EUROPEAN UNION

Acropolis under snowstorm on 17 February 2021

STRENGTHENING CULTURAL HERITAGE RESILIENCE FOR CLIMATE CHANGE

WHERE THE EUROPEAN GREEN DEAL MEETS CULTURAL HERITAGE

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WHERE THE EUROPEAN GREEN DEAL MEETS CULTURAL HERITAGE

This report summarises the work of the EU Open Method of Coordination (OMC) group of Member States' experts on 'Strengthening cultural heritage resilience for climate change'. It is based on the discussions and information, provided and approved by the members of the OMC expert group in the meetings during 2021 – 2022 in addition to presentations given by the invited external experts.

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- Pfister, C. and Wanner, H. (2021), *Klima und Gesellschaft in Europa – Die letzten tausend Jahre (Climate and Society in Europe – The last thousand years),* Haupt Verlag, Bern.
- Earth's CO_2 Homepage (2022).
- European Commission (2019), Commission communication - The European Green Deal, COM (2019) 640 final.
- European Commission (2021), Commission communication – New European Bauhaus: Beautiful, sustainable, together, COM (2021) 573 final.
- Potts, A. (2021), *European Cultural Heritage Green Paper,* Europa Nostra, The Hague and Brussels.
- International Council on Monuments and Sites (ICOMOS) Climate Change and Cultural Heritage Working Group (2019), *The Future of Our Pasts: Engaging cultural heritage in climate action,* ICOMOS, Paris.
- Intergovernmental Panel on Climate Change (IPCC) (2022), *Sixth Assessment Report – Impacts, adaptation and vulnerability,* IPCC, Geneva.

CONTENTS

EXECUTIVE SUMMARY

This document is addressed to a wide audience of policymakers and decision-makers at European Union, national, regional and local levels; heritage managers; and society as a whole.

PREAMBLE

The European Green Deal, presented by the President of the European Commission, Ursula von der Leyen, in December 2019, is Europe's response to the grand challenges posed to our societies by climate change and aims to make Europe the first climate-neutral continent by 2050. In line with commitments made under the Paris Agreement, it seeks to transform the EU into a modern, resource-efficient and competitive economy, with no net emissions of greenhouse gases by 2050, economic growth decoupled from resource use and no person or place left behind. However, cultural heritage was not explicitly mentioned in the Green Deal. Contemporaneously, in accordance with the Work Plan for Culture 2019-2022, an Open Method of Coordination group of Member States' experts on strengthening cultural heritage resilience for climate change was established. The group's mandate was to explore the contributions of cultural heritage to the European Green Deal and identify threats and gaps related to cultural heritage in the context of climate change.

1. ABOUT THE OMC EXPERT GROUP AND ITS MAIN OBJECTIVES

Cultural heritage is one of the pillars of European society and identity. For the **first time**, a group of experts was nominated by **25 EU Member States and 3 associated countries** to cooperate at European level on **the application of climate action to cultural heritage**. This group examined the state of play, gaps in knowledge and structural deficiencies at EU and Member State levels. The information gathered is shocking: cultural heritage is under attack from climate change at an unprecedented speed and scale. Yet EU Member States do not have proper policies and action plans in place to mitigate these attacks, nor does the EU. Besides, **cultural heritage is not only a victim; it can provide solutions to help Europe** to become a green, climate-neutral continent. A total of **83 best practice examples** collected from 26 countries demonstrate the potential of cultural heritage solutions in the context of climate change; they provide an invaluable source of inspiration and ideas to emulate. Through the setting up of the OMC expert group on strengthening cultural heritage resilience for climate change, cultural heritage has received a strong commitment from the highest political level for support in the fight against climate change.

2. THE UNPRECEDENTED SPEED AND SCALE OF CLIMATE CHANGE IS THREATENING CULTURAL HERITAGE

Climate change is directly and indirectly threatening all forms of cultural heritage, whether a World Heritage Site or a small pilgrimage chapel in the countryside, an old steelworks or a historic garden. The most evident threats stem from extreme climatic events – severe precipitation, long heatwaves, droughts, strong winds and sea-level rise – all of which will increase dramatically in the future, as predicted by the Intergovernmental Panel on Climate Change. These events have immediate consequences, such as floods, forest fires and erosion, for Europe's tangible and intangible cultural heritage. **The impacts of catastrophic events are coupled with the slow onset of changes arising from deterioration processes.** Gradual climate change – continuous increase in temperature and fluctuations in temperature and humidity or fluctuations in freeze–thaw cycles – causes degradation and stress in materials, leading to a greater need for restoration and conservation. Biological degradation caused by microorganisms, for example in the form of mould and algal growth, and insect infestations attacking the physical fabric of buildings and the collections of galleries, libraries, archives and museums are more likely to occur. Cultural heritage is also **vulnerable to maladaptation, when inadvertent loss or damage is caused by adaptation measures**. There is little in-depth knowledge about the impacts of the climate crisis on intangible heritage. The topic of rapidly increasing, **simultaneous or concurrent extreme events** is currently a subject of debate in climate science, but **the consequences of concurrent catastrophic events for the whole cultural heritage sector** have not yet been adequately dealt with or investigated – this is now a major source of concern.

3. LACK OF AWARENESS AND LACK OF ACTION IN EU MEMBER STATES AND AT THE EU LEVEL

Out of the 28 countries having taken part in this expert group, **nine do not have any legal framework for heritage and climate change**. 15 countries stated that their cultural heritage policies mention climate change, and only 12 countries stated that cultural heritage is present in climate change policies. In general, at national level, different ministries are in charge of the two topics (13 responses). **Only seven countries mentioned that there are plans to coordinate the two areas of work: Ireland, Greece, Italy, Cyprus, Slovenia, Finland and Sweden.**

4. ADAPTATION AND MITIGATION MEASURES IN LINE WITH THE GREEN DEAL

Making cultural heritage fit for climate change while avoiding maladaptation is the monumental challenge of today for all types of cultural heritage, from archaeological sites and built heritage to landscapes and movable heritage. This requires **careful (budgetary) planning and a holistic approach that takes into account the whole life cycle and embedded, or grey, energy to reach net zero** without losing heritage qualities. This will entail small changes, such as continuous maintenance and monitoring, and larger adaptations, such as installing alternative energy sources and/or smart retrofitting to avoid waste. Historic buildings, settlements and cultural landscapes, together with traditional

Half-timbered building in Bad Windsheim (Germany) after extreme rainfall on July 15, 2021 © Freilandmuseum Bad Windsheim

knowledge, are an inspiration in terms of sustainable living, the circular economy and resource efficiency.

Nevertheless, so far, there have been **no economic assessments capturing the full range of costs of climate change impacts on European cultural heritage**. Neither do we have a full picture of the wider range of benefits to European societies arising from investments in the capital that cultural heritage offers. The OMC expert group strongly believes that the costs of action are lower than the costs of inaction. Therefore, we must act now and include cultural heritage in all mainstream policies and funding programmes.

Climate actions for heritage resilience involve a **strategic choice to invest in new forms of development**. Opportunities exist at EU and national levels to finance and invest in cultural heritage. However, making the most of these opportunities will require a radical change in the cultural heritage sector – a change in mindset. Most current processes and methods will have to be altered; we must make available and use new and traditional technologies, change institutional behaviour, create adequate business models, revise city and rural planning processes, and ensure efficient resource management. It is **more climate friendly to maintain, repair, reuse and retrofit than to demolish and build new**, and this fact must be widely communicated.

5. RESEARCH: THE INDISPENSABLE DRIVER TO MAKE HERITAGE CLIMATE RESILIENT

The **role of research and innovation** in protecting cultural heritage from climate change by making Europe's heritage climate resilient **is paramount**. The 83 best practice examples collected by the OMC expert group members clearly demonstrate that research is the most important driver of action to help heritage to fight against climate change. **Researchers were the first** to draw attention to the threats posed by climate change to cultural heritage, after the **European Commission launched, in 2003, the world's first call for research projects** to investigate the impacts of climate change on outdoor cultural heritage. In 2008, there followed research to study the **impacts on indoor cultural heritage** and the **future energy demands of built heritage** by coupling climate models with building simulation. Research and innovation, especially at national level, are an integral part of the mandate of this expert group. An evaluation of the state of play of research shows that there is still a need to identify and better understand the most severe threats. We need to understand their potential impacts, and good practices and innovative measures to prevent or mitigate them, so that we can safeguard all forms of European cultural heritage from climate change. In addition, we need to know the costs involved in making heritage resilient to climate change. The **OMC expert group recognises the unique role that research has played and will continue to play** in promoting cultural heritage in the context of climate change discussions, actions and research development, and its contributions to science diplomacy.

6. EDUCATION AND TRAINING: VITAL PREREQUISITES FOR MASTERING THE FUTURE

Education is of primary importance in understanding the profound role that cultural heritage plays in European societies. Cultural heritage is the treasure trove of European memory, inspiration, well-being and economic development; it offers enjoyment, comfort and truth. Heritage education provides insights into and an understanding of the world we live in, as it is grounded in the past and provides the tools to enable us to imagine the future. It empowers us to make **moral, spiritual and intellectual sense** of the world, in the face of **fake news, conspiracy theories and 'alternative facts'**. In armed conflicts, the first to suffer are people, but **cultural heritage is also targeted for destruction**, as it forms a visible **pillar of identity and community solidarity**. Given the importance of cultural heritage, it is **vital to start as early as possible to spark enthusiasm for it in young children**, to show them how exciting and interesting heritage is and that it can be explored using fun and innovative tools such as games and immersion through virtual reality in heritage worlds of the past and future.

In general, **cultural heritage has not yet been systematically included in the national education systems** of Member States, and the link between cultural heritage and climate change is addressed in hardly any education systems. This is a **missed opportunity, as heritage can be used as a vehicle to communicate information on climate change and all its consequences for European societies**. The role of and risks to cultural heritage could be integrated into climate change education. Overall, climate change education remains largely focused on technical/functional and sometimes also economic aspects, while cultural and social aspects are neglected. In order to change this, the promotion of specific projects and **teaching programmes and awareness raising of teachers** must be strengthened, which is a task for both education and the cultural heritage preservation sector.

Regarding the professionals responsible for implementing climate adaptation measures for heritage, it is essential to **build capacity through training, upskilling and imparting expertise in new knowledge and technologies** while **revitalising traditional, forgotten skills**. Our ancestors have much to teach us about coping with limited resources, using local materials and adapting to heatwaves, cold spells and floods.

Estonia, Ecomess of the Centre of Sustainable Renovation and Partners 2014, Tallinn. Photo: Toomas Tuul, 21.09.2014

7. AWARENESS RAISING AND OUTREACH: EUROPE TALKS CLIMATE CHANGE AND CULTURAL HERITAGE

Awareness of the vulnerability of cultural heritage and the increasing threats posed by climate change to European heritage **is still very low in the heritage community and even lower in wider society and at the political decision-making level**. This lack of awareness could heighten the indirect impacts of climate change on heritage. However, **heritage has the power to touch people's hearts**, as it resonates with their sense of identity, values and world view. Therefore, this report addresses the combined efforts by the EU, national governments and bodies, museums, heritage and academic institutions, charities, community organisations, non-governmental organisations, businesses, craft companies and – especially importantly – the media to **spread the message about what is at stake and how heritage can help solve the climate crisis**. The setting up of this **OMC expert group was a first and important step towards achieving the necessary changes**.

8. GAPS AND STRUCTURAL DEFICIENCIES IMPEDING THE GREEN DEAL

In order to enhance the protection of cultural heritage against climate change, it is necessary to **identify existing gaps and obstacles**. It was a very difficult and laborious task for the OMC expert group to find the right contacts to provide the information needed. Major **weaknesses are the fragmentation of the sector**, which lacks an efficient structure, and the fact that there is **little exchange, cooperation and coordination** with regard to climate change issues. These weaknesses are exacerbated by insufficient research programmes mainly at national level. The group identified major gaps and structural deficiencies.

There is a lack of:

- awareness of cultural heritage in the context of climate change in policymaking and integration of cultural heritage into mainstream climate change policies at EU and Member State levels;
- knowledge about the scale and dimensions of climate change damage and loss of cultural heritage;
- a coherent methodology for obtaining reliable information, quantitative data (e.g. showing how many sites are under immediate and long-term threats) and deep knowledge about rates and forms of decay affecting indoor, outdoor and underwater tangible heritage, loss of intangible heritage and future climate prospects at local level;
- incentives / tax reductions / support specifically for cultural heritage to adapt to or mitigate the effects of climate change at EU and national levels;
- resources (financial and human) at all levels of cultural heritage bodies to research, develop policies and implement actions to protect cultural heritage;
- quantitative data on the costs and economics of adaptation/mitigation measures for cultural heritage in times of climate change at national and EU levels;
- a website or platform at European level to provide information on the state of the art and progress;
- an inventory and central entry point covering damage to / loss of / risk to cultural heritage as a result of climate change at national and EU levels (a heritage climate change risk map);
- a permanent task force or forum for discussion and mutual exchange;
- contact persons and experts, at local, regional, national and EU levels, who can respond to enquiries;
- cooperation at national level – pointing to a need for exchange between ministries, administrations and planning bodies on cultural heritage and climate change;
- regard for cultural heritage concerns in the activities of other ministries and authorities when dealing with climate actions;
- cooperation between experts working in cultural heritage, climate change, economics and the humanities;
- active participation and integration of wider society and engagement of the younger generation in cultural heritage and the climate crisis;
- continuous long-term monitoring of cultural and natural heritage to document the evolution of changes;
- scientists and climate change experts in cultural heritage institutions (ministries and authorities);
- quantitative data on the contribution of historic buildings to the Green Deal / CO_2 saving (i.e. a holistic approach and life cycle analysis).

Considering all the above, the OMC expert group agreed on the **recommendations** listed below.

RECOMMENDATIONS

PREAMBLE

Our cultural heritage is being damaged and lost as a result of climate change, which is advancing at an unprecedented speed and scale. At the same time, cultural heritage offers green, sustainable solutions to the climate crisis. One key solution is the renovation of old buildings, which has been proven to be more climate friendly than demolition. Research and innovation are indispensable drivers of change that can make substantial contributions in the fight against climate change. Adaptation and mitigation measures must be in line with quality principles to ensure the protection of cultural heritage, avoiding maladaptation resulting in a cultural heritage crisis. Appropriate measures will stimulate climate resilience, economic recovery and skills development in line with the European Green Deal. Europe's joint effort, which has already produced good practice examples, will be a source of inspiration for other regions of the world.

RECOMMENDATIONS FOR THE EUROPEAN UNION AND MEMBER STATES

The open method of coordination (OMC) expert group makes the following 10 recommendations.

1. The European Commission must emphasise the importance of cultural heritage in times of climate crisis and propose new actions at European level to adapt cultural heritage and enable it to mitigate climate change in a new Commission communication, for instance in an update to the new European agenda for culture.

2. The European Commission must ensure structured cooperation at all levels of governance between EU directorates-general responsible for climate change and/or cultural heritage.

3. The European Commission must develop and regularly update, together with the Member States and associated countries, a European climate change cultural heritage risk assessment map by 2025.

4. The European Commission must initiate a full review of the economic costs of climate change adaptation/mitigation solely for cultural and natural heritage.

5. The European Commission must establish a common European platform for exchange, discussion, expertise and knowledge sharing about the impacts of climate change on cultural heritage and its contributions in the fight against climate change, providing a central entry point for cultural heritage in times of climate change.

6. National-/regional-level and local-level administrations must include cultural heritage and the cultural domain in all actions and plans addressing mitigation of and adaptation to climate change. Actions must be undertaken to fully integrate culture and cultural heritage issues into environmental sustainability and climate policymaking both at national/regional/local levels and international level.

7. National and regional authorities must build capacity and multidisciplinary expertise to ensure the safeguarding of cultural heritage against climate change through education, training and upskilling at all levels. The European Commission, through relevant EU-funded programmes, could support these initiatives.

8. National authorities must recognise the importance of research as the indispensable driver to advance the cultural heritage sector. In addition to EU-funded programmes, governments must initiate research programmes at national level to enhance knowledge sharing and cooperation between cultural heritage experts and climate science to create data collection mechanisms, collect and analyse data, and develop tools, infrastructures, best practices and strategies.

9. National-/regional-level and local-level governments and institutions must encourage investment immediately and incentivise the safeguarding of cultural heritage against climate change through monetary and fiscal policies.

10. The ministries and administrations of Member States and associated countries and local and regional authorities must ensure cooperation at all levels of governance and in relevant policy domains, especially in planning bodies, between those responsible for climate change actions and those responsible for cultural heritage.

Bartjan, a Sámi cultural environment and camp © Swedish National Heritage Board CCBY

CLIMATE CHANGE AND CULTURAL HERITAGE: CONNECTING THE PAST, PRESENT AND FUTURE

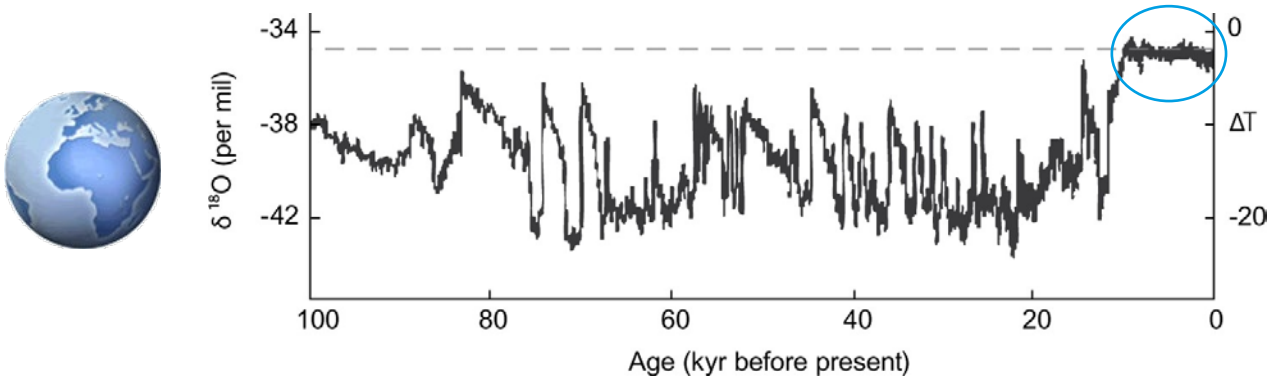

Figure 1. Instability/stability of the climate system in the past 100 000 years (higher or lower temperatures calculated using oxygen-18 (^{18}O) measurements from the Greenland Icecore Project); kyr: thousand years; per mille: parts per thousand. © Greenland Icecore Project (European Science Foundation)

Climate has always been one of the strongest forces on our planet. The past evolution of the earth has been very dynamic, with various climate modes, ice ages and interglacial periods, and has shaped the present natural and cultural environment. The emergence of *Homo sapiens* and the development of civilisation are inseparably entangled with the changing climate. Only in the recent past (the last 10 000 years) has humanity lived with a stable climate.

