upgrades that trap moisture (such as non-vapour-permeable insulation).

4.6.2 Impacts of Climate-Change Projections

CI projections for the middle of the century (2041–2060) indicate an increase 1–1.6°C in mean annual temperatures, with the largest increase in the east of Ireland. The number of frost days is projected to halve and the number of ice days to decrease by over 70% (Nolan, 2015).

Winter precipitation will increase, by up to 9% in the south-west of Ireland. There will also be an increase in the frequency of heavy precipitation, particularly during autumn and winter.[47]

More information and long-term monitoring are needed to track and project exactly how climate change will impact microbiological growth on built and archaeological heritage in Ireland.

4.6.3 Case Study 10 – Barryscourt Castle, County Cork

Built around 1400, Barryscourt Castle is a national monument in state care and the OPW is responsible for site maintenance.[48] In the last decade torrential rain brought about by a succession of storms caused water to penetrate the masonry walls, causing damage to the underfloor heating and electrical systems. Trapped moisture also caused mould to grow on the inner walls

[46] The International Council of Monuments and Sites (ICOMOS) is developing a Climate-Change Vulnerability Index, a rapid yet comprehensive assessment tool to evaluate whether a heritage site is vulnerable to climate change. The index is currently being developed for World Heritage Sites, but it may be modifiable and applied more widely (Day and Heron, 2019).

[47] Relative humidity projections were prepared by Paul Nolan and his team from the Irish Centre for High-end Computing (ICHEC) for the writing of the CCSAP for built and archaeological heritage.

[48] National monument no. 641; SMR no. CO075-018001.

Figure 25. Aerial view of Barryscourt Castle, County Cork (left) (DCHG); mould growth on the interior of the castle (centre and right) (OPW)

Figure 26. Aerial view of the Rock of Cashel, Country Tipperary (left) and the interior of Cormac's Chapel (right) (DCHG)

of the castle, leading to a deterioration of surfaces (Figure 25). The OPW was forced to close the castle to the public to allow the walls to be regrouted and repointed, preventing further water ingress. Once the interior has completely dried out, all residual traces of mould will be removed and repairs will be made to any damaged internal plaster with compatible materials. The damaged heating and electrical systems will also be replaced.

4.6.4 Case Study 11 – Cormac's Chapel, Rock of Cashel Complex, County Tipperary

Cormac's Chapel,[49] which forms part of the Rock of Cashel complex in County Tipperary (Figure 26),[50] is a national monument in state care and the OPW is responsible for site maintenance. The chapel was consecrated in 1134 and is one of the best-preserved examples of the Irish Romanesque style (OPW, 2018b). The mid-twelfth-century wall paintings inside the chapel are some of the earliest of their kind in Ireland (O'Dea, 2019).

Because of a failing roof, rainwater was able to penetrate the chapel over many years, dissolving salts and other materials. The crystallisation of these salts caused spalling of the stone surfaces. The rainwater ingress also caused algae and other microorganisms to grow on the interior walls, including the valuable wall paintings. The evaporation of moisture from wet

[49] SMR no. TS061-025001.
[50] National monument no. 128.

surfaces caused the internal humidity levels to increase and further encouraged the spread of microbiological activity (O'Dea, 2019).

To remedy these issues the OPW carried out extensive conservation works on Cormac's Chapel from 2010 to 2017. During this period a temporary roof structure was erected to protect parts of the castle, including the chapel, against extreme weather. Environmental monitoring was established to gather data on the temperature and relative humidity of both the internal and external surfaces of the chapel. Through the repair of the structural masonry, the installation of rainwater-drainage systems and proper internal ventilation, moisture levels inside the chapel were reduced and stabilised, discouraging further microbiological growth. The OPW also carried out ultraviolet-radiation treatment to reduce the level of microbiological growth on the internal wall surfaces of the carvings and paintings (O'Dea, 2019). The number of daily visitors to the chapel is now restricted in order to maintain safe humidity levels (OPW, 2018b).

4.6.5 Sectoral Consequences and Possible Actions

The surface and structural damage caused by microbiological growth is a slow-onset impact of climate change, but the range of built and archaeological heritage that could be negatively affected is extensive. More time and resources will need to be dedicated to monitoring the short- and long-term impacts of increased humidity, temperatures and microbiological growth on a variety of heritage. A long-term environmental-monitoring strategy for heritage should be established (Goal 1.3) and, as the case study of Cormac's Chapel demonstrates, environmental monitoring should be considered in management strategies for all vulnerable national monuments and valuable heritage sites.

4.7 Conclusion

The case studies detailed here begin to build a picture of how different heritage assets may be affected by climate change. They also endeavour to link those effects with possible responses, and with the adaptation goals and objectives developed under this plan. There is a lack of baseline data on many impacts for heritage, however, and in the future case studies for burial preservation, wildfires and maladaptation should be built.

5 Developing the adaptation plan

5.1 Adaptation Goals and Objectives

Climate change adaptation is an ongoing process that is managed over time by committing to shorter term actions embedded within a clear long-term vision (Adamson et al.*, 2018).*

Developing an adaptation strategy means establishing goals, sequencing objectives and identifying and prioritising actions that can help in achieving these short- and long-term goals (DCCAE, 2018b). The goals and objectives presented here are commensurate with the five-year term of this plan but also outline a long-term strategic vision. A monitoring and review process will allow for adjustments over time based on improvements in understanding, advances in science and implementation experience.

The formulation of the goals and objectives in this plan was based on:

1. Review and prioritisation of climate-change impacts (Steps 2–4 of the *Sectoral Planning Guidelines for Climate Change Adaptation*)
2. Consultation of other sectoral plans
3. Literature research (including the 2017 background report by Daly)
4. Analysis of the determinants of adaptive capacity specific to heritage management (Phillips, 2015; Fatoric and Seekamp, 2017)
5. Consultation with stakeholders, with the DCHG's CCAG, with relevant organisations and experts, and with the public (see details of consultation published on the Department's website www.chg.gov.ie/heritage/climate-change)

The DCCAE guidelines for sectoral planning suggest two main aims for adaptation strategies:

a. To build adaptive capacity, i.e. the ability or potential to respond to climate change (via monitoring, awareness-raising, etc.)
b. To respond to climate change through actions that reduce vulnerability and enhance opportunity

The goals and objectives outlined here, and the action plan detailed in Section 5.2.2: Adaptation Action Plan, are formulated in line with these concepts. The focus is on addressing the key priority impacts identified, but many capacity-building measures will help to address a broader range of climate-change impacts as they become apparent, which will be an advantage given the uncertainties involved.

Five primary adaptation goals for built and archaeological heritage in Ireland have been identified and the suggested mechanisms to achieve each goal are outlined in the accompanying objectives.

Table 5. Adaptation goals and objectives for built and archaeological heritage

GOAL 1	**Improve understanding of each heritage resource and its vulnerability to climate-change impacts**
Objective 1	Establish a baseline for heritage resources from which change can be measured
Objective 2	Conduct risk and vulnerability assessments for climate-change impacts on heritage
Objective 3	Undertake monitoring of climate change and its impacts
GOAL 2	**Develop and mainstream sustainable policies and plans for climate-change adaptation of built and archaeological heritage**
Objective 1	Integrate heritage issues into relevant national and local intersectoral policies and plans
Objective 2	Introduce climate-change adaptation into sectoral policy and conservation planning at all levels
Objective 3	Increase and improve disaster-risk management for heritage
GOAL 3	**Conserve Ireland's heritage for future generations**
Objective 1	Increase the resilience of heritage resources under current conditions
Objective 2	Develop management and conservation approaches for changing environments
Objective 3	Find ways to capture value when loss is inevitable
GOAL 4	**Communicate and transfer knowledge**
Objective 1	Create a vision for the sector and demonstrate leadership in the response to climate-change challenges
Objective 2	Create guidance and disseminate information
Objective 3	Enable the collection, archiving and sharing of data, experiences and learning related to heritage and climate change
Objective 4	Develop training
GOAL 5	**Exploit the opportunities for built and archaeological heritage to demonstrate value and secure resources**
Objective 1	Explore potential revenue streams and partnerships for the resourcing of Goals 1–4
Objective 2	Develop a better understanding of how the historic building stock and its adaptive reuse contributes to sustainable communities
Objective 3	Maximise the potential of heritage as an engagement tool for cross-sector research and initiatives, public engagement and education in relation to climate change and adaptation

5.1.1 GOAL 1. Improve Understanding of Each Heritage Resource and Its Vulnerability to Climate-Change Impacts

5.1.1.1 OBJECTIVE 1. Establish a Baseline for Heritage Resources from which Change Can Be Measured

In order to set a baseline from which future climate-related changes can be monitored, data from all heritage properties and sites must be centralised into an integrated GIS mapping system, freely available to all, from which a representative number can be selected for documentation and monitoring in greater detail.[51]

Actions

a. Produce a baseline quantification of the number, nature and location of heritage assets
b. Coordinate a single mapping portal and information system for relevant heritage assets
c. Carry out a condition assessment of a sample of heritage sites/properties in public ownership

National monuments, protected structures and the NIAH list are currently split between the Historic Environment Viewer, the Wreck Viewer and heritagemaps.ie. These should be combined into a single mapping system which could be integrated with other GIS layers, such as OPW flood maps, to inform stakeholders including local authorities and emergency-response teams (Goal 1.d).[52] The recording of coastal heritage on the Wild Atlantic Way by Donegal County Council was cited as an example by workshop participants (Ballinasloe). Condition assessment and digital recording should be undertaken on a representative selection of historic properties, national monuments and archaeological resources in public ownership.[53]

5.1.1.2 OBJECTIVE 2. Conduct Risk and Vulnerability Assessments for Climate-Change Impacts on Heritage

Actions

d. Carry out a hazard and risk assessment, overlaying maps of heritage sites with maps for flooding, coastal erosion and other priority impacts (where available) and calculating risk

Macro-level risk assessments using GIS maps and existing datasets have been developed for heritage properties (Harkin et al., 2018) and could be applied to a sample group of assets, such as buildings and monuments in public ownership.

e. Assess the vulnerability of a number of heritage assets to the prioritised impacts of climate change (focussing on high-value and/or high-risk sites)

Vulnerability assessments are a site-specific approach and would be useful if carried out on a small subset, concentrating on sites of high value thought to be at high risk (Daly, 2014; Day and Heron, 2019). Recent EU H2020 Project STORM (Safeguarding Cultural Heritage through Technical and Organisational Resources Management) has developed a site-based risk-assessment methodology and management platform that not only helps to measure risk but also to reduce and respond to it.[54]

f. Engage with communities in high-risk areas to create evaluations of vulnerability and priorities for response for local heritage

Increased community engagement in mapping heritage of value and recording sites at risk will raise awareness and have the added benefit of helping to avoid reputational damage for the heritage sector when preventative measures are not taken and sites are lost (Fluck, 2016). A ‘beyond-saving’ list of sites, agreed with communities, would help to communicate the severity of the problem and create a shared responsibility for decisions.

5.1.1.3 OBJECTIVE 3. Undertake Monitoring of Climate Change and Its Impacts

Detailed long-term monitoring is necessary to understand the direction and magnitude of change and to devise management strategies to deal with current and predicted climatic changes (Rowland, 2008). Given the scale of potential losses, resources will be stretched and there is a need to create sustainable solutions and partnerships to address the impacts on heritage. Recommendations for monitoring climate-change impacts at national monuments (Daly *et al.*, 2010) consist of climate monitors to observe local environmental conditions

[51] To provide a comprehensive and up-to-date baseline of heritage resources, surveys that are currently incomplete will need to be finished and others may need to be updated.
[52] For an example of this approach see https://myplan.ie/.
[53] Public rather than private ownership is suggested to ensure ease of access, enable continuity and avoid issues around privacy and data rights.
[54] See http://www.storm-project.eu/.

and impact monitors specific to each heritage type and effect of concern. Comparing these two sets of data over the long term would allow correlation between changes in the climate and measured deterioration to be noted.[55]

Actions

g. Monitor atmospheric climate at selected heritage properties

Relative humidity, temperature and rainfall are measured at Clonmacnoise in a partnership between the OPW and Met Éireann. The NMS provides a secure location for the equipment and Met Éireann manages the data collection and provides a reliable archiving facility. The scheme thus has benefits for both agencies and there is clear potential for replicating it at other sites within Ireland.

h. Monitor ongoing maintenance and repair works undertaken and emergency response, including costs (where available)

Systematic recording of the nature of maintenance and repairs made to heritage properties, sites and historic museum buildings, as well as requests for assistance during emergencies, should be carried out by agencies such as the OPW, local authorities and institutions participating in the Museum Standards Programme for Ireland. This would provide empirical data on climate impacts, their financial implications and the effectiveness of adaptation measures. Ireland is already committed to collecting and reporting costs for, and damage to, heritage due to disasters under the United Nations Office for Disaster Risk Reduction (UNDRR) Sendai Framework for Disaster Risk Reduction 2015–2030.

i. Monitor the impacts of climate change on a representative selection of sites for which condition monitoring has been conducted (see Goal 1.c)

The choice of monitoring tools will vary depending on the impact of concern and the type of heritage at risk, e.g. landscape-scale erosion vs. micro-scale surface recession. Currently five national monuments have a legacy-indicator tool in place. This is designed to track climate-change impacts on the weathering of stone and focuses on slow-onset issues such as microbiological growth and surface abrasion (Daly, 2016, 2019).

j. Develop monitoring and response regimes which build on citizen-science approaches and utilise new technologies

Crowdsourcing and citizen science provide a possible approach to expanding the monitoring and recording of sites (SCAPE Trust, 2012; CITiZAN, 2019). This action links to Goal 1.f, which aims to engage communities and create action at local level. Workshop participants mentioned the All-Ireland Pollinator Plan as a good model. The Adopt a Monument scheme run by the HC is another.

