WHITE PAPER

Cultural Heritage and Climate Change: New challenges and perspectives for research

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JPI Cultural Heritage & JPI Climate

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Cover illustration:

Bryggen, the old wharf of Bergen, Norway

EXECUTIVE SUMMARY

Collaboration between the two Joint Programming Initiatives "Cultural Heritage and Global Change" (JPI CH), and "Connecting Climate Knowledge for Europe" (JPI Climate) began in 2019 and led to the organisation of a joint workshop a year later. Following the recommendations in the workshop report, an expert working group was set up to scope research gaps and opportunities at the interface of cultural heritage and climate change, culminating in the publication of this White Paper. This strategic document is expected to support the two JPIs to generate policy-relevant research outcomes.

Four key messages are brought forth reviewing the state of the art in the field of cultural heritage and climate change research:

- Research on individual geopolitical regions, or a few in immediate vicinity of one another, remains prevalent: there is an opportunity to stimulate research and knowledge exchange that crosscuts several regions which - although geographically disparate - present common challenges and opportunities.
- Quantitative and qualitative methods remain siloed in their applications; mixed methods, which reflect a cross-disciplinary approach, are more likely to be found in pre-policy publications.
- There is a need for further understanding of culture and heritage as embedded in their socio-environmental contexts to inform policy, including the role of traditional and local knowledge, as well as learning from the past.
- The ecological and social impacts related to losses and opportunities for cultural assets and values from adaptation and mitigation need to be researched more intensively.

Based on this comprehensive literature review**, key research gaps and priorities under five themes** have been identified for the European region and beyond that require more advanced knowledge in the coming years and that should be addressed by researchers to support climate adaptation and mitigation measures:

- Addressing the Climate Emergency: Strengthening the commitment of the cultural heritage sector to address the climate emergency
- The Impacts of Climate Change: Predicting and assessing the impacts of climate change on and through cultural heritage
- Protecting Cultural Heritage: Building protection and adaptation strategies for cultural heritage
- Contributing to Climate Adaptation: Assessing the potential of cultural heritage to inform the development of climate adaptation
- Cultural Heritage as a Resource: Investigating how cultural heritage can support societal transformations and be a resource for climate mitigation and sustainable futures.

To address the research gaps and priorities, both JPIs propose **three types of instrument** that could be used in supporting collaborative efforts between and beyond the two initiatives:

- **Funding instruments** enable the mobilisation of new research funding from the participating partners to launch joint funding calls, to provide better use of public resources, add value and avoid duplication.
- ***Networking and capacity building instruments*** focus on knowledge exchange, capacity building, communication and dissemination across relevant communities and promote joint activities between these communities, in cooperation with other instruments.
- ***Exploration and assessment instruments*** touch upon those required to gather, assess, and synthesise knowledge needed to inform and guide decisions on addressing the knowledge gaps identified in this White Paper.

Both JPIs will work hard to support and promote, on the one hand, research that complements, and builds upon existing findings and ensures that these contribute to future prevention and adaptation policies; and on the other hand, research that further explores how to make cultural heritage a readily available resource for climate mitigation and sustainable development.

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Introduction

In its Sixth Assessment Report published in August 2021, the Intergovernmental Panel on Climate Change (IPCC) painted a dire image of the future by pointing out that 'recent changes in the climate are widespread, rapid, and intensifying, and unprecedented in thousands of years.' Climate change is having an increasing and lasting impact on our environment and society, and cultural heritage is in no way spared. With hotter and drier summers and warmer and wetter winters, with the increasing frequency of extreme weather events and sea-level rise, tangible and intangible assets are exposed to new risks, and their vulnerability is far greater.

Researchers have investigated the impacts of climate change on cultural heritage. However, there remain gaps in knowledge and research is needed to complement and build upon existing findings and to ensure that these contribute to future prevention and adaptation policies. If cultural heritage is often described as being challenged by climate change, global agreements - such as the Paris Agreement and the 17 United Nations Sustainable Development Goals (SDGs) - acknowledge its potential to play an active part in the transition towards more sustainable socio-economic and governance models. Many opportunities have arisen from research, and many are still to be discovered.

About ten years ago, based on a concept introduced by the European Commission, ten Joint Programming Initiatives (JPIs) were established to pool national research efforts and foster the implementation of the European Research Area (ERA) to address grand societal challenges. JPIs are flexible intergovernmental partnerships with the aim of better aligning the research and innovation investments spent at the national level. They involve countries that voluntarily agree to work in partnership towards common visions encapsulated in Strategic Research and Innovation Agendas and implemented through joint activities.

JPIs play a key role in realising the potential of the ERA. They are concrete instruments to take up new challenges, develop knowledge, build capacity, and translate Europe's scientific leadership into products, services, processes, and solutions that support the wellbeing of citizens, economic prosperity, policymaking, and strategic autonomy. Addressing climate change and achieving a transition towards more sustainable societies are high priorities that JPI Cultural Heritage and JPI Climate have placed at the core of their activities. This White Paper, which results from a joint effort, aims to sustain the current momentum for climate action by mobilising research-funding organisations and supporting research communities in providing the knowledge and data needed.

This paper has three main objectives:

- To inform about pressing research gaps and opportunities at the interface of cultural heritage and climate change that need to be addressed to support the implementation of relevant national, European, and international policies in this field.
- To promote high-quality, transdisciplinary, and cross-regional research involving cultural heritage and climate research communities.
- To showcase how both JPIs can concretely help generate policy-relevant research outcomes, build international networks, support funding leverage and foster science as a diplomatic mechanism at a global scale.