This stability (see Figure 1) allowed humanity to develop an agricultural society, cultivating and domesticating crops, as well as domesticating and pastoralising animals, and to live together in cities with great monuments and buildings.

However, this stability is about to change dramatically: the climate is again becoming unstable and much warmer, and is changing at a greater speed, scale and intensity than anticipated by various climate models. This is considered a global existential threat to societies and our planet. There have not been any global average temperature fluctuations exceeding 3 °C above pre-industrial levels for many thousands of years; civilisation is entering a totally new era (see future temperature changes under various emission scenarios in Figure 2 (right panel)). Uncertainties arise from tipping points and an increased number of simultaneous or concurrent extreme climate events such as extreme heat and extreme low precipitation, and, as Europe has experienced in recent years, high storm surges and heavy rainfall.

Robust scientific evidence from the Intergovernmental Panel on Climate Change (IPCC) shows that global warming is caused by human beings, as ever-increasing CO_2 emissions are caused by burning fossil fuels. The state of the art in climate change is described in the IPCC's series of assessment reports; this report draws on the latest (sixth) assessment report. In 2021, the **Nobel Prize was awarded for climate research**. It was awarded to Klaus Hasselmann, Syukuro Manabe and Giorgio Parisi for their groundbreaking contributions to the 'physical modelling of earth's climate, quantifying variability and reliably predicting global warming' and 'understanding of complex systems'. Furthermore, a new field called 'attribution science' corroborates that higher CO_2 emissions increase the probability of extreme climate events by a factor of 1.2–9 when examining the 2021 extreme rainfall events in Belgium, Germany and the Netherlands.

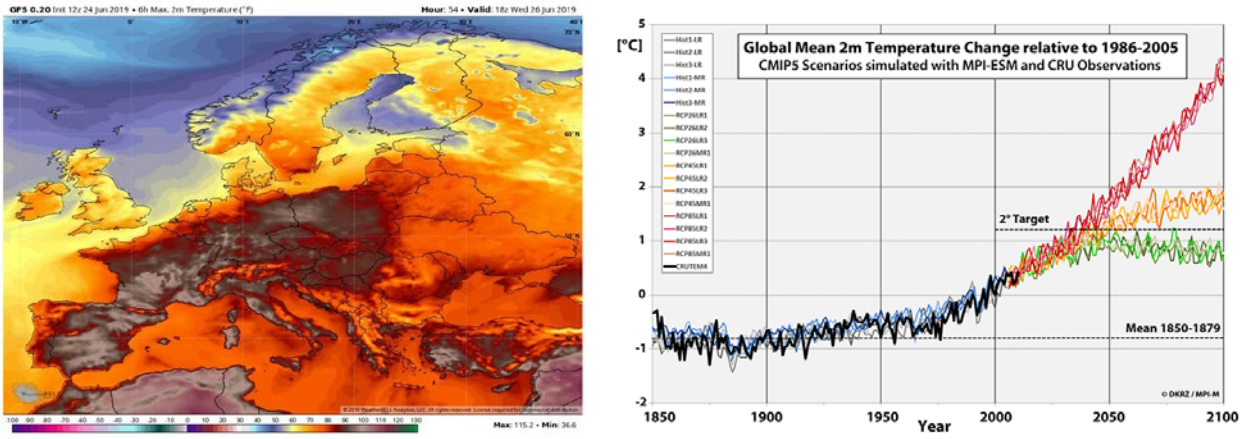

Figure 2. *Left panel:* Map of European heatwave in July 2019 © the Sun. *Right panel:* future temperature changes under different emission scenarios (the red representative concentration pathway (RCP) of 8.5 is where Europe is heading now, the yellow RCP of 4.5 is the moderate pathway and the green RCP of 2.5 is the pathway as per the Paris Agreement); CMIP5, Coupled Model Intercomparison Project; CRU, Climate Research Unit; MPI-ESM, Max Planck Institute Earth System Model © Deutsches Klimarechenzentrum

Records of the **past 1 000 years show that it was cold climates that caused the most problems**, catastrophes and dearth of resources for people, such as during the Little Ice Age. Human societies have adapted in response to climate variations, although there is an **abundance of evidence showing that certain societies and civilisations have collapsed in the face of rapid and severe climatic changes**. Climate change poses enormous risks to livelihoods, but also threatens cultural heritage, which became evident in recent years for a steadily growing number of heritage sites and items.

In this regard, **Europe's leading role must be emphasised.** It was due to the research programmes of the European Commission that the topic of climate change impacts on cultural heritage was taken to a scientific level and studied more systematically. In 2003, the **European Commission launched the world's very first call for a research project** on this topic: Noah's Ark. This project found, for the first time, that **climate change has a severe impact on outdoor built heritage** and **cultural landscapes**. From 2009 to 2014, the second European research project Climate for Culture was active. The consortium of 29 partners from 16 European Union countries investigated the **impact of gradual climate change on indoor cultural heritage and the future energy demand** by coupling, for the first time, high-resolution regional climate models with whole-building simulation tools.

Despite the progress made by further EU and national research projects, such as 'heritage resilience against climate events on site' (Heracles), 'safeguarding cultural heritage through technical and organisational resources management' (STORM) and 'risk assessment and sustainable protection of cultural heritage in changing environment' (ProteCHt2save), it is **only very recently** that the awareness of national and European decision-makers and heritage managers about the **far-reaching consequences of climate change impacts** and what is at stake has begun to increase (more information on EU research projects is provided in Annex 2). The United Nations Educational, Scientific and Cultural Organization (UNESCO), International Council on Monuments and Sites (ICOMOS), the Council of Europe, the European Council, the Cultural Affairs Committee and many more have since published documents and reports on the impacts of climate change on cultural heritage.

The **importance of cultural heritage for the future of humanity is paramount**. Cultural heritage contains the memory of our civilisation's history. The **loss of this memory will plunge societies into chaos and disorientation**. Therefore, the EU and its Member States have agreed – in Article 3 of the Treaty of Lisbon – to safeguard cultural heritage. In 2019, the EU set up the **European Green Deal to tackle the grand challenges** posed by climate change, showing EU leadership in preventing the worst consequences and in preparing for the best adaptation strategies. With the creation of the Open Method of Coordination group of Member States' experts (OMC expert group), **Europe is focusing on the urgent need for an intensive debate on the topic of climate change and cultural heritage**, to ensure that discussion and planning of climate change measures at European and national levels start now.

Inspired by and building upon the Green Deal, the 2019–2022 Council Work Plan for Culture[1], under priority A, 'sustainability in cultural heritage', provided for the first time for the creation of an OMC group of Member States' experts to focus on climate change and cultural heritage, looking at the current situation in the Member States, the existing knowledge, and the gaps and obstacles that need to be addressed to increase resilience to climate change.

1 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52018XG1221(01)

EUROPE ACTS NOW

The OMC expert group on strengthening cultural heritage resilience for climate change is the first structured group of experts nominated by the EU Member States to cooperate at European level on climate action applied to cultural heritage. This represents a **strong commitment from the highest political level** to support **cultural heritage in the fight against climate change**.

Since starting its work in January 2021, the OMC expert group has already achieved **significant visibility at EU level, at national level and even at international level**: it participated in the 2021 United Nations Climate Change Conference in Glasgow, the 2021 G20 Rome summit, and the United Nations Framework Convention on Climate Change–UNESCO and the Greek initiative 'Addressing climate change impacts on cultural and natural heritage' at the 2019 United Nations Climate Action Summit in New York. It has paid attention to the **threat climate change** is posing to cultural heritage but has also considered that **heritage can deliver solutions to mitigate the climate crisis**. That Europe has taken this timely initiative underpins its world-leading role in protecting heritage and safeguarding this non-renewable resource for future generations.

A total of **25 EU Member States and 3 associated countries** agreed to participate in the OMC expert group, resulting in the participation of 28 countries: Austria, Belgium, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and Switzerland. The large number of countries taking part in the OMC expert group shows that **the topic of cultural heritage in times of climate change gains increasingly more importance** and that there is a **need for cooperation, identification of gaps and exchange of best practices at European level.**

The group was chaired by Dr. Johanna Leissner (Germany).

OPEN METHOD OF COORDINATION

The OMC is an EU policymaking process used by Member States to cooperate at European level, in fields such as education, employment or culture. The OMC does not result in EU legislation. It is a voluntary process that aims to share and spread best practices and to achieve convergence towards EU goals in those policy areas that fall under the partial or full responsibility of EU Member States. Sharing practices and policy experiences allow EU Member States to learn from one another and to consequently improve their domestic policies, on a voluntary basis.

MANDATE OF THE OMC EXPERT GROUP

The objectives of the OMC expert group on strengthening cultural heritage resilience for climate change, which are specified in its mandate, are to:

- collect information about the state of play in the Member States;
- identify and exchange good practices and innovative measures for the protection of cultural heritage, both tangible and intangible, in relation to climate change;
- formulate recommendations to stimulate discussion and planning of climate change measures at European and national levels;
- examine the contribution cultural heritage can make to mitigating and combating climate change in line with the Green Deal's goals;
- examine the current and emerging threats posed by and impacts of climate change on cultural heritage;
- discuss the appropriate adaptation and mitigation measures available, identifying potential risks, and focus on building the resilience of cultural heritage assets in the face of a changing environment while avoiding maladaptation;
- ensure complementarities and synergies with other relevant initiatives of the Work Plan for Culture, including the OMC groups on the cultural dimension of sustainable development and on high-quality architecture and the built environment;
- involve external experts such as researchers and representatives of civil society and relevant professional networks such as the recently created Climate Heritage Network;
- contribute to awareness raising and capacity building of national heritage experts on the sustainability of cultural heritage, whose recommendations will contribute to discussion and planning of climate change measures at European and national levels.

Parc de la Boverie during the July 2021 flooding, Liège (Belgium). © Service public de Wallonie – Territoire Logement Patrimoine Energie and the Walloon Heritage Agency

THE CURRENT SITUATION IN EU AND NATIONAL POLICIES

At its first meeting in January 2021, the group agreed, as an initial task, to develop a questionnaire to compile an overview of the state of play in Europe and to define what the term 'cultural heritage' encompasses. Due to COVID-19 restrictions, almost all meetings were held online. The questionnaire addressed the following topics:

- the state of play in Member States and associated countries
- identification of direct and indirect threats from climate change
- collection of good practice examples.

Old farm buildings destroyed due to flooding in the river of Flåmsdalen, Aurland (Vestland county, Norway). Several buildings, a bridge and agricultural land along the riverside were washed away after heavy rain © 2015 Marte Boro, Directorate of Cultural Heritage

THE STATE OF PLAY IN EUROPE

In total, 31 questionnaires from 26 countries, representing 93 % of Member States, had been received by June 2021.

The responses to the question on the state of play showed that, in the majority of countries, **different (i.e. separate) institutions and/or ministries deal with climate change and cultural heritage** (Figure 3), which is an obstacle to cultural heritage protection. It has been found that cultural heritage policies and laws tend to reflect climate change issues more than the other way round. Out of the 28 countries, **9 do not have any legal framework for heritage and climate change**. Another key finding is that more information on the impacts of climate change on heritage is available for tangible heritage than for intangible heritage. Looking at the national situation with regard to coordinated work on climate change and cultural heritage, 15 countries stated that their cultural heritage policies mention climate change, and only 12 countries stated that cultural heritage is present in climate change policies. In general, at national level, different ministries are in charge of the two topics (13 responses). **Only 7 countries mentioned that there are plans to coordinate the two areas of work:** Ireland, Greece, Italy, Cyprus, Slovenia, Finland and Sweden.

In order to highlight that **cultural heritage needs to be considered in the fight against climate change**, it is necessary that it is included in all **mainstream policies at both national level and EU levels**. In Europe, the most important policy tackling climate change is the **European Green Deal**, which is the successor to the EU sustainability strategy. It is a huge investment programme and will transform the EU into a modern, resource-efficient and competitive economy. It aims to ensure:

- no net emissions of greenhouse gases by 2050;
- economic growth is decoupled from resource use;
- no person and no place are left behind.

However, **cultural heritage is not mentioned at all in the European Green Deal**. This drawback prompted ICOMOS and Europa Nostra to issue the ***European Cultural Heritage Green Paper***[2]**) in 2021**, in which Europe's shared heritage has been put at the heart of the European Green Deal. The report highlights the role of heritage in making the European Green Deal a real success. The 2020 **New European Bauhaus initiative** of the European Commission at least mentions cultural heritage. The various situations

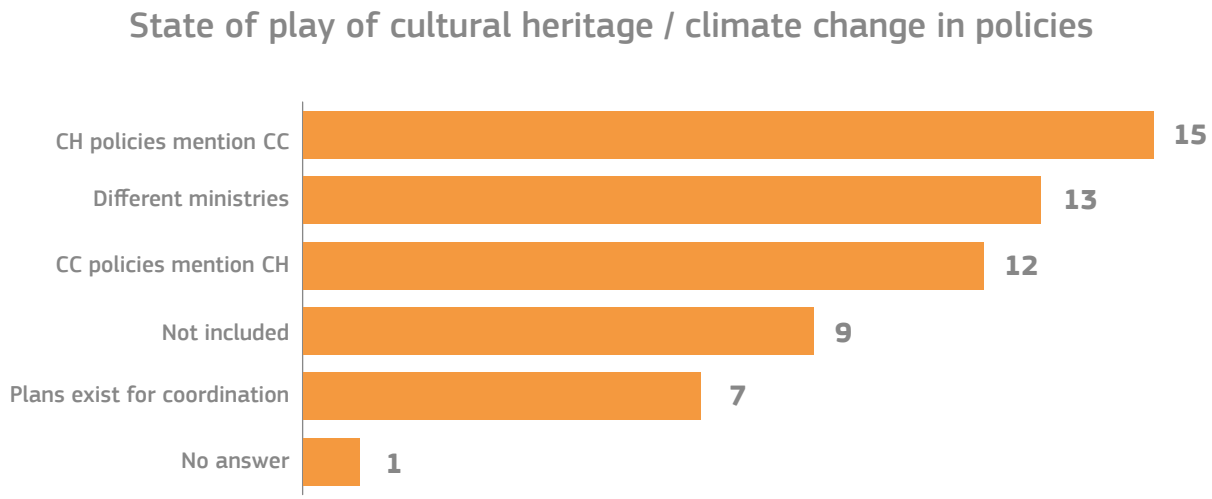

Figure 3. State of play, with the number of responses from the OMC expert group members concerning policies addressing cultural heritage (CH) and climate change (CC)

[2] https://issuu.com/europanostra/docs/20210322-european_cultural_heritage_green_paper_fu

of each of the countries are provided in Table 1. It shows in which countries cultural heritage is cited in the three most important policies: the **national sustainability strategy, the national climate adaptation plan and the national recovery and resilience plan([3])**. The recovery and resilience plan in particular provides for an ideal opportunity to invest in adaptation and mitigation measures for cultural heritage.

The majority of the countries have integrated cultural heritage into this plan; only 9 countries did not refer to the protection of cultural heritage in their recovery and resilience plans. However, **cultural heritage is often cited in the policies without any further consideration of concrete measures to be taken**, which reduces the opportunities for cultural heritage to benefit from the policies.

Table 1. Overview of national policies that mention cultural heritage

Country code	Country	National sustainability strategy	National climate adaptation plan	National recovery and resilience plan
AT	Austria	Yes	Yes	Yes
BE	Belgium	No	No	Yes
CH	Switzerland	No	No	No
CY	Cyprus	Yes	Yes	No
CZ	Czechia	Yes	Yes	Yes
DE	Germany	Yes	No	No
EE	Estonia	No	Yes	No
EL	Greece	Yes	Yes	Yes
ES	Spain	Yes	Yes	Yes
FI	Finland	No ([4])	Yes	No
FR	France	No	No	No
HR	Croatia	Yes	Yes	Yes
IE	Ireland	Yes	Yes	No
IS	Iceland	No	No	No
IT	Italy	Yes	Yes	Yes
LT	Lithuania	No	Yes	Yes
LV	Latvia	Yes	Yes	Yes
MT	Malta	No	No	No
NL	Netherlands	Yes	No	Yes
NO	Norway	Yes	Yes	Yes
PL	Poland	No	Yes	Yes
PT	Portugal	Yes	Yes	Yes
RO	Romania	Yes	Yes	Yes
SE	Sweden	No ([5])	Yes	Yes
SI	Slovenia	Yes	Yes	Yes
SK	Slovakia	Yes	Yes	Yes

[3] https://ec.europa.eu/info/business-economy-euro/recovery-coronavirus/recovery-and-resilience-facility_en

[4] Instead of a national strategy, Finland prepared society's commitment to sustainable development as a key instrument for implementing the United Nations 2030 agenda for sustainable development. Cultural heritage is mentioned in many individual commitments. https://kestavakehitys.fi/en/commitment2050

[5] There is no specific Swedish sustainability strategy, but sustainability is included in other policies.

CURRENT AND EMERGING CLIMATE CHANGE THREATS TO CULTURAL HERITAGE

BACKGROUND

Only in recent years has it become clear that climate change threatens all forms of cultural heritage. Already a few years ago the effects of climate change could be seen directly in the **historic gardens and cultural landscapes where mostly extreme climate events** have been affecting trees, bushes, hedges and flowers. Proof of global warming has also been observed in northern Europe: as **ice begins to melt**, it accelerates the **decay of archaeological heritage**. Clear signs of the impacts of climate change on tangible heritage are now recognised with respect to events related to climate change, such as forest fires, extreme weather events, floods and erosion. However, **it is still difficult to directly relate damage to monuments and built heritage** to climate change and **even more difficult to relate climate change to indoor cultural heritage**.

