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Understanding the impacts of climate change on cultural heritage buildings: a case of York, UK

Ksenia Chmutina¹, Rohit Jigyasu² and Lee Bosher¹

¹ School of Civil and Building Engineering, Loughborough University, UK
²Ritsumeikan University, Japan

Abstract

Cultural heritage is not only an important part of a country’s identity but also a key driver of tourism (which can play an important role in a nation’s economic and social resilience). However worldwide heritage buildings are gradually becoming more vulnerable, due to natural decay and deterioration, effects of climate change, and human-induced impacts, such as poor or ineffective maintenance. An increased number of extreme weather events, many of which are associated with the impacts of climate change, are posing significant problems in managing and conserving cultural heritage around the globe. Being exposed to a number of natural hazards and having a great cultural heritage, York (UK) presents a case study that provides the basis for the exploration of the strategies required for the improved disaster risk management of vulnerable heritage buildings. Through the engagement with practitioners responsible for the management of a range of heritage sites, this paper identifies the challenges faced when considering climate change adaptation measures. It argues that improved climate change adaptation and enhanced hazard mitigation strategies, involving a broad range of suitably trained stakeholders, are extremely important considerations when it comes to the assessment, maintenance and conservation of cultural heritage.

Keywords: cultural heritage buildings, climate change, mitigation, adaptation, case study
1. Introduction

Heritage sites are crucial assets for local communities and national states on both social and economic levels (Choi et al., 2010). Despite having stood strong for, in some cases, thousands of years, they remain under constant threat from natural hazards and human-induced threats. While close attention is paid to the protection of human life and livelihood as well as economic infrastructure, the protection of cultural heritage can be somewhat overlooked and under prioritised. A key factor indicating the need to increase the resilience of heritage sites to the impacts of climate change is the particular fragility of their historic fabric (Throsby, 2012), and thus their vulnerability to the effects of climate change and impacts of natural hazards.

Cultural heritage is exposed to a number of risks that can be divided into natural hazards (such as earthquakes and volcanoes), and those related to climate change (such as increased precipitation, flooding, droughts and heat waves). In addition, human-induced threats, which are essentially social and economic in nature and range from increased urbanisation, mass tourism and traffic congestion to industrial air pollution and increasing energy demand, can compound the problem (Jigyasu, 2006). All the risks associated with natural hazards, impacts of climate change, and human-induced threats, put significant pressures on cities and possible conservation efforts of historic urban environments. The increasing vulnerability of heritage sites and their assets is not merely due to increased exposure to hazards and extreme weather events. With increasing urbanisation, many urban heritage sites are now becoming engulfed by dense urban areas with huge concentrations of people and restricted access for emergency vehicles and personnel. Transformation processes in historic settlements are also breaking traditional urban boundaries, disturbing delicate ecological relationships and exposing these settlements to increased disasters and climate-related risks. Furthermore, cities have special climates which, due to complex characteristics, can be very difficult to predict: streets and buildings alter wind patterns and solar radiation, resulting in temperature and humidity changes as well as precipitation and pollutant concentrations.

The increasing pressures on heritage sites’ environment, carrying capacity and socio-economic developments are likely to reach a critical point in the near future and require urgent action (UNISDR, 2015). As a consequence of the ever changing environmental and economic climates, heritage sites may currently be exposed to a greater risk from various threats than ever before in history (Croft, 2013). Heritage sites are critical to any community, and the importance of their conservation cannot be understated. Post disaster damage and potential destruction of heritage sites can cause catastrophic emotional damage to communities and residents, the avoidance of such occurring should be viewed with the utmost importance (Spennemann and Graham, 2007). Heritage sites are not merely important on a sentimental level: the economic and social benefits of their conservation have to be considered. They provide communities with character and substance, but the economic value of these sites and the revenue and tourism they bring to communities should also be noted (Choi et al., 2010).
In using York as a case study, this paper will explore current approaches to climate change mitigation for cultural heritage and discuss the challenges to the implementation of climate change adaptation measures, as well as the gaps in these strategies.

2. Types of climate change adaptation and mitigation measures for cultural heritage buildings

Whilst a great range of disaster risk reduction measures exist, not all of them are appropriate for cultural heritage due to their potential negative impacts on their values. However a number of structural and non-structural measures can be utilised if used appropriately taking into account the specific heritage values.

Non-structural activities such as education and training are the most appropriate in the context of cultural heritage. A number of training programmes have been set up that focus on heritage specific engineering techniques: they are designed to train stakeholders in heritage engineering and to equip them with the skills required to continually maintain cultural heritage sites, and sufficiently protect sites from natural hazards and human-induced threats. Hazard mapping is also becoming increasingly popular. For instance in the UK, English Heritage have recently began working with the Environment Agency to map hazards and potential threats around the UK, and is reflected in the UK National Heritage Protection Plan (Davis, 2002). Non-structural adaptation measures for cultural heritage sites also include financial management, visitation practices, and policies.

