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# Developing Climate Risk Assessments for World Heritage: the Climate Vulnerability Index

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## Summary



Aerial view of the New Towns of Edinburgh, taken from the north in 2007, looking across to the Castle and Old Town © Historic Environment Scotland

Climate change is recognised by [ICOMOS](#) and the [IUCN](#) as the fastest growing threat to World Heritage (WH) properties. The [Climate Vulnerability Index](#) (CVI) was first piloted at the Natural WH property of Shark Bay, Western Australia, in 2018; the first application to a Cultural WH property took place in April 2019 at the [Heart of Neolithic Orkney](#) in Scotland. This article outlines the results of the Orkney workshop together with one for Edinburgh conducted in May-June 2021 and looks at the benefits of the CVI assessment process.



# 1. Introduction

'Climate change has become one of the most significant and fastest growing threats to people and their cultural heritage worldwide.' International Council on Monuments and Sites (ICOMOS) 2017 (Resolution 19th General Assembly of ICOMOS [2017](#)).

'Climate change is the fastest growing threat to natural World Heritage.' International Union for the Conservation of Nature (IUCN) [2017](#).

These two statements made in 2017 by the two advisory bodies to the World Heritage Centre at the United Nations Educational Scientific and Cultural Organisation (UNESCO) declare what is now widely recognised: that climate change poses a growing threat to our global heritage. In the case of World Heritage (WH), these properties have been deemed nationally and internationally of outstanding value to all humanity for their cultural and/or natural values. There are currently (as at end of 2021) 1154 properties inscribed on the [World Heritage list](#) from 167 countries.

While there are various tools and techniques available for assessing climate change risks to heritage sites, the [Climate Vulnerability Index](#) (CVI) was developed by two of the authors (Day and Heron) as a rapid yet systematic assessment tool that is applicable to all types of World Heritage properties. Thanks to support from ICOMOS's [Climate Change and Heritage Working Group](#), the [Union of Concerned Scientists](#) (USA) and, most recently, the [Royal Society of Edinburgh](#), we report here on the application of the CVI to two World Heritage properties in Scotland.

## 2. The Climate Vulnerability Index (CVI)

The CVI has been developed to apply a risk-assessment approach that builds on the vulnerability framework used by the [Intergovernmental Panel on Climate Change](#) (IPCC). This has been customised in order to be applied to World Heritage (and now other heritage) properties.

The CVI methodology is intended to be rapid, systematic, repeatable and flexible, thereby making it adaptable to a wide array of properties. Its first application was for the *natural* World Heritage property of Shark Bay, Western Australia in 2018 (followed up in 2019: Heron *et al.* [2020a](#)). After this initial trial, some of the initiators of the project - Scott Heron and Jon Day of James Cook University, Australia, and Adam Markham from Union of Concerned Scientists - worked with the ICOMOS Climate Change and Heritage Working Group to select a *cultural* World Heritage property to test the CVI framework.



Figure 1: Aerial view of the Ring of Brodgar, part of the Heart of Neolithic Orkney World Heritage property, taken in 2019 (© Historic Environment Scotland)

The property selected was the [Heart of Neolithic Orkney](#) (HONO), a group of four sites on the main island (Mainland) of Orkney (an archipelago in the north of Scotland) that represents one of the most complete and impressive Neolithic landscapes in western Europe (Figure 1). HONO was chosen to trial the CVI approach because of the recognition of the vulnerability of the Orkney sites to climate change impacts; leadership and innovation by [Historic Environment Scotland](#) (HES – Scotland's lead body for the historic environment) in addressing the heritage impacts of climate change; the active engagement by the [Archaeology Institute of the University of the Highlands and Islands](#) (UHI), along with the wider Orkney community and a wide array of local researchers; and the availability of good local climate change scenarios and research. HES manage the component parts of the WH property and its overall coordination, in partnership with the Council. As a member of ICOMOS's Climate Change and Heritage Working Group, the Director of the Archaeology Institute at the University of the Highlands and Islands, Professor Jane Downes, enthusiastically supported the analysis. The second Scottish WH property selected for a CVI application was the Old and New Towns of Edinburgh in 2022, with other workshops planned in the coming years.