The OMC expert group member countries consider **extreme climatic events a priority** in their responses to the most evident threats; they predict that severe precipitation, long heatwaves, droughts and sea-level rise will be the **biggest dangers in the future** (see Figure 4). These climate events are the **most visible and have direct consequences for built heritage as well as for archaeological sites, cultural landscapes and historic gardens**. Sea-level rise is a significant threat for many European countries, as many of their **heritage sites are situated in coastal areas**. Indirect threats will also cause many problems, if people leave the sites, tourism decreases and public funding is devoted to other areas.

Gradual climate change – a continuous increase in temperature, fluctuations in temperature and humidity, and fluctuations in freeze–thaw cycles – **should not be neglected** (i.e. the focus should not be on extreme events only), as it causes increased degradation and stress in materials, leading to a **greater need for restoration and conservation**. Biological degradation caused by **microorganisms**, for example in the form of mould or algal growth, an increase in pests and the appearance of new species in **museums and archives** are mentioned as further problems related to climate change.

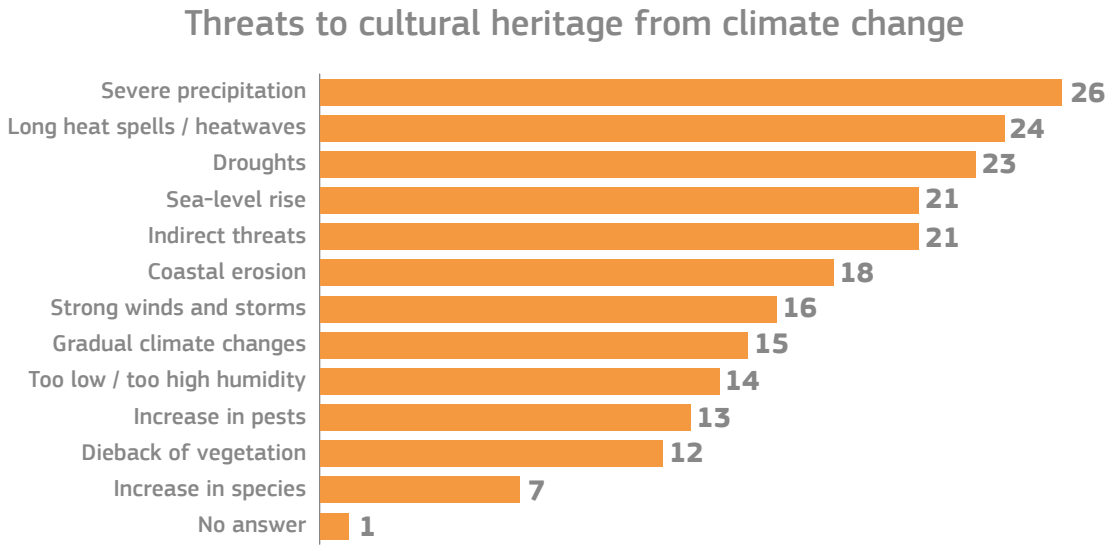

Figure 4. Threats to cultural heritage from climate change, with the number of responses from group members

In relation to the type of cultural heritage at risk, climatic issues play a major role for the built immovable cultural heritage and cultural landscapes. Threats to underwater cultural heritage were mentioned too, but **less information is available on movable cultural heritage displayed and stored in museums, historic houses, archives and libraries**. This lack of information is mainly due to the **lack of research** on the impact of climate change on the influence of the future climate or climate events on **indoor climate conditions** and thus the **stability of museum collections and written heritage** (Figure 5).

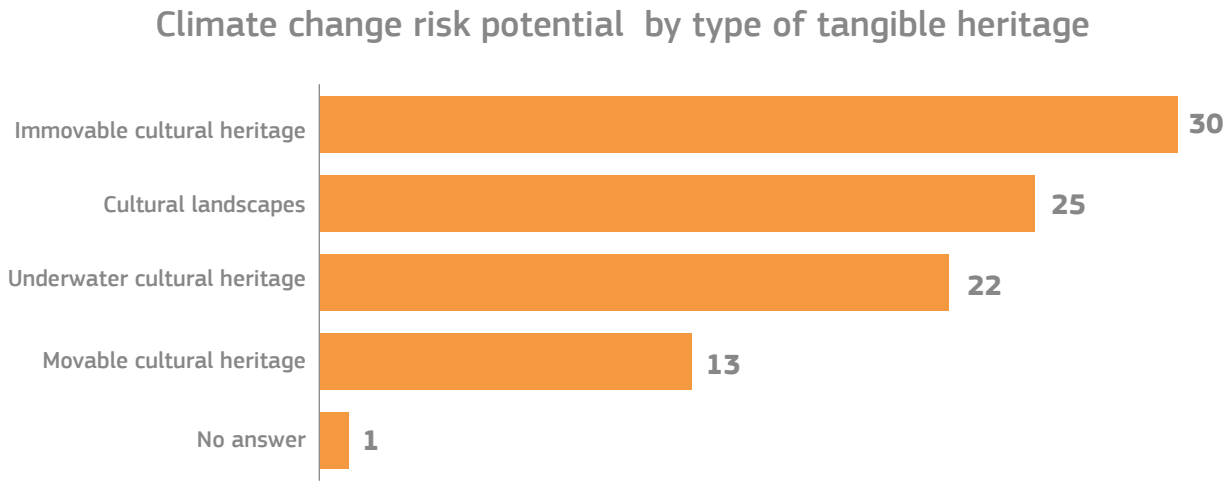

Figure 5. Type of tangible heritage at risk from climate change, with the number of responses from group members

A **very low level of knowledge** regarding the impacts of climate change on **intangible heritage** was revealed by the questionnaire (see Figure 6). Rituals, oral traditions and performing arts were named, but the low number of responses, together with the fact that most participants selected the 'no answer' option, clearly showed a significant lack of knowledge of the intangible aspects of the heritage at risk.

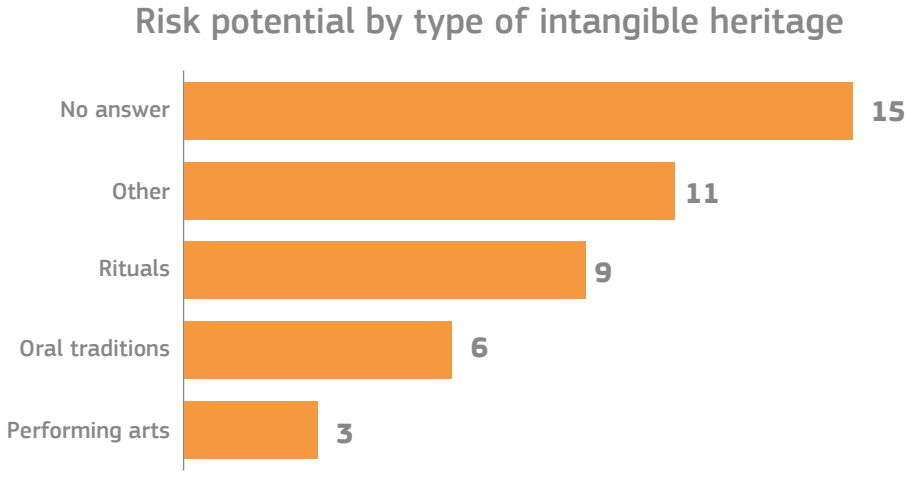

Figure 6. Type of intangible heritage at risk from climate change, with the number of responses from group members

The questionnaire revealed that some information on climate change impacts on cultural heritage is available but, in most of the participating countries, **in-depth knowledge and understanding are still absent** and far from being addressed in the protection and **forward-planning strategies and in daily practice** in the conservation, restoration and management of heritage. This also applies to climate-related risks and the scale of losses of all kinds of cultural heritage.

INSPIRATION: GOOD PRACTICE EXAMPLES

In addition to that first questionnaire, a central objective of the OMC expert group was to **identify and collect good practices and innovative measures** for the protection of cultural heritage, both tangible and intangible, in relation to climate change. This **kind of information did not exist in Europe nor globally**. Therefore, the collection of case studies from the 28 member countries was of **utmost importance**; they provide an overview of different approaches, which can serve as a source of inspiration and provide climate change decision-makers with real and useful examples of the role that cultural heritage can play in tackling climate change. However, **obtaining the information and knowledge** of current approaches **was a time-consuming and often difficult task**. There is currently no inventory or central entry point in any of the member countries or at European level. The **information and data that were needed either did not exist** or were **highly fragmented and dispersed**. The task of finding good practice examples in Europe **required an investigative approach**.

The aim was to include at least one case study per country. Countries that are already very active in the field of climate change impacts on heritage were able to deliver more than one example, whereas there were difficulties in identifying best practices in and obtaining all the necessary data for other countries. For each case study, the case study contacts were asked to fill out the template prepared by the OMC expert group to ensure the results were relevant to the mandate. The information gathered included the type of case study, how climate change is being taken into account, how resilience is being addressed and the innovative character of the case study. By February 2022, the **impressive number of 83 case studies had been received from 26 countries** (see Figure 7).

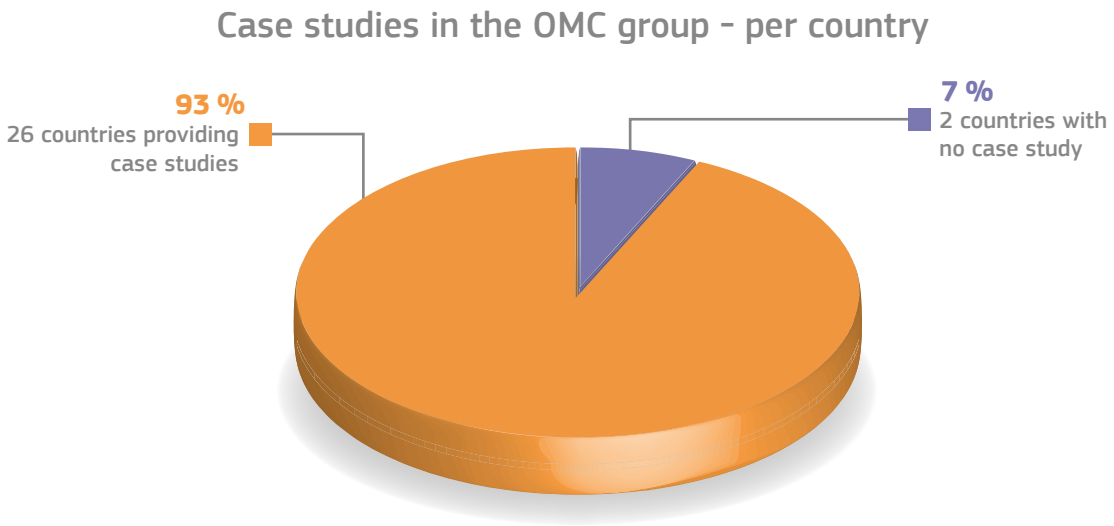

Figure 7. Case studies provided, by number of countries

This large number of case studies and countries clearly testifies to the **commitment of the countries** to develop pioneering projects and to promote knowledge of the issue of cultural heritage resilience in the face of climate change. There are examples of innovative works and measures to respond sustainably. These **83 case studies are the key element** of the work of the **OMC expert group** and offer an invaluable **source of information and inspiration** in this field.

The cases were analysed in detail, allowing for classification according to the type of heritage.

- **Tangible heritage represents the majority of case studies.** In most of the case studies, tangible heritage specifically refers to built heritage, which suggests that the knowledge and focus lies within built heritage rather than other types of heritage. A total of 70 out of the 83 case studies address tangible heritage as a category (Figure 8)

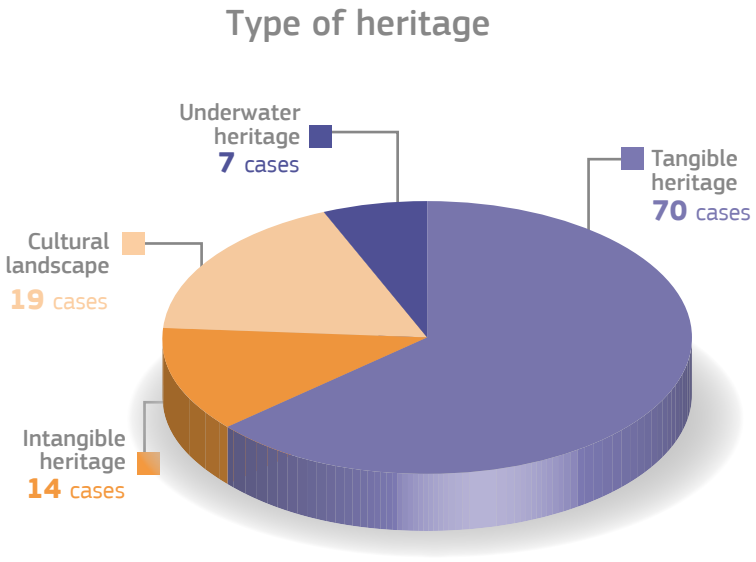

Figure 8. Type of heritage covered, by number of case studies

and, more specifically, 54 address only tangible heritage, without including any other type of heritage. These numbers confirm that built heritage plays a very important role and is therefore at the centre of the expert group's work.

- **Cultural landscapes, another type of heritage, are mentioned in 19 case studies.** These are mostly considered together with other types of heritage. This combination is a realistic picture, as built heritage, such as castles and historic houses, is often embedded in cultural landscapes representing a unique ensemble of artworks. This implies that adaptation and mitigation strategies need to be considered holistically in terms of reducing the carbon footprint without harming built heritage.
- **Intangible heritage is addressed in 14 case studies.** This is normally in combination with other types of heritage, as intangible heritage is often linked to traditional skills used to create tangible heritage, for example the art of drystone walling. Intangible heritage is at the centre of only a few best practice case studies.
- **Underwater cultural heritage is the subject of 7 case studies.** It represents the smallest number of case studies, probably due to the specificity of this type of heritage, which involves ethical considerations and has a lack of research projects.

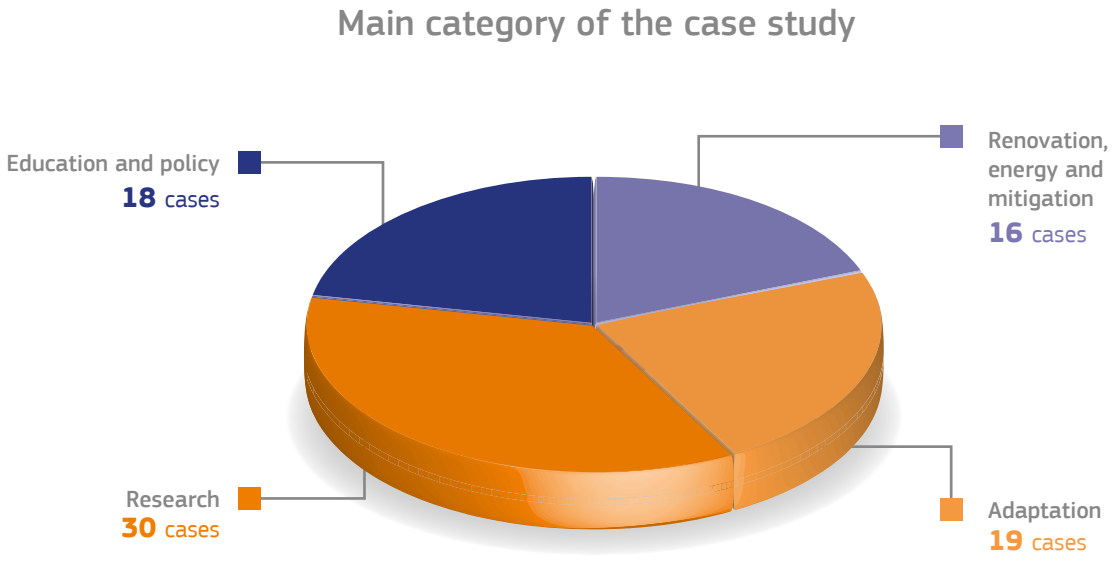

Figure 9. Types of projects covered, by number of case studies

It is worthwhile mentioning that a **majority** – more than one third – of the case studies were **research projects** (Figure 9), which clearly underlines the prominent role of research as a driver of innovation in this area. There are only a few implementation-only projects undertaken by the heritage/site managers.

The questionnaire asked which of four categories most clearly represented the type of project; the most common response was 'research'. Research projects are followed by three other categories with similar numbers of case studies: 'adaptation', 'education and policy' and 'renovation, energy and mitigation'.

The questionnaire results also revealed other considerations, such as the lack of knowledge about intangible heritage. In addition, the role of communities and the development of policies continue to be pending issues for the OMC expert group, although some of the good practice examples touch on these matters. A larger number of case studies provide examples from urban areas than from rural areas; therefore, the **particularities of rural areas are still not well understood and data are missing**.

The case studies also revealed that **interdisciplinarity is the key methodological approach** to be followed in the area of climate change and cultural heritage. Furthermore, **continuous monitoring and maintenance play a vital role in adapting heritage to climate change**: these measures must be implemented within heritage management, and appropriate budgets must be provided. Stronger promotion of **applied research has been shown to lead to policy development**, and it fosters the implementation of initiatives. Only a small number of (convincing) case studies dealt with another big topic of the climate debate – the **role of buildings in the low-carbon economy** – again demonstrating the lack of research in this area. The whole-life-cycle assessment of existing buildings compared with that of new buildings shows that **more attention should be given to embodied, or grey, energy**, which is one of the hot topics of the Green Deal and the European renovation wave. This finding highlights that **both qualitative and quantitative data are lacking throughout Europe** to convincingly demonstrate that old **buildings can be climate friendly and green**. To demonstrate this, it is necessary to holistically assess the entire existing building stock and its preservation. The enormous advantage of the approach of preserving existing buildings, which is primarily based on the decades - to centuries-long service life of historic and listed buildings, is often not understood or taken into consideration by policymakers. Finally, the need for better and reliable data and statistics remains a challenge for future actions.