The STORM project provides exemplars for climate-change monitoring at particular sites, combining data from climate stations, impact-specific monitors (e.g. crack monitors) and crowdsensing (gamification and social media). It has focussed on testing innovative solutions that are likely to be sustainable and cost effective (Resta *et al.*, 2019).

5.1.2 GOAL 2. Develop and Mainstream Sustainable Policies and Plans for Climate-Change Adaptation of Built and Archaeological Heritage

5.1.2.1 OBJECTIVE 1. Integrate Heritage Issues into Relevant National and Local Intersectoral Policies and Plans

It is essential that there is coordination between different sectors where cross-cutting issues have been identified. Establishing procedures that facilitate cooperation and communication between departments, agencies and stakeholders will ensure that efficiencies in the use of resources are identified. Cooperation and communication with each individual local authority are necessary to ensure that climate-change adaptation for built and archaeological heritage is reflected in their climate-change adaptation plans and relevant to the issues in their functional areas.[56]

[55] Early nineteenth-century signal towers could be good indicators of change as they were built to a ‘standard’. Their condition will evidence differential erosion and weathering conditions (workshop participant, Ballinasloe).

[56] Of the 15 local-authority climate-change adaptation plans published as of June 2019, all but one made some mention of heritage. However, local authorities are committed to working in partnership with the sectors identified in the NAF and relevant actions that are outlined in the sectoral plans will be incorporated into future iterations of local plans.

Actions

a. Ensure cooperation and communication between departments, agencies, state bodies and other stakeholders
b. Coordinate with local authorities to ensure that national and regional policy and plans align

Communication with the Climate Action Regional Offices (CAROs) will be vital in these tasks.

c. Work with other sectors and local authorities to identify heritage assets within their remit that may be under threat, directly or indirectly, because of climate change

For example, the Forest Service of the DAFM, Coillte and local authorities could support the pruning/pollarding of high-risk trees near structures and sites of archaeological or architectural heritage significance located in forest holdings so as to reduce the threat from windthrow in a severe storm event.

5.1.2.2 OBJECTIVE 2. Introduce Climate-Change Adaptation into Sectoral Policy and Conservation Planning at All Levels

Effective adaptation requires the integration of climate-change thinking into existing policies and procedures at all levels, from Heritage Ireland 2030 (the national heritage plan) to site-level activities. Adaptation activities will take place at a local level, and therefore the translation of policy into pragmatic action requires 'flexible and responsive bridging organisations' (Gray et al., 2014) such as the CARO offices. Conversely, 'cleavages' within the governance regime will hinder effective strategy development (Powell *et al.*, 2012).

Actions

d. Inventory existing policies and plans with regard to whether they address climate change
e. Integrate climate-change adaptation into all heritage-management plans and policies as these are updated/revised
f. Provide training for staff and communities in climate-change-adaptation policy

Better communication and capacity-building will be needed to support the development and implementation of adaptation strategies.

5.1.2.3 OBJECTIVE 3. Increase and Improve Disaster-Risk Management for Heritage

Additional policies, procedures and training will be required in the specific arena of climate disasters. Recognising the significance of this issue, the UNDRR Sendai Framework for Disaster Risk Reduction specified cultural heritage as a disaster-loss indicator in 2016. Coordination with the Office of Emergency Planning and the National Directorate Fire and Emergency Management will be critical for the preparation and management of effective disaster responses. Currently there are no guidelines at national or regional level for disaster response and recovery for heritage. This, together with training both for those in the heritage sector and for first responders, should be addressed as a priority (Leonard, 2017; Neto and Pereira, 2018; Resta *et al.*, 2019). These actions are also stipulated under the recently ratified 1954 UNESCO Hague Convention for the Protection of Cultural Property in the Event of Armed Conflict and its second protocol, pointing to potential cross-sectoral partnerships with the Department of Defence and Department of Foreign Affairs.

Actions

g. Cooperate actively with the Office of Emergency Planning and the National Directorate Fire and Emergency Management

The facility for the DCHG to have a representative on the National Emergency Steering Group should be fully utilised, ensuring that cultural heritage is represented in emergency management decisions at national level.

h. Develop cultural-heritage guidelines for national and regional emergency-response services

Blue Shield Ireland (BSI) have initiated discussions on this with the DHPLG.

i. Enable training on disaster preparation for cultural heritage

BSI delivered a three-day course on disaster response for cultural heritage in conjunction with the International Centre for the Study of the Preservation and Restoration of Cultural Property in 2017 that could serve as a model.

j. Ensure flexible policies and systems are in place to enable timely and effective response to and recovery from disasters

Disaster-planning and response capacities within the sector should consider likely changes in the scale and nature of future events, e.g. by using worst-case-scenario OPW flood-risk maps for Dublin. The DCHG could engage with conservation/archaeology experts in other government departments, agencies or local authorities to agree best practice and ensure that coordinated policies and procedures are in place. The STORM decision-making platform provides a template for how disaster preparation and response can be managed effectively at site level (Resta *et al.*, 2019).

5.1.3 GOAL 3. Conserve Ireland's Heritage for Future Generations

With increased weathering and severe climate events, the repair cycle on built heritage is likely to become shorter. More frequent intervention will increase the risk that original materials and historic features will be lost (Berghäll and Pesu, 2008). The renovation of historic buildings for greater thermal comfort or energy efficiency may also compromise the integrity and authenticity of heritage buildings and features (Cassar, 2009). In addition, inappropriate renovation measures may introduce new issues such as increased moisture retention and damp caused by the use of incompatible materials. A mixture of policy (integrated within planning procedures), research and preventative works (focussed on non-heritage elements such as services and infrastructure) is proposed to address these issues. In relation to archaeology, both terrestrial and underwater, the current policy favouring preservation in situ will need to be reassessed (Van de Noort *et al.*, 2001).

5.1.3.1 OBJECTIVE 1. Increase the Resilience of Heritage Resources under Current Conditions

In many cases the most severe effects of climate change will be felt where it is acting on top of existing stresses (Cassar and Pender, 2005). Maintenance is a low-loss, cost-effective way to increase resilience to both current stressors and the impacts of future climate change (Hurd, 2008). Appropriate measures may already be in place but a baseline knowledge of current practice is necessary in order to understand where the key gaps lie.

Actions

a. Engage with planning authorities to climateproof planning procedures for heritage properties
b. Review, and continue to build on, existing practice relevant to climate resilience (e.g. maintenance and monitoring regimes, stabilisation and weatherproofing activities, the development of informative case studies)

5.1.3.2 OBJECTIVE 2. Develop Management and Conservation Approaches for Changing Environments

Actions

c. Undertake cost-effectiveness analysis (CEA) and life-cycle assessment for conservation interventions to address priority impacts under future climate conditions

CEA and life-cycle analysis for conservation interventions will help to ensure that resources are allocated responsibly and to maximum effect (Revez et al., 2018). The economic case for investing in adaptation of the built environment is strong. For example, the National Institute of Building Sciences estimates that $1 spent on disaster resilience can save $6 in recovery (2017). Where possible the CEA should be holistic (including energy efficiency, historic value of the buildings, embodied carbon, etc.) to help make the case for renovating rather than demolishing historic building stock (workshop participant, Dublin).

d. Integrate climate-change adaptation into all heritage works and maintenance plans

All remedial works should be climateproofed to ensure both cost-effectiveness and sustainability.

e. Identify and implement practical measures to protect heritage against extreme weather impacts

These impacts may be the direct effects of climate change or indirect effects related to visitors accessing the sites during periods of extreme weather, e.g. the erosion of parched vegetation and the churning of waterlogged soils.

f. Promote research into techniques that specifically address conservation and management challenges related to the priority climate-change impacts

Existing conservation practice is founded on experience of past conditions. Therefore research is required to inform the selection of sustainable treatments that are transferable to the future (Powell *et al.*, 2012).

g. Instigate research to investigate and make recommendations regarding the sustainability of preservation in situ as a long-term strategy for maintaining heritage resources

This is of immediate concern for archaeological deposits, especially those with good organic preservation by damp or waterlogged conditions.

5.1.3.3 OBJECTIVE 3. Find Ways to Capture Value when Loss Is Inevitable

Where loss is unavoidable, the triage approach is recommended as a means to achieve transparent decision-making. This outlines three categories: endangered sites to be recorded before they are lost; iconic sites to be saved at any cost; and sites that may be saved by forward planning (Berenfeld, 2008). Survey and recording, including rescue excavations, will be necessary for sites identified as high risk.

Actions

h. Survey and record high-risk assets (identified under Goal 1.d–f)
i. Increase research, recording and rescue excavations in high-risk areas

New procedures will be needed to address the rapidly increasing pace and scale of loss. This is likely to require a considerable shift in the current top-down approach in heritage management and the adoption of more flexible, imaginative and community-centred approaches (Goal 1.f, j).

5.1.4 GOAL 4. Communicate and Transfer Knowledge

5.1.4.1 OBJECTIVE 1. Create a Vision for the Sector and Demonstrate Leadership in the Response to Climate-Change Challenges

Leadership and the communication of a clear vision are key requirements for the adaptive management of cultural heritage (Phillips, 2015). At both stakeholder workshops the need for senior-management buy-in and leadership was highlighted. The heritage sector also has a contribution to make in the reduction of greenhouse gases, establishing and demonstrating green ways of working with and within historic buildings (Historic Scotland, 2012). The challenge will be to formulate strategies that create a balance between the reduction of greenhouse-gas emissions and the preservation of cultural heritage (Flatman, 2012).

Actions

a. Establish and demonstrate green ways of working in historic buildings, ensuring that the carbon footprint of adaptation measures is considered
b. Cooperate actively and share knowledge with international partners
c. Establish a working group to pool information, promote research and drive the implementation of the plan

5.1.4.2 OBJECTIVE 2. Create Guidance and Disseminate Information

Much damage through maladaptation is likely, owing in part to a lack of awareness of the existence and significance of individual heritage resources (workshop participant, Dublin). The communication of information on heritage (Goal 1) to those designing and engineering adaptation measures for other sectors should be a priority. The need for coordination and promotion of research and the creation of guidance, including case studies, for different audiences was highlighted in workshops (similar to the guidance produced for the All-Ireland Pollinator Plan).[57] Ireland can draw on international best practice in this area. In Norway, for example, an online resource was created for municipal authorities and property owners. It contained fact sheets on likely

[57] Additional comments from stakeholder workshops included:
'Thanks to good data, people living in Kinvara village [Galway] were able to protect local heritage by digging a channel during a flooding event in 2010.' (Ballinasloe)
'There are 10,000 protected structures in Dublin and many of them are in private ownership. The owners need to understand the vulnerability of their buildings and they need guidelines.' (Dublin)
'Get communities involved. If they understand local heritage better, including the heritage properties they own, they will be better able to preserve and protect them.' (Dublin)

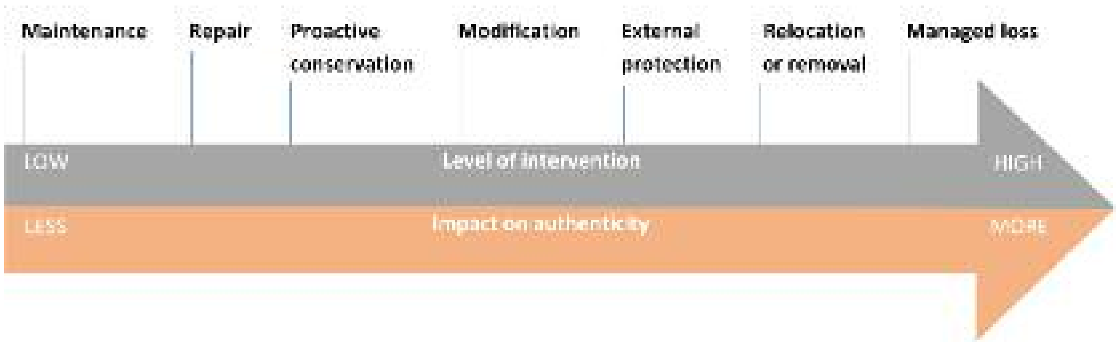

Figure 27. The relationship between different levels of adaptive intervention and the authenticity of heritage resources (Historic Environment Group, 2018)

impacts, suggested monitoring strategies and possible adaptation and mitigation responses (Haugen et al., 2011; Risan et al., 2011).

Actions

d. Create guidelines for the heritage sector on preparing for and recovering from priority climate-change impacts; utilise a cost-effectiveness study (Goal 3.c)

e. Create guidelines for non-specialists on sensitive adaptation, recovery from climate-change impacts and sustainable reuse and energy conservation in historic buildings

f. Work with and provide guidance for the public sector on appropriate adaptation and response measures (building on Goal 2.c)

5.1.4.3 OBJECTIVE 3. Enable the Collection, Archiving and Sharing of Data, Experiences and Learning Related to Heritage and Climate Change

Decision-making requires long-term data and mechanisms of organisational memory that enable a feedback loop. The collection, archiving and sharing of data, experiences and learning related to heritage and climate change are vital (this was highlighted in both workshops). The financial implications of this may be ameliorated through creating links and pooling knowledge and resources between national sectors where cross-cutting issues have been identified. There are best-practice exemplars that Ireland can follow – e.g. Scotland's Dynamic Coast Project[58] and the EU Risk Data Hub.[59]

Actions

g. Establish a system for harmonising the collection of baseline data on the impacts of climate change, adaptation responses (including costs) and potential funding sources

h. Ensure that heritage is included in any future modelling of impacts conducted for Ireland

i. Support the gathering and sharing of experience and knowledge across stakeholder bodies

5.1.4.4 OBJECTIVE 4. Develop Training

Sustainable solutions require adaptive co-management, recognition that local populations have unique place-based knowledge, the sharing of responsibility and full cooperation with stakeholders (Markham et al., 2016). There is a potential tension between the preservation of heritage value and the need for adaptation interventions (Figure 27). Capacity-building within the sector will be necessary to create informed support for changing approaches.