Structural adaptations are sometimes inevitable; however, they should be avoided where possible due to the risk of altering the fabric of a heritage site. For instance, Jigyasu (2006) highlights that some post-earthquake reconstruction measures in Marathwada region of India led to the destruction of significant components of cultural heritage rather than to protecting them. In the UK heritage sites are not permitted to perform key structural changes or introduce major structural measures. However, structural adaptations can be applied to sites by professional construction stakeholders (Davis, 2002) – this however is not often performed as it requires extra funding. It is also important to bear in mind that structural measures applied within the surrounding landscape might also reduce or increase the probability and the extent of the hazards’ impact (Perry, 2015). These measures are to an extent supported by a number of international, regional and national frameworks described in the next section.

2.1 Legal framework and governance for the protection of cultural heritage from climate-induced hazards

In 1954 the first convention designed to draw attention to heritage protection was put in place - the Hague convention for the Protection of Cultural Property in the Event of Armed Conflict
(UNESCO, 1954). It outlined that the protection of world heritage and culture from human-induced threats, such as armed conflict, should be a priority on both a national and international level, and further underlined that these sites require safeguarding and treating with the utmost respect. This followed by the establishment of the ICOMOS principles and charters of heritage conservation, which over years have not only extended the scope of cultural heritage beyond select monuments but also conservation approaches beyond mere preservation to management of change.

More recently, the Sendai Framework for Action (SFA) (UNISDR, 2015) marks significant progress with respect to the former policy document on disaster risk reduction (DRR), the Hyogo Framework for Action. Culture is now explicitly recognised as a key dimension of DRR and the need to protect and draw upon the various benefits of heritage as an asset for resilience is more clearly highlighted (Dean and Boccardi, 2015).

The UNESCO World Heritage Committee has recommended that State Parties include risk preparedness as an element in their World Heritage site management plans and training strategies (Paragraph 118 Operational Guidelines). This was extended in 2011 to all cultural heritage sites by highlighting risk management within the Historic Urban Landscape approach that emphasised the necessity of legal compliance and effective integration into national or regional legislation (UNESCO, 2011). In order to ensure the effectiveness it emphasises the particular importance of raising awareness and communicating the benefits of a formalised risk management approach in order to increase political will and to increase the resilience and the safeguarding of the historic cities to the primary and secondary hazards and threats. The risk management system has to consider the costs associated with the impact of disaster and climate change effects on human settlements, economic and social activities, environment, cultural heritage and historical urban properties, and consequentially the benefits of introducing a system for mitigation of risks.

The EU and Member States have also reacted to the challenges posed by climate change and other threats with activities in several fields. Among the most important actions is the setting of a consistent and supportive legal framework for targeting these challenges. The global legal outline shows a complex system where EU has a general legislative competence in the field of environmental management; some specific matters regulated by binding acts, such as Water and Flood directives (Directive 2007/60/EC); a general international system of soft law aimed to improve the resilience of communities, where international bodies and organisations, mainly represented by UNESCO for cultural heritage and UNISDR for disaster reduction, have an important role. Climate change is seen by many governments as a risk multiplier that has influenced shifts in policy that covers natural hazards, thus requiring not only improvements in emergency management, but also in prevention and preparedness (Werrel and Femia, 2015). Accordingly, a number of adaptation and mitigation programmes and strategies have been introduced in the last decade, however the extent to which these initiatives encompass cultural heritage is negligible. With reference to culture, the EU supports cooperation between Member States to conserve and safeguard European cultural heritage and the adoption of incentive
measures through special culture programmes and dedicated budget lines, but expressly excludes any harmonisation of laws and regulations of the Member States (art.167 TFEU).

However, recently, following the “Europe 2020 Strategy for a Smart and Sustainable Growth”, new EU cultural policies and related funding programmes have considered that special attention should be given to cultural heritage threatened by natural hazards and human induced threats and to propose dedicated plans. Specifically, the European Work Plan for Culture 2015-2018, expressly mentions as a goal to be pursued, a study on risk assessment and prevention to safeguard cultural heritage against natural risks (OJ 23.12.2014 – C463).