The damage on trees after the glaze ice impact of the Lime Avenue in Logatec (Slovenia) in 2014
© IPCHS, Petra Jernejec Babič

THE HOT TOPIC: CLIMATE VERSUS HERITAGE

BACKGROUND

Cultural heritage, as a central part of European society, has an important role to play in the fight against climate change: **cultural heritage is both a victim of climate change and an integral part of the solution**. This role may include the provision of traditional knowledge and craft techniques, which are often born of energy and resource scarcities, and old agricultural techniques that shaped cultural landscapes, which have been forgotten or lost. **Buildings in particular – due to their nature as carbon sinks**, their thermal behaviour and the cultural values they convey – need to be taken care of, repaired and (re)used. Ultimately, they must be considered a **key element of the circular economy, with a role in solving the climate crisis**, rather than a problem. Heritage buildings represent a common European base for historical and cultural development and serve to store information. This value, shared by all, must be safeguarded from damage due to climate change impacts and irreparable loss or damage as a consequence of climate change mitigation / energy efficiency measures. The vast majority of Europe's historic building stock does not have statutory protection, yet these buildings are central to the character of Europe's cities, towns and rural settlements, and are of great value to communities. **These buildings are vulnerable to damaging alterations that fail to take account of the hygrothermal properties of traditional constructions and their real rather than assumed thermal transmission levels.**

In the European Commission's December 2019 communication on the Green Deal, including the European renovation wave, **European cultural heritage and buildings particularly worthy of preservation are not explicitly referred to**. From the point of view of the OMC expert group, this is a **considerable drawback** and weakness, endangering the success of the Green Deal, which must be changed. Historic buildings and neighbourhoods can be found in almost every European city and rural region, and they constitute Europe's cultural value and diversity. Europe has a rich and large building stock that documents the historical and cultural development from antiquity to the present in a way that can be read and experienced. Therefore, the **Green Deal, with its renovation wave, must take into account the needs and requirements of built cultural heritage**.

CULTURAL HERITAGE BUILDINGS AND THE GREEN DEAL

The greenest building is the one already built.

Carl Elefante, President of the American Institute of Architects (2007)

The totality of the built environment, especially new construction of buildings, is a source of significant carbon emissions and accounts for at least 40 % of anthropogenic greenhouse gas emissions. However, **cultural heritage buildings and architectural monuments are materialised ecology**. The same applies to the vast stock of older buildings that have not been granted protection but contribute to the character and history of cities, towns and rural villages. **These types of buildings are often abandoned and lie empty for years before being demolished**, while on the outskirts of communities **new monotonous houses are built**, consuming valuable land and fertile soil that is needed for the production of food. In the field of construction, **existing buildings are intrinsically environmentally friendly**, as the CO_2 produced and energy used in this sector are primarily associated with building materials, transporting materials and transforming the materials into buildings. Thus, **old buildings – compared with new ones – save resources and improve the carbon footprint of the sector**. In connection with the manifold efforts to achieve the Green Deal and in the New European Bauhaus initiative, the area of construction and climate change is covered at European level.

THE BIGGER PICTURE

To promote the use of existing buildings instead of new construction, it is necessary to **holistically assess the existing building stock and its preservation**. **Life cycle analysis** is a holistic approach indicating a **building's** ability to mitigate climate change throughout its construction and existence, not just **energy performance** during its operational phase. Existing buildings have already expended energy through their construction and use of materials. The CO_2 produced during the building process has already been emitted. The **energy performance assessment of a building should not only cover the operational phase, but also take into account mitigation during**

the construction phase and demolition if applicable. As a goal, **all regulations must take into account that the preservation of existing buildings**, and in particular protected monuments, which have the potential to be renovated and improved, has a climate-friendly advantage, including the key aspect of **grey energy**. This enormous advantage, which is primarily based on the decades- to centuries-long service life of historic and listed buildings, **is often not known** or not taken into consideration by the **construction sector or policymakers**.

Among the categories of existing building stock, listed **built heritage occupies a top position in terms of ecological building**: a very high percentage of these monuments use climate-friendly building materials (wood, clay, etc.) both in the context of their earlier construction and in their ongoing restoration. Furthermore, traditionally the building materials were **locally sourced and manufactured**, avoiding high transport costs and CO_2 emissions.

Due to these two factors, **architectural monuments have an above-average positive ecological impact**, for example through the wide use of wood, with its high CO_2-binding properties, from domestic forests, in contrast to concrete, which contributes 6–10 % of global anthropogenic CO_2 emissions. This extremely positive aspect, together with the whole-life-cycle assessment of a building, must be adequately taken into account in current evaluations of expected additional requirements and regulations for the construction industry and in line with the principle 'energy efficiency first'.

Together with the undoubtedly outstanding importance of historic buildings and architectural monuments, with their impact on an **infinitely wide range of public and private areas, as the core of Europe's identity**, the preservation and consideration of their characteristics are now also being seen as important and are highly topical in the context of the Green Deal. As part of the **Green Deal's renovation wave, the Commission launched the New European Bauhaus initiative**. This initiative aims to act as an incubator of innovation and creativity and to promote sustainable buildings in Europe and beyond. However, the New European Bauhaus initiative will not only focus on creating something new but also demand and promote a new way of thinking. Ultimately, it seeks to develop **holistic renovation concepts based on renewable energies**, which require the use of innovative tools and concepts and necessitate creative design, but also meet the requirement that the approach to a solution be in **keeping with the principles of cultural heritage** preservation.

Roof covering with insulation in Ljubljana, Slovenia, 2016. Photographer: Tatjana Adamič © Institute for the Protection of Cultural Heritage of Slovenia, Tatjana Adamič

CULTURAL HERITAGE AS A ROLE MODEL

The proposed approach thus follows the goal of the **New European Bauhaus initiative: to realise environmentally friendly and climate protection-oriented renovations in the building stock at a larger scale** without impairing the historic character of European cities and landscapes. In this way, **cultural heritage also serves as a transformation instrument of the New European Bauhaus initiative**, allowing the transfer of sustainable and climate-protecting concepts to the normal building stock. Finally, interdisciplinary projects and networks create experimental spaces in which unique European values in the form of art, social togetherness, the tradition of the built environment, the promotion of science and the creation of innovative technologies can be mutually beneficial and appreciated in planning the future of Europe.

Therefore, aspects of the preservation of materials, building protection needs and compatibility with climate change adaptation measures must be included in the European Commission's documents. In addition to the historic building stock already considered particularly worthy of preservation, other historic buildings require a more sensitive use of innovative measures, components and concepts than those used for the normal building stock and new construction. A strategy that is evaluated in the context of and adapted to historic buildings, **rather than the common efficiency strategy applied in the normal building stock**, should be used. Furthermore, **new opportunities exist for the cultural heritage** stock and other buildings worthy of preservation, as **careful energy upgrade and modernisation can improve comfort, usability and energy efficiency, and can contribute to resource conservation and resource efficiency** in cultural heritage.

The **environmental impact of existing buildings is only about half of the impact of new buildings**. And it takes **decades before new buildings pay off** environmentally. The greenhouse gas emissions that are reduced or avoided completely by the repair and reuse of existing buildings are mainly related to the production, transport, construction, replacement and disposal of building materials and elements, and are called bound emissions. Emissions from energy use in the operational phase of a building are often lower for newer buildings, but the bound emissions are relatively higher when building new than when upgrading. **Norwegian case studies calculated** that greenhouse gas emissions related to the use of materials in upgrading existing buildings are only around **one third of the corresponding emissions from new construction**. The high levels of emissions associated with the construction of a new building today will contribute to overall increased emissions, and the gap between the 2030 and 2050 emissions targets and the actual emissions will increase. For **new buildings**, it will take **decades before the benefit of lower annual emissions** related to energy use **offsets the high emissions associated with their construction**.

RENOVATION AND REBUILDING VERSUS DEMOLITION AND NEW CONSTRUCTION

Renovation is a more efficient way of avoiding emissions in the coming decades than demolition, as proved by a calculation of life cycle costs from the Finnish case study '**To demolish or to repair?**'. Looking at emissions reductions per invested amount, the results indicate that upgrading is more cost-effective than new construction, if the aim is to reduce greenhouse gas emissions. Energy improvement measures suggested for historic buildings in energy certificates must consider cultural values together with the energy consumption of a building during its operation. **Energy efficiency improvements such as to stop air leakage and improve heating and cooling effectiveness, and other system approaches, can often be used in historic buildings.**

Such thorough measures need to be prescribed with precaution for objects' cultural values to be sustained. The heating requirement of a gently renovated historic building can often be reduced for a generation when the primary energy content of the building material is considered. **Historic buildings usually have lower follow-up costs in building operation than comparable new buildings equipped with sophisticated smart building control.**

The **new methodology to couple climate change predictions with whole-building simulation tools** developed as part of the EU Climate for Culture project calculated that, for many regions of Europe, **the heating requirement will decrease in the coming years in both old buildings and new buildings**: in Austria, there will be a reduction of 5–10 %. However, the cooling requirements of **new buildings**, which are generally made of concrete and glass, **will increase disproportionately compared with those of old buildings, which generally have thick walls and external shading** (case studies: Air well system of the Vienna Burgtheater – sustainable cooling strategies (Austria); and Climate for Culture research project (Germany/EU)). In addition, a **more precise thermodynamic simulation results in a 10–20 % (in some cases even up to 30 %) lower heating energy demand in old buildings** than with the static calculation used in the energy certificate. Where a building is located, in which kind of environment it is embedded (within a green space or a densely built-up area) and by which transportation mode it can be reached should be considered when the overall energy balance and CO_2 emissions are looked at.

Three office buildings being demolished, Helsinki, Finland, 2020. Photographer: © Harri Hakaste

CULTURAL HERITAGE AS A KNOWLEDGE BASE FOR SUSTAINABILITY

Cultural heritage has significant capacity to contribute to ensuring sustainability for the following reasons.

- The building and construction techniques and materials were produced to last for a long time. The buildings are continuously **repairable, recyclable and reusable** using sustainable materials and techniques, and this will remain the case for a long time.

- **Buildings display the skills and knowledge of previous generations well suited to deal with climatic challenges.** During their lifetime, they have been adapted and transformed to meet constantly changing usage requirements.

- **Built cultural heritage** is the result of the **best technical capacities that past generations** were able to reach. In this sense, the future renovation of built cultural heritage for resilience to new climatic conditions again requires the implementation of the greatest complex and multidisciplinary innovations that present generations can access. This renovation must also focus on climate change mitigation.

- Resilience is one of the main characteristics that define **cultural heritage**, **as it has been able to survive manifold adversities**. Therefore, actions taken in response to climate change should not put the resilience of cultural heritage at risk.

- **Cultural heritage, in the broadest sense, is a product as much as it is a process.** Cultural heritage provides societies with a wealth of resources inherited from the past, curated in the present and able to bestow its benefits upon future generations. All actions taken for the sake of sustainable renovation should not compromise these resources, but rather reinforce and adapt them to the new reality of climate change.

IDENTIFIED GAPS

- There is a **lack of methods that realistically assess the energy efficiency potential in large stocks of historic buildings** to contribute to regional planning and national and EU strategies.

- There is a **lack of in-depth knowledge of and datasets** on the properties of older buildings to make climate-mitigated and future-proof new investments and policy decisions concerning renovation, preservation, upgrading and demolition.

- There is a **need to record data from both the private sector and the public sector**. To avoid 'climate-blind' decisions, data should be collected and shared in a comprehensive and harmonised way.

- There is a **need to collect data on the costs of climate change mitigation / adaptation** of built heritage to set up and provide financial resources in budget-planning procedures.

RECOMMENDATIONS

The European Commission's publications on the European renovation wave give no indication of how European cultural heritage can contribute to improving climate protection. To **significantly increase the climate-friendly renovation rate in all European regions in the coming years as part of the European renovation wave**, significant financial resources have been promised and legislative instruments have been significantly sharpened. These are intended to promote the implementation of energy-efficient and sustainable measures. However, these requirements and subsidies alone are not sufficient to renovate the considerable stock of historic buildings and other buildings in Europe that are particularly worthy of preservation in such a way that the cultural appearance of European cities, villages and landscapes can be preserved.

The **OMC expert group sees** the **European Green Deal**, with the accompanying European renovation wave and the proclaimed **New European Bauhaus initiative**, as a **unique opportunity to secure a long-term future for historic buildings** and buildings particularly worthy of preservation by means of approaches to solutions that are appropriate for cultural heritage and are based on **innovative, creative and holistic components and concepts that serve both the use of the buildings and the preservation of cultural values**. It should be noted that the consideration of the concerns of the historic and preservation-worthy building fabric of Europe is indispensable in European Commission publications and that urgent efforts must be made to achieve this. The financial means made available by the European Commission during the renovation wave must also be **made available to the cultural heritage building stock** in order to carry out the often urgent and hitherto unrealised upgrades and modernisations. However, in addition to improving energy efficiency and sustainability, planned solutions and measures should also be required to be in line with the requirements of historic cultural heritage in order to ensure its preservation. The increased **promotion of lighthouse and demonstrator projects**, which serve to broadly discuss and evaluate measures and concepts appropriate to cultural heritage, should be worked towards, as they provide excellent support for the transfer of suitable measures and concepts.

In addition to sustainable, energy-efficient measures, the European Commission must demand and promote the preservation of historically valuable buildings. Although this requires the **intensification of research and development**, the results will **directly benefit the normal building stock and new construction**. The historic building stock worth preserving requires a holistic and interdisciplinary approach that goes far beyond purely technical solutions. This will lead and stimulate the creativity and innovative power of many sectors and companies – such as construction; restoration/ conservation small and medium-sized enterprises; craft companies; design, architectural and engineering studios; digitalisation; and artificial intelligence (AI) / machine learning – strengthening Europe's global competitiveness and economic power through cross-national and cross-disciplinary networking of all participants. What is needed are **ambitious alliances**, such as those the European Commission is trying to strengthen. Following such an approach, building authorities, building professionals and private and public builders can create a **new identity-forming European building culture** through supportive cooperation of professionals from the preservation of historic cultural heritage and from scientific and research centres. In accordance with the goals of the New European Bauhaus initiative, this procedure directly addresses and actively involves citizens. Public interest in Europe's culturally significant building stock ensures that solutions for energy-efficient and sustainable renovation of the historic building stock will be met with great interest from European society; this interest will also result in significant support for climate protection and sustainability goals through participation and action. Transferring the solutions developed for historic buildings and neighbourhoods to the normal building stock will also make a substantial **contribution to significantly increasing the renovation rate**. Even in new buildings, the holistic solutions developed through interdisciplinary work will meet with interest and have the potential to be transferred.

Repairing dry stone terraces of the Takala vineyard, the first protected dry stone landscape in Takala, Croatia, 2018. Photographer: © Filip Šrajer, Dragodid

A RESILIENT FUTURE THROUGH ADAPTIVE CULTURAL HERITAGE

One of the aims of the European Green Deal is to launch a set of policies that will transform, in Europe, the economy, industry, production and consumption, large-scale infrastructure, transport, food and agriculture, construction, taxation and social benefits. It promises a new growth strategy for Europe, in which environmental, economic and social sustainability go hand in hand. Undertaking climate planning in a culturally appropriate, inclusive and equitable manner and rooting it in the cultural values and identities of affected communities contribute to more durable environmental action, new job creation and resilient outcomes.

This chapter mainly focuses on **adaptive measures collected from the case studies from all over Europe** to make cultural heritage more resilient and how cultural heritage can contribute to increasing awareness of climate change at all levels in order to combat it in line with the Green Deal's goals. The salient case studies for this chapter are '**Adapt Northern Heritage: assessing risks and planning adaptation**' and '**SAAMI: adaptation of the Saami people to climate change'**.

MALADAPTATION: A NEW THREAT TO CULTURAL HERITAGE

Maladaptation is often an unintended consequence of action taken to deal with climate change, when this action fails to recognise potential adverse impacts on heritage assets. As such, **maladaptation is one of the foremost climate-related threats to cultural heritage**. Examples include adverse outcomes from climate adaptation actions such as the construction of flood and coastal defences. Maladaptation may also result from works to mitigate climate change such as **inappropriate works to upgrade energy efficiency, which damage the character or the fabric of historic buildings and areas**. Poorly considered or badly sited renewable infrastructure, including wind turbines and solar panels, can damage cultural landscapes or the setting, appearance and functionality of buildings of cultural heritage significance.

Maladaptation is often a result of a **lack of awareness on the part of decision-makers or project promoters** of the existence or the sensitivity of heritage assets. For this reason, it is essential that heritage assets are mapped and described together with their locations integrated into general climate vulnerability mapping. Proposed climate adaptation and mitigation actions should undergo **risk assessment at all stages** of development and implementation to ensure that heritage considerations are fully addressed and take into account the opinions and concerns of relevant heritage organisations and authorities. Where there is the potential for adverse impacts, appropriate mitigation measures should be taken to avoid or minimise these. It is recommended that the ***European quality principles for EU-funded interventions with potential impact upon cultural heritage*** **(2020)**[6] should be followed to ensure high-quality outcomes.

Although the impacts of climate change on Europe's non-renewable and irreplaceable cultural heritage are obvious and even visible, the scale and the urgent need to adapt and react to climate change is only beginning to be understood and strategies are only beginning to be developed. The following three prerequisites need to be considered before adaptation strategies and measures are applied.

- **What will the future climate look like at cultural heritage sites?** Examples include a high predicted number of days of heatwaves, high precipitation, dry spells and storms, and a high probability of sea-level rise and storm floods.
- **What is the current state of cultural heritage (state of conservation)?** Examples include the condition and vulnerability of a building, a historic garden or landscape, or an archaeological site.
- **What can be learnt from cultural heritage to achieve the goal of a sustainable, climate-resilient society?** Examples include historic building techniques; specific architecture, particularly vernacular in specific climatic regions; and traditional knowledge and skills in preserving cultural heritage, landscapes and gardens.

[6] http://openarchive.icomos.org/id/eprint/2436/

Aerial view of Dunbeg Promontory Fort, Fahan, Dingle Peninsula, County Kerry, Ireland, 2018. © Office of Public Works

MAPPING AND MONITORING CULTURAL HERITAGE

Climate change is an ongoing process and mapping the risks of physical cultural monuments, buildings and landscapes at a regional/local level is important to get an overview of how cultural heritage has been and will be affected by the changing climate. This mapping will enable an **early warning system as a first step** in resilience measures and will ensure that heritage issues are recognised in disaster risk management policies and practices. A comprehensive overview of risks as a basis for knowledge-based management is important to enable the use of resources in the best possible way and to reduce losses and damage.