Actions

j. Provide training to supply identified skills shortages and gaps in capacity in relation to the adaptation of cultural heritage to climate change

Priority training needs identified by workshop participants included traditional building and renovation skills to improve the longevity and energy performance of historic buildings. 'Building professionals and tradespeople need to understand that historic buildings work differently from modern buildings and must be able to advise building owners on same' (workshop participant, Dublin). The Irish Georgian Society (IGS) has run seminars on energy

[58] See http://dynamiccoast.com/.

[59] The EU Risk Data Hub is currently under development: https://www.euractiv.com/section/energy-environment/news/risk-data-hub-to-enhance-eu-resilience-to-climate-hazards/.

efficiency for homeowners. These could be built upon. The Irish chapter of the Society for the Protection of Ancient Buildings holds annual Maintenance Week campaigns and hands-on working weekends to teach historic-building owners and enthusiasts traditional building skills and the importance of regular maintenance. Engagement with existing heritage organisations could enable greater uptake of educational and skills-training courses. The Irish Underwater Council, in partnership with the Nautical Archaeology Society, carry out training for recreational divers and dive clubs who wish to partake in surveys and recording of shipwreck sites. The Discovery Programme and the NMS have also assisted with training. This could be expanded to encourage the diving community's involvement in assessment of climate-change impacts on other underwater cultural-heritage sites.

5.1.5 GOAL 5. Exploit Opportunities for Built and Archaeological Heritage to Demonstrate Value and Secure Resources

In the future, increasing competition for resources to battle the effects of climate change may result in the re-evaluation and possible downgrading of cultural heritage (Egloff, 2006).

> *...should conditions deteriorate significantly... the likelihood of being able to compete successfully against more fundamental claims for resources to provide food, transport and shelter in order to preserve cultural heritage will be small (Christoff, 2008).*

Actions under this goal aim to achieve long-term investment and resourcing for Goals 1–4 – in part by ensuring that the value of built and archaeological heritage to society is demonstrated clearly.

5.1.5.1 OBJECTIVE 1. Explore Potential Revenue Streams and Partnerships for the Resourcing of Goals 1–4

The relationship between heritage and tourism should be fully explored, especially the link between predicted increased summer visitor numbers and the maintenance of sites. Tourism agencies which market Ireland based on its built and archaeological heritage should also be invested in the long-term preservation of those resources. While tourism is an obvious choice for collaboration, the potential for partnerships with all sectors should be pursued.

Actions

a. Analyse the potential for loss of tourism resources because of the impacts of climate change on heritage
b. Undertake a CEA of adaptation investment for high-risk sites (identified in Goal 1.e) which are also a priority for tourism
c. Actively seek to establish cost-saving collaborations on cross-sectoral issues

For example, the Forestry Programme 2014–2020: Ireland supports a grant of up to €750 per hectare for the retrofitting, reinstatement or enhancement of setbacks and other open areas within existing forests for environmental reasons, including to protect archaeological sites.

d. Develop grant schemes for preventative maintenance, sensitive adaptation and recovery from climate-change impacts, supported by guidance documents

Workshop participants' comments highlighted the need for an easily accessible central guide to funding sources, and for Sustainable Energy Authority of Ireland (SEAI) grants to stipulate conditions to ensure works are appropriate when funding energy renovations of historic properties.

5.1.5.2 OBJECTIVE 2. Develop a Better Understanding of how the Historic-Building Stock and Its Adaptive Reuse Contributes to Sustainable Communities

Cultural resources are primary sources of data regarding past human interactions with environmental change and are thus valuable for studying and building resilient systems (Rockman, 2012). In addition, the historic-building stock and its capacity for adaptive reuse can make a significant contribution to a low-carbon society through compatible energy-efficiency upgrades and the revitalisation of our historic town and city centres, both of which will lower our dependency on fossil fuels.

Actions

e. Analyse the value of heritage to society, including recreation, health and climate-change mitigation[60]
f. Create a green heritage award for sustainable reuse and energy conservation in historic buildings

5.1.5.3 OBJECTIVE 3. Maximise the Potential of Heritage as an Engagement Tool for Cross-Sector Research and Initiatives, Public Engagement and Education in Relation to Climate Change and Adaptation

Heritage can be used as a vehicle for education and creating public engagement on the topic of climate change, as illustrated by the 'every place has a climate story' approach of the US National Parks Service (Rockman et al., 2016).

> *Strategies for improving protection of cultural heritage might need to start with simply raising awareness of the value of what might be at risk from climate induced change (Powell* et al., *2012).*

Actions

g. Build public awareness of the risks of climate change (in general and for heritage) and of efforts to mitigate it and adapt to it
h. Promote research to understand and, where possible, take lessons from past climate-related impacts and community responses
i. Use interpretation of heritage sites to raise public interest, engage schools and engage young people in climate-change issues through heritage-centred 'climate stories'

5.2 Adaptation Action Plan

5.2.1 Overview of the Adaptation Action Plan

In this section the adaptation goals and objectives described in Section 5.1: Adaptation Goals and Objectives have been mapped onto an action plan. Each action is detailed in terms of the priority impact(s) it addresses, the expected output by which success may be measured, the stakeholders involved and the timeframe for delivery. The achievement of each objective may require a series of separate or sequential actions, over different timescales.

Short-term actions are expected to be completed within three years. Medium-term actions are to be completed or nearing completion within five years. Long-term actions are expected to run beyond the scale of this five-year plan.

While the DCHG is currently assigned lead responsibility for delivering most of the plan, it is expected that additional agreements will be reached with relevant governmental and non-governmental organisations to take specific actions. Many of those actions will require interdepartmental coordination and the active involvement of several stakeholders, including some in the private sector.

Adaptation actions can generally be divided into three categories:

1. **Technological or engineering solutions** (grey), e.g. building flood defences and installing monitors. These are often effective short-term measures but can be costly to maintain.
2. **Ecological solutions** (green), e.g. reinstating sand dunes to prevent coastal erosion and using hedgerows to slow flood waters. These may require a long lead-in time but are sustainable over the long term.
3. **Policy solutions** (soft), e.g. changing heritage-management processes and influencing the behaviour of property owners. These options are usually relatively inexpensive. However, they require leadership and ongoing commitment if they are to be successful.

In developing this action plan the complexities and uncertainties surrounding climate change and its impacts have been addressed through the selection of 'win-whatever' approaches – i.e. actions which will enhance resilience regardless of the degree of future change (Welsh Government, 2013). Most of the actions outlined should be accomplished within a five-year cycle, although several may continue beyond that. Considering this timeframe, attempts have been made to ensure that the nature and number of actions are realistic and achievable. Efforts have also been made to include actions from each category. However, because of the strategic remit of sectoral planning, the majority are in fact 'soft' solutions.

5.2.2 Adaptation Action Plan

The following tables outline an action plan for adapting heritage to climate change.[61]

[60] The HC is carrying out a programme of research to establish the best methodology for establishing such a valuation. This builds on its report *Economic Value of Ireland's Historic Environment* (2012) and other work done.
[61] See Appendix I: Glossary and Abbreviations for a list of abbreviated items.

GOAL 1: Improve understanding of each heritage resource and its vulnerability to climate-change impacts														
	ACTION	Flooding – Inland	Flooding – Coastal	Storm Damage	Coastal Erosion	Soil Movement	Burial Preservation	Pests and Mould	Fire	Maladaptation	OUTPUT	LEAD	TIMESCALE Short (1–3 years) Medium (≤5 years) Long (≥5 years)	STAKEHOLDERS
Objective 1. Establish a baseline for heritage resources from which change can be measured														
a.	Produce a baseline quantification of the number, nature and location of heritage assets	√	√	√	√	√	√	√	√	√	Desktop study	DCHG	Short	OPW, LAs, HC, AACO, HON, GSI
b.	Coordinate a single mapping portal for relevant heritage assets	√	√		√	√	√		√		GIS maps	DCHG	Short	As above, GSI, CHERISH
c.	Carry out a condition assessment of a sample of heritage sites/properties in public ownership	√	√	√	√	√	√	√	√	√	Condition assessments and digital imaging	DCHG	Short	OPW, NMS
Objective 2. Conduct risk and vulnerability assessments for climate-change impacts on heritage														
d.	Carry out a hazard and risk assessment, overlaying maps of heritage assets with hazard maps for flooding,coastal erosion and other priority impacts (where available) and calculating risk	√	√		√	√	√		√		GIS-based risk assessment	DCHG	Short	OPW, NMS, GSI
e.	Assess the vulnerability of a number of heritage assets to the prioritised impacts of climate change (focussing on high-value and/or high-risk sites)	√	√	√	√	√	√	√	√		Site-specific vulnerability reports	DCHG	Short–medium	OPW, NMS, GSI
f.	Engage with communities in high-risk areas to create evaluations of vulnerability and priorities for response for local heritage	√	√	√	√	√	√	√	√		Community-based adaptation plans for specified areas of high risk	DCHG	Short–medium	HC, community groups, CHERISH
Objective 3. Undertake monitoring of climate change and its impacts														
g.	Monitor atmospheric climate at selected heritage properties	√	√	√	√	√	√	√	√	√	Met Éireann stations installed at 2–3 sites	DCHG	Short–medium	CI
h.	Monitor ongoing maintenance and repair works undertaken and of emergency response, including costs (where available)	√	√	√	√	√	√	√	√	√	Statistics relating to climate-change impacts and response for heritage in public ownership	DCHG	Short	OPW, local authorities, NMS,CI
i.	Monitor the impacts of climate change on a representative selection of assets for which condition monitoring has been conducted (see Goal 1.c)	√	√	√	√	√	√	√	√		Design and establishment of sustainable impact-monitoring regimes at a number of sites	DCHG	Medium–long	ICOMOS
j.	Develop monitoring and response regimes which build on citizen-science approaches and utilise new technologies	√	√	√	√	√	√	√	√		Established schemes with community engagement	DCHG	Medium	HC, RS, community groups, CHERISH

GOAL 2. Develop and mainstream sustainable policies and plans for climate-change adaptation of built and archaeological heritage

	ACTION	Flooding – Inland	Flooding – Coastal	Storm Damage	Coastal Erosion	Soil Movement	Burial Preservation	Pests and Mould	Fire	Maladaptation	OUTPUT	LEAD	TIMESCALE Short (1–3 years) Medium (≤5 years) Long (≥5 years)	STAKEHOLDERS
Objective 1. Integrate heritage issues into relevant national and local intersectoral policies and plans														
a.	Ensure cooperation and communication between departments, agencies, state bodies and other stakeholders	√	√	√	√	√	√	√	√	√	Existing channels to mainstream consideration of heritage	DCHG/ NASC	Short	CARO, DCCAE, CCSAPs, OPW
b.	Coordinate with local authorities to ensure that national and regional policy and plans align	√	√	√	√	√	√	√	√	√	Regular liaison with county managers	DCHG/ CARO	Short–medium	CARO, LAs, AACO, HON, HC
c.	Work with other sectors and local authorities to identify heritage assets within their remit that may be under threat, directly or indirectly, because of climate change	√	√	√	√	√	√	√	√	√	Working group meetings and exchange of information gathered under Goal 1.1	DCHG/ CARO	Medium	DCCAE, CCSAPs, LAs, OPW, IAI, AACO, HON
Objective 2. Introduce climate-change adaptation into sectoral policy and conservation planning at all levels														
d.	Inventory existing policies and plans with regard to whether they address climate change	√	√	√	√	√	√	√	√	√	Inventory	DCHG	Short	NMS, OPW
e.	Integrate climate-change adaptation into all heritage-management plans and policies as these are updated/revised	√	√	√	√	√	√	√	√	√	Revised policies and systems	DCHG	Short–medium	CCAG, OPW, LAs
f.	Provide training for staff and communities in climate-change-adaptation policy	√	√	√	√	√	√	√	√	√	Cohort of trained individuals	DCHG	Short–medium	DCCAE, OPW, CARO, HC
Objective 3. Increase and improve disaster-risk management for heritage														
g.	Cooperate actively with the Office of Emergency Planning and the National Directorate Fire and Emergency Management	√	√	√	√				√		Individual nominated to national emergency steering group	DCHG	Short	Department of Defence, DHPLG, OPW
h.	Develop cultural-heritage guidelines for national and regional emergency-response services	√	√	√	√				√		Published guidelines	DCHG	Short	DHPLG, BSI, Defence Forces, Emergency Services
i.	Enable training on disaster preparation for cultural heritage	√	√	√	√				√		Four regional training courses	DCHG	Short–medium	CI, BSI, Defence Forces, Emergency Services
j.	Ensure flexible policies and systems are in place to enable timely and effective response and recovery	√	√	√	√	√	√	√	√		Improved emergency-response systems and recovery procedures	DCHG	Short	OPW, LAs, CNCI