In the UK, the sole driving force behind the protection, prioritisation and allocation of funding to heritage sites throughout England is centred in the National Heritage Protection Plan (the Plan) introduced in April 2011. The plan consists of two key elements: first, it establishes a framework for determining heritage prioritisation throughout the UK, highlighting which sites require most urgent protection; this will help to increase collaboration of sites and aim to eradicate duplication of works, with the hope of outlining areas which have been overlooked or dismissed. Second, it proposes that action plans would be put in place to address the needs of the aforementioned prioritised sites in the form of resources and funding (English Heritage, 2013). The framework set up throughout this plan consists of four key areas:

- **Foresight**: Identifies potential threats and issues from economic, environmental and historical perspectives; assesses awareness of relevant parties; and gains perspective on issues from within these parties and organisations.
- **Threat**: assesses the risk of all potential natural hazards and human induced threat, and their impact on a site; and establishes strategic action. One of its particular focuses is flooding.
- **Understanding**: identifies site-related information in order to understand its vulnerabilities; and prioritises the significance of the sites and the issues they are facing.
- **Response**: sets out response measures including protective, managerial and help and advice oriented measures.

### 3. Methodology

York has been chosen as a case study city for this paper (it is introduced in the next section). The case study method is deemed appropriate as it allowed focusing on understanding of dynamics presented within a single setting and answering whether and how questions (Yin, 1994; Eisenhardt, 1989). Whilst a case study cannot offer generalisation, its conclusions can be applied to the development of new theories and concepts, and the revision of existing ones.

An extensive web and literature research was initially conducted to identify any secondary literature. Four site visits from April to June 2015 were then conducted as it helps to obtain valuable insight (Lofland and Lofland, 1995) when discussing the projects and to understand the environment and the context in which the project is taking place. Finally eight semi-structured interviews with a number of key stakeholders involved in the management of the heritage sites...
were conducted; this was deemed important because the stakeholders’ perspective on the process of the project implementation could provide valuable information on existing measures as well as the challenges faced by the heritage sites in the context of climate change. The interviews covered the following aspects: main threats faced by heritage sites, risk assessment and risk mitigation measures, funding, and impact of policies. The interviews were recorded, transcribed and thematically analysed. Thematic analysis was chosen due to the complexity of the dataset and the need for a flexible analytical process to provide a structure (Howitt and Cramer, 2011).

### 3.1 York case study

York is a historic walled city with a population of 200,000 at the confluence of the rivers Ouse and Foss in North Yorkshire, England, and is the traditional county town of Yorkshire. The city has a rich heritage and has provided the backdrop to major political events in England throughout much of its two millennia of existence. The city offers a wealth of historic attractions, of which York Minster is the most prominent, and a variety of cultural and sporting activities making it a popular tourist destination for millions. The city was founded by the Romans as Eboracum in 71 AD. It became the capital of the Roman province of Britannia Inferior, and later of the kingdoms of Northumbria and Jorvik. In the Middle Ages, York grew as a major wool trading centre and became the capital of the northern ecclesiastical province of the Church of England. Consequently the historic building stock in York is widely variable and noticeable periods of growth can be observed through analysis of historic maps of the city: it ranges from Roman style to the medieval timber framed structures, and there is also a strong Georgian architectural influence (Stephenson and D’Ayala, 2014).

York therefore has a large variety of cultural heritage sites, many of which are prone to climate-induced hazards, and in particular flooding (Hutton and March, 2002). A number of actions are taken by the City of York (and its York Prepared team) in order to reduce the impacts of flooding, as a large number of heritage and historic sites requires protection and prioritisation to avoid suffering permanent damage as a consequence of the ever-changing environmental climate. Although York has suffered historically at the hands of flooding since the early thirteenth century (Radley and Simms, 1971), studies have been carried out which outline that flooding has become significantly worse in York over the past century (Archer, 1999; Macdonald et al., 2003; Macdonald and Black, 2010); notably this occurred between the 1940s and 50s (Farrant, 1953), until significant flooding in the 1980s and 2000s.

### 4. Discussion: Living with floods or surviving floods?

As described in previous section, York and its heritage sites are regularly affected by flooding. Current flood mitigation measures deployed in York include a flood wall and the Foss Barrier. These mitigation measures however do not fully protect the heritage related built environment of the city. The York local authorities treat flooding as a natural process and thus emphasise that it is impossible to fully prevent such events and therefore the focus should be on risk management (City of York Council, 2015).
The majority of York’s environmental issues have historically come in the form of flooding, usually as a direct result of the River Ouse bursting its banks after periods of heavy rainfall. The continued worsening of flooding in the York region has to some extent been related to the land usage of areas north (upstream of the River Ouse) of York; the removal of sufficient vegetation is seen as a key factor in increasing run off and thus causing increased flooding in York (Sansom, 1996); this could be exacerbated in the future by the effects of climate change (English Heritage, 2008). According to the analysis of epigraphic flood markings (inscribed markings) (Macdonald, 2007) inside the basement of the old Merchant Venturers’ Hall in central York, the city had been built up over the original flood plain during the centuries. Although the ground level in York has been raised, there was no change in base river level during the historical period. Examination of historic and contemporary maps indicates that no significant changes to the channel form through York appear to have occurred in the past 250 years (Macdonald and Black, 2010).