It is necessary to **establish baseline information on heritage assets**. **Geographical information system mapping and long-term monitoring of vulnerable heritage assets** are important to establish priorities. Such mapping should ideally be carried out in three dimensions, as height above sea level is crucial. This mapping **needs to be reviewed periodically and should be communicated to all relevant stakeholders** so that prioritisation and focus can be established for decision-making. Such mapping should also capture information on the condition of the structure or site, maintenance and repair works undertaken, past climate records, and impacts and responses, among other things. This information then needs to be coordinated with general mapping systems so that other sectors will be alerted to the potential heritage impacts of their proposed adaptation works. **It is important to ensure heritage is included in future modelling of climate impacts.** After the mapping exercise, the results should be communicated, ideally through an open source, to relevant stakeholders. As an example, the environmental monitoring of the consequences of the climate impacts on listed buildings project case study details the monitoring and analyses of surfaces and temperature/humidity being carried out to keep track of the development of the risk of damage and the development of damage due to climate impact on mediaeval buildings and other buildings at two of Norway's UNESCO World Heritage Sites. **Detailed monitoring on site is crucial to collect the necessary information.** It can help with the management of the site, but also provides knowledge that can be applied at a more general level.

Consolidation of the Guadalperal Dolmen in Cáceres, Spain, 2021. Photographer: © Juan José Gordón Baeza

STRONG REGULATION AND FRAMEWORKS

With regard to historic city centres, a successful example from the World Heritage City of Bordeaux shows that **urban planning regulations** can combat climate change while maintaining the ethics and requirements of urban heritage preservation. Practical measures included thermal insulation of buildings and revegetation of courtyards to fight urban heat, which helps to maintain biodiversity, improves well-being and health, and incorporates the needs of the residents. **In Bordeaux, the objectives are no longer to pit architectural heritage against sustainable development but to combine its preservation with climatic issues.** The UNESCO World Heritage City of Strasbourg will follow this example, and the measures are scheduled to be completed in 2022.

Loss of or damage to the cultural environment as a result of climate-related stresses will, in some cases, be inevitable. It is therefore important to document cultural environments that are priorities for protection before loss to monitor the success of preservation measures and thus contribute to gathering knowledge.

REGULAR MAINTENANCE AND GUIDANCE

Continuous good maintenance is of great importance to prevent cultural heritage sites from the effects of a changing climate, but there is also a need to find, evaluate and implement adaptation measures to respond to the identified risks. Risk management and climate change adaptation are important for the sites, as well as in improving the integration of cultural environment considerations into **society's emergency planning, keeping in mind long-term resilience**.

To identify good and resource-efficient adaptation options, systematic approaches are needed and checklists for maintenance should be developed where they are not already available. Such routine maintenance must be tightly tied to conservation actions, proactive management decisions and good timing to optimise energy efficiency. Moreover, long-term monitoring will be necessary to understand any changes occurring and to adapt and plan new management strategies to deal with the current and predicted climate change.

There is already **some very valid groundwork being carried out by different regions/countries, and the dissemination and sharing of information resulting from this is crucial**. Local/regional climate data in relation to cultural heritage are becoming more available. One example of good practice that should be taken on board by other countries and adapted according to regional needs is Adapt Northern Heritage. This guide – which strives for best practice concerning climate adaptation and cultural heritage, both tangible and intangible, with the latter being quite under-represented and not fully recognised – was produced with the involvement of several northern countries. The guide differs from standard guidelines for risk assessment related to climate and climate change by including assessments and consequences of possible loss of cultural-historical values. The project **supports stakeholders by helping them to build capacity and providing tools that enable owners, communities and authorities in northern regions of the world to better cope with the complexities added to historic place management in times of a changing climate**. This guide provides a practical process and a procedure to work through the steps of the risk management

process. This guide was presented and disseminated at an OMC expert group meeting, on websites, at conferences and seminars, and in one-to-one meetings with public property managers. It has been used to some extent, and efforts are being made to increase its use.

Once the findings of such research are made accessible, investments can be made to address gaps in research and ensure that adequate resources, including financial ones, are available to the heritage sector to deal with the impacts of climate change. This should make up for the current lack of institutional cooperation, coordination and financial commitment at both local level and international level. It is of utmost importance to integrate cultural heritage issues into all relevant climate change plans and policies, and, conversely, to integrate climate change adaptation into all cultural heritage plans and policies.

Cultural heritage can provide useful lessons, which can be used in several ways to achieve the goal of a sustainable society. It can teach us how to adapt to the climate, for instance how we design our buildings, what materials we use, how we place them in the landscape and how we take care of them. Cultural heritage can also teach us and inspire us when it comes to frugal resource use and reuse, that is, how to **contribute to a circular society**. By using **endogenous knowledge and the history of heritage sites**, past human interactions and the effects of the environment can be tracked to establish baselines from which the contemporary climate and society are shifting.

Paleoenvironmental, climate and archaeological data can also be collated to assess past baselines and tipping points for ecological and social change, including the adaptation of agriculture, spatial land use patterns, subsistence strategies, mobility and use of cultural materials. **There is a very strong link between traditional knowledge and the sustainable use of biodiversity**, which has enabled people to support themselves and survive in a harsh and barren climate with the resources available.

As in the case study from Finland entitled 'SAAMI: adaptation of the Saami people to climate change', traditional knowledge was transferred between generations through storytelling and learning in childhood. Sámi tradition was used in the development of the climate risk assessment in parallel with scientific knowledge, not by separating tangible and intangible heritage but rather by endorsing a holistic view of the landscape and their heritage. It is the Sámi view that tangible heritage is built from the materials of nature; when abandoned, it goes back to nature. Using this reasoning, stories, skills and traditional knowledge are highly valued and protected. This is a different view from the institutional model of valuing heritage and what should be protected. The institutional model of valuing heritage and assessing risk of climate change could have more value when integrated with a holistic approach to nature and heritage, and traditional knowledge. This more holistic approach is more often seen in relation to the intangible heritage of (indigenous) communities.

In a similar vein is the Italian case study 'Alpe Pedroria and Alpe Madrera: restore pastures and landscape in the Alpine region to increase the resilience of territories'. Historical and cultural factors and values have been related to ecological and environmental values, generating a project with good sustainability at environmental, cultural and social levels. The project aims to reverse the process of abandoning the mountainous region and reintegrating the region's productive functions. This recovery project involved historical, landscape and environmental restoration. It created the conditions for the restoration of pastoral activity and the start of the production of a local traditional cheese called Bitto. The reintroduction of productive activities and of sustainable agriculture in the mountains gives the territory more resilience, allowing adaptation to and the mitigation of climate change. Moreover, it supports the repopulation of animal species in danger of extinction, and promotes the enhancement of the intangible heritage linked to traditional pastoral activity and a renewed awareness in the local community, starting with the youngest people. The protection of the traditional method of producing Bitto cheese contributes to the sustenance of the intangible cultural heritage.

House in the mountains, Alpe Pedroria, Talamona, Italy, 2011. Photographer: Benedetta Colombo. © Fondo Ambiente Italiano

In addition to the cultural heritage itself, there are **cultural institutions and platforms, such as museums, which can be regarded as excellent vehicles for engaging citizens in the decarbonisation** challenge as strong actors in this transition. Europe's cultural heritage, much of it from pre-carbon eras, represents millennia-old living laboratory experiments on ways to boost the zero-carbon economy through circular lifestyles.

CULTURAL INSTITUTIONS AS ROLE MODELS TO IMPLEMENT THE UNITED NATIONS SUSTAINABLE DEVELOPMENT GOALS

Museum, archive, monument and heritage site organisations are highly visible across Europe, and their products and services touch millions. With around **55 000 museums in the world**, their impact is probably comparable to that of a small country. In order to realise their potential, museums, museum networks and individual museum workers need to understand how they can commit and contribute to the sustainable development goals (SDGs).

Cultural institutions need to be seen as spaces for cultural transmission, intercultural dialogue, learning, discussion and training. They must also play an important role in education systems (formal, informal and lifelong learning), social cohesion and sustainable development. Cultural heritage destinations can showcase mitigation strategies, educate visitors on climate change and support behavioural changes towards greener practices. Cultural institutions can also serve as places of refuge during climate-related emergencies.

In addition to the institutions, it is also important to consider the individuals working in them. The following two paragraphs provide examples of how **curators and conservators, both at the heart of museum management, can contribute** to the **17 SDGs with 169 targets**.

Curators can readily support seven activities, for example (target 1) by caring for and developing collections to support the SDGs, and making them available in sustainable

ways; (targets 2 and 3) developing exhibitions and collections linked to the SDGs, supporting education and cultural participation for all; (target 4) supporting tourism in support of the SDGs through exhibitions and other activities; (target 5) and facilitating the use of collections for research, and making collections and collection information widely available (notably online), to support the SDGs. In addition, curators can ensure that all their activities promote sustainability through the resources they use and decisions they take (target 6), and can build partnerships and collaborations to support the SDGs (target 7).

Conservators can make a distinctive contribution through caring for collections and making them available to support learning opportunities and cultural participation (targets 1, 2 and 3). Furthermore, conservators can support research for the SDGs (target 5) and can make a distinctive contribution through ensuring the chemicals and other resources they use as part of conservation treatments are not harmful to the natural environment (targets 1 and 6).

Heritage management is constantly changing, and this needs to be taken into account from an academic point of view , as it will influence the way research is carried out. It is important to invest in research to develop knowledge that can help us to develop a sustainable circular society and contribute to better care for cultural heritage. It is necessary to identify skills shortages and capacity gaps in relation to climate change adaptation. It is also necessary to ensure that there is a sufficient workforce trained in traditional building skills to carry out the enhanced maintenance and repair work necessary to ensure heritage assets are resilient to climate impacts. It is imperative to upskill heritage staff in climate change adaptation monitoring and practice. Workers will also need to **develop the skills required for the green transition**. Leveraging the potential of the crafts sector, creative industries and cultural heritage can support just outcomes and help deliver a green and just transition and strengthened social inclusion.

Considering the **impact on socioeconomic activities**, community engagement is imperative. Communities need to be placed at the heart of decision-making processes. The recognition that what people value may change with environmental vulnerability can be utilised to maximise the potential of heritage to act as a **vehicle for climate change education and public engagement**.

Tools such as heritage value assessments – for example UNESCO's World Heritage List and ICOMOS – can be used to support climate adaptation and make people aware of the potential loss of such prestigious assets. It is also important to **establish and maintain connections between heritage managers and researchers in climate change** science and communications fields by sharing good practice examples. The development of citizen science should be invested in to enable the public to assist in the widespread monitoring and recording of impacts on heritage sites.

Last but certainly not least are the **financial barriers that the cultural sector constantly faces**. There needs to be considerable investment in the **mentality of people at all levels of decision-making**. Considering the lack of resources across the cultural sector, it would be advantageous to collate all the existing research and share best practices to maximise the potential for the cultural heritage sector to compete for the resources necessary to effectively adapt to climate change.

IDENTIFIED GAPS

- High-resolution climate predictions for cultural heritage should be readily available.
- Data quantifying losses as a result of climate-related disasters are unsatisfactory: such data are often not recorded and/or not available in accessible formats and databases once collected.
- Financial resources and incentives for adaptation measures are lacking.
- Continuous maintenance and long-term monitoring of heritage is poorly implemented.
- There are gaps in the research needed to ensure adequate resources and identify shortages in expertise, skills and financial resources.

RECOMMENDATIONS

- Enhance cooperation between climate science and cultural heritage managers.
- Establish documented baseline information on heritage assets to aid prioritisation.
- Set up cultural heritage climate change risk maps for Member States and Europe.
- Set up an early warning platform.
- Provide a database and register of best practice examples at EU and Member State levels.
- Communicate to all relevant stakeholders – regionally, nationally and internationally – existing climate information.
- Use endogenous knowledge and history of heritage sites to assess baselines from which the contemporary climate and society are shifting.
- Use museums and historic sites to engage citizens in the decarbonisation challenge, showcase mitigation strategies, and educate visitors about climate change and greener practices.

RESEARCH AND INNOVATION: INDISPENSABLE DRIVERS

BACKGROUND

The **role of research and innovation** in protecting cultural heritage from climate change by making Europe's heritage climate resilient is **paramount**. **Researchers were the first** to draw attention to the threats posed by climate change to cultural heritage after the **European Commission in 2003 launched worldwide the first call for research projects** to investigate the impacts of climate change on outdoor cultural heritage. In 2008, the second European project began to study the impacts on indoor cultural heritage and the future energy demands of built heritage. Research and innovation are an integral part of the mandate and objectives of the OMC expert group. An evaluation of the state of play of research shows that **we still need to identify and better understand the most severe threats and their impacts, as well as good practices and innovative measures showing how European cultural heritage**, in all its forms, can be protected from climate change, but also how heritage can contribute to mitigating climate change. Therefore, an in-depth assessment of cases gathered by the members of the OMC expert group has been performed. The OMC expert group recognises the **unique role that research has played and will continue to play in promoting cultural heritage** in the context of climate change discussions, actions and research development.

ADDRESSING THE NEED FOR RESEARCH TO SUPPORT CULTURAL HERITAGE ADAPTATION

Although there has been substantial scientific progress in identifying the impacts of climate change on cultural heritage in the past decade, **many gaps still exist, preventing understanding of the full picture**. More importantly, there is an urgent need to perform research on innovative technological solutions and their compatibility with old structures. In addition, questions about how to implement the concepts of sustainability and climatic resilience in the management of cultural heritage sites, both built and natural heritage, need more in-depth research including the engagement of civil society. For policy development, greater integration of **quantitative data and qualitative socioeconomic research on life cycle assessment and the contribution of the aesthetics of cultural heritage to well-being and livelihoods** will be necessary in future.

The following needs have been identified for the main sectors of research, described according to the type of research and innovation applied to cultural heritage and climate change.

A. BASIC RESEARCH

Basic research, as the prerequisite for any advancement in knowledge, is particularly necessary in this field due to the specificity of research on cultural heritage. More tailored research approaches, involving the following activities, are required in the areas in bold:

- carrying out more in-depth studies on the behaviour of **cultural heritage** materials (organic, inorganic and composite) in times of climate change, including studies based on modelling and simulation (including protection, conservation, green materials and consolidation), and studies on the compatibility of adaptation measures with cultural heritage guidelines and innovative materials monitoring (using sensors, three-dimensional documentation and AI / machine learning processing);
- exploring the **contribution of cultural heritage to people's, including children's, mental health and cultural identity** in times of change;
- better understanding the impact of climate change on **intangible cultural heritage**, and assessing the role of traditional skills, craft techniques and knowledge embedded in Europe's communities in the preservation of culture;
- studying **cultural heritage and its history**, assessing their role in revealing how previous generations coped with climate change;
- studying the role of **concurrent extreme climate events and tipping points** for cultural heritage;
- specifically addressing the **important role of the European Research Council** as a protagonist of developing basic research on cultural heritage and climate change.

B. APPLIED RESEARCH

The **multidisciplinary and interdisciplinary character of the cultural heritage sector**, with its irreplaceable and unique assets, calls for a specific research development. It is necessary to promote research on cultural heritage and climate change, focusing on the following methods, data and tools:

- using **qualitative and quantitative approaches** in research projects;
- using **simulation and modelling tools** based on big data and AI, predicting the behaviour of cultural heritage materials in both indoor and outdoor environments, and the impact of various future climate scenarios on cultural heritage (aspects to consider include strong winds, extreme events, heatwaves, wind-driven rain, water management and sea level);
- reanalysing using **experimental observation data**, as well as comparing with previous simulations and model outputs in indoor and outdoor environments, leading to the improvement of models;
- assessing the **life cycle of traditional materials and of old and new conservation materials**, investigating the opportunities for the reuse of building materials taking into account quality controls for recycling materials;
- conducting **comparative research** and knowledge exchange between regions with similar climates and environmental conditions, similar types of buildings and similar environmental threats;
- assessing the **post-COVID-19 situation in view of climate change**, in relation to real estate, landscape, lifestyle, and the economic recovery and management of historic villages;
- developing **innovative and reproducible adaptation solutions** for diverse types of heritage threatened by gradual climate change, or extreme and/or concurrent climatic events;
- developing **innovative solutions** to include cultural heritage in **urban adaptation plans** and **smart city programmes**;
- examining **economic and socioeconomic innovative analyses** to produce data on the role of cultural heritage in climate change adaptation strategies and plans;
- conducting studies on the **economic costs of interventions to adapt cultural heritage** to climate change, for better decision-making;
- evaluating **ecological and social costs** related to the loss of cultural assets as a result of biodiversity loss and energy retrofitting;
- exploring **climate change as an opportunity** for cultural heritage to promote sustainable tourism and community resilience;
- evaluating the **positive effects of natural heritage** in the fight against climate change and the ability of natural heritage to act as a CO_2 sink, as well as the role of small landscape elements (i.e. verges, dykes, ditches, sunken roads and thickets) in mitigating the impacts of climate change.

An image from the EU project Climate for Culture: a historic building travelling through time and space in the context of climate change. © Climate for Culture

C. RECOGNITION OF THE INTERDISCIPLINARY CHARACTER OF 'HERITAGE SCIENCE'

The 'heritage science' research area is not yet fully recognised as a multidisciplinary science domain, and therefore the following actions are needed.

- The **European Research Council** should add the multidisciplinary umbrella topic '**heritage science**' to thesauri/standards on research disciplines.
- Holistic, value-based **climate risk assessment frameworks** that include the specificities of cultural heritage should be implemented, and risks at national and local levels should be mapped.
- **Collaboration among the ministers for culture, the environment, research, education, mobility and economic development/planning** at national (Member States and associated countries) and EU levels should be facilitated.
- **The number of scientists** in local cultural heritage management structures (museums, peripheral offices, archaeological areas, etc.) **should be increased** to facilitate the transfer of research results in the heritage sectors.
- **Cooperation** among cultural heritage management institutions at **various hierarchical levels** (i.e. national, regional and local levels), particularly in the face of extreme events, should be encouraged.
- Systematic **cooperation** between the **cultural heritage sector and the climate science field** within the EU and national programmes should be fostered.

D. REGULAR AND LONG-TERM MONITORING AND MAINTENANCE

To identify changes in cultural heritage as a result of climate change, measurements are needed, which are highly costly and time consuming. In order to achieve sustainable protection of Europe's cultural heritage, particularly in times of climate change, the following need to be promoted:

- **the development of new methodologies and tools** to monitor the state of conservation and its evolution over time, and the damage to various types of assets in indoor and outdoor environments in the long term;
- **continuous monitoring of the different types of change** in materials and structures caused by natural and anthropogenic climate change and threats, including the use of remote real-time sensing, **satellite data and earth observations**;
- the application of **advanced ICT and AI technologies**, including the use of big data and remote sensing, to the prevention, conservation and management of cultural heritage, which demands **specific skills and training for conservators, cultural professionals and managers**, particularly at **national level (ministries)**.