GOAL 3. Conserve Ireland's heritage for future generations														
	ACTION	Flooding – Inland	Flooding – Coastal	Storm Damage	Coastal Erosion	Soil Movement	Burial Preservation	Pests and Mould	Fire	Maladaptation	OUTPUT	LEAD	TIMESCALE Short (1–3 years) Medium (≤5 years) Long (≥5 years)	STAKEHOLDERS
Objective 1. Increase the resilience of heritage resources under current conditions														
a.	Engage with planning authorities to climateproof planning procedures for heritage properties	√	√	√		√		√		√	Amended planning requirements	DCHG	Short	CARO, historic building owners, developers, architects, LAs
b.	Review, and continue to build on, existing practice relevant to climate resilience (e.g. maintenance and monitoring regimes, stabilisation and weatherproofing activities, the development of informative case studies)	√	√	√	√	√	√	√	√	√	Survey and evaluation of current measures	DCHG	Short	LAs, wider heritage sector
Objective 2. Develop management and conservation approaches for changing environments														
c.	Undertake CEA and life-cycle assessment for conservation interventions to address priority impacts under future climate conditions	√	√	√	√	√	√	√	√	√	Critical evaluation of current conservation practice	DCHG	Short	OPW, HC, EPA, SEAI
d.	Integrate climate-change adaptation into all heritage works and maintenance plans	√	√	√	√	√	√	√	√	√	Climate-ready maintenance and conservation regimes	DCHG	Medium	OPW, NMS, LAs, HC
e.	Identify and implement practical measures to protect heritage against extreme weather impacts	√	√	√	√	√			√		Climate-ready infrastructure and visitor services at state-owned sites	DCHG	Medium–long	OPW, NPWS, NMS, LAs
f.	Promote research into techniques that specifically address conservation and management challenges related to the priority climate-change impacts	√	√	√	√	√	√	√	√	√	Development and piloting of new approaches	DCHG	Medium–long	RS, OPW, RIAI, CARO
g.	Instigate research to investigate and make recommendations regarding the sustainability of preservation *in situ* as a long-term strategy for maintaining heritage resources				√	√	√	√	√		Improved understanding and recommendations for management	DCHG	Short–medium	NMS, RS, Peatland Conservation Council, NPWS, OPW
Objective 3. Find ways to capture value when loss is inevitable														
h.	Survey and record high-risk assets (identified under Goal 1.d–f)	√	√	√	√	√	√	√	√		Archive of high-quality datasets	DCHG	Ongoing	OPW, LAs, Discovery Programme
i.	Increase research, recording and rescue excavations in high-risk areas			√	√	√		√			Preservation by record	DCHG	Short–long	NMS, NMI, RS, Discovery Programme

GOAL 4. Communicate and transfer knowledge														
	ACTION	Flooding – Inland	Flooding – Coastal	Storm Damage	Coastal Erosion	Soil Movement	Burial Preservation	Pests and Mould	Fire	Maladaptation	OUTPUT	LEAD	TIMESCALE Short (1–3 years) Medium (≤5 years) Long (≥5 years)	STAKEHOLDERS
Objective 1. Create a vision for the sector and demonstrate leadership in the response to climate-change challenges														
a.	Establish and demonstrate green ways of working in historic buildings, ensuring that the carbon footprint of adaptation measures is considered									√	Best-practice exemplar	DCHG	Medium	SEAI, historic building owners, construction sector, HC
b.	Cooperate actively and share knowledge with international partners	√	√	√	√	√	√	√	√	√	Contribution to EU Risk Data Hub or similar	DCHG	Short	EU, ICOMOS
c.	Establish a working group to pool information, promote research and drive the implementation of the plan	√	√	√	√	√	√	√	√	√	Working group	DCHG	Short	DCCAE, CCAG, CARO
Objective 2. Create guidance and disseminate information														
d.	Create guidelines for the heritage sector on preparing for and recovering from priority climate-change impacts; utilise a cost-effectiveness study (Goal 3.c)	√	√	√	√	√	√	√	√		Published impact-based resilience and recovery guidance	DCHG	Short–medium	OPW, historic building owners, LAs
e.	Create guidelines for non-specialists on sensitive adaptation, recovery from climate-change impacts and sustainable reuse and energy conservation in historic buildings	√	√	√				√		√	Published and widely promote guidelines	DCHG	Short–medium	SEAI, historic building owners, construction sector, ICOMOS, IGS, HC
f.	Work with and provide guidance for the public sector on appropriate adaptation and response measures (building on Goal 2.c)	√	√	√	√	√	√	√	√	√	Disseminated guidance	DCHG	Short–medium	CCSAPs, LAs, EPA, Teagasc, ICOMOS
Objective 3. Enable the collection, archiving and sharing of data, experiences and learning related to heritage and climate change														
g.	Establish a system for harmonising the collection of baseline data on the impacts of climate change, adaptation responses (including costs) and possible sources of funding	√	√	√	√	√	√	√	√	√	Enhanced, secure and accessible database	DCHG	Medium	CHERISH, OPW, RS, LAs, CCAC, CARO, GSI, EPA, FI
h.	Ensure that heritage is included in any future modelling of impacts conducted for Ireland	√	√	√	√	√	√	√	√	√	Inclusion in climate-risk atlas	DCHG	Medium–long	DCCAE, EPA, RS, ICHEC, CI
i.	Support the gathering and sharing of experience and knowledge across stakeholder bodies	√	√	√	√	√	√	√	√	√	Workshop	DCHG	Short	CCAG, CARO
Objective 4. Develop training														
j.	Provide training to supply identified skills shortages and gaps in capacity in relation to the adaptation of cultural heritage to climate change	√	√	√	√	√	√	√	√	√	Training delivery	DCHG	Short–medium	CIF, OPW, HC, SEAI, IGS, IAI, ICOMOS, AACO, HON, IPI, EI, RIAI

GOAL 5. Exploit the opportunities for built and archaeological heritage to demonstrate value and secure resources														
	ACTION	Flooding – Inland	Flooding – Coastal	Storm Damage	Coastal Erosion	Soil Movement	Burial Preservation	Pests and Mould	Fire	Maladaptation	OUTPUT	LEAD	TIMESCALE Short (1–3 years) Medium (≤5 years) Long (≥5 years)	STAKEHOLDERS
Objective 1. Explore potential revenue streams and partnerships for the resourcing of Goals 1–4														
a.	Analyse the potential for loss of tourism resources because of the impacts of climate change on heritage	√	√	√	√	√	√	√	√	√	Report	DCHG	Short	FI, HC
b.	Undertake a CEA of adaptation investment for high-risk sites (identified in Goal 1.e) which are also a priority for tourism	√	√	√	√	√	√	√	√	√	Costed and funded action programme for key sites	DCHG	Short–medium	FI
c.	Actively seek to establish cost-saving collaborations on cross-sectoral issues	√	√	√	√	√	√	√	√	√	Collaborative agreements	DCHG	Short	CCSAPs, DCCAE, DHPLG, HES
d.	Develop grant schemes for preventative maintenance, sensitive adaptation and recovery from climate-change impacts, supported by guidance documents	√	√	√	√	√	√	√	√	√	Successful grant allocations	DCHG	Medium	FI, HC, RCB, CARO, LAs
Objective 2. Develop a better understanding of how the historic building stock and its adaptive reuse contributes to sustainable communities														
e.	Analyse the value of heritage to society, including recreation, health and climate-change mitigation									√	Quantification of social benefits, e.g. carbon contribution	DCHG	Short–medium	FI, ICOMOS, SEAI, EPA, HC
f.	Create a green heritage award for sustainable reuse and energy conservation in historic buildings									√	Promotion of best practice	DCHG	Short–long	SEAI, historic building owners, construction sector, RIAI, CARO
Objective 3. Maximise the potential of heritage as an engagement tool for cross-sector research and initiatives, public engagement and education in relation to climate change and adaptation														
g.	Build public awareness of the risks of climate change (in general and for heritage) and of efforts to mitigate it and adapt to it	√	√	√	√	√	√	√	√	√	Assessment of existing communication gaps and strategy for public engagement	DCHG	Short	FI, CCAG, CCSAPs, historical societies, CHERISH, CARO
h.	Promote research to understand and, where possible, take lessons from past climate-related impacts and community responses	√	√	√	√	√	√	√	√	√	Information resource	DCHG	Medium	RS, EPA
i.	Use interpretation of heritage sites to raise public interest, engage schools and engage young people in climate-change issues through heritage-centred 'climate stories'	√	√	√	√	√	√	√	√	√	Integration of climate change into visitor interpretation and education	DCHG	Long	FI, OPW, NMS, education sector

5.3 Cross-Sectoral Implications for Heritage

The NAF lists 12 sectors for which adaptation plans will be produced. It is therefore vital that each adaptation plan considers the cross-sectoral nature of climate risks, impacts and planned adaptation, including both potential synergies and conflicts (DCCAE, 2018b). This section will identify areas of intersection between this plan and the parallel sectoral areas (here grouped according to government department).

5.3.1 Department of Agriculture, Food and the Marine

The draft adaptation plan for the DAFM identifies natural and cultural capital as a cross-sectoral theme and specifically refers to the interaction between heritage, agriculture and forestry and the implementation of measures to preserve monuments or features in these contexts.

Table 6. Cross-sectoral implications for the DAFM

Agriculture, Forestry and Seafood				
	Issue Identified[62]	**Potential Synergies**	**Risk of Conflict**	**Corresponding Heritage-Adaptation Actions**[63]
	The introduction of new plants, crops, trees and livestock	Some farming and land-management practices, which are beneficial to the historic environment (e.g. stable, well-managed pasture over buried archaeological sites)	Some adaptations in relation to new crops, changes in land use and cultivation may damage historic assets	Goal 3.g
	The development of risk assessment, warning and response systems for wildfires and guidance on post-fire land management	An understanding of what built and archaeological heritage may be present and how best to recover heritage after fire events		Goal 1.a, b, d Goal 2.g–j
	Sustainable forest management, including training and advice on species selection and the importance of managing what remains of native and historic woodlands	Identifying areas of historic woodland, changes in species and creating the management regimes required to adapt to drier and wetter conditions. 'Heritage forests' could be grown to provide old-growth timber as replacements in historic buildings. Monitoring and managing the historic structures including over 1,300 recorded monuments on Coillte estate.	Potential for loss of archaeology and architectural heritage and impact on cultural landscape	Goal 1 Goal 2.c Goal 3.b, e, f Goal 5.c Goal 3.b
	Agri-environment measures to maintain heterogeneity and connectivity in the wider landscape	Enhancing the resilience of traditional land use, which will benefit both tangible and intangible cultural heritage (e.g. hedgerows preserve a sense of place and slow flood waters)		

[62] From the DAFM's Agriculture, Forest and Seafood Sectoral Climate Change Adaptation Plan: Draft for Public Consultation (2019) and Adaptation Planning – Developing Resilience to Climate Change in the Irish Agriculture and Forest Sector (2017). Both available at https://www.agriculture.gov.ie/.

[63] See Section 5.2: Adaptation Action Plan.

5.3.2 Department of Culture, Heritage and the Gaeltacht

Although the two adaptation plans have been given quite distinct remits, there are many points of intersection between natural and cultural heritage, as recognised in the department's National Landscape Strategy for Ireland 2015–2025. Additional synergies may become apparent as the plans enter the implementation phase.

Table 7. Cross-sectoral implications for the DCHG

Biodiversity				
	Issue Identified[64]	**Potential Synergies**	**Risk of Conflict**	**Corresponding Heritage-Adaptation Actions**[65]
	Enhancement and restoration of natural systems management	The cultural significance of landscapes, which are rich repositories for buried archaeology and environmental data (e.g. peat bogs)		Goal 3.f–g
	The establishment of an all-island programme to monitor the spread of terrestrial, aquatic and marine invasive species	Importance for underwater archaeology, cultural landscapes and built or movable heritage with organic components (e.g. wood, thatch, collections)		Goal 5.c
	The development of an integrated coast-management strategy	Ecosystems-based approaches to protecting coasts, which may benefit cultural heritage by slowing erosion and loss	Potential negative impact on heritage resources, especially buried archaeology, which require negotiated solutions	Goal 3.f
	Agri-environment measures to maintain heterogeneity and connectivity in the wider landscape (commonage farm plans/commonage management plans)	Enhancing the resilience of traditional land use, which will benefit both tangible and intangible cultural heritage (e.g. hedgerows preserve a sense of place and slow flood waters)		Goal 3.b
	Understanding of the impacts of climate change on biodiversity	Information and data sharing between different fields using traditional knowledge, research, monitoring and citizen science		Goal 5.c

[64] From Ireland's Biodiversity Sectoral Climate Change Adaptation Plan: Public Consultation (2019), available from https://www.npws.ie/.
[65] See Section 5.2: Adaptation Action Plan.

5.3.3 Department of Communications, Climate Action and Environment

Table 8. Cross-sectoral implications for the DCCAE

Electricity and Gas Communications Networks				
	Issue Identified[66]	**Potential Synergies**	**Risk of Conflict**	**Corresponding Heritage-Adaptation Actions**[67]
	Diversification of the electricity-generation portfolio	Heritage-based solutions for carbon reduction	Commitment to increased use of renewable energy and development of energy-infrastructure projects has implications for archaeology and landscapes that require negotiated solutions	Goal 5.e–f
	Harmonised collection of baseline data and costs to the economy related to past extreme weather events	Information- and data-sharing between different fields using traditional knowledge research, monitoring and citizen science		Goal 1.g–h
	Asset management and maintenance approaches and policies	The regular maintenance of historic buildings, both protected and unprotected, increasing their resilience to the impacts of climate change, also making them more thermally efficient at retaining heat. They will thus require less energy to heat and emit less carbon.	Potential significant impact on heritage values. Adaptation measures should adhere to best practices in conservation and be in line with the relevant planning and development regulations.	Goal 2.c Goal 3.d Goal 4.f
	Communications and awareness-raising	Avenues for creatively engaging people with climate-change issues		Goal 5.g–i

[66] From Draft Statutory Climate Change Adaptation Plan for the Electricity and Gas Networks Sector: Public Consultation, February 2019, available from https://www.dccae.gov.ie/.