4.1 Main challenges

Although relatively resistant to flood damage, historic-building materials can all suffer some degradation and may need appropriate treatment. The degradation is often triggered by a combination of flooding and weathering, which affect materials of the site structures. These materials include stone, solid brick and mortar walls, timber frames, wattle-and-daub panels, timber boarding and panelling, earthen walls and floors, lime-plaster walls and ceilings and many decorative finishes (English Heritage, 2008). Organic materials such as timbers swell and distort when wet and suffer fungal and insect infestations if left damp for too long; if dried too quickly and at temperatures that are too high, organic materials can shrink and split, or twist if they are restrained in panels (Historic England 2015). Inorganic porous materials do not generally suffer directly from biological attack. Significant damage can occur when inherent salt and water (frost) crystals carried through the substrate are released through inappropriate drying or very cold conditions; in addition to severe water damage, water contaminants and sediment concentration significantly increase during a flood period (Longfield and Macklin, 1999), which can result in heritage and historical sites suffering from erosion and contamination, as well as generic water damage.

As already mentioned in Section 2, physical damage requires structural interventions that would enhance protection, however the interviews have demonstrated that there are a number of flaws that make the existing protection system not as effective as it could be, despite the UK having a system in place that inspects heritage sites (as described in Section 2.1). The following challenges have been highlighted by the interviewees:

- **Ineffective communication**: There is a very little contact between English Heritage and the owners and managers of the heritage sites. This impacts the ability of the latter to identify possible hazards and address them in a timely manner. Whilst most of the site owners and managers are aware of the hazards based on their experience, they are not prepared to deal with other potential hazards. The communication with local authorities exists however it is
mainly aimed at the emergency response. In addition, in the event of flooding local authorities team heritage building similar to any other building assets affected by flooding.

- **Lack of formal stakeholders’ engagement:** Whilst some collaboration exists, it is often informal and depends on personal relationships, as there is no specific contact for heritage site protection.

- **Lack of competencies:** local stakeholders are mainly responsible for the identification of the damages and risks; they however are not appropriately trained to conduct such exercises. This leads to the rather reactive nature of strategies adopted by the site owners and managers. Whilst the inspections take place every five years, it is not sufficient for the levels of pre-emptive decision-making that are typically required for effective DRR.

- **Lack of funding for pre-emptive measures:** instead the funding can only be received once the site has been damaged (and the damage may be irreversible).

### 5. Conclusions

This paper has discussed that despite an increasing number of frameworks for addressing climate-induced hazards for heritage sites, there is still a need for change in the way these frameworks are implemented locally. The lack of practical enforcement results in sites remaining unprotected and exposed.

The remarkable robustness of many historical structures in York has already demonstrated their resilience and ability to adapt to changing environment, however with the increase in extreme weather events, there is a need to support and enhance such resilience.

This is the case not only in York but internationally. Although Sendai Framework on DRR establishes the recognition of culture as a key dimension of DRR, there is still a challenge of implementing the policies, which would build the capacities and set up institutional mechanisms at different levels and ensure that culture is given its due recognition.

Despite a large range of policies and tools, the actions aimed at the mitigation of climate change impacts for cultural heritage are dispersed. It is necessary to provide appropriate tools to proactively act in minimising (or indeed preventing) the impacts of climate change as well as in the case emergencies caused as a result of climate-induced hazards. In addition, there is a need for sharing knowledge and actions with stakeholders, through either close interaction with environmental and construction professionals, and through training and guidance at site level. It is also important to incorporate climate adaptation strategies and develop risk management plans for cultural heritage as a part of a larger pro-active planning and development strategies and risk mitigation plans, rather than in isolation. Risk management of cultural heritage sites should be seen as one of the important components of the urban space, with the impacts of new
spaces on heritage spaces being considered. The most important aspect of ensuring the effective implementation of the prevention and mitigation measures to heritage sites is through empowering and engaging communities and encouraging full participation in the preservation of what is notably their cultural and heritage sites. It is often the case that local stakeholders are those who are most passionate in maintaining the cultural fabric of sites, and the most enthusiastic about site preservation.

The main question however remains: How can site managers and custodians be supported in finding adequate responses to increase the resilience of heritage from natural hazards and climate change related risks? There is a need for an integrated multi-sectorial disaster risk management framework that would address this issue focussing on pro-active strategies and formal multi-stakeholders’ engagement.

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