JPI Cultural Heritage and Global Change

The Joint Programming Initiative on Cultural Heritage and Global Change[1] (JPI CH) brings together 19 countries in Europe represented by ministries and organisations responsible for research funding. Its main objective is to promote the safeguarding of cultural heritage - be it tangible, intangible, digital or natural - and enhance sustainability through better-coordinated research and innovation. Through its activities, the JPI CH aims to increase awareness of citizens, policymakers, and stakeholders, identify short and long-term research needs and priorities, concentrate and increase human, material and financial resources allocated to research, and promote joint and multidisciplinary approaches. Over the last decade, the JPI CH has implemented six thematic calls, awarded 29 Mio EUR and funded more than 50 research projects, some of which address the impacts of climate change. In 2020, the initiative published a new Strategic Research and Innovation Agenda[5] that sets climate and environmental change as one of four priority research areas for the coming years.

JPI "Connecting Climate Knowledge for Europe"

The Joint Programming Initiative "Connecting Climate Knowledge for Europe"[2] (JPI Climate) gathers 19 European countries. JPI Climate, comprised of representatives from ministries and organisations for research funding, aims through its activities to connect research performers and funders across Europe to promote the creation of new knowledge in the natural and anthropogenic climate change domain that is fundamental and relevant for decision support. Since its establishment, JPI Climate has mobilised more than 100 Mio EUR in research investments and has provided access to knowledge and expertise across Europe and beyond. This has been possible with the support of its member countries and the European Commission (EC), and it has been done in partnership with other JPIs, and, at the global level, with the Belmont Forum. JPI Climate has and continues to fund projects that advance the understanding of fundamental climate science and the societal transformations that are required in the face of climate change. It is also exploring key current issues, such as carbon neutrality and climate adaptation and resilience.

The JPI CH and the JPI Climate collaboration began in 2019 when representatives from both initiatives met several times to explore areas of shared interests. This led to the organisation of a joint online expert workshop in September 2020, where about 70 participants discussed two main topics: the impact of climate change on cultural heritage and the opportunities for climate mitigation and sustainable development.

From the discussion, ten key messages and several recommendations emerged. These were summarised in a short report that was regarded as the starting point for further cooperation. Subsequently, the Governing Board of both JPIs approved the development of a joint White Paper to scope research gaps and opportunities that could be addressed jointly by the JPIs. A working group composed of 20 experts from the cultural heritage and environmental field was established and coordinated by a dedicated joint Task Force.

This joint effort is motivated by the belief that tackling climate change and building resilient and sustainable societies would benefit from greater collaboration between the cultural heritage and climate research communities. This is particularly relevant for the understanding and assessment of risks, impact and vulnerabilities that threaten the values of cultural heritage, but also for the development of adaptation and mitigation strategies powered by the knowledge, data, experiences, and skills inherited from the past and which are at the heart of people's daily lives.

This very timely collaboration is taking place in a context where cultural heritage considerations and contributions to climate action have gained visibility and momentum:

- In 2019, **ICOMOS published 'The Future of Our Pasts: Engaging Cultural Heritage in climate action' report**[3], which highlights how climate change drivers affect cultural heritage and underlines the potential of cultural heritage considerations, knowledge, and skills to make valuable contributions to climate action.

- In the same year, a group of cultural and heritage organisations launched the **Climate Heritage Network**[4]. This network encourages the sector to further engage with climate action and promote the potential of arts, culture, and heritage to inform and support climate adaptation and mitigation, particularly towards climate frameworks such as the United Nation Framework Convention on Climate Change (UNFCCC). In November 2021, thanks to their commitment, almost thirty heritage and culture-related events took place at COP26.

- In January 2021, the European Commission launched **the New European Bauhaus**[5], which invites everyone 'to revisit Europe's cultural heritage and shape its future' for more sustainable, inclusive, and beautiful forms of living.

- In the same period, the Commission started to host the meetings of **the new Open Method of Coordination (OMC) 'strengthening Cultural Heritage Resilience for Climate Change'**. An OMC is a light but structured way of cooperation bringing together experts that share knowledge, identify best practices, and whose recommendations will support the implementation of heritage policies for climate change.

- In March 2021, Europa Nostra, ICOMOS and the European Investment Bank Institute released **the European Cultural Heritage Green Paper**[6], which demonstrates the role of cultural heritage in achieving the ambitions of the European Green Deal and stresses the role of research and innovation in doing so.

- In July 2021, the G20 Culture ministers published **the Rome Declaration**[7] that calls for the mainstreaming of cultural considerations in the climate agenda. They also commit to 'facilitate target research and increased scientific cooperation on the reciprocal effects of climate change and culture'.

- In December 2021, **IPCC, ICOMOS and UNESCO hosted a co-sponsored meeting on culture, heritage, and climate change** to assess the state of knowledge and practice in connecting them, identify research gaps and catalyse research and collaboration. Three white papers were prepared to support the discussion and the report resulting from the meeting will serve as a resource for the IPCC Seventh assessment cycle.

The work carried out by the JPIs in the context of this White Paper aims to support and foster this dynamic.