[67] See Section 5.2: Adaptation Action Plan.

5.3.4 Office of Public Works

Table 9. Cross-sectoral implications for the OPW

Flood Risk Management				
	Issue Identified[68]	**Potential Synergies**	**Risk of Conflict**	**Corresponding Heritage-Adaptation Actions[69]**
	Structural flood protections, which can impact negatively on the built and archaeological environment	The protection of heritage properties by flood defences, which may provide an impetus to undertake maintenance and stabilisation measures on affected properties	Flood defences, which may significantly impact heritage values, will require negotiated solutions, integrating heritage into the planning and design stage	Goal 2.a Goal 4.f
	Research to improve understanding of potential flood risk, responses and community vulnerabilities	Interdisciplinary research, information and data-sharing		Goal 1.d, f, j Goal 2.c Goal 5.h
	Flood-risk preparation, response and resilience	Importance for both private and public historic buildings, including cultural institutions. The heritage sector can contribute preparations on a national level (e.g. eighteenth-century bells used for flood warning)[70]		Goal 2.g–j
	Communications and awareness-raising	Avenues for creatively engaging communities with flood risk and responses		Goal 5.g–i
	Capacity-building on climate-change adaptation for partners and communities	Possible efficiencies from intersectoral training and capacity-building		Goal 4.j

[68] From *Draft for Consultation: Climate Change Sectoral Adaptation Plan, Flood Risk Management (2015–2019)*, available from https://www.opw.ie/.

[69] See Section 5.2: Adaptation Action Plan.

[70] Eighteenth-century church bells in Starcross, Devon are to be used to warn villagers of flooding if the Environment Agency's electronic warning and other forms of communication have failed. The restoration of the bells was part-funded by the Environment Agency (https://www.bbc.co.uk/news/uk-england-devon-47350638).

5.3.5 Department of Transport, Tourism and Sport

Tourism is not covered by the sectoral plan as the climate-change adaptation strategy focusses solely on transport. Tourism will be impacted by climate change, however, with knock-on effects for other parts of the economy, and is considered within the heritage plan as a significant intersecting issue (Goal 5). Ireland's natural and cultural heritage feature strongly among the main reasons why visitors choose Ireland for their holidays. According to Fáilte Ireland (FI), 10.6 million overseas visitors holidayed in Ireland during 2018 and the country's environment (97%) and history and culture (95%) registered high in visitor-satisfaction surveys.

Table 10. Cross-sectoral implications for the Department of Transport, Tourism and Sport

Transport Network				
	Issue Identified[71]	**Potential Synergies**	**Risk of Conflict**	**Corresponding Heritage-Adaptation Actions[72]**
	Emergency response and recovery, including clear-up procedures		Infrastructure clear-up procedures, which need to respect heritage significance. Ways to retain this where possible should be discussed.	Goal 2.h Goal 2.j
	Data and risk management	Harmonising collection of data on past weather events, identifying vulnerable built heritage and undertaking collaborative research and knowledge-sharing between sectors, which has mutual benefits (e.g. monitoring and maintenance of historic bridges by Iarnród Éireann)		Goal 1.g–h
	Investment and development of infrastructure		Adaptation/response measures for historic infrastructure (bridges, harbours, buildings), which must adhere to best practice in conservation and be in line with the relevant planning and development regulations	Goal 2.c Goal 3.d Goal 4.f
	Futureproofing coastal infrastructure against SLR	Documentation of coastal heritage	Loss of heritage (built and archaeological) caused by hard coastal defences, the elevation of walls or changes to harbours. This needs to be considered and integrated into the planning process	Goal 1.a–b Goal 2.a, e
	Communications and awareness-raising	Avenues for creatively engaging people with climate-change issues		Goal 5.g–i

[71] From Adaptation Planning: Developing Resilience to *Climate Change in the Irish Transport Sector* (2012), available from http://www.dttas.ie/.
[72] See Section 5.2: Adaptation Action Plan.

5.3.6 Department of Health

At the time of writing there no adaptation plan has been published by the Department of Health. It has therefore not been possible to detail cross-cutting issues. Areas where potential synergies may be expected are:

- The contribution of heritage to physical and mental well-being, e.g. providing sustainable models of living, avenues for recreation, education and social identity
- Indoor climate and air quality – any refurbishment works to improve the thermal properties and energy efficiency of historic buildings must follow good practice in moisture management and ventilation in order to improve the physical and mental health of the inhabitants (the DHPLG could also be involved in tackling this issue – see Section 5.3.7: Department of Housing, Planning and Local Government)

The Department of Health owns and occupies numerous historic buildings which may be vulnerable to climate-change impacts and require sensitive adaptations.

5.3.7 Department of Housing, Planning and Local Government

This department has responsibility for several areas where there are potential synergies with the action plan for heritage:

- Housing
- Planning
- National Directorate Fire and Emergency Management
- Met Éireann
- Local authorities

The adaptation plan required from the department under the NAP is to consider water quality and water-services infrastructure only. Table 11 outlines the

Table 11. Cross-sectoral implications for the DHPLG

Water Quality and Water-Services Infrastructure				
	Issue Identified[73]	**Potential Synergies**	**Risk of Conflict**	**Corresponding Heritage-Adaptation Actions[74]**
	Ecosystem and habitat restoration	Restoration of ecosystems, which has benefits for cultural landscapes and buried archaeology (e.g. peatlands restoration)		Goal 3.f–g
	Monitoring and research	Potential for collaborative research and monitoring in areas of mutual interest such as water pollution and catchment modelling		Goal 1.d, e, i
	Upgrade of assets		Adaptation/response measures for historic assets, which must adhere to best practice in conservation and be in line with the relevant planning and development regulations	Goal 2.c Goal 3.d Goal 4.f
	Flood-risk assessment and defences	Flood defences, which may protect heritage from flooding and contamination by pollutants	Physical and visual impact on heritage caused by flood defences. Negotiated solutions will be necessary, integrating heritage into the planning and design stage.	Goal 2.a Goal 4.f
	Communication	Avenues for creatively engaging people with climate-change issues		Goal 5.g–i

[73] From Draft Climate Change Sectoral Adaptation Plan: Water Quality and Water Services Infrastructure, May 2019, available from http://www.housing.gov.ie.

[74] See Section 5.2: Adaptation Action Plan.

adaptive measures, described in the water adaptation plan, which intersect with the action plan for built and archaeological heritage.

5.3.8 Local-Authority Plans

Under the NAF, each local authority is required to make and approve a local climate-change adaptation strategy, following a similar process and timeline to that outlined for the sectoral plans. At the time of writing, local authorities are at various stages in this process. Of the 15 draft plans surveyed, cultural heritage was mentioned in all but one. However, in most cases coverage was limited. As local authorities are committed to working in partnership with the sectors identified in the NAF, it is expected that relevant actions for built and archaeological heritage will be incorporated into future iterations of local plans where they are relevant to the functions and activities of the council. Collaboration between the DCHG and the CAROs envisaged as part of the action plan will help to ensure this.

5.4 Co-Benefits

The IPCC defines 'co-benefits' as the **'positive effects that a policy or measure aimed at one objective might have on other objectives**, irrespective of the net effect on overall social welfare. Co-benefits are often subject to uncertainty and depend on local circumstances and implementation practices, among other factors' (IPCC, 2014, emphasis added). Adapting heritage to the likely impacts of climate change is an opportunity to address vulnerabilities and to support sustainable development in the sector (Stern, 2007), but it may also contribute to achieving other policy objectives (DCCAE, 2018b). In this section, the positive effects the adaptation strategy for built and archaeological heritage might have on other policy objectives will be explored – with particular focus on co-benefits for the objectives of the Climate Action and Low Carbon Development Act 2015.

5.4.1 National and International Policy Driving Climate Action

The Climate Action and Low Carbon Development Act 2015 (henceforth the Climate Act) provides the statutory basis for the **'national transition objective', i.e. the transition to a low-carbon, climate-resilient and environmentally sustainable economy by the end of 2050**. In order to achieve this objective, the Minister for Communications, Climate Action and Environment must submit to government a series of successive National Mitigation Plans and NAFs (under which this sectoral plan sits). Government must also ensure that the 'national transition objective' is achieved through the implementation of measures that are cost-effective and are aligned with the 1992 UNFCCC, the EU mitigation commitments and the general principle of climate justice.

Section 7.5 of the Paris Agreement states that **adaptation should be carried out using the best available science, with reference to traditional and indigenous knowledge** (Goal 5.h). In effect, this is an acknowledgement of the important role that heritage, embodying traditional and historic ways of interacting with the environment, can play in societal adaptation to climate change.
The Paris Agreement emphasises the need to stress urgency about climate change and to increase knowledge and awareness of the risks this can pose for heritage. Iconic sites at risk from storms or coastal erosion can alert the public to the very real cost of climate change (Goal 5.g).[75] **Heritage sites hold significance for local and national communities alike and are linked to identity, continuity and sense of place. In this way they are ideal vehicles for highlighting climate-change impacts and communicating issues to the public in a readily relatable way (Goal 5.i)** (Rockman *et al.*, 2016).

Cultural heritage is a link to the past and can be used as a tool to help people understand and connect to a place. This is commonly exploited for tourism but, as climate migration becomes more common and large communities are forced to move from their homelands to new and foreign places, cultural heritage takes on a more important role in the assimilation process.

The Sustainable Development Goals (SDGs) set forth by the UN 2030 Agenda for Sustainable Development, **mention the threat that climate change poses to cultural heritage specifically in Target 11.4**, which calls for the strengthening of

[75] For an example see Casey, 2018.
[76] See https://sustainabledevelopment.un.org/sdg11.

'efforts to protect and safeguard the world's cultural and natural heritage'.[76] Several of the SDGs correspond with factors that affect the survival and protection of built and archaeological heritage. A number of the adaptation actions within this plan correspond to the SDGs. However, the plan primarily aligns with SDG Goals 3, 11, 13 and 17 as follows:

- **Goal 3 (Good Health and Wellbeing)** corresponds to Goal 3 (Conserve Ireland's heritage for future generations) and Goal 5, Objective 2 (Develop a better understanding of how the historic building stock and its adaptive reuse contributes to sustainable communities)
- **Goal 11 (Sustainable Cities and Communities)** corresponds to Goal 1 (Improve understanding of each heritage resource and its vulnerability to climate-change impacts) and Goal 2 (Develop and mainstream sustainable policies and plans for climate-change adaptation of built and archaeological heritage)
- **Goal 13 (Climate Action)** corresponds to Goal 2 (Develop and mainstream sustainable policies and plans for climate-change adaptation of built and archaeological heritage) and Goal 4 (Communicate and transfer knowledge)
- **Goal 17 (Partnerships for the Goals)** corresponds to Goal 5 (Exploit the opportunities for built and archaeological heritage to demonstrate value and secure resources)

5.4.2 Learning from the Past

> *Study the past if you would define the future* (Confucius).

The acknowledgement of built and archaeological heritage as an asset for understanding climate adaptation and resilience will be a directly beneficial outcome of the actions proposed under this plan. *Research into aspects of history and archaeology that provide insight across a range of topics related to climate change will benefit adaptation processes in other sectors.* Paleoenvironmental data can be used to set baselines, while societal reactions to past change can tell us about key moments in adaptation (or failure to adapt) and the implications of these (ICOMOS International Climate Change Working Group, 2018). Lessons can be learned from past societies that were forced to adapt to changes in their local conditions, such as the adoption of alternate environments or more resilient food types for agricultural purposes and traditional ways of living in dense settlements with low transport needs.

Climate change is itself a historic manmade phenomenon. Anthropogenic influences on the climate can be traced back to the beginning of the Industrial Revolution (circa 1750) and possibly further through research into the historical and archaeological record (ICOMOS International Climate Change Working Group, 2018). Modern economies are built on notions of progress and the exploitation of natural resources, so efforts to mitigate and adapt to climate change will not be without conflict. Tensions may arise where actions to reduce carbon emissions or to protect heritage resources intersect with other aspects of socioeconomic development, such as tourism (Markham *et al.*, 2016). The adaptation plan outlined here attempts to address this through a series of measures aimed at creating sustainable cross-sectoral partnerships. **For example, the tourism sector could use heritage resources to enhance visitor understanding of climate change. Wider societal co-benefits could be achieved through a greater acceptance of responsible behaviours and practices that extend beyond the immediate visitor experience.**

5.4.3 Carbon Mitigation

The revitalisation of historic town centres and the redensification of our cities could play a major role in lowering carbon emissions. The recent Oireachtas report, *Climate Change: A Cross-Party Consensus for Action*, identified specific ways of reducing carbon emissions due to private car transport and dispersed housing developments (Joint Committee on Climate Action, 2019). The transport sector is the second-largest (and fastest-growing) source of emissions in Ireland, currently contributing 20% of overall greenhouse-gas emissions, with an expected growth of 13% between 2017 and 2035 after investments in public transport and electric-vehicle penetration targets have been

considered (Joint Committee on Climate Change, 2019). To lower emissions drastically in the short term, the public must be encouraged to take more sustainable means of transport, like cycling or walking, and be given the option to travel less or to travel shorter distances, e.g. by working from or closer to home. A great many older buildings are currently vacant or derelict in towns and cities across Ireland. Policies that encourage their reuse, and disincentivise new building on the outskirts of towns, will contribute to carbon-emission reductions from the transport sector. The reuse of existing buildings also recognises the embodied carbon of buildings – i.e. the environmental cost already paid during its construction (ICOMOS Australia, 2018). Moreover, the retention and revitalisation of historic town and city centres contribute to social cohesion, cultural longevity and a sense of belonging (Goal 5.e–f).
The regular maintenance of historic buildings will increase their resilience to the impacts of climate change but will also make them more thermally efficient. They will thus require less energy to heat and emit less carbon (Goal 4.a, e). The National Mitigation Plan for Ireland 2017 states that, by 2050, existing buildings should require less energy after undertaking energy-efficiency upgrades. What energy they do use should come from low-carbon, renewable sources. During 2017, residential and public buildings accounted for 11% of Ireland's overall greenhouse-gas emissions (Joint Committee on Climate Action, 2019).