E. PLATFORM AND OBSERVATORY (EUROPEAN UNION/NATIONAL)

Innovation is based on the **access of the research community to the most advanced technologies**. This access is lacking in the cultural heritage sector. Therefore, the heritage community needs to foster:

- the use of **knowledge and technological infrastructures** at national and EU levels in response to the requirements, needs and specificities of cultural and natural heritage in the face of climate change;
- the **creation and use of (big) data** (including historical and archival findings, remote sensing, and satellite measurements and monitoring), tools and products (ICT, AI and high-performance computing) to achieve cost-effective solutions based on a user-driven approach through transnational concerted actions, promoting public–private collaborations and including cultural heritage in the future developments of earth observation applications;
- the creation of a **knowledge and technological platform/hub for the collection** and sharing of big data, tools and products addressing cultural heritage safeguarding (protection, conservation, restoration and management) as a priority.

F. COMMUNICATION OUTREACH

The transfer of research results to cultural heritage professionals needs to be facilitated by promoting the following:

- **the communication of research** results addressed to a **broad interdisciplinary group** of stakeholders (not limited to cultural heritage stakeholders);
- the formulation of research products in stakeholder-oriented forms of application, and engagement of local authorities to encourage the **implementation of policy recommendations** adapted to local level;
- **the centralisation of research outputs and data, in an open-source and online format** not limited to the heritage sector;
- **interdisciplinary collaboration**, strengthened from the initial phases of research projects, among the management staff of cultural heritage institutions (museums, archaeological sites, etc.) and among cultural heritage professional organisations;

- **the revitalisation of EU conferences about the results of EU-funded research on cultural heritage**, targeting a large private and public sector audience, regularly organised with high media coverage.

G. UPSCALING: FROM RESEARCH TO WIDER IMPLEMENTATION

Every **cultural heritage object is unique** in terms of materials, structure and value, which makes it difficult to generalise and use one-size-fits-all guidelines. However, upscaling in terms of unification and harmonisation is required to find common solutions to common problems. Research provides the tools and methodologies required to **upscale site-specific knowledge** and tailored solutions for more extensive use in different contexts. Research is the first step in this journey of driving future change.

The OMC expert group has identified four examples with significant potential for upscaling.

- The **use of a holistic climate risk assessment** framework to provide risk maps and guidelines to identify criticalities and strategies related to extreme climate events linked to climate change at European level.
  - Case study from Italy: ProteCHt2save (Interreg project).
- The use of **climate modelling together with whole-building simulation** tools to predict **future indoor climate conditions and energy demand** in historic buildings and museums for cultural heritage stakeholders.
  - Case study from Germany: Climate for Culture (EU project).
- The **use of satellite data** for preventive conservation based on high-resolution continuous monitoring of wide areas, including cultural landscapes.
  - Case study from Italy: Colosseum Archaeological Park (Parco archeologico del Colosseo).
- The use of an **ICT platform collecting and integrating multisource information** (new materials for cultural heritage in climate change, protocols and operational procedures) to provide complete and updated situational awareness and to support decision-making by end users.
  - Case study from Italy: heritage resilience against climate events on site (Heracles) (EU project).

H. INTERNATIONAL COOPERATION AND SCIENCE DIPLOMACY

International cooperation enables the advancement of research and innovation. Cultural heritage is an integral and essential asset of Europe's wealth. International cooperation in cultural heritage research can protect and strengthen this asset. Therefore, the following actions are needed.

- **Cultural heritage and climate change** should be fully included in **future reports of the IPCC** and other relevant policy preparatory documents. So far, only a small number of high-quality, peer-reviewed scientific articles resulting from cultural heritage research on the impacts of climate change have been published. Therefore, the urgent support of the European Research Council is needed.
- International research projects on cultural heritage and climate change should be encouraged as an **instrument to support diplomacy**, recognising the role played by cultural heritage in transnational and international diplomacy.
- **Cultural heritage research should act as a catalyst** to improve the role of **women and young professionals in research**.

RECOMMENDATIONS

Taking into account the global dimension of vulnerability of cultural heritage to climate change and the responsibility of European countries at global scale, regarding knowledge-related research and innovation, the following actions are strongly recommended:

- recognise the **importance of cultural heritage research** through supporting a multidisciplinary approach in both basic research programmes and applied research programmes that address climate change and integrate the traditional knowledge of communities, at EU and Member State levels;
- foster the **exploitation, availability and accessibility of big data** addressed to the cultural heritage sector in European and national programmes and actions;
- promote **innovative solutions for climate change mitigation and adaptation** to protect and manage cultural heritage, both indoor and outdoor, and develop effective formats for fostering dialogue with civil society at national, regional and local levels;
- support the **use of knowledge and technological infrastructures**, including advanced technologies, remote sensing technologies and related ICT, through the inclusion of cultural heritage in the EU earth observation programmes, which will promote economic, managerial and social benefits for the sustainable protection of cultural heritage, and support public–private cooperation;
- pilot, create and promote effective actions for facilitating links, **cooperation and teamwork between cultural heritage institutions and climate scientists**.

EUROPE TALKS CLIMATE CHANGE: MAINSTREAMING CULTURAL HERITAGE INTO THE CURRENT DEBATES

LOW LEVELS OF AWARENESS AND KNOWLEDGE AT ALL LEVELS OF DECISION-MAKING

Awareness of the vulnerability of cultural heritage and the increasing threats posed by climate change to Europe's heritage **is still low in the heritage community and even lower in wider society and among policymakers.** Only in recent years – when extreme climate events, such as the long heatwaves and dry spells in 2018 or the disastrous extreme rainfall events in July 2021 in Belgium, Germany and the Netherlands, led to obvious damage to and loss of cultural heritage – has the situation begun to slowly change. Museums, for example, are increasingly beginning to reflect on climate change, and are asking how the heritage sector can transform itself and how they can help society to achieve carbon neutrality.

Investing in awareness raising, education, training and policy development is key for cultural heritage to survive in times of climate change. In other words, it is important to base policymaking strategies on the results of assessments of energy efficiency and climate change mitigation, as well as on adaptation opportunities, and research and innovation. These results will also contribute immensely to the development of measures for training and education, as well as activities undertaken to raise awareness.

A. AWARENESS RAISING

Currently, **fundamental awareness of the role of and risks to cultural heritage in the context of climate change is not anchored well enough in wider society and politics**, nor in the professional world and private sector.

The attested general lack of inclusion of cultural heritage in national policies throughout the EU and the observed differences between Member States in the way cultural heritage is included and presented in such policies suggest that it is important to develop a common strategy, the starting point of which should be awareness raising. In addition to the lack of inclusion of cultural heritage in policies and common practices, the same has been observed within society; in particular, the public seem to be generally unaware of the threats and the positive contributions cultural heritage can make in all aspects of everyday life. As a result, there is a lack of understanding of the contributions cultural heritage can make to combating climate change. **Even worse, the growing urgency of climate action seems to be increasingly perceived as having a conflict of interest with cultural heritage conservation. Often, energy efficiency is seen as more important than the protection of cultural heritage** and cultural landscapes, meaning that easier and faster implementation of energy measures and the production of renewable energy are favoured.

Thus, awareness raising must address the following three central aspects.

- **The contribution of cultural heritage conservation to climate protection.** Efforts should be based on the well-documented knowledge that preserving and reviving cultural landscapes enable cultural heritage to contribute to the prevention of disasters and the preservation of biodiversity. In areas such as energy life cycle considerations, the circular economy, increasing the durability of buildings and infrastructures and their reparability and sufficiency of use, the expertise of cultural heritage conservation is crucial.

- **The risks of damage to and loss of cultural heritage as a result of climate change impacts.** By taking into account that climate change and natural disasters are occurring more often and in a more devastating manner, awareness raising should become the vehicle for highlighting the need to propose and adopt policies and practices, including in the realm of education and training, to address this situation and employ mitigation measures. Not enough attention is currently being paid to possible gradual and longer-term climate change impacts on cultural heritage with a continuous and long-term perspective: these will have an impact on the

behaviour of materials, susceptibility to biological pests and thus the conservation of cultural heritage assets.

- **No conflict of interest between cultural heritage conservation and the net zero goal.** Current climate protection policies focus on the reduction of the use of fossil fuels and the improvement of energy efficiency. If these approaches are pursued in an undifferentiated manner, they pose a risk to cultural heritage. **The climate crisis cannot be solved with a cultural heritage crisis.** It is therefore important to demonstrate that cultural heritage conservation does not stand in the way of the net zero goal, but rather must become part of any comprehensively sustainable climate strategy. In recent years, in almost all European countries the cultural heritage sector has developed the basic principles, techniques and methods necessary for climate change mitigation, such as those required to carry out improvements to the energy efficiency of monuments or to install solar panels in sites worthy of protection. This knowledge is currently not widely known or adequately recognised.

RECOMMENDATIONS

- **Explicitly integrate cultural heritage preservation into the New European Bauhaus initiative**, and promote its significant contribution to climate protection and the Green Deal.

- Highlight the importance of cultural heritage to the public through dissemination activities, at both national level and EU level, for example by organising events in **schools, kindergartens and shopping centres; organising national heritage days**; and using various media formats, including social media, national television and radio, podcasts and interactive exhibitions.

- **Promote awareness-raising** campaigns aimed at all stakeholders, including **national and local authorities**; the tourism sector; municipalities; non-governmental organisations; spatial/town planning departments/organisations; and education and research authorities and institutions. This aspect should be included in policies.

- **Actively support EU initiatives** and other organisations' activities (UNESCO, ICOMOS, Council of Europe, etc.) and engage with them (e.g. European Year of Youth 2022).

- Actively address the **tourism industry to strengthen engagement with cultural heritage** among tourists and local communities.

B. EDUCATION AND TRAINING

Education is of primary importance in highlighting the vital role of cultural heritage and the need to preserve it for the reasons outlined previously. It is necessary to first aim to increase awareness among children, as they are the key to positive change and sustainability for a better future. In general, cultural heritage has not yet been systematically included in the national education systems of Member States, and the link between cultural heritage and climate change is addressed in hardly any education systems. The integration of cultural heritage into school curricula is a long-standing requirement that remains difficult to implement because of the general pressure on school systems. Climate change and the associated challenges are probably already better anchored in European curricula. The aim is therefore to integrate the role of and risks to cultural heritage into the treatment of climate change. Basically, **education on climate change remains focused on technical/functional and sometimes also economic aspects, while cultural and social aspects are neglected**. In order to change this, the promotion of specific projects and teaching programmes and awareness raising of teachers must be strengthened, which is a task for both the education sector and the cultural heritage preservation sector.

KEY GAPS IN ACADEMIC EDUCATION

- **Research on the impact of climate change on cultural heritage is still not sufficient, especially at Member State level**, regarding the expected long-term effects. The available results and data are not very tangible, are often very specific and do not adequately enable concrete actions. Praxis and policymaking thus lack the necessary bases – and the corresponding experts – to be able to develop effective strategies for the long-term safeguarding of cultural heritage at regional or national levels. It therefore seems absolutely necessary to strengthen scientific research and education in this field.

- **Interdisciplinary and multisectoral scientific education is not adequately implemented due to its complex and time-consuming nature.** The skills needed to work together in such multidisciplinary and interdisciplinary environments can be successfully gained only when opportunities for training are provided. The resulting lack of knowledge transfer between the scientific areas involved makes it difficult to adequately integrate cultural heritage into climate science. The significant complexity of climate change in general and the link with cultural heritage conservation in particular necessitate a significant improvement in interdisciplinary scientific education.

In addition to the need to focus on education, it is **equally important to encourage training at all levels** and among all stakeholders. Training is considered to be a basic tool for underlining the importance of cultural heritage and for achieving its protection and preservation against the threats of climate change. Training can also help to address the lack of multisectoral exchange and knowledge transfer. Experts in cultural heritage conservation often know too little about the basics, current policies and strategies from the climate debate, and are rarely actively involved in this debate. Conversely, **experts in the fields of energy, climate protection and related spatial planning have little knowledge of the field of cultural heritage**. Constructive interdisciplinary and multisectoral cooperation, which is absolutely necessary, is thus extremely difficult, resulting in silo strategies that do not achieve their goals.

A **lack of training and knowledge can also be observed in the crafts sector**, resulting in a loss of knowledge of traditional building and conservation techniques. This is also important in relation to climate change because such knowledge is gaining renewed significance not only to cultural heritage conservation but also to resource-saving building techniques, to durable and mechanical connections, and, even more, to the circular economy in terms of the recyclability of modern buildings. There is currently not enough emphasis on training, despite its importance among both specialists and non-specialists. **This lack of emphasis applies especially at regional and local levels but also at national level**, where, however, some schemes do exist as part of the Erasmus+ programme. Furthermore, existing training efforts are mostly not systematic and do not include all stakeholders.

RECOMMENDATIONS

- Establish a **European platform on heritage and climate change** that includes information on, provides links to and fosters interdisciplinary and multisectoral research and education. This platform should be managed by an existing structure or academic institution and should be supported by EU and national funds.
- **Include cultural heritage in national education systems (curricula) at all levels**, in order to address different ages, skills and needs. The current generation of high school / university students has good awareness of climate change issues and is responsive to actions and initiatives; it would be wise to take advantage of this attitude and highlight cultural heritage as one of the methods of fighting climate change.
- Pair **site visits with teaching traditional arts and techniques from the diverse cultural heritage**.
- Organise and fund **workshops for different age groups**, including adults and older people.
- Involve universities and research institutes, and put emphasis on funding research projects focusing on the preservation of tangible and intangible cultural heritage and the development of conservation techniques to address the impacts of climate change and its association with other sectors (tourism, urban development, the green and circular economy, etc.).
- Focus on the **study of risks and the use of interdisciplinary approaches** when proposing solutions to mitigate or adapt to climate change.
- Promote and **facilitate synergies and networks** among EU Member States in education and research.
- Encourage/establish a **national register of licensed professionals**.
- Include training in the strategic plans of all stakeholders (government and local authorities, municipalities, non-governmental organisations, spatial / town planning departments/organisations, education and research institutions, etc.).
- Increase the **transfer of specific know-how among Member States and non-EU countries**.
- Take **advantage of EU-funded programmes** such as Creative Europe and Erasmus+ to inspire greater mobility of cultural heritage professionals.
- Review **current training mechanisms** proposed by cultural heritage organisations such as the International Centre for the Study of the Preservation and Restoration of Cultural Property, ICOMOS, the International Council of Museums and UNESCO.

Garmo stave church, Lillehammer, Norway, 2015. Photographer: Dagfinn Rasmussen © Directorate of Cultural Heritage, Norway.

C. POLICY DEVELOPMENT

The review of current policies of EU Member States revealed that **many countries have omitted cultural heritage in their national policies and action plans for sustainable development and growth**. Even when it is mentioned, it is mostly not linked to the threats posed by climate change.

To action the aforementioned recommendations, and most importantly to secure the protection of cultural heritage and pinpoint the threats of climate change, it is vital to **establish clear-cut and binding policies not only at EU level but also within each Member State**. As mentioned above, the existing EU policies aim to secure a sustainable future to combat climate change and associated risks through adopting a series of measures and increasing the resilience of societies. It is thus imperative to include cultural heritage in existing and new policies, with the objective of directly linking climate change to the protection of cultural heritage.

Europe can and must combine the goal of net zero with the preservation of cultural heritage. The climate crisis cannot be solved by provoking a heritage crisis. **The necessary techniques and methods exist, as the 83 best practice examples from all over Europe convincingly show.** It is therefore particularly wrong to grant the demands for energy efficiency and renewable energy production a fundamentally overriding priority. What is needed is constructive, equal and intensive cooperation between the scientific fields, sectors and stakeholders involved, to develop effective and prudent energy and climate policies. This will enable both the implementation of effective climate protection and a high quality of the built environment (and thus also the preservation of cultural heritage), in line with the goal of net zero. In addition, communication between government institutions, as well as between government institutions and other stakeholders, must be enhanced.

It makes sense to link political efforts to ensure the high quality of the built environment, based on the 2018 Davos Declaration, the OMC expert group recommendations and the 2021 Council conclusions, with efforts towards better integration of cultural heritage into climate change policies. These efforts coincide, and can come together to reconcile climate change and climate change mitigation measures with a high-quality built environment.

Referring to the Commission communication 'Towards an EU strategy for international cultural relations', published in June 2016, in which cultural heritage features prominently, the findings and recommendations of the OMC expert group on how to protect cultural heritage in times of climate change can substantially contribute to the implementation of the **instrument of cultural diplomacy at EU level**.

RECOMMENDATIONS

- Include **cultural heritage in all national and EU climate policies and action plans** aiming to address mitigation of and adaptation to climate change.
- Call for a permanent **European task force on heritage and climate change** comprising eminent experts of different relevant disciplines, senior national representatives and representatives of the private sector, with the mandate of providing advice and input for climate protection policies that integrate heritage preservation, a high-quality built environment and biodiversity.
- Appoint a **national coordinator for cultural heritage and climate change**, and encourage/establish a joint state management related to cultural heritage and climate change.
- Establish a **centralised digital information system** related to cultural heritage and climate change, which will enable the exchange of new knowledge, data, best practices and strategies. Encourage cross-sectoral coordination to implement cultural heritage into climate change policies at all levels.
- At **national level, establish policies – to be implemented by all relevant stakeholders** – aiming to raise awareness; enhance education, research and training; develop assessment reports; and provide cultural heritage climate change risk maps.
- Establish a **permanent European expert group on cultural heritage** comprising individuals with various, multidisciplinary backgrounds and invite climate change experts to participate in meetings of the existing EU cultural heritage expert group.

Herd of reindeer, Finland © Helen Simonsson CCBY

FINAL REMARKS

The OMC expert group has proven to be an important forum for sharing and discussing experiences, knowledge and best practices but also for identifying gaps and lack of information. Such a forum should continue at EU level and similar bodies should be created at Member State level.

This is a **very special moment in history in which concurrent catastrophes are taking place, for example the COVID-19 pandemic and the current Russia–Ukraine war, in an era of climate change**. The pathway to a **sustainable, peaceful, inclusive and resilient Europe** could be the growth and development story of the 21st century. **The dangers of climate change – dramatic losses and damage to Europe's cultural heritage – are significant.** Nevertheless, so far there have been **no economic assessments capturing the full range of costs of climate change impacts on European cultural heritage**. Neither do we have a full picture of the wider range of benefits to European societies arising from investments in the capital that cultural heritage offers. **The OMC expert group strongly believes that the costs of action are lower than the costs of inaction.** Therefore, Europe needs to act now. It is necessary to include all forms of cultural heritage in all mainstream policies and funding programmes, and offer **financial incentives to tap the hidden potential** of heritage.