The White Paper is divided into three sections. Section 1 introduces the current state of the art in the field of cultural heritage and climate change based on a comprehensive review of literature where cultural heritage and climate change are clearly connected. Section 2 outlines five thematic research areas that require more advanced knowledge in the coming years and should be addressed by researchers to support climate adaptation and mitigation measures. Finally, section 3 describes a list of actions and instruments that both JPIs could implement to help address the knowledge gaps identified in this paper. The White Paper concludes with a list of references.

1. Cultural heritage and climate change: the State of the Art as Signposts to Research Gaps and Priorities

Key Messages

1. Research on individual geopolitical regions, or a few in immediate vicinity of one another, remains prevalent: there is an opportunity to stimulate research and knowledge exchange that crosscuts several regions which - although geographically disparate - present common challenges and opportunities.

2. Quantitative and qualitative methods remain siloed in their applications; mixed methods, which reflect a cross-disciplinary approach, are more likely to be found in pre-policy publications.

3. There is a need for further understanding of culture and heritage as embedded in their socio-environmental contexts to inform policy, including the role of traditional and local knowledge, as well as learning from the past.

4. The ecological and social impacts related to losses and opportunities for cultural assets and values from adaptation and mitigation need to be researched more intensively.

Society is reflecting on how socioeconomic systems can support the grand challenges of our time: well-being, equality and inclusivity, and sustainable development in the context of an increasing digital society (National Heritage Science Forum, 2021), and further challenges have been introduced by a global pandemic. These changes emphasise the importance of understanding culture and heritage in the context of a fifth grand challenge: climate change and how cultural heritage is managed and engaged within a dynamic and rapidly changing environment, as well as its role in addressing the aforementioned societal challenges.

The state of the art is defined herein as represented by innovative and ground-breaking: a) research sources that have pushed the state of the art forward in terms of scale, accuracy, knowledge, innovation or preparedness, and b) policy literature that has brought about, or has the potential to manifest as, visionary and concrete change where the scale of the ambition and the recommendations are well matched. Acknowledging the diverse and large body of relevant literature, only literature that is clearly situated by the authors in the field of climate change and cultural heritage is considered as defining the state of the art in this White Paper.

An examination of recent literature (2016-2020)[8]reveals the continued dominance of publications produced by European and North American authors, focusing on their respective geopolitical regions. Although in smaller quantities, individual political regions are the focus of most research on cultural heritage and climate change. However, some publications have taken a comparative approach,[9] or grappled with a particular geographic context.[10]

There remain opportunities for knowledge exchange and collaboration across regions: for example, those with similar environmental and socioeconomic challenges and opportunities, and from those that have experienced challenges for which they have found solutions that might inform decisions elsewhere.

Research

Impacts of climate change on cultural heritage

Increased knowledge and understanding of the impacts of climate change on cultural heritage are primarily generated using quantitative methods. Modelling is typically employed to characterise future exposure of tangible heritage under future scenarios, such as wind-driven rain,[11] or in combination with hygrothermal simulation to assess several mechanisms of material change.[12] GIS and remote sensing techniques have enabled the assessment of entire urban areas,[13] although studies of individual buildings and/or monuments remain prevalent. Identifying types/rates of change caused by anthropogenic climate change remains an open challenge: despite a call for longitudinal monitoring campaigns,[14] only simulations (laboratory and computational) are available to provide a comparison with a historical baseline or between different emission scenarios. Much of the recent literature[15] incorporates intangible aspects of cultural heritage, but sometimes so indirectly acknowledged as to be missed. While other literature does explore intangible aspects, few studies combine tangible and intangible heritage explicitly. One exception is a recent study of how climate change has altered the timing of cherry trees' blossoming in Japan, causing annual traditional celebrations to be out of sync with the natural environment.[16]

In climate change literature, a risk framework is typically composed of three main factors: exposure, hazard, and vulnerability (vulnerability encompasses sensitivity and adaptive capacity[17]). To date, the majority of studies on cultural heritage and climate change risks have focused on developing and advancing quantitative frameworks, methods, tools which evaluate solely exposure, i.e. proximity of cultural heritage asset to hazard.[18] Yet, research is needed to more holistically evaluate climate change risks to cultural heritage assets by integrating exposure, sensitivity and adaptive capacity of cultural heritage together with cultural/historical significance or values i.e., values-based considerations.[19]

When it is marginally included,[20] there is an agreement about the need to undertake vulnerability assessment of historic structures, and to specially develop cultural and structural criteria.[21]

Adaptation and mitigation

The role of cultural heritage in informing our response to climate change, including barriers, is primarily the domain of qualitative research methods to further knowledge and preparedness.[22] One exception is evaluating energy retrofit options, which are more closely aligned with quantitative methods used to evaluate the impact of climate change. A growing body of literature evaluates professional views on the challenges or opportunities for cultural heritage within climate change adaptation.[23] Yet, limited research exists on developing adaptation solutions for diverse tangible and intangible cultural heritage.[24] Some recent studies have focused on the development of novel decision support tools for prioritisation of cultural heritage for climate adaptation planning,[25] and applying values-focused approaches with diverse stakeholder and community groups for designing feasible adaptation actions[26] including evaluation of loss and damage of cultural heritage.[27] The role of cultural heritage in communicating climate change and inspiring action is also an emerging area of research.[28]

Indigenous knowledge and traditional ways of living

The literature, primarily based in Australia and the USA, focuses on community-based, bottom-up approaches to the management and adaptation that involve indigenous communities.[29] Other research has also highlighted the need to address socio-ecological contexts in future management responses, particularly for traditional ways of living.[30] Opportunities for cultural heritage to enhance community resilience and promote sustainable heritage and tourism developments has also been explored.[31] One recent publication notability highlights the benefit of partnership between indigenous perspectives and climatological science in a Kenyan context.[32]

Timescales

The literature is often not explicit or is unspecific about timescales[33] where it refers to changes that are 'already being seen'. This results in perspectives on change that are not situated within its natural and social context and the associated timescales of change and decision making. A deeper understanding and explicit approach to timescales of change is imperative to characterise accurately impacts of climate change on cultural heritage, understanding its role in mitigation and adaptation, empowering indigenous communities to sustainably manage cultural heritage in transition and inform policy.