All of the 99 Irish citizens enlisted to take part in the 2017 Citizens' Assembly on Climate Change agreed that the state should take a leading role in mitigating climate change through measures including the energy renovation of public buildings; 96% agreed that the state should undertake a comprehensive assessment of critical infrastructure vulnerabilities, including those in the built environment (Citizens' Assembly, 2018). **Historic buildings should not be exempt from the need to improve their energy efficiency. However, there is growing concern among architecture-conservation professionals that the increasing demand for historic buildings to perform at an efficiency standard higher than they were designed to will lead to overzealous renovation works and unintended negative consequences.** The installation of inappropriate insulation, increased airtightness and poor ventilation can lead to disastrous moisture-related issues, particularly in solid-wall buildings. Such interventions may also undermine or destroy the heritage qualities of a historic property. However, there are numerous low-risk maintenance measures that can improve both the energy and thermal efficiency of historic buildings, including draughtproofing, insulating attics and floors, upgrading boilers and services, installing heat-recovery ventilation systems and integrating renewable or low-carbon energy sources. **By undertaking regular maintenance and low-risk energy-renovation measures, historic buildings can contribute to the DHPLG's mandate to reduce energy use and carbon emissions.**

5.4.4 Sustainable Development and Rural Employment

According to the SEAI, the energy-renovation market will be worth over €35 billion to the Irish economy between now and 2050. This could in fact reach an even higher level – the Oireachtas Joint Committee on Climate Action now estimates that up to 1.5 million existing Irish homes will need deep energy-renovation works in order to meet the national carbon-reduction targets (Joint Committee on Climate Action, 2019). The rate of delivery is contingent on the availability of knowledge and skilled labour and, currently, there is a national shortage of both, in traditional building as well as energy renovation appropriate to historic buildings. Investment in training will ensure not only that renovation works are appropriately carried out, but also that the expected growth in demand for renovation can be met. *Investment in the energy-renovation sector will provide employment opportunities in a range of skill and income levels but, perhaps more importantly, will create sustainable jobs in rural as well as urban areas of Ireland* (Goal 4.j). To address the skills shortage, the Joint Committee on Climate Action recommends that by the third quarter of 2019, the DCCAE, with the SEAI and the DHPLG, should produce a plan 'to meet the training and educational requirements of an enlarged workforce needed to deliver the retrofitting programme', and that this should include specific training for historic and protected buildings (Joint Committee on Climate Action, 2019).

6 Implementation, evaluation and review

6.1 Implementing the Adaptation Plan

6.1.1 The Purpose of Monitoring and Evaluation

The monitoring and review process described in this section will be crucial to improving functionality and overcoming the inherent uncertainties of this first iteration of the adaptation plan for the heritage sector.

The purpose of monitoring and evaluation is to:

1. Follow the implementation of planned actions
2. Assess progress towards stated objectives
3. Share information on good practice
4. Assess the effectiveness of resource commitments
5. Provide information required for governance
6. Inform and incentivise stakeholders
7. Identify problems and formulate improvements

The systematic collection of data, based on defined indicators, enables transparent tracking of progress towards objectives. Results can be used to revise and adjust the action plan, the monitoring system itself and ultimately the adaptation strategy. The evaluation plan is thus best seen as a 'living document for continuous and consistent adaptation planning and implementation' (Climate-ADAPT, 2019). It should be used iteratively as the process continues and where adjustments are made the decision-making process should be transparent and the learning shared.

6.1.2 Governance

Monitoring and reporting, review and accountability are central to adaptation governance (DCCAE, 2018b).

Monitoring and reporting in relation to climate-change adaptation will occur at several levels and it is important that the timing and formulation of monitoring mechanisms proposed here are appropriate for all required scales of evaluation (Figure 28). Under the NAF, the Minister for Communications, Climate Action and Environment chairs the Climate Action High-Level Steering Group. The interdepartmental NAF Steering Committee oversees the sectoral adaptation process and reports on the progress of the individual plans to the Steering Group. The ministers responsible for sectoral plans are required to submit annual transition statements to both houses of the Oireachtas, and the Minister for the DCCAE must submit a review of the NAF every five years. In addition, the EU requires adaptation-progress reports from member states every four years; the UN requires them every five years.

6.1.3 Indicators

Indicators should meet SMART criteria – i.e. be specific, measurable, assignable (who is responsible?), realistic

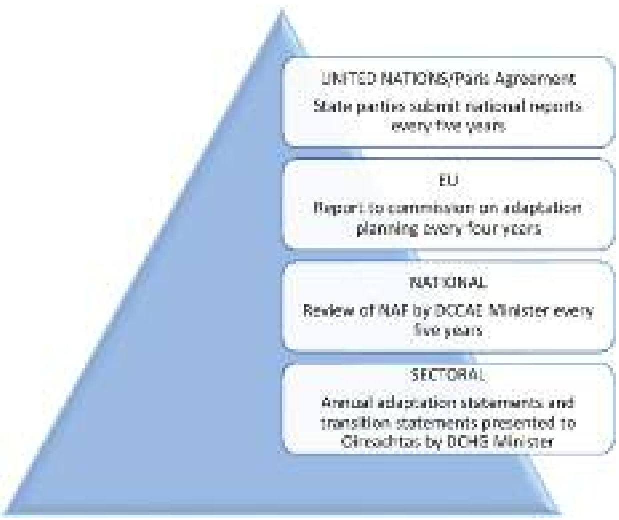

Figure 28. Scale and timing for review and reporting arrangements under the Climate Act 2015 and associated government commitments (DCCAE, 2018b)

(data can be collected effectively and efficiently) and time specific. There are additional challenges in selecting indicators for climate-change adaptation, given the inherent uncertainties involved and the fact that successful outcomes – i.e. the moderation of harm – may not be determinable for many years (Klostermann et al., 2015). In this initial phase the indicators selected are mostly 'process-based' and 'output-based' and are intended to capture the development of governance and the implementation of the adaptation action plan. As the adaptation process matures and baseline information becomes available, it will be possible to develop more 'outcome-based' indicators that measure the effectiveness of the strategy in reducing negative impacts for built and archaeological heritage.

6.1.4 Multi-Stakeholder Engagement

All stakeholders with a role and responsibility for implementation need to be part of the Monitoring & Evaluation process (Climate-ADAPT, 2019).

The successful implementation of this plan requires the active participation of responsible agencies, individuals and communities at all levels and scales across Ireland. Raising awareness and enabling and maintaining engagement is a cornerstone of the implementation process. Dissemination of the activities achieved is planned in the review scheme. Bottom-up approaches also need to be fostered through continuous communication of progress to stakeholders and activities aimed at local communities. There is a need for clarity as regards governance and ownership of the implementation of planned adaptation actions, and an integrated and coordinated approach is necessary to minimise gaps and facilitate cross-sectoral partnerships (DCCAE, 2018b).

6.1.5 Resourcing the Plan

Successful implementation cannot occur without the allocation of resources, both human and financial. Many of the preliminary actions are 'soft' and fall within the responsibility of DCHG, which will be required to implement the plan.

6.1.6 Evaluation Mechanisms and Timing

There are currently no defined monitoring mechanisms for evaluating the implementation of the sectoral plans. The proposed monitoring scheme outlined here includes dependent (internal) and independent (external) mechanisms at intervals to reflect the governance-reporting requirements. The dependent organisational relationships will ensure feedback and reflexive learning throughout the process, while independent aspects will be most useful in objectively assessing progress of implementation and dissemination (Klostermann et al., 2015).

The final evaluation plan may include the following mechanisms:

Written Notification (WN)
Internal reporting on progress and implementation is envisaged. Written reports will be presented to the National Adaptation Steering Committee (NASC) for monitoring the progress of the NAF and will inform the Annual Transition Statements made by the Minister for Culture, Heritage and the Gaeltacht.

DCHG Climate Change Planning Team (CCPT)
It is recommended that the CCPT be convened quarterly and that it reviews the progress of the adaptation plan's implementation, as well as providing general oversight. The continued involvement of stakeholders will be important for maintaining awareness, enabling implementation through sectoral engagement and tracking the ongoing relevance of the plan through feedback and the sharing of experiences. This engagement will be maintained by the CCPT through the existing DCHG Climate-Change Advisory Group (CCAG) or similar. The CCPT will produce recommendations after each meeting.

External Evaluation
Independent evaluation of the implementation and success of the plan is suggested at months 36 and 60. The second evaluation will feed directly into the strategy update (starting at the latest in month 60). This independent report can be used for both EU and NAF reporting procedures.

6.1.7 Implementation and Monitoring Plan

The following tables outline an implementation and monitoring plan for the actions detailed in Section 5.2.2: Adaptation Action Plan.

GOAL 1: Improve understanding of each heritage resource and its vulnerability to climate-change impacts									
	ACTION	Lead	Milestones	Delivery	Output	Dissemination	Indicator of Success	Evaluation Schedule	Evaluation Mechanism
Objective 1. Establish a baseline for heritage resources from which change can be measured									
a.	Produce a baseline quantification of the number, nature and location of heritage assets	DCHG		Y(ear) 1	Desktop study	Online	Public availability of output	Month 12	WN
b.	Coordinate a single mapping portal for relevant heritage assets	DCHG		Y1	GIS maps	Online	Public availability of output	Month 12	WN
c.	Carry out a condition assessment of a sample of heritage sites/properties in public ownership	DCHG	Milestone 1 – Selection of sites M2 – Field assessment	Y1 Y2	Condition assessments and digital imaging	Internal	M2 – Internal digital record	M1 – Month 12 M2 – Month 24	WN CCPT
Objective 2. Conduct risk and vulnerability assessments for climate-change impacts on heritage									
d.	Carry out a hazard and risk assessment, overlaying maps of heritage sites with maps for flooding, coastal erosion and other priority impacts (where available) and calculating risk	DCHG	Prerequisite Goal 1.b	Y2	GIS-based risk assessment	Online	Public availability of output	Month 24	WN
e.	Assess the vulnerability of a number of heritage assets to the prioritised impacts of climate change (focussing on high-value and/or high-risk sites)	DCHG	Prerequisite Goal 1.d	Y3	Site-specific vulnerability reports	Internal	Internal publication	Month 36	CCPT
f.	Engage with communities in high-risk areas to create evaluations of vulnerability and priorities for response for local heritage	DCHG	M1 – Prioritisation of areas using Goal 1.d M2 – Engagement M3 – Assessment	Y1 Y2 Y2 and ongoing	Community-based adaptation plans for specified areas of high risk	Community-based activities	M1 – Plans circulated and approved at local level M2 – Community engagement M3 – Dissemination	M1 – Month 24 M2 – Month 30 M3 – Months 36 and 48	CCPT WN CCPT

	ACTION	Lead	Milestones	Delivery	Output	Dissemination	Indicator of Success	Evaluation Schedule	Evaluation Mechanism
GOAL 1: Improve understanding of each heritage resource and its vulnerability to climate-change impacts CONT'D									
Objective 3. Undertake monitoring of climate change and its impacts									
g.	Monitor atmospheric climate at selected heritage properties	DCHG	M1 – Selection of sites in partnership M2 – Installation of equipment	Y1 Y2	Met Éireann stations installed at 2–3 sites	Met Éireann database	M1 – MoU[77] with OPW and Met Éireann M2 – Equipment installed and operating	M1 – Month 12 M2 – Month 24	WN WN
h.	Monitor ongoing maintenance and repair works undertaken and emergency response, including costs (where available)	DCHG	M1 – Establishment of data collection M2 – Continued operation	Y1 Y2 and ongoing	Statistics relating to climate-change impacts and response for heritage in public ownership	Internal database	M1 – Database launch M2 – Ongoing data entries	M1 – Month 12 M2 – Ongoing	WN WN
i.	Monitor the impacts of climate change on a representative selection of sites for which condition monitoring has been conducted (Goal 1.c)	DCHG	M1 – Selection of sites using Goal 1.c and g M2 – Design and implementation of monitoring processes	Y2 Y3 and ongoing	Design and establishment of sustainable, tailored impact -monitoring regimes at multiple sites	Internal databank of monitoring results	M1 – Justified list of properties for monitoring M2 – Operational monitoring regime	M1 – Month 24 M2 – Month 36 and ongoing	WN WN
j.	Develop monitoring and response regimes which build on citizen-science approaches and utilise new technologies	DCHG	M1 – Identification of potential areas, activities and communities (Goal 1.f) M2 – Support for innovative and publicly accessible initiatives	Y3 and ongoing	Established schemes with public engagement	Community-based and/or online activities	M1 – Concept outlined and outreach created M2 – Growth of initiatives at different levels supported	M1 – Month 36 M2 – Month 36 and ongoing	CCPT CCPT

[77] Memorandum of understanding.