The CVI process is run as a collaborative workshop and uses the property's Statement of Outstanding Universal Value (SOUV – outlining the reason for its inscription on the World Heritage list) as the foundational basis for the CVI assessment. The *OUV Vulnerability* for the property considers how the recognised values will be affected by climate change and is determined by assessing the exposure, sensitivity, and adaptive capacity with respect to physical climate stressors. Another key feature of the CVI is the assessment of the *community* associated with the property. This *Community Vulnerability* is



undertaken by considering economic, social and cultural impacts, and the capacity of the community to adapt to future change.

## 3. Applying the CVI to Orkney

*Webinar: Introduction to the Orkney Climate Vulnerability Index workshop*

In order to effectively plan the Workshop, a Steering Group was set up comprising representatives from HES, the UHI Archaeology Institute, Orkney Islands Council, the Union of Concerned Scientists and the CVI developers from James Cook University. This group met regularly in early 2019 on Zoom (before it became a normal mode of working!) to plan the workshop, which took place over three days in Orkney in April 2019. In advance of the workshop, a webinar was created presenting climate science data and climate change management in relation to Orkney.



Figure 2: Workshop participants discussing climate risks at Skara Brae, Orkney (@ 2019 Frank Bradford Photographer)

There were 36 participants at the workshop, with over half intentionally drawn from the local community in Orkney (Figure 2). Alongside the international members of the Steering Group (US and Australia) there were participants from Ireland, Norway and England as well as the other Scottish island groups. Participants were chosen because of their range of expertise, including archaeology, climate science, site management, planning, academia and tourism.

Prior to the workshop, the Steering Group went through the Statement of Outstanding Universal Value for HONO and grouped excerpts into eight key values (e.g. prehistoric cultural landscape; architecture) – these formed the basis for the assessments throughout the CVI workshop. Participants were asked to think about



other Significant Property Values (SPVs) for HONO and its environs, to capture the wider values that were important to the community but not explicitly stated in the SOUV.

Participants evaluated the current condition and recent trend for each of the eight key values taken from the SOUV, benchmarked against the date of WH inscription (1999). Current condition was assessed as: Good, Good with some concerns, Significant concern or Critical; categories for assessment of recent trend were Stable, Improved or Deteriorated. A series of break-out groups discussed various pre-determined climate stressors and considered their impact on the eight key values. For this, a timescale and climate future scenario were selected to consider impacts (c. 2050, RCP8.5). Using a ranking system, the top three climate stressors likely to have the greatest impact on the OUV for HONO were determined as:

- Sea level rise (trend) (noted as Sea Level Change in the report as the stressors have since been updated);
- Precipitation trend; and
- Storm intensity and frequency.

One further benefit from this rapid approach, gathering the views of a range of stakeholders, was the identification of research needs and policy gaps. The impact of Temperature trend (air/water) was considered an unknown and flagged for further work in the future. This could affect the humidity in the inner chamber at Maeshowe chambered tomb, changes to flora and fauna of the contemporary landscape, and changes to biological activity on the stone monuments.

Once selected, the predicted exposure to the three climate stressors was assessed, as were the sensitivity of property values to those and the adaptive capacity of the property and its management. These assessments were discussed in break-out groups and subsequently synthesised in plenary. The potential impact of these climate stressors on the key values for HONO was determined as **extreme** (the highest category on a four-point low to extreme scale), recognising the potential for major loss or substantial alteration to the key values comprising the property's OUV.

The Adaptive Capacity of the OUV was then assessed by considering the local management response and scientific support and their effectiveness. These were all determined as moderate to high (on a three-point low to high scale). All these statistics were combined to produce an overall vulnerability of HONO's OUV as high (highest on a three-point scale).

The workshop then considered the vulnerability of the community associated with the property by assessing the economic, social and cultural components of dependency (i.e. sensitivity) and the resilience of the community to climate change risks. Again, these were discussed in break-out groups and outcomes synthesised in plenary. The economic component focused on the tangible effect on businesses dependent on HONO, including tourism, conservation, education and services, noting that tourism was predominant at that time. Less tangible effects were considered in the social and cultural assessments. Combining the results from the discussions led to the conclusion that the overall economic, social and cultural dependency of HONO was at a moderate-negative level, while the adaptive capacity of the local community was



recognised to be high. Combining all these assessments determined that the Community Vulnerability for HONO was **moderate** (on a three-point low to high scale).