Policy

Context

An important precursor and a key outcome of research is policy. The pre-policy literature and the emerging areas for policy development in the state of the art are rooted in extensive, rich and layered literature. In discussing how risks arise through the complex interplay of social and ecological feedbacks,[34] a unified theoretical and conceptual framework is proposed for studies of past and present vulnerability and resilience and how future vulnerability and resilience can be approached. A study[35] offers the concept of non-economic losses (i.e., social, and cultural values) in the context of negotiations on loss and damage under the UNFCCC. This is further explored in another study[36] which suggests that the future of cultural heritage is a series of frequently updated manifestations of changing perceptions of the past over time and that the social consequences of climate change need further study. In contrast and yet complementary, a third study[37] deals with the materiality of cultural heritage threatened by climate change and signals the importance of a cross-disciplinary approach.

Pre-policy

While the literature does not discuss fully developed policies, there are a number of pre-policy papers worthy of inclusion in the state of the art. The literature shows that archaeology is at the forefront of changes in engagement with the past from nation-state to transnational modes to multilateral development.[38] Archaeology points to a sector that understands the need to inform policy. For example, studies[39] have the potential and ambition to bring about visionary and concrete policy changes in several areas. The literature also presents the archaeological record as a bridge to mobilise social change through public understanding.[40] Additional studies include community public engagement,[41] transformation,[42] and new paradigms for science, engagement, and policy.[43] This body of pre-policy literature demonstrates a holistic view or perspective on heritage and culture in the context of climate change, in contrast to the body of literature primarily focused on research outputs.

Emerging areas for policy development in the state of the art

Three emerging areas for policy development are evident from the literature that grapple with cultural heritage and climate change in its socioenvironmental context to provide 'nature-culture approaches' (ICOMOS Climate Change and Heritage Working Group, 2019). One focusses on historic centre regeneration and the need for their integration in urban strategies. One study[44] argues that this could happen through better understanding of the social and ecological costs related to the loss of cultural assets, including the challenges for cultural heritage of supporting biodiversity in the face of climate

change[45] and energy retrofit.[46] The second emerging policy area focusses on impoverished communities affected by coastal erosion in developing island states.[47] A third area is about managing loss and understanding acceptable change, or "valuing the validity of cultural heritage as a dynamic territorial resource in today's heterogeneous societies."[48]

2. Key research gaps and priorities for the European region and beyond

This white paper aims to identify relevant and pressing priorities for research at the interface between cultural heritage and climate change. Researchers have already begun to investigate the impacts of climate change, but there is **still a need for more research to complement and build upon existing findings and to ensure that these contribute to future prevention and adaptation policies.**

Global agreements acknowledge the potential of cultural heritage to play an active part in the transition towards more sustainable models. Research must **further explore how to make cultural heritage a readily available resource for climate mitigation and sustainable development.**

There is a need to:

- Strengthen the commitment of the cultural heritage sector to address the climate emergency
- Predict and assess the wider impacts of climate change on and through cultural heritage
- Develop protection and adaptation strategies
- Demonstrate the potential of cultural heritage to support societal transformations and be a resource for climate mitigation and sustainable futures
- Move away from a focus on individual geopolitical regions to increased collaboration across countries and regions
- Undertake more interdisciplinary, transdisciplinary, and interactive research
- Consider all forms of cultural heritage in a holistic way, including tangible, intangible, and digital heritage
- Demonstrate the role of cultural heritage in communicating climate change to society and policy-makers, therefore inspiring action.

The following sections set out a number of research gaps which JPI Cultural Heritage and JPI Climate see as priorities for stimulating exchange among the research community across countries and regions, and for advancing knowledge and informing policy at a global level.

2.1 Addressing the climate emergency

Strengthening the commitment of the cultural heritage sector to address the climate emergency

Until the recent launch of the European Cultural Heritage Green Paper "*Putting Europe's shared heritage at the heart of the European Green Deal*" on 22 March 2021, the cultural heritage sector had been largely excluded from the European Green Deal.

The integration of cultural heritage into the discussion of the causes and effects of climate change and of the solutions to address it had not been a priority for managers and policymakers, something that was evident at different levels, from IPCC reports to local, regional, and national policies, and that raised criticism from the sector during the past decade.

Following this progressive awakening of the sector, there are now a number of initiatives, publications and reports that claim the role cultural heritage may play not only in identifying issues related to the climate emergency but also in building sustainable solutions to it. Similarly, new initiatives have been created in the framework of governmental bodies and networks e.g., EU Open Method of Coordination group of Member States' experts on Strengthening Cultural Heritage Resilience for Climate Change; Climate Heritage Network; and the international IPCC-ICOMOS-UNESCO meeting that aims to result in increased awareness of cultural heritage in future IPCC reports.