Climate actions for heritage resilience involve a strategic choice to invest in new forms of development. More opportunities must be **made available at EU and national levels to finance, invest in and incentivise action on cultural heritage**. However, seizing these opportunities will require **a radical change in the cultural heritage sector**. Most of what we currently do **will have to be done differently**; it will be necessary to embrace new and traditional technologies, change institutional behaviour, create adequate business models, revise city and rural planning processes, and ensure efficient resource management.

Do the **EU and its Member States have the political will** and capability? Can it be done?

Yes, Europe can do it.

ANNEXES

ANNEX 1 – LIST OF INSTITUTIONS AND MEMBERS PARTICIPATING IN THE OMC EXPERT GROUP

Member State	Expert	Title/department	Organisation
Austria	Christian Hanus	Head of the Department for Building and Environment (Dean of faculty)	Danube University Krems, Faculty of Education, Arts and Architecture
	Hannah Leodolter	Policy Officer in the Department for Cultural Heritage, Baukultur and Art Restitution	Federal Ministry of the Arts, Culture, the Civil Service and Sport
Belgium	Thomas Deruyver	Architect	Walloon Heritage Agency, Strategic Development Directorate
	Nathalie Vernimme	Advisor Research Programme	Flanders Heritage Agency
	Jasper Standaert	Grants Manager in the area of cultural infrastructure and youth infrastructure	Department of Culture, Youth and Media
Croatia	Pia Sopta	Expert Adviser	Ministry of Culture and Media
Cyprus	Anthi Kaldeli	Archeological Officer	Ministry of Transport, Communications and Works, Department of Antiquities
Czechia	Martin Cernansky		National Heritage Institute
Denmark			Heritage Centre of the Danish Agency for Culture and Palaces
Estonia	Ave Paulus	ICOMOS expert	Ministry of Culture
	Liina Jänes	Adviser on Cultural Heritage	Ministry of Culture
Finland	Tuija Mikkonen	Senior Ministerial Adviser	Ministry of the Environment
	Ulla Salmela	Director of Development	Finnish Heritage Agency
France	Bruno Mengoli	Heritage Inspector	Ministry of Culture
Germany	Johanna Leissner	Scientific Representative for Fraunhofer	Cultural Heritage Research Alliance
	Christina Krafczyk	President	Niedersächsisches Landesamt für Denkmalpflege
Greece		Directorate of Prehistoric and Classical Antiquities of the General Directorate of Antiquities and Cultural Heritage	Hellenic Ministry of Culture and Sports
	Constantinos Cartalis	Professor and Director of the Department of Environmental Physics, Member of the United Nations Framework Convention on Climate Change Subsidiary Body for the Implementation of the Climate Convention and the Paris Agreement	National and Kapodistrian University of Athens
Iceland	Saedis Gunnarsdóttir	Cultural Heritage Manager for North East Iceland	Cultural Heritage Agency of Iceland
			Ministry of Education, Culture and Science

Member State	Expert	Title/department	Organisation
Ireland	Jacqui Donnelly	Senior Architect Built Heritage Policy	Department of Housing, Local Government and Heritage
Italy	Elisabetta Giani		Central Institute for Restoration
	Cristina Sabbioni		Institute of Atmospheric Sciences and Climate
Latvia			National Heritage Board
		Climate Change Department, Climate Change and Adaptation Policy Division	Ministry of Environmental Protection and Regional Development
Lithuania	Lukas Straševičius	Chief Specialist of the Cultural Heritage Policy Group	Ministry of Culture
			Ministry of Environment
Malta	Sharon Sultana	Senior Curator	Heritage Malta
Netherlands	Martijn Kahlman	Policy advisor	Ministry of Education, Culture and Science Department for Arts and Heritage
	Gerda De Bruijn	Policy advisor	Ministry of Education, Culture and Science, Cultural Heritage Agency
			Ministry of Infrastructure and Water management, Department for climate adaptation and governance
Norway	Marte Boro	Senior Advisor	Norwegian Institute for Cultural Heritage Research
Poland		Department of Monuments Protection	Ministry of Culture and National Heritage
	Łukasz Bratasz	Professor, Head of the Cultural Heritage Research Group	Jerzy Haber Institute of the Polish Academy of Sciences
Portugal	Helena Martelo	High-level Technician	Competence Centre for Planning, Policy and Foresight in Public Administration
Romania	Marius Streinu	Head of the Museum and Archaeological Documentation Department	National Institute of Heritage
	Ioana-Maria Vasiliu	European Affairs Counsellor	Ministry of Environment, Water and Forests
Slovakia		Department of Protection of the Monument Fund	Monuments Board of the Slovak Republic
	Michal Ganobjak	Postdoctoral Researcher at Empa – Standort Dübendorf in Switzerland	Special Assitant at the Slovak University of Technology, Faculty of Architecture and Design
Slovenia			Ministry of Culture
	Tanja Hohnec	Conservator Counsellor	Institute for the Protection of Cultural Heritage of Slovenia
Spain	Marta Hernandez	General Deputy Director	Spanish Cultural Heritage Institute
	Ana Cabrera		Spanish Cultural Heritage Institute
	Francisco Holgiun Aguilera	Department of Architecture	Spanish Cultural Heritage Institute
Sweden	Therese Sonehag	Cultural heritage expert	Swedish National Heritage Board
			Uppsala County Administrative Board
Switzerland	Oliver Martin	Head of Section Baukultur	Federal Office of Culture

ANNEX 2 – SUMMARY OF 83 GOOD PRACTICE EXAMPLES FROM 26 EUROPEAN COUNTRIES

	Country	Case study	Brief description
1	**AT**	Air well system of the Vienna Burgtheater: sustainable cooling strategies	This project focuses on the evaluation of an air-cooling system dating from the 19th century, known as the 'old' air well system of the Burgtheater, to obtain data on its effectiveness while finding minimally invasive options to optimise the reduction of heat in the auditorium.
2	**BE**	Omal fortified refuge	This project on the restoration of built heritage provides examples of energy-saving interventions in a historic building, reducing its environmental impact while retaining the heritage values. This was a modern and efficient project, which resulted in a new life for a building that had been abandoned for years.
3	**BE**	P-Renewal	This research project aimed to enhance heritage values while implementing relevant energy measures in historic buildings, focusing on a very pragmatic way for historic buildings to adapt to the demands for improved thermal comfort and the integration of energy-saving measures.
4	**BE**	Policy-oriented research to make built heritage in Flanders climate resistant and sustainable	The objective of this research project is to study if and how heritage can be made more energy efficient and low carbon in such a way that heritage values are preserved, and to provide best practices for building owners and architects. It includes an awareness-raising aspect.
5	**BE**	Development of adequate policy tools (energy audits / grants / energy consultant programme for heritage buildings, and guidelines and recommendations) for sustainable, climate-resilient built heritage in Flanders	This case study presents the 'energy audit for built heritage' instrument used by the heritage authorities in Flanders to retrofit built heritage. The objective is to encourage the encompassing of built heritage in the goal of making buildings low carbon (i.e. built heritage should not be considered an exception), and to provide appropriate tools to ensure that refurbishments are planned and carried out in such a way that heritage values are preserved.
6	**BE**	Interreg innovative research and demonstration project (Flanders–Netherlands) demonstration of energy efficiency by measurement and innovation gives more (DEMI MORE)	This research and awareness-raising project focuses on the smart introduction of innovative refurbishment materials and techniques in heritage buildings. One key output is a visual decision tool, and a method for integrated description of the conservation process was also developed. It is an Interreg project developed by Belgium (Flanders) and the Netherlands.
7	**BE**	Resilient Storage (ReStora)	The main goal of this project is to lower energy costs by 10–30 % in museum infrastructure by developing a national strategy with respect to the optimal conditions for the preservation of artworks and objects.
8	**BE**	Reuse of historic building materials and techniques in contemporary buildings	This awareness-raising project, focused on historic built heritage, promotes mitigation through reusing materials: trading in salvaged materials reduces the quantity of demolition waste and offers good-quality building materials that have a negligible environmental impact.
9	**CH**	Flood protection for the city of Bern	The planning process for the infrastructure/climate adaptation project in the urban heritage area of Bern guarantees effective flood protection without negatively affecting the heritage value and high-quality *baukultur* of the city and its setting, and develops solutions in a holistic and participatory way.
10	**CH**	Aerogel use in architecture and civil engineering, and renovation of heritage buildings	This research project documents and analyses the usage of aerogel building materials in Switzerland, and studies and measures realised retrofits and applications in new buildings, providing free access to a comprehensive body of knowledge detailing the results. The project aims to foster knowledge of superinsulating materials, investigating their effect on cultural heritage and bridging the gap between research and use in practice.

	Country	Case study	Brief description
11	**CY**	Use of satellite remote sensing to monitor cultural heritage sites: the case of recent fires in mountainous areas of Larnaca District and Limassol District (3–4 July 2021)	In the event of a fire, timely information on current fire parameters is vital to making informed decisions. This project shows how satellite imagery can provide valuable information, as thermal sensors have the ability to detect the exact location and intensity of an active fire. This information can be generated and disseminated in almost real time, allowing an overview of the current fire activity.
12	**CY**	Soil erosion by water	This project applies a soil erosion processing chain at the archaeological sites of Nea Paphos and Amathus, as well as at European level, with the aim of better understanding the potential impact of soil erosion on buried archaeological remains. The soil erosion processing chain, using earth observation data, is able to predict erosion rates within the spatial limits of a watershed basin and can be used to present the spatial heterogeneity of soil erosion.
13	**CZ**	Current approach to the restoration of the green monuments	This restoration project aimed to strengthen the protection of monuments against climate change, with the goal of tackling long-term drought, through the inclusion of new modern innovations and materials in a historic site, and the renovation of origin water systems and water management in the countryside.
14	**DE**	Climate for Culture	This research and training project investigated the future impact of climate change until 2100 on indoor climate conditions in historic houses and their future energy demand. It coupled, for the first time, high-resolution climate models with building simulation tools. Using these modelling and simulation tools, better preventive conservation strategies and climate adaptation measures can be developed for the whole of Europe.
15	**DE**	Climate-neutral castle and park of the Schloss Dyck Foundation	The main goal of this model project is to develop and test innovative solutions for the conservation and development of the English landscape park and the Schloss Dyck castle, which are affected by climate change, in the interplay and interaction of dealing with an intensively used and listed site. Climate neutrality by 2025 will be reached by the use of reed as a renewable raw material in a glass-heating plant, photovoltaic systems, and the electrical operation of machinery and equipment.
16	**DE**	Energy-efficient housing estates through sustainable concepts for the listed stock: the energy-efficient Margarethenhöhe quarter of Essen	This research project examined how historic buildings can contribute to an energy-efficient heritage area: it investigated the legal, structural and technical conditions for improving the building envelope in line with the preservation requirements, modernising the buildings and providing a future-oriented energy supply. The inclusion of renewable energy sources and the digital networking of all components are of particular importance. The main aim is to work out holistic renovation concepts for the individual buildings.
17	**DK**	Rudersdal Rådhus (Rudersdal Town Hall, former Søllerød Town Hall)	This restoration project aims to re-establish the original ventilation system of the original Danish functionalistic architecture instead of installing new technology, restoring the original cohesion between the town hall's architecture, technical solutions and design. The three pillars of the project are energy efficiency, the circular economy and avoiding maladaptation.
18	**EE**	Network of Information Centres for Sustainable Renovation in Estonia	This network of information centres works with owners of historic houses and with people living in historic urban districts, as well as with restorers, architects and engineers. Using training courses and consultation facilities, it promotes the use of old buildings and provides knowledge of how they can be used in the 21st century (e.g. how to make historic buildings more energy efficient with minimal intervention while maintaining a healthy indoor climate).
19	**EL**	Climascape: a multicriteria system and data platform in support of the adaptation of eight archaeological sites to climate change and its impacts	This research project leading to policy development at local level has the aim of demonstrating the importance of multicriteria systems and data repositories for archaeological sites concerning the design of plans for adapting to the impacts of climate change (extreme weather events, floods, forest fires, drought, erosion, heatwaves and sea-level rise).

	Country	Case study	Brief description
20	**EL**	National policy development for the adaptation of cultural heritage to the impacts of climate change	This example of policy development at national level focuses on adaptation plans: draft vulnerability risk maps, the preparation of a controlling system (adaptation measures) and the compilation of a national strategy. As a result, direct provisions considering the nexus between climate change and cultural heritage are implemented as part of several national projects.
21	**ES**	Lighting the Prado	In the context of the environmental policy of the Prado Museum, this pioneering initiative consisted of replacing the whole existing halogen lighting system with a modern light-emitting diode lighting system. The results show ways for historic museum buildings to achieve higher energy-efficiency levels and to reduce CO_2 emissions while improving the conservation of and giving appropriate consideration to artworks and masterpieces.
22	**ES**	2021–2030 national climate change adaptation plan	This is an example of a national climate change adaptation plan in which cultural heritage is one of the defined working areas. Its aim is to promote coordinated and coherent action to address the effects of climate change in Spain and to build a more resilient economy and society.
23	**ES**	Documentation of and archaeological intervention in the Dolmen of Guadalperal in the Valdecañas reservoir basin (Cáceres)	This research project created a multidisciplinary team to analyse the drastic changes in the water levels affecting the megalithic complex of the Valdecañas reservoir basin. It promoted research in biodeterioration, the conservation of the megalithic monument, three-dimensional documentation of the reservoir and the dolmen, and archaeological works, together with an important social awareness campaign.
24	**ES**	RESCUhE project: improvement of the structural resilience of cultural heritage to extreme directional hydrometeorological events in the framework of climate change	This research project aims to characterise the current and future vulnerability (in the different scenarios of climate change) of Spanish cultural heritage, by developing new climate risk indexes and a methodology that allows the effective design of physical shielding barriers (natural or artificial) for the mitigation of climate change effects.
25	**ES**	Methodological and instrumental developments for preventive conservation	This research project aims to offer and create a diagnostic tool for curators and scientists in charge of the conservation of tangible heritage collections. It will allow them to know, at any time, the risk situation due to changing weather conditions, and possible measures to adopt.
26	**FI**	To demolish or to repair? Carbon footprint impacts, life cycle costs and steering instruments	This research project provided significant new information on the impact of the carbon footprint and life cycle cost impacts of building renovation and development compared with the those of demolition and new construction. This information is relevant to the mitigation of climate change through built heritage.
27	**FI**	SAAMI: adaptation of the Saami people to climate change	The main objective of this research project was to produce scientific information on the Sámi culture and climate change adapted for both decision-makers and Sámi communities. The project produced a holistic overview of climate change and its diverse effects on the environment in the Sámi home region and on Sámi culture, community, health and well-being based on available research literature and ethnographic fieldwork.
28	**FI**	Improving energy efficiency in renovation projects concerning buildings of cultural and historical value (2018)	This guide advises how energy efficiency can be improved in connection with renovation projects concerning buildings of cultural and historical value. The project showed that, in many cases, there does not need to be contradiction between improving energy efficiency and cultural-historical values.
29	**FI**	Zero Arctic: concepts for carbon-neutral Arctic construction based on tradition (2018–2020)	The main objective of this research project was to provide research-based statements for carbon-neutral, resilient and sustainable Arctic construction with special reference to tradition, vernacular architecture and collaboration with indigenous communities. This traditional architecture forms a source of knowledge of structural and material innovations that can be evaluated and used in modern buildings.

	Country	Case study	Brief description
30	**FR**	Bordeaux: safeguarding and enhancement plan	This example of urban planning regulations and changes in the city to combat climate change was drawn up on the basis of an in-depth diagnosis of the built heritage: the characteristics of the heritage were finely analysed to assess the level of efficiency and performance with regard to the challenges of climate change (thermal insulation, urban heat, energy and water saving, etc.). The result is a solid knowledge base that enables all actors to be educated on the often-ignored effectiveness of heritage and traditional systems regarding these issues.
31	**HR**	The art of drystone walling	This research project, which considered the role of training and education, focused on young people and the dissemination of drystone walling techniques. Drystone structures play a vital role in preventing landslides, floods and avalanches; combating the erosion and desertification of land; enhancing biodiversity; and creating adequate microclimatic conditions for agriculture.
32	**IE**	Built and archaeological heritage: climate change sectoral adaptation plan (2019)	Ireland's built and archaeological heritage climate change sectoral adaptation plan, published in 2019, is believed to be the first national climate change adaptation plan dedicated to cultural heritage. It aims to set a baseline from which future climate-related changes can be monitored. It aims to centralise all relevant data on heritage assets, bringing the information together into a single portal, which can then be integrated with other relevant systems such as flood risk and coastal vulnerability mapping.
33	**IE**	2021–2022 Gort energy-upgrading pilot project	This research project explores ways to deliver on policy to provide energy upgrades for traditional buildings. The project is the latest stage in a community-based project that began in 2017, designed to 'localise the SDGs' in a small, historic town in the west of Ireland.
34	**IE**	Dunbeg Promontory Fort, County Kerry, Ireland	This case provides an example of the maintenance and repair of a national monument site that is gradually being lost due to coastal erosion resulting from climate change, including the provision of safe visitor access to the site. It is a good example of the practice of 'managed retreat' from a heritage site that will eventually be lost to the sea.
35	**IE**	Fingal Heritage X Climate Project	This is a citizen science initiative focused on facilitating ongoing monitoring of changes to and impacts on heritage sites. Research was carried out on the monitoring systems of different heritage sites, focusing on those that used community volunteers to collect data.
36	**IE**	Fingal cultural heritage and climate change risk assessment	The purpose of this project was to form an initial baseline assessment of the risk to Fingal's heritage assets from identified climate change hazards to inform and allow the development of monitoring, adaptation and citizen science programmes.
37	**IE**	Skellig Michael, World Heritage Site, County Kerry, Ireland	This is an example of the challenges of climate change and mitigation measures at an Irish UNESCO World Heritage Site. It promoted the use of a climate change risk assessment, together with the maintenance and repair of a national monument and World Heritage Site that is at risk of storm damage.
38	**IE**	Ballinskelligs Priory, County Kerry, Ireland	This is the first climate change risk assessment for a national monument site in Ireland; it was carried out on Ballinskelligs Priory in 2020. This project promoted the use of a climate change risk assessment, together with the maintenance and repair of a national monument site that is at risk of storm damage and coastal erosion.
39	**IE**	Climate, Heritage and Environments of Reefs, Islands and Headlands	The CHERISH project undertakes work in Ireland and Wales; it answers the calls for strong research and data-gathering initiatives in order to understand, mitigate and adapt heritage resources from local to national levels in the context of climate impacts. This work feeds into broader understanding and research studies at international level.
40	**IS**	Survey of coastal cultural heritage	The aim of this study was to evaluate the impact of costal erosion on cultural remains in specific areas of Iceland. Climate change impact adaptation, immediate threat reduction and a long-term conservation strategy against incremental change are some of the subjects of key analyses carried out.