GOAL 2. Develop and mainstream sustainable policies and plans for climate-change adaptation of built and archaeological heritage									
	ACTION	Lead	Milestones	Delivery	Output	Dissemination	Indicator of Success	Evaluation Schedule	Evaluation Mechanism
Objective 1. Integrate heritage issues into relevant national and local intersectoral policies and plans									
a.	Ensure cooperation and communication between departments, agencies, state bodies and other stakeholders	DCHG/ NASC		Y1 and ongoing	Use of existing channels to mainstream consideration of heritage	N/A	Integration of heritage concerns in wider policy	Annual	WN
b.	Coordinate with local authorities to ensure that national and regional policy and plans align	DCHG/ CARO		Y1 and ongoing	Regular liaison with county managers	via CARO	Alignment of regional and national plans	Annual	WN
c.	Work with other sectors and local authorities to identify heritage assets within their remit that may be under threat, directly or indirectly, because of climate change	DCHG/ CARO		Y1 and ongoing	Working group meeting and exchange of information gathered under Goal 1.1	via CARO	Schedule of meetings held	Annual	WN
Objective 2. Introduce climate-change adaptation into sectoral policy and conservation planning at all levels									
d.	Inventory existing policies and plans and with regard to whether they address climate change	DCHG		Y1	Inventory	Internal publication	Comprehensive inventory	Month 12	WN
e.	Integrate climate-change adaptation into all heritage-management plans and policies as these are updated/revised	DCHG		Y1 and ongoing	Revised policies and systems	Sectoral channels	Sector-wide events, e.g. seminars and CCPT	Annual	WN
f.	Provide training for staff and communities in climate-change-adaptation policy	DCHG	M1 – Identification of training needs M2 – Delivery of training	Y1 and ongoing	Cohort of trained individuals	N/A	Training held	Annual	WN

GOAL 2. Develop and mainstream sustainable policies and plans for climate-change adaptation of built and archaeological heritage CONT'D

	ACTION	Lead	Milestones	Delivery	Output	Dissemination	Indicator of Success	Evaluation Schedule	Evaluation Mechanism
Objective 3. Increase and improve disaster-risk management for heritage									
g.	Cooperate actively with the Office of Emergency Planning and the National Directorate Fire and Emergency Management	DCHG		Y1 and ongoing	Individual nominated to National Emergency Steering Group	N/A	DCHG present at meetings	Annual	WN
h.	Develop cultural-heritage guidelines for national and regional emergency-response services	DCHG		Y1	Published guidelines	Online by DHPLG	Publication of guidance	Month 12	WN
i.	Enable training on disaster preparation for cultural heritage	DCHG	M1 – Establishment of MoU for delivery of training M2 – Delivery of training	Y1 and ongoing	Four regional training courses	Regional courses	Number of training events	Annual	WN
j.	Ensure flexible policies and systems are in place to enable timely and effective response and recovery	DCHG	Liaison with stakeholders and survey of preparation level in the sector	Y2	Improved emergency-response systems and recovery procedures	Sectoral channels (ICRI[78] etc.)	SWOT[79] analysis	Month 12	WN

[78] Institute of Conservator-Restorers in Ireland.
[79] Strengths, weaknesses, opportunities, threats.

GOAL 3. Conserve Ireland's heritage for future generations

	ACTION	Lead	Milestones	Delivery	Output	Dissemination	Indicator of Success	Evaluation Schedule	Evaluation Mechanism
Objective 1. Increase the resilience of heritage resources under current conditions									
a.	Engage with planning authorities to climate-proof planning procedures for heritage properties	DCHG		Y1	Recommendations on planning requirements	Online	Production of recommendations	Month 12	WN
b.	Review, and continue to build on, existing practice relevant to climate resilience (e.g. maintenance and monitoring regimes, stabilisation and weatherproofing activities, the development of informative case studies)	DCHG		Y1	Survey and evaluation of current measures	Internal	List of measures	Month 12	WN
Objective 2. Develop management and conservation approaches for changing environments									
c.	Undertake CEA and life-cycle assessments for conservation interventions to address priority impacts under future climate conditions	DCHG	Cost-effectiveness assessment and lifecycle assessment (prerequisite Goal 3.b)	Y2	Critical evaluation of current conservation practice	Internal	Report on cost-effectiveness and life-cycle cost of measures	Month 24	CCPT
d.	Integrate climate-change adaptation into all heritage works and maintenance plans	DCHG	Integration of costed actions into planning (prerequisite Goal 3.c)	Y3	Climate-ready maintenance and conservation regimes	Sectoral channels	Documented application of chosen measures to heritage resources	Month 36	CCPT
e.	Identify and implement practical measures to protect heritage against extreme weather impacts	DCHG	Site-based needs assessment and works (prerequisite Goal 1.d)	Y2 and ongoing	Climate-ready infrastructure and visitor services at state-owned sites	LA publications	Visitor infrastructure functioning as required	Month 24 onward	WN
f.	Promote research into techniques that specifically address conservation and management challenges related to the priority climate-change impacts	DCHG	M1 – Establishment of funding (prerequisite Goal 3.c) M2 – Research project	Y2 Y5	Development and piloting of new approaches	Sectoral channels Publications	Improved evidence base for treatments; selection and application	M1 – Month 24 M2 – Month 36 onward	CCPT
g.	Instigate research to investigate and make recommendations regarding the sustainability of preservation *in situ* as a long-term strategy for maintaining heritage resources	DCHG	M1 – Establishment of funding M2 – Research project	Y1 Y4	Improved understanding and recommendations for management	Sectoral channels Publications	Improved evidence base for preservation *in situ*	M1 – Month 12 M2 – Month 24 onward	CCPT

GOAL 3. Conserve Ireland's heritage for future generations CONT'D									
	ACTION	**Lead**	**Milestones**	**Delivery**	**Output**	**Dissemination**	**Indicator of Success**	**Evaluation Schedule**	**Evaluation Mechanism**
Objective 3. Find ways to capture value when loss is inevitable									
h.	Survey and record high-risk assets (identified under Goal 1.d–f)	DCHG	Prerequisite Goal 1.d–f	Y2 and ongoing	Archive of high-quality datasets	Internal	Internal publication of surveys	Month 24 onward	WN
i.	Increase research, recording and rescue excavations in high-risk areas (based on current levels of reporting for Y1 and from Y2 utilising risk-mapping from Goal 1)	DCHG	Prerequisite Goal 1.d–f M1 – Establishment of funding M2 – Targeted projects	Y1 and ongoing	Preservation by record	Sectoral channels Publications and media	Number of disseminated rescue and research projects	Month 12 onwards	CCPT

GOAL 4. Communicate and transfer knowledge

	ACTION	Lead	Milestones	Delivery	Output	Dissemination	Indicator of Success	Evaluation Schedule	Evaluation Mechanism
Objective 1. Create a vision for the sector and demonstrate leadership in the response to climate-change challenges									
a.	Establish and demonstrate green ways of working in historic buildings, ensuring that the carbon footprint of adaptation measures is considered	DCHG	M1 – MoU with SEAI M2 – Identification and development of case studies	Y1 Y3	Best-practice exemplar	Online	Publication/media	M1 – Month 12 M2 – Month 36	WN WN
b.	Cooperate actively and share knowledge with international partners	DCHG		Y1 and ongoing	Contribution to EU Risk Data Hub or similar	Online	Evidence of collaboration	Month 12 onward	WN
c.	Establish a working group to pool information, promote research and drive the implementation of the plan	DCHG		Y1	Working group established within department	Internal	Dedicated human resources	Month 6	WN
Objective 2. Create guidance and disseminate information									
d.	Create guidelines for the heritage sector on preparing for and recovering from priority climate-change impacts; utilise a cost-effectiveness study (Goal 3.c)	DCHG	Prerequisite Goal 3.c	Y3	Published impact-based resilience and recovery guidance	Online	Publication of guidelines	Month 36	CCPT
e.	Create guidelines for non-specialists on sensitive adaptation, recovery from climate-change impacts and sustainable reuse and energy conservation in historic buildings	DCHG	M1 – Identification of priorities M2 – Production of guidelines	Y1 Y2 and ongoing	Published and widely promote guidelines	Online	Publication of guidelines	M1 – Month 12 M2 – Month 24	WN WN
f.	Work with and provide guidance for the public sector on appropriate adaptation and response measures (building on Goal 2.c)	DCHG		Y2	Disseminated guidance	Internal	Publication of guidelines	Month 24 onward	WN

GOAL 4. Communicate and transfer knowledge CONT'D

	ACTION	Lead	Milestones	Delivery	Output	Dissemination	Indicator of Success	Evaluation Schedule	Evaluation Mechanism
Objective 3. Enable the collection, archiving and sharing of data, experiences and learning related to heritage and climate change									
g.	Establish a system for harmonising the collection of baseline data on the impacts of climate change, adaptation responses (including costs) and potential funding sources	DCHG	M1 – Design of appropriate system M2 – Data collection	Y1 Y2	Enhanced, secure and accessible database	Internal	Internal data-management system functioning as required	M1 – Month 12 M2 – Month 24 onward	WN WN
h.	Ensure that heritage is included in any future modelling of impacts conducted for Ireland	DCHG		Y1 and ongoing	Inclusion in climate-risk atlas or similar	Publication	Inclusion in climate-change research	Month 12 and ongoing	WN
i.	Support the gathering and sharing of experience and knowledge across stakeholder bodies	DCHG		Y3	Workshops – e.g. reconvened stakeholder consultation	Sectoral channels	Two workshops	Month 36	CCPT
Objective 4. Develop training									
j.	Provide training to supply identified skills shortages and gaps in capacity in relation to the adaptation of cultural heritage to climate change	DCHG	M1 – Prioritisation of training needs and identification of providers and funding M2 – Delivery of training	Y1 Y2 and ongoing	Training on range of skills related to adaptation	Online	Number of training events supported	M1 – Month 12 M2 – Month 24 onward	WN CCPT

GOAL 5. Exploit the opportunities for built and archaeological heritage to demonstrate value and secure resources

	ACTION	Lead	Milestones	Delivery	Output	Dissemination	Indicator of Success	Evaluation Schedule	Evaluation Mechanism
Objective 1. Explore potential revenue streams and partnerships for the resourcing of Goals 1–4									
a.	Analyse the potential for loss of tourism resources because of the impacts of climate change on heritage	DCHG		Y1	Best estimate	Sectoral channels	Report circulated	Month 12	WN
b.	Undertake a CEA of adaptation investment for high-risk sites (identified in Goal 1.e) which are also a priority for tourism	DCHG		Y3	Costed and funded action programme for key sites	Internal	Action programme	Month 36	WN
c.	Actively seek to establish cost-saving collaborations on cross-sectoral issues	DCHG		Y1	Collaborative agreements	Internal	MoUs/partnerships established	Month 12	WN
d.	Develop grant schemes for preventative maintenance, sensitive adaptation and recovery from climate-change impacts, supported by guidance documents	DCHG	Supported by Goal 4.d–e	Y3 and ongoing	Online funding and guidance hub	Online	Number of successful grant allocations	Month 36 onward	CCPT
Objective 2. Develop a better understanding of how the historic building stock and its adaptive reuse contributes to sustainable communities									
e.	Analyse the value of heritage to society, including recreation, health and climate-change mitigation	DCHG	M1 – Establishment of funding M2 – Research project	Y1 Y2	Research project	Online/ publications	Quantification of social benefits, e.g. carbon contribution	M1 – Month 12 M2 – Month 24	WN CCPT
f.	Create a green heritage award for sustainable reuse and energy conservation in historic buildings	DCHG		Y1 and ongoing	Promotion of best practice	Online/media	Establishment of annual award	Month 12 onward	WN
Objective 3. Maximise the potential of heritage as an engagement tool for cross-sector research and initiatives, public engagement and education in relation to climate change and adaptation									
g.	Build public awareness of the risks of climate change (in general and for heritage) and of efforts to mitigate it and adapt to it	DCHG		Y1 and ongoing	Assessment of existing communication gaps and strategy for public engagement	Online/media	Number of public-engagement activities initiated/facilitated	Month 12 onward	WN
h.	Promote research to understand and, where possible, take lessons from past climate-related impacts and community responses	DCHG	M1 – Establishment of funding M2 – Research project	Y1 Y2 and ongoing	Information resource	Online/media	Online resource	M1 – Month 12 M2 – Month 24 onward	WN CCPT
i.	Use interpretation of heritage sites to raise public interest, engage schools and engage young people in climate-change issues through heritage-centred 'climate stories'	DCHG	M1 – MoU/ partnerships M2 – Site-based activities	Y1 Y2 and ongoing	Site-based interpretation and education activities and tools Integration of climate change into visitor interpretation and education	Online and at properties	Number of heritage properties engaged Number of schools/youth organisations involved	M1 – Month 12 M2 – Month 24 onward	WN CCPT

6.2 Strategic Environmental Assessment and Appropriate Assessment Screening Reports

The CCSAP for built and archaeological heritage has undergone screening for strategic environmental assessment (SEA) and appropriate assessment (AA). The SEA and AA Screening Reports will be published separately from the adaptation plan.

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Appendix I: Glossary and Abbreviations

Glossary[81]

2030 Agenda for Sustainable Development A UN resolution of September 2015, which adopted a plan of action for people, the planet and prosperity in a new global-development framework anchored in 17 SDGs (UN General Assembly, 2015). (See also Sustainable Development Goals (SDGs).)

Adaptation The IPPC defines adaptation as any adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects which moderates harm or exploits beneficial opportunities.

Adaptive Capacity The ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities or to cope with the consequences.

Carbon (CO_2 Equivalent) The cumulative warming effect of multiple greenhouse gases on the atmosphere is often represented by the CO_2 equivalent, which has a Global Warming Potential of 1. This is done to enable the simple comparison of various gases and their effect on the global climate. The term 'carbon' is then often used to represent all Global Warming Potential gases.

Climate Change A change in the state of the climate that can be identified (e.g. by using statistical tests) by alterations in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer.

Climate Justice This links development and human rights to achieve a human-centred approach to addressing climate change, safeguarding the rights of the most vulnerable people and sharing the burdens and benefits of climate change and its impacts fairly. This definition builds upon the one used by the Mary Robinson Foundation – Climate Justice (https://www.mrfcj.org/).