Figure 3: Damage to the footpath at the Ring of Brodgar, Orkney, taken in 2019 (© Historic Environment Scotland)

While the HONO property is highly vulnerable to the pressures of climate change, the Community Vulnerability was in the middle category, recognising the adaptive capacity of the community on Orkney. Overall, the workshop participants recognised that climate impacts are increasingly likely to add to and compound other issues on the islands, which include increased tourism numbers, infrastructure development and changing agricultural practices (Figure 3). While the Covid pandemic had a dramatic impact on tourism for Orkney, the gradual return of cruise ships and other tourists to the islands in 2021 has demonstrated that there will still be a tourism demand on Orkney, but the exact character of this in the future is now far harder to predict.

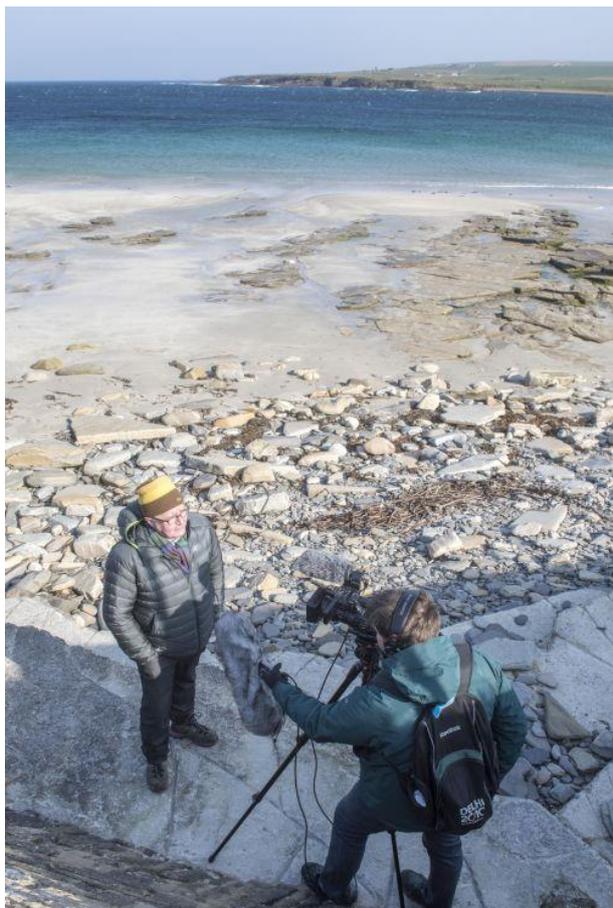


Figure 4: Adam Markham (Union of Concerned Scientists, US) being interviewed by the media at the seawall at Skara Brae on Orkney (@ 2019 Frank Bradford Photographer)

What the categorical assessments did not show was the other outcome of the CVI Workshop, in that it served as a significant catalyst for conversations about climate change, heritage and the Heart of Neolithic Orkney across a diverse and insightful group of people. There was a significant amount of media interest, with interviews conducted for radio and television as well as various media articles highlighting the pioneering aspect of the work (Figure 4). An evening event presenting the results held at the UHI Archaeology Institute (Orkney College in Kirkwall) was at capacity, demonstrating the interest of the local community in the workshop and its results. (For the report of the workshop see Day *et al.* [2019](#).)

## 4. Applying the CVI to Edinburgh

After the HONO application, there were further refinements to the CVI process by the developers. In 2020, a CVI workshop assessing OUV Vulnerability was held for the Wadden Sea natural World Heritage property (Heron *et al.* [2020b](#)) (in Germany, Netherlands and Denmark). With travel constraints resulting from the pandemic, CVI applications were transitioned to online delivery and in 2021 these included the second phase assessment of Community Vulnerability for Wadden Sea and the full CVI for Sukur Cultural Landscape (Nigeria). Preparations are underway for further applications across three continents.