While these recent developments are extremely positive, there is still a need for commitment of the cultural heritage sector to be strengthened and consolidated, not only with regards to built monuments but for all forms of cultural heritage, whether tangible or intangible.

For this it is necessary to consider both the internal and external factors that could possibly contribute to, or restrict, the role that the cultural heritage sector may play in addressing the climate emergency:

- Cultural heritage has been forming over centuries and millennia and in the face of increasing threats, people have developed adaptation strategies over time. The cultural heritage sector needs to fully acknowledge that dealing with the causes and effects of climate change has become an unavoidable and important part of its work. A culture change is required to ensure that **more research is carried out on best practice case studies relating to cultural heritage adaptation strategies that include the option to scale up.**

- There is a need to overcome the latent "soft" versus "hard" sciences discourse when dealing with climate change, which can be seen from the dominant physical science approach e.g., IPCC 2013 report. **It is necessary for cultural heritage studies to integrate environmental data** that provides information on long-term processes and on mitigation strategies of past communities, and that they can hence inform the decision-making process. These data also provide vital information on proxies that cannot be retrieved from any other disciplines e.g., archaeological analysis of local and micro-regional changes through time, such as site and settlement displacement due to sea-level rise, to alterations in ecotope biodiversity, to geomorphological and sedimentary changes, etc.

- The cultural heritage sector, along with policymakers and experts from the physical and natural sciences, must raise awareness within wider society that cultural heritage is a common good threatened by the effects of climate change, such as flooding, sea level rise, acidic rains, in the same way that animal and plant species and human infrastructures are. Each individual, each group, each society develops a specific link with its cultural heritage, tangible and/or intangible, and a loss of cultural heritage means also a loss of social, cultural and historical identity. **More interdisciplinary research undertaken in collaboration with stakeholders and policymakers is required to ensure that future generations do not lose this sense of identity.**

- The degradation of cultural heritage weighs heavily on the economy, especially on tourism, for example the case of Venice, but also in the safeguarding process. In a world increasingly driven by economics, cultural heritage is not fully valued, however, it is essential to human societies. Acceptance by -and collaboration with- specialists and stakeholders involved in the study and safeguarding of other economic sectors is essential to help consolidate the engagement of the cultural heritage sector. In this sense, **more initiatives supporting a broader notion of natural and cultural heritage are needed.**

2.2 The impacts of climate change

Predicting and assessing the impacts of climate change on and through cultural heritage

The impact of climate change on cultural heritage was addressed descriptively and qualitatively by the UNESCO World Heritage Centre in 2007. Over recent years, whilst further research into the impacts on cultural heritage has been undertaken, it should be noted that:

- The qualitative assessment of impacts, which results from the observation of changes entailed by the intensification of climate factors in recent decades, **could be improved by integrating quantitative assessment and objective metrology.**

- The general inventory of the qualitative impact of climate change on cultural heritage is well-advanced, although **not completely exhaustive, especially for intangible heritage**.

- Climate change impacts are generally perceived as negative, but **in some cases, effects could be positive** (e.g., reducing stone erosion resulting locally from reduced rainfall).

- Cultural heritage can make an original contribution to the **documentation of past climates**. It encompasses various types of valuable materials for climate history such as written documents, religious parades data, census, maps, photographs, drawings, newspapers, administrative archives, ancient weather records or data hidden in the beams of historic buildings).

- There are past observations, scientific data or surveys that have been preserved and which can be processed to **detect long term dynamics impacted by climate change** such as sea level rise, coastal subduction, the melting of glaciers, or the evolution of floristic species distribution.

2.3 Protecting cultural heritage

Building protection and adaptation strategies for cultural heritage

Climate change adaptation can be employed to reduce damage to cultural heritage or to exploit opportunities associated with climate change impacts (IPCC 2014) and is vital for safeguarding cultural heritage. Despite the **need for climate adaptation solutions for cultural heritage**, these have not been widely initiated and few examples of completed climate adaptation plans or policies that address various cultural heritage types exist at the national level.

Climate adaptation planning and policy are impeded by various technical, institutional, financial, and social barriers. Previous research has shown that barriers may include insufficient data or unfamiliarity with existing data on climate change risks, impacts and vulnerabilities of diverse cultural heritage types, alongside lack of knowledge on feasible adaptation measures, and lack of expertise or decision-makers' ability to utilize data on climate.

Critically, there has been **little research on the design and implementation of climate adaptation measures** for both tangible and intangible heritage and associated governance challenges, as well as on **monitoring and evaluation of adaptation measures for cultural heritage**. To date, most research has focused on developing and piloting assessment methods and tools for climate change risks, impacts and vulnerabilities, mostly for tangible cultural heritage.

There is a need for increased research in the following areas:

Adaptation principles and issues

Research should ensure that:

- **Adaptation solutions align with conservation principles** and are sensitive to cultural needs and compatible with Climate Action i.e., sustainable and carbon neutral.
- **Efficient resource management** is at the core of climate adaptation and guides the transition towards more sustainable practices.
- **Adaptation is place-based** with the ability to transfer research results across multiple locations by creating a suite of carbon-costed and effective adaptation options for specific impacts for practitioners to adopt.
- **Translational and trans-disciplinary research** applying adaptation actions from other sectors to cultural heritage contexts is undertaken.
- **Continuous monitoring and evaluation (and revision) of implemented adaptation strategies** is facilitated.
- **Maladaptation** in the sense that climate adaptation responses for some cultural heritage types may be detrimental to other socio-economic, cultural and natural systems, such as coastal ecosystems, water management, agriculture, is tackled.