Climate Model A numerical representation of the climate system based on the physical, chemical and biological properties of its components, their interactions and feedback processes, and accounting for some of its known properties. The climate system can be represented by models of varying complexity. Climate models are applied as a research tool to study and simulate the climate and for operational purposes, including monthly, seasonal and interannual climate predictions.

Climate Projection The simulated response of the climate system to a scenario of future emission or concentration of greenhouse gases and aerosols, generally derived using climate models. Climate projections are distinguished from climate predictions by their dependence on the emission/concentration/radiative-forcing scenario used, which is in turn based on assumptions concerning, for example, future socioeconomic and technological developments that may or may not be realised.

Co-Benefits The positive effects that a policy or measure aimed at one objective might have on other objectives, thereby increasing the total benefits for society or the environment. Co-benefits are often subject to uncertainty and depend on local circumstances and implementation practices, among other factors. Co-benefits are also referred to as 'ancillary benefits'.

Conservation All actions designed to understand a heritage property or element, know, reflect upon and communicate its history and meaning, facilitate its safeguard and manage change in ways that will best sustain its heritage values for present and future generations (Nara + 20, 2015).

Conservation-Management Plan A document that is used as the framework for managing a heritage place, including any future change. It identifies the heritage significance of the place and how that significance is vulnerable to change. It then identifies policies that will conserve that significance in the future. In some countries, the term 'conservation plan' is also used (ICOMOS International Committee on Twentieth Century Heritage, 2017).

Cost-Effectiveness The degree to which something is effective or productive in relation to its cost.

Cost-Effectiveness Analysis (CEA) is a form of economic analysis that compares the relative costs and outcomes (effects) of different courses of action. CEA is distinct from cost–benefit analysis, which assigns a monetary value to the measure of effect (Wikipedia). CEA is recommended in this plan because it is not feasible to monetise the benefits of climate-change adaptation for heritage values.

[81] The majority of the definitions are drawn from the ICOMOS International Working Group on Climate Change outline document, The Future of Our Pasts (2019), which itself relied heavily on the following sources: IPCC, 2018 (Annex I: Glossary); ICOMOS Australia, 1999; ICOMOS International Committee on Twentieth Century Heritage, 2017.

Cultural Heritage An expression of the ways of living developed by a community and passed on from generation to generation, including customs, practices, places, objects, artistic expressions and values. Cultural heritage is often expressed as either intangible or tangible cultural heritage (ICOMOS, 2002). Heritage is not only manifested in tangible forms such as artefacts, buildings or landscapes but also in intangible forms. Intangible heritage may include cuisine, clothing, forms of shelter, traditional skills and technologies, religious ceremonies, performing arts and storytelling.

Cultural Landscape The combined works of nature and of humankind, illustrative of the evolution of human society and settlement over time in response to physical constraints and/or opportunities presented by their natural environment and of successive social, economic and cultural forces, both external and internal.

Cultural Significance (also 'significance') The aesthetic, historic, scientific, social and/or spiritual value of a heritage asset for past, present or future generations. Cultural significance is embodied in a heritage site itself, its attributes, its setting, fabric, use, associations, meanings, records, related places and related objects. Heritage places may have a range of significances for different individuals or groups (ICOMOS International Committee on Twentieth Century Heritage, 2017). The cultural significance of a place and other issues affecting its future are best understood by a sequence of collecting and analysing information before making decisions. Understanding cultural significance comes first; then comes development of policy; last comes management of the place in accordance with that policy. This is the Burra Charter process (ICOMOS Australia, 1999).

Disaster Risk The potential loss of life, injury or destruction of or damage to assets which could occur in a system, society or community in a specific period of time, determined probabilistically as a function of hazard, exposure, vulnerability and capacity (United Nations International Strategy for Disaster Reduction (UNISDR), 2017).

Disaster-Risk Assessment A qualitative or quantitative approach to determining the nature and extent of disaster risk by analysing potential hazards and evaluating existing conditions of exposure and vulnerability that together could harm people, property, services, livelihoods and the environment on which they depend.

Disaster-Risk Management The application of disaster-risk-reduction policies and strategies to prevent new disaster risk, reduce existing risk and manage residual risk, contributing to the strengthening of resilience and reduction of disaster losses (UNISDR, 2017).

Disaster-Risk Reduction The prevention of new disaster risk, the reduction of existing risk and the management of residual risk, all of which contribute to strengthening resilience and therefore to the achievement of sustainable development. Disaster-risk reduction is the policy objective of disaster-risk management, and its goals and objectives are defined in disaster-risk-reduction strategies and plans (UNISDR, 2017).

Emission Scenario A plausible representation of future emissions of substances that are radiatively active (e.g. greenhouse gases, aerosols) based on a coherent and internally consistent set of assumptions about driving forces (such as demographic and socioeconomic development, technological change, energy and land use) and their key relationships. Concentration scenarios, derived from emission scenarios, are often used as input to a climate model to compute climate projections.

Exposure The degree to which an identified heritage value is exposed to climatic variations and their related impacts. It is determined by environmental conditions (physical and atmospheric).

Greenhouse Gases These include a number a gases such as carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O) that, when released, warm the atmosphere and contribute to climate change. The burning of fossil fuels is a common source of anthropogenic greenhouse gases.

Hazard A potential source of harm.

Heritage Asset An item that has value because of their significance as cultural heritage (see below). In this document, the concept refers primarily to tangible physical assets such as buildings, sites and objects.

Heritage Resource One of the tangible and intangible elements that together make up cultural heritage. Tangible cultural heritage is generally considered a non-renewable resource – once a heritage asset is lost, any replacement or reproduction would not have the same value.

Life-Cycle Assessment Compilation and evaluation of the inputs, outputs and potential environmental impacts of a product or service throughout its life cycle.

Local Knowledge The understandings and skills developed by individuals and populations, specific to the places where they live. Local knowledge informs decision-making about fundamental aspects of life, from day-to-day activities to longer-term actions. This knowledge is a key element of the social and cultural systems that influence observations of and responses to climate change; it also informs governance decisions (ICOMOS International Climate Change Working Group, 2019).

Maintenance The continuous protective care of a place and its setting. Maintenance is to be distinguished from repair, which involves restoration or reconstruction. Maintenance is fundamental to conservation. Maintenance should be undertaken where fabric is of cultural significance and it is necessary to retain that cultural significance (ICOMOS Australia, 1999).

Maladaptive Actions (Maladaptation) Actions that may lead to increased risk of adverse climate-related outcomes, including via increased greenhouse-gas emissions, increased vulnerability to climate change or diminished welfare, now or in the future. Maladaptation is usually an unintended consequence.

Mitigation (of climate change) A human intervention to reduce emissions or enhance the sinks of greenhouse gases. A sink is any process, activity or mechanism which removes a greenhouse gas or aerosol from the atmosphere.

Ocean Acidification A reduction in the pH of the ocean over an extended period, typically decades or longer, which is caused primarily by uptake of carbon dioxide (CO2) from the atmosphere, but can also be caused by other chemical additions to or subtractions from the ocean. Anthropogenic ocean acidification refers to the component of pH reduction that is caused by human activity (IPCC, 2018).

Resilience The capacity of social, economic and environmental systems to cope with hazardous events, trends or disturbances, responding or reorganising in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, learning and transformation.

Risk Assessment The qualitative and/or quantitative scientific estimation of risks.

Risk Management Plans, actions, strategies or policies intended to reduce the likelihood and/or consequences of risks or to respond to consequences.

Risk The potential for adverse consequences where something of value is at stake and where the occurrence and degree of an outcome is uncertain. In the context of the assessment of climate-change impacts, the term ‘risk’ is often used to refer to the potential for adverse consequences of a climate-related hazard, or of adaptation or mitigation responses to such a hazard on lives, livelihoods, health and well-being, ecosystems and species, economic, social and cultural assets, services (including ecosystem services) and infrastructure. Risk results from the interaction of vulnerability (of the affected system), its exposure over time (to the hazard) and as the (climate-related) hazard and the likelihood of its occurrence.

Sensitivity is the degree to which an identified heritage value is affected, either adversely or beneficially, by (climate-related) stimuli. The effect may occur at artefact, assemblage or system level.

Storm Surge is a rise in sea level that occurs during tropical cyclones, hurricanes and intense storms also known as typhoons. The storms produce strong winds that push the water in to shore, which can lead to flooding. This makes storm surge very dangerous for coastal regions.

Sustainable Development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs (UN World Commission on Environment and Development, 1987) and balances social, economic and environmental concerns. (See also Sustainable Development Goals (SDGs).)

Sustainable Development Goals (SDGs) The 17 global goals for development for all countries established by the United Nations through a participatory process and elaborated in the 2030 Agenda for Sustainable Development, including: ending poverty and hunger; ensuring health and well-being, education, gender equality, clean water and energy and decent work; building and ensuring resilient and sustainable infrastructure, cities and consumption; reducing inequalities; protecting land and water ecosystems; promoting peace, justice and partnerships; and taking urgent action on climate change. (See also Sustainable Development.)

Tangible and Intangible Heritage Heritage is not manifested through material entities like artefacts, buildings and landscapes, but also through abstract entities. Intangible heritage may include cuisine, clothing, forms of shelter, traditional skills and technologies, religious ceremonies, performing arts and storytelling.

Uncertainty A state of incomplete knowledge that can result from a lack of information or from disagreement about what is known or knowable. It may have many sources, from imprecision in the data to ambiguously defined concepts or terminology, incomplete understanding of critical processes or indeterminate projections of human behaviour.

Vulnerability Assessment A growing field with multidisciplinary origins. There are two basic approaches to vulnerability: biophysical and social. In the biophysical approach vulnerability is conceptualised as a pre-existing condition determined by exposure and sensitivity to hazard. It is similar to risk but differs in the absence of probability as a function. In the social approach vulnerability is dependent on the social, political and economic determinants that control resistance and recovery – i.e. adaptive capacity. A growing number of researchers combine the social and biophysical when conducting vulnerability assessments. The ultimate goal of vulnerability assessment is to inform decision-makers about options for adapting to the effects of global change.

Vulnerability The degree to which an identified cultural-heritage value is susceptible to, or will be adversely affected by, effects of climate change, including climate variability and extremes. Vulnerability (V) is a function of exposure (E), sensitivity (S) and adaptive capacity (AC), as represented by the equation $V = (E + S) - AC$.

Abbreviations

AA Appropriate Assessment

AACO Association of Architectural Conservation Officers

ACA Architectural Conservation Area

ASI Archaeological Survey of Ireland

BSI Blue Shield Ireland

CARO Climate Action Regional Office

CCAC Climate Change Advisory Council

CCAG Climate Change Advisory Group

CCSAP Climate Change Sectoral Adaptation Plan

CCPT Climate Change Planning Team

CEA Cost-Effectiveness Analysis

CFRAM Coastal Flood Risk Assessment and Management

CHERISH Climate, Heritage and Environments of Reefs, Islands and Headlands

CI Climate Ireland

CIF Construction Industry Federation

CNCI Council of National Cultural Institutions

DAFM Department of Agriculture, Food and the Marine

DCCAE Department of Communications, Climate Action and Environment

DCHG Department of Culture, Heritage and the Gaeltacht

DHPLG Department of Housing, Planning and Local Government

EI Engineers Ireland

EPA Environmental Protection Agency

EU European Union

FI Fáilte Ireland

GIS Geographic Information System

GLAM Galleries, Libraries, Archives and Museums

GSI Geological Survey Ireland

HC Heritage Council

HES Historic Environment Scotland

HON Heritage Officer Network

IAI Institute of Archaeologists of Ireland

ICHEC Irish Centre for High-End Computing

ICOMOS International Council on Monuments and Sites

ICPSS Irish Coastal Protection Strategy Study

ICRI Institute of Conservator-Restorers in Ireland

IGS Irish Georgian Society

IPCC Intergovernmental Panel on Climate Change

IPI Irish Planning Institute

NAF National Adaptation Framework

NASC National Adaptation Steering Committee
NIAH National Inventory of Architectural Heritage
NMI National Museum of Ireland
NMS National Monuments Service
OPW Office of Public Works
RCB Representative Church Body
RIAI Royal Institute of the Architects of Ireland
RMP Record of Monuments and Places
RPS Record of Protected Structures
RS Research Sector
SDG Sustainable Development Goal
SEA Strategic Environmental Assessment
SEAI Sustainable Energy Authority of Ireland
SLR Sea-Level Rise
SMR Sites and Monuments Record
STORM Safeguarding Cultural Heritage through Technical and Organisational Resources Management
TCD Trinity College Dublin
UHI Urban Heat Island
UNDRR United Nations Office for Disaster Risk Reduction
UNFCCC United Nations Framework Convention on Climate Change
UNISDR United Nations International Strategy for Disaster Reduction
WIID Wreck Inventory of Ireland Database
WN Written Notification

Appendix II: Relevant Policy and Planning Legislation

There are many planning and protection protocols and legislation in place for historic buildings, archaeological sites and natural sites that can be relevant when adapting built and archaeological heritage to the impacts of climate change. These may include, but are not limited to:

- National Monuments Act 1930-2004
- Planning and Development Act 2000 (as amended)
- Planning and Development Regulations 2001 (as amended)

also

- Architectural Heritage (National Inventory) and Historic Monuments (Miscellaneous Provisions) Act 1999
- Arterial Drainage Act 1945 (as amended)
- Forestry Act 2014 (as amended)
- Forestry Regulations 2017 (as amended)

- Planning and Development (Strategic Infrastructure) Act 2006
- Wildlife Acts 1976-2018

Appendix III: Development Team

An experienced multidisciplinary team was gathered for the preparation of this work.

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Notes

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