The partners in HES and James Cook University were keen to further embed the CVI workshop process in the Management Planning for World Heritage in Scotland. An application was submitted to the Royal Society of Edinburgh's Arts and Humanities Research Network fund for a two-year research grant aimed at delivering further CVI workshops for World Heritage in Scotland as well as provide training to the Scottish coordinators and partner organisations. This funding enabled the partners to successfully host an online CVI workshop over five half-days in late May/early June 2021 for the Old and New Towns of Edinburgh (ONTE) World Heritage property. While the Covid pandemic normalised online working for the workshop leaders and participants, the time zone differences between Scotland and Queensland meant that morning sessions (UK time) were preferred, which were early evening in Australia. In addition to being the first CVI workshop fully conducted online, the application for ONTE was the first heritage city assessed using the CVI process.



Figure 5: Aerial view of the New Towns of Edinburgh, taken from the north in 2007, looking across to the Castle and Old Town © Historic Environment Scotland

ONTE was inscribed in 1995 (Figure 5). The World Heritage property comprises the significant centre of the city including the:

- inward-looking and defensive medieval city;
- expansive Enlightenment planning of the 18th and 19th centuries in the New Town; and
- 19th-century rediscovery and revival of the Old Town, with Scottish Baronial architecture adapted for an urban setting.

Edinburgh had a major influence on the development of urban architecture and town planning throughout Europe in the 18th and 19th centuries.



As with the HONO workshop, the Steering Group created a key values document based on the SOUV for ONTE. The CVI workshop benefited from the availability of good climate data for the area and a Climate Change Risk Assessment (CCRA) for the city undertaken by Edinburgh World Heritage.



Figure 6: Participants at the online Old and New Towns of Edinburgh workshop

Forty participants from various sectors represented national and local bodies, local community representatives, academia and tourism (Figure 6). Starting with the key values document, there was considerable discussion regarding their current condition and recent trend, which was revisited on the final day following further refinement. Many of the participants were concerned about the impact of developments within the World Heritage property, and the cumulative impacts of many small-scale developmental changes. But it was eventually resolved that some of these did not have a significant detrimental impact on the overarching key values for which the property was inscribed.

When the key climate stressors were discussed, the focus was on those representing aspects of the water-cycle, temperature and storms:

- Precipitation trend
- Temperature trend
- Storm intensity and frequency.

The workshop then followed a similar format to that of HONO, with exposure to climate stressors assessed for c. 2050 assuming a high-emissions scenario (RCP8.5). This assessment and those of the property's sensitivity to and adaptive capacity in response to the key climate stressors were discussed in (virtual) breakout groups, and these were then synthesised in plenary. The OUV Vulnerability with respect to Precipitation trend was high, while that for Temperature trend and Storm intensity and frequency was moderate (three-point scale, low to high). The overall assessment of OUV Vulnerability was **moderate**, indicating a balance between the likelihood for extreme weather with the sensitivity and adaptive capacity of the overall property.



Discussions of the economic, social and cultural aspects were far more complex for ONTE than HONO, unsurprising for a major city that is the capital of Scotland, internationally renowned for its festivals and also a UNESCO Creative City of Literature. A lesson learned for future workshops was to spend more time on this aspect for the more complicated properties such as cities, and that the ONTE application would have benefited from running the workshop over six half-days (rather than five). However, the CVI process was successfully completed and concluded that the Community Vulnerability of the overall property was **moderate** (on a three-point scale, low to high).

Some benefits were absent from the online workshop that were apparent during the in-person Orkney workshop, such as the participants being able to mingle, to experience the property together and to interact during plenary and break-out sessions. It was, nevertheless, a valuable discussion by multiple stakeholders of the issues that the city faces in the climate emergency and how they should consider aspects of mitigation.

Following the workshop, five members of the ONTE CVI Steering Group discussed the results at an Edinburgh World Heritage's 'In Conversation' online event: Heritage Under Threat: Climate Change and the Old and New Towns of Edinburgh.

*Heritage Under Threat | Climate change and the Old and New Towns of Edinburgh*

## 5. Next Steps

The results of the HONO workshop were published as a [report](#) and YouTube video. Other methods to promote the CVI and its results have included online articles (e.g. Heron *et al.* [2019](#)) and the report was presented at an ICOMOS Climate Change and Heritage Working Group event at the World Heritage Committee in Baku, Azerbaijan, in July 2019 (Figure 7).