- **Specific adaptation responses that may increase vulnerability** of cultural heritage to climate change, or adversely affect significance, integrity and values, are considered.

- **Perceptions and uses of cultural heritage** that may promote backward-looking attitudes, incite conflicts over power and territory, and make change and adaptation generally more difficult, are explored in more depth.

- **The future risks and opportunities of different perceptions and uses of cultural heritage for climate adaptation planning** are investigated.

Knowledge generation and exchange

Research should ensure that:

- More attention is given to traditional materials and knowledge that are locally sourced and the reuse of materials and buildings i.e., **circular economy approaches alongside nature-based solutions.**

- The potential to **build on local knowledge and existing professional practice by re-examining them through a Climate Action lens is realised** e.g., traditional skills related to local materials or existing disaster risk management practices.

- **Knowledge co-production for adaptation planning**, including loss of cultural heritage with local, marginalized, and indigenous people, is enabled.

- Approaches for **sharing lessons learned** (failures and successes) **in designing and implementing climate adaptation responses** are established.

Stakeholder engagement

Research should ensure that:

- Existing awareness and activities amongst individuals and non-governmental organizations are supported and developed, recognising that much tangible and intangible heritage is in the ownership or custodianship of private citizens.

- Training for stakeholders and decision-makers regarding feasible climate adaptation solutions (including effective methods to evaluate benefits and harm of conservation actions for climate adaptation) is increased.

2.4 Contributing to climate adaptation

Assessing the potential of cultural heritage to inform the development of climate adaptation

Cultural heritage can contribute to studying climate change and finding adaptive solutions. For this cultural heritage research should produce and share data of relevance to climate change study, to mitigation and adaptation strategies design, as well as adoption across different scales, and in particular co-operate with climate and climate adaptation research for identifying knowledge gaps that could be addressed by cultural heritage research, develop methods for transmitting the results to climate adaption research and practitioners, and communicate the potential of cultural heritage to contribute to climate adaption strategies to research communities outside of cultural heritage.

Scenarios and predictability of present and future effects of climate change can be enhanced through the use of knowledge on tangible and intangible cultural heritage, such as sites, landscapes, and the history of how societies have interacted with their environment. Cultural heritage represents historical actions, processes and knowledge constituting examples of adaptive practices, including traditional and nature-based practices, to risks and disasters.

In order to realise the potential of cultural heritage to inform climate adaptation, it should be noted that:

- There is a **need for more research on how to detect the roots and effects of climatic phenomena, risks, and disasters,** and of historical and traditional adaptive practices to these, based on the tangible, intangible and digital cultural heritage and landscapes. Such results could feed into present and future climate adaptation strategies by providing knowledge on effects of historical risks, disasters, and the efficiency of adaptive practices for increased predictability and scenario building of present and future effects of climate change.

- **Historical and cultural heritage-based data of relevance to climate change** can provide both preconceived and unexpected knowledge of relevance to climate adaptation strategies. Importantly, knowledge based on cultural heritage, and its representation of past and present events and processes, can inform both successful and unsuccessful risk and disaster management and preventive strategies of climate change and effects of climate change.

- Historical and cultural heritage-based research can be especially informative regarding **root causes, such as the roles of social, cultural and institutional organisations at different levels of society**, factors for promotion of or hindrances to knowledge transfer for successful management and adaptation, including efficiency and impact of different regulations and practices and acceptability of new policy that may disrupt social and cultural habits, but also for assessing the possibility to reproduce strategies across different places, sites and landscape planning and use of building materials and techniques.

- **Collaborative research between the fields of climate change and cultural heritage would identify better adaptation strategies based on historical and cultural heritage data**. Although there are some recommended strategies from climate change research requiring knowledge on past and traditional practices and there is some historical data already available, they are currently underused

in research and climate adaptation strategies due to a **gap between the fields of cultural heritage and climate adaptation.**

• A major challenge, requiring more interdisciplinary, transdisciplinary, and interactive research, is **how to transmit cultural heritage-based knowledge, including historical, cultural, and traditional adaptive practices, to present and future climate adaptation research and practitioners**. There is a need to develop methods and models, including experimental archaeology and ethnography, for transmitting cultural heritage-based knowledge to climate adaptation on different scales and levels, from generalised policies, taking different cultural contexts into account, to knowledge sharing on hands on issues such as selection of building materials and techniques.

• The **potential of cultural heritage to contribute to climate adaption strategies should be communicated to other research communities, practitioners and to society in general, including policymakers**. Cultural heritage should also engage in multi-level debates and commitments to design a common project for our planet and specific projects for nations and places, bringing in experiences from the past and contributing to cross cultural understanding.

2.5 Cultural heritage as a resource

Investigating how cultural heritage can support societal transformations and be a resource for climate mitigation and sustainable futures

Cultural heritage is both a primary resource in the negotiation of societal transformations, climate change impacts and trajectories for sustainable growth, and an archive or real-time simulation of previous successes and failures. Cultural heritage is simultaneously vulnerable to climate change, through impacts to environment and populations, and consequent damage to tangible forms and disruption of living forms of cultural heritage, and a potent reservoir of ideas and inspiration for the future. In meeting these challenges, cultural heritage is often positioned as a brake on innovation and adaptation, through the mistaken belief that authenticity resides in faithful and unvarying reproduction of cultural heritage over time; but this view reflects a failure to understand and appreciate the dynamism, flexibility, and adaptive capacity of all forms of cultural heritage.

It is important to recognise that:

- Cultural heritage can empower social resilience to climate change, helping to build resilient communities in anticipation and in the aftermath of loss. Cultural heritage contributes to social cohesion when it is seen to represent the collective identity of a community or society. Climate change may diminish cultural heritage or force communities or societies to relocate into other areas with an existing population.

  → *Research is needed on ways of enhancing social cohesion through cultural heritage in communities and societies impacted by climate change that lack shared cultural heritage or joint identities, and on the threats and opportunities of reducing, renewing, reconstructing, and regenerating cultural heritage for future social cohesion.*

- There is a critical cultural dimension to climate change which must be understood in order to address the present gap in the planet's response to adaptation and mitigation. Cultural patterns influence how people make sense of the world and what they believe is important in their lives. Cultural meanings and values affect people's responses to adaptation and mitigation related to climate change.

  → *More research is needed on the effects of global cultural patterns on climate change and on how, in different contexts, cultural meanings and values can enhance climate adaptation and mitigation and support climate action.*

- Cultural heritage is forged through human interactions with their environments, and constantly modified to meet the challenges of weather extremes and climatic changes. Both tangible and intangible forms of cultural heritage are registers of these histories of adaptation and climate adaptation. Local and traditional knowledge provides an exceptional record of successful climate change assessments and adaptations to climate change.

  → *More research with more rigorous frameworks is needed on the past transformations and adaptations of environments to understand how and why they are successfully sustainable. Similarly, we need to model the long-term transmission of intangible cultural heritage, and its integration with tangible forms of heritage, if we are to understand its vulnerabilities as well as its capacity to contribute to.*

- To embrace the full potential of cultural heritage to support a just transition to sustainability, it needs to be harnessed as a strategic resource. This requires a systemic approach, embracing novel social innovation and further development of methods and models that link cultural heritage and its representation of past and present societal transformation to climate mitigation and sustainable development. Both tangible and intangible approaches to cultural heritage can become resources for sustainable development.

  → *We need to understand how cultural meanings and values linked to cultural heritage can contribute more effectively to achieving a wide range of Sustainable Development Goals, by fostering synergies and revealing trade-offs between cultural heritage and related policy sectors such as climate, nature conservation, agricultural, or health policies, for instance through "integrated landscape management" approaches.*

- 'Heritage futures' is a term coined in the late 2010s to name the roles of heritage in managing the relations between past, present, and future societies. Therefore, Heritage futures are inevitably linked to 'climate futures', *i. e.* plausible scenarios of future climate. More research is needed on the potential of foresight and anticipation for policymaking regarding cultural heritage in relation to future climate change. More research is also needed on the ways in which different cultural and historical responses can help us to envisage and plan multiple and alternative futures within the context of climate change.

3. Potential instruments to address the knowledge gaps

This chapter presents tables of instruments that could be used by both JPIs to address the knowledge gaps and cross-cutting issues identified in the previous chapters of this White Paper. The instruments presented here are intended to support collaborative efforts between both JPIs, with or without additional funding. The list of instruments is not exhaustive and may be adapted, combined, or further developed, as decided by the JPIs.

These instruments presented are expected to provide added value for the research community, research funders, policymakers, local authorities, practitioners, the private sector, NGOs, citizens' organisations, youth and education organisations, community groups, communicators, and all interested individuals.

These instruments are clustered into three groups, according to their nature and objectives:

1. Funding instruments
2. Networking and capacity building instruments
3. Exploration and assessment instruments

For each instrument, the following information is presented: a short description, its priority level (*short-term: the instrument could be implemented in the next two years; long-term: the instrument could be implemented in the next two to five years*), relevant European programmes, and potential international partners. Instruments with a short-term priority level are highlighted in bold.

Funding instruments

Funding instruments enable the mobilisation of new research funding from the participating partners to launch joint funding calls, to provide better use of public resources, add value and avoid duplication.

Priority Level:	Short term:	Long term:

Instrument	Description
Transnational joint JPI calls Relevant European programmes Horizon Europe European Partnerships EU Missions Potential international partners Belmont Forum	• Transnational calls with a joint call text, centralised call management, and common review procedure. • These calls can be implemented by the JPIs only or in collaboration with external partners, within and beyond Europe. • By stimulating exchanges among relevant communities across several regions, these calls are expected to contribute to knowledge advances by tackling the gaps identified in this White Paper at the global level.
Exploratory calls	• Smaller calls might be a stepping-stone to transnational joint calls (see above), enable the involvement of policymakers, civil society, and younger generations, and answer the challenges of inclusion, co-creation, and participation. • Small-scale exploratory calls may also build capacity in the research community in a given topic, allowing the community to address the knowledge gaps identified in this White Paper in more detail in subsequent larger scale calls (including calls from the Horizon Europe Framework Programme).
Mobility calls Relevant European programmes European Partnerships EU Missions Interreg programmes	• Targeted calls to underpin mobility and integration of new and established researchers and established researchers in research institutions, national and other relevant agencies, small and medium-sized enterprises (SMEs), industry, and other relevant organisations. • These calls may also support staff exchange schemes between research institutions and practitioner and policymaking institutions.
Impact accelerator calls Relevant European programmes European Partnerships EU Missions Interreg programmes	• Calls to develop new knowledge exchange and engagement activities. • These calls may also support staff exchange schemes between research institutions and practitioner and policymaking institutions.