*Evaluating the impact of climate change on World Heritage sites*

The project also helped to raise the profile of Scotland's World Heritage and Climate Heritage work internationally (e.g. UNESCO [2020](#); [2021](#)). This also supports HES's lead role in climate heritage, with the [launch](#) of the Climate Heritage Network at Edinburgh Castle in autumn 2019.



Figure 7: Dr Scott Heron presenting the CVI at the 43rd World Heritage Committee in Baku, Azerbaijan

The results of the CVI for HONO are feeding directly into the next Management Plan for the property. Climate change will be a key theme, woven throughout the plan. In many ways, the application of the CVI process is only the beginning. Through this, the vulnerability of the World Heritage property was assessed, but it does not tell us what to do about it. However, it proved to be a useful tool for focusing minds and generating discussions and ideas. Importantly it has ensured that the climate vulnerability of the property and its associated community are key considerations in the management regime. The outcomes will inform choices made by the partners, including the potential to aid with difficult decisions further down the line for the management partners and the community associated with the property.

The current Edinburgh World Heritage Management Plan is undergoing review and the ONTE workshop was also timely in that management planning cycle as well as connecting with Edinburgh World Heritage's CCRA work. Several opportunities were taken to discuss some of the issues at events associated with the COP26 summit in Glasgow in November 2021 (e.g. An online Climate Resilience Heritage Summit in late October 2021: *UK heritage agencies join forces to protect heritage from climate change*).



## 6. Future CVIs in Scotland

The partners completed our next online workshop for the Frontiers of the Roman Empire: the Antonine Wall (FRE-AW) in February 2022 and are currently drafting the workshop report. This Roman monument stretches for some 60km between the Firths of Clyde and Forth in central Scotland (Figure 8). Unlike its southern neighbour, Hadrian's Wall, the Antonine Wall is a turf rampart with a deep ditch in front, with several forts, fortlets and other structures along its length. Built 'to separate the Romans from the barbarians' (SHA *Antoninus Pius* 5.4) and only occupied for a generation in the mid-2nd century AD, it is part of the transboundary World Heritage property together with Hadrian's Wall in England and the Upper German-Raetian *Limes* in Germany.



Figure 8: Aerial view of the Antonine Wall and Roman fort at Rough Castle, looking west along the Wall, taken in 2006 © Historic Environment Scotland

A Climate Change Risk Assessment published in 2018 (HES [2018](#)), included those stretches of the Antonine Wall that are Properties in the Care of Scottish Ministers (and looked after by HES). This risk assessment concluded that a number of stretches had a high risk of slope instability, groundwater flooding and pluvial flooding, and is currently being revised using new climate projection, new flood maps and a new coastal erosion dataset.

The FRE-AW Climate Vulnerability Index work will aid our understanding of the vulnerability of the property. The workshop results suggested a level of inherent risk to the property, which needs to be mitigated in order to reduce the impacts from climate change and this will feed into the management planning cycle for the Antonine Wall.



In the far north of mainland Scotland, the Flow Country is a region of unique blanket bog that will become the UK's next nomination for WH inscription (planned for 2023). Taking advantage of existing travel by the CVI developers to Europe, a small workshop was conducted to consider climate vulnerability of this region for inclusion within the nomination dossier in March 2022. Whilst not a full CVI analysis, this was the first time the CVI techniques were applied for a proposed WH nomination.

Later in 2022, Covid restrictions permitting, it is planned to hold an in-person CVI workshop for St Kilda, the UK's only 'mixed' World Heritage property (inscribed for both its cultural and natural heritage). This will provide an opportunity for the Australian CVI developers to train coordinators and others in Scotland. This will enable HES to conduct CVIs in future and to mainstream these analyses into their management planning processes. After this, it is hoped to complete assessments of the remaining WH properties in Scotland.

The collaboration between HES and CVI has proven very successful in providing assessing the climate vulnerability of Scotland's World Heritage. The applications of the methodology with local partners and participants have demonstrated how the CVI approach is effective across a range of property types. As noted, the outcomes are contributing to the management of the properties, including the identification of knowledge gaps, research opportunities and policy needs. In the current era of rapidly evolving climate change, this understanding is critical to support and maintain these places and their globally-significant heritage.

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