Networking and capacity building instruments

Networking and capacity building instruments focus on knowledge exchange, capacity building, communication and dissemination across relevant communities and promote joint activities between these communities, in cooperation with other instruments.

Instrument	Description
Outreach and valorisation activities Relevant European programmes Horizon Europe European Partnerships EU Missions Interreg programmes Potential international partners Belmont Forum JPI CH and JPI Climate Advisory Board Organisations	• Outreach and valorisation activities (e.g., workshops, conferences, seminars, exhibitions, and other research uptake activities) bring together researchers, policymakers, practitioners, and other relevant stakeholders from across Europe (and beyond) and are essential knowledge exchange and networking opportunities. • By promoting knowledge exchange and networking among different communities, these activities aim to increase the impact of the funded research. • This instrument can be combined with other instruments, particularly with transnational and exploratory calls.
Joint capacity building Relevant European programmes Horizon Europe European Partnerships EU Missions Potential international partners Belmont Forum JPI CH and JPI Climate Advisory Board Organisations	• This instrument will allow building capacity of researchers and other relevant actors at different levels (local, regional, national, European, global) with a focus on conducting multidisciplinary, interdisciplinary, and transdisciplinary research at the transnational level. This research is expected to generate the knowledge needed to inform the implementation of relevant national, European, and international policies in the field of cultural heritage and climate change. • This instrument can be combined with other instruments, particularly with exploratory, mobility and impact accelerator calls.

Priority Level: Short term: Long term:

Thematic annual programming networks (TAP) Relevant European programmes Horizon Europe European Partnerships EU Missions Potential international partner Belmont Forum	TAP are clusters of already funded projects (by the JPIs or external partners) to facilitate exchange of knowledge on research methods and results in a given topic.
Institutional alliances/ Pooling capacities Relevant European programmes Horizon Europe European Partnerships EU Missions Potential international partners Belmont Forum JPI CH and JPI Climate Advisory Board Organisations	• This instrument includes the co-development of a joint transnational research programme that promotes cooperation and builds alliances and shared knowledge and expertise. • This could include sharing infrastructure, such as hardware (e.g., high-performance computing), equipment, software (community models), databases, or knowledge portals.
Knowledge Hubs Relevant European programmes Horizon Europe European Partnerships EU Missions Potential international partners Belmont Forum JPI CH and JPI Climate Advisory Board Organisations	• Knowledge Hubs aim to provide a networking platform to promote exchange, synthesis, integration, and generation of knowledge on cultural heritage and climate change to support the development and implementation of related policies at different levels (local, regional, national, European, global). • The platform will facilitate the interaction between research and policy professionals with different disciplinary backgrounds and expertise by assessing and communicating recent scientific and socio-economic developments at an aggregation level adjusted to ongoing themes and debates in policy and public arenas.

Exploration and assessment instruments

This category of instruments includes those required to gather, assess, and synthesise knowledge needed to inform and guide decisions on addressing the knowledge gaps identified in this White Paper.

Exploration and assessment instruments should consider developments in the research and policy landscapes to inform the design of future collaborative actions between both JPIs, and other European and international partners, in the field of cultural heritage and climate change.

To achieve these goals, this category also includes monitoring, evaluation, and learning (MEL) instruments, designed to assess the progress and performance of the joint collaborative actions between both JPIs (and other European and international partners), developed to address the knowledge gaps identified in the previous chapters. These instruments are also expected to serve as a learning tool to inform the design of future implementation actions. When developing MEL instruments, the work from the Task Force on Monitoring & Evaluation of the JPIs (TF M&E) should be considered[49]

Instrument	Description
Scoping workshops Relevant European programmes Horizon Europe European Partnerships EU Missions Potential international partners Belmont Forum	• This instrument provides organised input from researchers and relevant stakeholders (policymakers, local authorities, practitioners, the private sector, NGOs, citizens' organisations, youth and education organisations, community groups, communicators, and all interested individuals). • Scoping workshops can build on the knowledge gaps already identified in this White Paper and help shape the scope of some of the funding instruments listed above (transnational joint calls, for example).
Joint Monitoring, Evaluation and Learning (MEL) exercises Relevant European programmes Horizon Europe European Partnerships EU Missions Potential international partners Belmont Forum	Joint MEL exercises using various methodologies and data sources (e.g., data analysis, surveys, interviews, narratives, case studies) allow tracking progress and performance of joint collaborative actions and programmes and serve as a tool for learning, informing the design of future actions and programmes.

Mapping exercises Relevant European programmes Horizon Europe European Partnerships EU Missions Potential international partners Belmont Forum	This instrument systematically collects and analyses existing knowledge and activities in a field to provide an overview.
Foresight exercises Relevant European programmes Horizon Europe European Partnerships EU Missions Potential international partners Belmont Forum	This instrument uses a range of methodologies, such as scanning the horizon for emerging changes and societal challenges, analysing megatrends, and developing multiple scenarios, to reveal and discuss useful ideas about the future.
Joint strategy papers Relevant European programmes Horizon Europe European Partnerships EU Missions Potential international partners Belmont Forum	• This instrument allows partners to agree on a strategy on how to prioritise and share work or infrastructure in a particular research area or challenge. • Joint strategy papers could include planning for various forms of collaboration or alignment such as those listed above.

Priority Level: Short term: Long term:

Notes

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