	Country	Case study	Brief description
41	**IT**	Colosseum Archaeological Park (Parco archeologico del Colosseo)	This project focused on satellite monitoring and early warning systems in archaeological areas of an urban historic centre. COSMO-SkyMed interferometric techniques are used to obtain continuous information on deformations of the ground, structures and buildings. The main objective of the project is the identification of a procedure that allows the application of sustainable management, capable of intervening in archaeological assets by preventing emergency situations, ensuring an early warning system through mitigation strategies.
42	**IT**	The defence of the Venetian cultural heritage from the effects of climate change	This research project aims at the development of policy for the protection of heritage. It is focused on the climate change effects faced by the city of Venice. The evaluation of the impact of climate change on the 90 bell towers of the city will be performed using satellite remote sensing combined with traditional *in situ* techniques to check the structural health of these particular architectures, characterised by high load levels. Tools for immediate threat reduction have been developed, and a long-term conservation strategy against incremental change has started, including improving the energy efficiency of buildings and boats, upgrading industrial areas and renovating public housing, to keep the population living inside the city.
43	**IT**	Risk assessment and sustainable protection of cultural heritage in changing environment (ProteCHt2save)	This was a research project on the development of feasible and tailored solutions for building the resilience of cultural heritage to extreme events linked to climate change. It supported regional and local authorities with preparedness measures and emergency evacuation plans. One of the major outputs is a risk-mapping web-based GIS (web GIS) tool for the identification of risk-prone areas and vulnerabilities for cultural heritage in central Europe exposed to extreme events, particularly heavy rain, flooding and fire due to drought periods.
44	**IT**	Heritage resilience against climate events on site (Heracles)	This research project is developing an ICT platform as a decision support system to increase cultural heritage resilience. It collects and integrates multirisk and multisource information (data). The approach is holistic and interdisciplinary, involving different actors (end users, industry / small and medium-sized enterprises, scientists, conservators/restorers, social experts, decision-makers and policymakers). This project's solutions are designed to be flexible and of general applicability.
45	**IT**	Podere Case Lovara: the sustainable recovery of an agricultural compendium, Cinque Terre National Park (Parco Nazionale delle Cinque Terre)	This research project and subsequent implementation of interventions was focused on sustainable water and energy self-sufficiency interventions as part of the landscape recovery of an abandoned agricultural complex. Case Lovara is now an agricultural compendium and has thus become a representative pilot site for the recovery of an agricultural settlement in a protected area, characterised by a typical terraced landscape.
46	**IT**	Alpe Pedroria and Alpe Madrera: restore pastures and landscape in the Alpine region to increase the resilience of territories	This is a historical, landscape and environmental restoration and recovery project in the Alps, which aims to restore the original productive activity of the Alpine pastures, abandoned for over 30 years, in the face of increases in extreme meteorological events and hydrogeological instability. In addition to the restoration of the pasture areas, structures and infrastructures functional to the pastural activities, which enables the return of agricultural activity and local cheese production, it is planned to set up spaces for learning and for storytelling for the public of the Alpine life and of its key role in sustainable development.
47	**IT**	The Garden of Kolymbethra (Giardino della Kolymbethra)	This is a restoration and recovery project of a garden at risk of disappearing, with its material culture, landscape and ancient biodiversity threatened by climate change. The project has recovered the traditional irrigation system of Arab origin by restoring the ancient hypogea: the network of tunnels that allows the supply and reuse of rainwater and resurgent water.
48	**IT**	Internet of underwater things technologies for underwater archaeology: best practice from the MUSAS project and its impact on monitoring and mitigating the effects of climate change	This research and innovation project develops the internet of underwater things technologies for monitoring and managing coastal sites, and identifies best practices. As a result, this study has not only developed an effective system to provide data on the conservation status of the site, which can be used for surveillance, but also developed technologies that can provide wireless real-time monitoring of the seas and oceans, an invaluable asset for understanding climate change and the effectiveness of proposed adaptation measures.

	Country	Case study	Brief description
49	**LT**	Fixus Mobilis	The main goal of this project is to create a new system of preventive monitoring and maintenance for cultural heritage objects, including raising heritage managers' and owners' awareness of the subject and strengthening practical skills. The result of this work is strengthened knowledge among cultural heritage owners and managers of their possessed objects and preventive maintenance, as well as of the prevention of major damage, which would result in excessive restoration works in the future.
50	**LV**	RIBuild: robust internal thermal insulation of historic buildings	The RIBuild research project strengthens the knowledge of how and under what conditions internal thermal insulation is to be implemented in historic buildings, without compromising their architectural and cultural values, with an acceptable safety level preventing the deterioration and collapse of heavy external wall structures. It involved many countries: Belgium, Denmark, Germany, Italy, Latvia, Sweden and Switzerland.
51	**MT**	Dock No 1	This example of urban regeneration provides the opportunity for the recuperation of a dockyard and waterfront for social purposes. Social aspects are key in the project, as the aim is also to revive cultural spaces through a reactive design sensitive to the needs of the community and a place that, for decades, has suffered a decline in prosperity.
52	**NL**	Towards climate-resilient castles and country estates (Klimaatbestendige Kastelen, buitenplaatsen en landgoederen)	This research and policy development project strengthens the contribution made by heritage to changes in our living environment, such as climate change adaptation and the energy transition. The knowledge programme will also act as an example and an incentive, showing how heritage can be an inspiration in provincial and regional climate policy.
53	**NL**	Traditional irrigation of grassland	Grassland irrigation is an old system that may be of interest as a solution for climate change adaptation. The aim of this project is to stimulate grass growth to ultimately harvest as much high-quality grass/hay as possible. This project was developed in Austria, Belgium, Luxembourg, the Netherlands and Switzerland.
54	**NO**	Conservation of cultural heritage: guidelines for improving the energy performance of historic buildings	These guidelines, relevant to all types of buildings, are on sustainably improving the energy performance of historic buildings while respecting their heritage significance. The procedure set out in the guidelines assesses the impact of adaptive measures in relation to preserving the character-defining elements of buildings. It should assist users in applying existing standards in the field of energy efficiency to the special conditions of historic buildings. It presents a systematic approach to facilitate the best decision in each individual case.
55	**NO**	Green is not only a colour: sustainable buildings already exist (Grønt er ikke bare en farge: Bærekraftige bygninger eksisterer allerede)	This project provides a systematic assessment and meta-analysis of life cycle analyses performed in connection with the rehabilitation and upgrading of existing buildings. The research indicates that the potential environmental benefits of upgrading existing buildings are considerable compared with those of new-build projects because the emissions generated during rehabilitation represent only half of those associated with new buildings.
56	**NO**	Climate gas emission from upgrading of historic buildings: 24 case studies from Innlandet county	This policy development research has the overall goal of assessing the climate change impact of cost-effective, targeted energy upgrading of buildings, compared with continued operation in the current state, and with demolishing the existing buildings and replacing them with new buildings. Calculations show that, for the majority of the buildings studied, upgrading results in lower greenhouse gas emissions than replacing the existing buildings with a standard new building built according to the current regulatory level.
57	**NO**	Environmental monitoring of the consequences of climate impacts on listed buildings	This project focuses on monitoring the development of the risk of damage and the development of damage due to climate impact on wooden and stone buildings from the mediaeval age. The monitoring will look at climate impact over 35–50 years.
58	**NO**	2021–2030 climate strategy for cultural environment management	This strategy has been made to help actors in the cultural heritage field to be better equipped to deal with climate change in the years to come. It aims to show how cultural environment management at national, regional and local levels can contribute to reducing greenhouse gas emissions and adverse climate change consequences.

	Country	Case study	Brief description
59	**NO**	Adapt Northern Heritage: assessing risks and planning adaptation – guidance on managing the impacts of climate change on northern historic places	This project is supporting communities and local authorities to adapt northern cultural heritage to the environmental impacts of climate change and associated natural hazards through community engagement and informed conservation planning. The project developed a tool to assess the risks to and vulnerabilities of historic places and provide guidance on the planning of strategic adaptation measures that takes into account cultural, economic, environmental and social sustainability. It was developed in Greenland (Denmark), Iceland, Ireland, Norway, Scotland (United Kingdom), Sweden and Russia.
60	**PL**	Energy-efficient partially passive storage for the National Archive in Kraków	This project looks at the implementation and testing of innovative solutions regarding conflicting needs to ensure high standards of the archive collection's care and managing environmental conditions for its preservation in an efficient and responsible manner in terms of energy and CO_2 emissions. The results show that the storage is very resilient to both extreme climatic events and power outages, ensuring the safety of the stored collection.
61	**PT**	Artificial intelligence system for cultural heritage (Sistema de Inteligência Artificial para o Património)	This research project will develop a prototype for detecting minor changes in heritage buildings, avoiding the current unnecessary and ineffective use of human labour and travel time. The developed model can be applied in areas difficult to access, such as coastal heritage buildings and known underwater heritage sites.
62	**PT**	Sobressalto	This is a project aiming to bring the cultural sector closer to environmental issues. Sobressalto brings together artists, organisations and cultural spaces across Portugal in a joint effort in which sustainability and resilience are top priorities.
63	**PT**	Natural biocides for the sustainable preservation of cultural heritage	The main objective of this research work is to develop new natural materials extracted from indigenous or naturalised plants that can be used as biocides in the preservation of cultural and artistic heritage. It focused on the use of green biocides in conserving cultural heritage; protecting biodiversity; strengthening natural resources and optimising their use; increasing land productivity; and avoiding pollution throughout the life cycle of the materials.
64	**SE**	2019–2023 climate action plan of the Swedish National Heritage Board	This climate action plan for national heritage authorities aims to prevent work for cultural heritage in a changing climate. It develops a knowledge base for immediate threat reduction and long-term conservation strategies against incremental change for the municipalities.
65	**SE**	Checklist for property owners: the church towns in the time of climate effects	This project developed tools and guidance through a public brochure on the effects of a changing climate in church towns. The brochure presents different types of damage connected to a changing climate and what property owners can do to improve conditions and to monitor changes over time.
66	**SE**	Brochure: climate change and historical wooden buildings – adaptation through preventive maintenance	This awareness-raising project created a short brochure that provides a brief overview of and an introduction to climate adaptation and its possible effects on wooden buildings. The brochure focuses on preventive maintenance and opportunities to prevent major damage caused by, for instance, heavy rainfall.
67	**SE**	Adapting reindeer husbandry to a changing climate	This policy development project prioritised the use of traditional Sámi knowledge in parallel with scientific knowledge in the development of the climate and vulnerability analyses of the region. This pilot project focuses on climate impacts on reindeer husbandry. The measures suggested form a baseline for the Sámi Parliament's continued work on climate change adaptation, and will help it to work preventively so that reindeer husbandry and the Sámi culture can better respond to climate change.
68	**SE**	The national network for climate change adaptation	This policy development project is an example of a national cross-sectoral network of climate adaptation, in which cultural heritage is one of the integrated sectors. The network connects the Swedish National Heritage Board and the cultural heritage sector to other sectors and authorities working in climate change adaptation.

	Country	Case study	Brief description
69	**SE**	Cooperation at regional level between climate adaptation coordinators of the county administrative board regarding the cultural environment	The role of the county administrative board is working towards development in which the environment, economic growth and good living conditions go hand in hand; it includes a working group specifically dealing with issues concerning cultural heritage. The role of the climate adaptation coordinators at regional level seems quite unique in Europe and provides an example of networking, knowledge base development and the provision of guidance to communities.
70	**SE**	Risk assessment plans for cultural heritage in a changing climate at county level: Norrbotten, Västra Götaland and Halland, Blekinge, Kalmar, and Stockholm	This project creates knowledge adapted for and oriented to municipal actors. Through the analysis of the coming climate effects, it spreads the current knowledge to better adapt for the future. Climate change is taken into account in the plans as something everyone working with cultural heritage must take into account now and in the future.
71	**SE**	Web GIS for cultural heritage and climate change	This research project uses a GIS tool to predict climate change and its impact on cultural heritage, compiling climate effects on different types of cultural heritage: ancient monuments, cultural-historical buildings and cohesive cultural environments. The map material can be used as a starting point for continued municipal risk management and community planning, and can by used by property owners and managers who want to adapt care and maintenance and take measures to minimise climate-related threats.
72	**SE**	Bartjan climate risk management plan, Adapt Northern Heritage	This case focuses on risk and vulnerability assessments of predicted climate change and the impacts on cultural heritage, especially on Sámi cultural heritage. It reinforces the importance of the management of intangible heritage, as the adaptive use of land and cultural landscapes in a changing climate is still unsolved. It includes climate change impact adaptation, immediate threat reduction and a long-term conservation strategy against incremental change.
73	**SE**	Research and training in the sustainable management of cultural heritage	This case emphasises the importance of university actors in the integration of climate change adaptation and mitigation into cultural conservation research and training. It creates forums and meeting points for different professionals, with the ambition of bringing together disciplines and researchers, at Uppsala University's Campus Gotland, who traditionally neither work together nor address questions related to cultural heritage and sustainability in their research.
74	**SE**	Sustainable integrated renovation (SIRen)	SIRen was a research environment for researchers in engineering, architecture and social sciences, and a number of companies and organisations, based on interdisciplinary collaboration. The focus has been on complex issues linked to both the renovation of existing individual buildings and upgrading entire areas.
75	**SE**	Research on building renovation and preservation: save and preserve	This research programme focuses on energy efficiency in historic buildings. Indoor climate control and other technical issues in churches and monumental buildings, and larger building stock, are studied to obtain best practices in improving the energy efficiency of cultural heritage while avoiding maladaptation.
76	**SE**	A living cultural heritage in a future climate	A model for spatial planning and risk management for municipalities was created, alongside two web GIS tools. The final output was a climate data mapping tool and a model for spatial planning and risk management for municipalities, which was developed by regional authorities based on national hazard mapping / regional analyses and heritage information.
77	**SI**	Dolenji Novaki: Franja Partisan Hospital (Partizanska Bolnišnica Franja) (EID 109)	This is an example of an adaptation strategy from a restoration project at a historic site after it was affected by flooding. It provides methods for the restoration and reconstruction of wooden shacks and for the implementation of preventive measures to reduce the impact of natural disasters.
78	**SI**	Sleet in February and March 2014	This methodology development project comes from the rehabilitation of a garden's architectural heritage after sleet. The damage caused by this sleet promoted the development of a methodology by scientists consisting of extensive photographic documentation and mapping with exact locations, descriptions, guidelines and instructions for the owners of sites.

	Country	Case study	Brief description
79	**SI**	Ljubljana: Hotel Tivoli (EID 364)	This renovation of a historic hotel provides an example of adaptive reuse of a heritage building. The complex renovation included reinforcing the static stability of the building, fire safety improvements and energy efficiency (insulation and new installations). It is a learning model in the construction business and showcases adaptation and a balance between conservation-restoration techniques for historic buildings and renovation in accordance with modern standards.
80	**SI**	Perceive, protect, preserve	This case includes educational training, workshops and seminars for children to learn about local and national cultural heritage: heritage professionals share their knowledge of architecture, archaeology, ethnology and landscape architecture, among other things with children throughout Slovenia. The main aim is to raise awareness among younger generations in a creative way.
81	**SI**	Meadow orchards in Kozjansko Park	This project focuses on a sustainable management strategy and policy development. The Kozjansko Park Public Institute ensures the sustainability of the landscape through the engagement of local communities and a network of farms that has operated for over 20 years. By reviving the meadow orchards, the institute helps to preserve biodiversity and many animal species, particularly birds.
82	**SI**	Paper futures: revitalisation and adaptive reuse of an abandoned part of the Vevče Paper Mill	This research project provides educational training at the Faculty of Architecture of the University of Ljubljana, linked to the challenge of revitalising an abandoned part of the Vevče Paper Mill and actively connecting it with the surrounding settlement. The case shows how a space can be revitalised through different levels of intervention, while preserving its distinct characteristics.
83	**SK**	Piešťany Power Plant, Slovakia	This project is focused on the conversion of industrial heritage into a hands-on science centre addressing energy topics such as electricity and the generation of energy, and providing informal environmental education. The high thermal inertia of the peripheral envelope (masonry walls) of the building was used in the design using a flexible method of intermittent heating and air conditioning.

ANNEX 3 – RESPONSE FROM THE EU OMC EXPERT GROUP ON STRENGTHENING CULTURAL HERITAGE RESILIENCE FOR CLIMATE CHANGE TO THE DIRECTORATE-GENERAL FOR ENERGY

The response draws on the following presentation: European Commission Directorate-General for Energy, 'Proposals for the energy performance of buildings directive (EPBD) and the energy efficiency directive (EED): the role of protected buildings', presentation to the sixth meeting of the OMC expert group, 3 February 2022.

INTRODUCTION

The OMC group members, set up in accordance with the Work-plan for Culture 2019-2022, welcome the increased ambition of these Directives and efforts to achieve climate neutrality in Europe by 2050. The OMC expert group is convinced and can demonstrate by various **best practice examples** from different Member States that the **built cultural heritage** can actively contribute to reach **climate neutrality by decreasing the CO_2 footprint**. Some aspects of these Directives, however, need to be enlarged taking into account a holistic approach, otherwise they pose a risk for Europe's built heritage. As a consequence further measures are required to ensure that the contribution of these buildings to climate action is fully appreciated and taken into account in these and future energy and climate-related Directives.

IMPORTANCE OF CULTURAL HERITAGE

First of all, it is clear that **cultural heritage** as an important part of society is involved in the fight against climate change. As such, due to its nature, its thermal behaviour and the cultural values it conveys, it must be considered to **be a part of the solution** rather than a problem. Heritage represents a common European base for historical and cultural development. This value, shared by all, must be preserved from **irreparable loss or damage**. The vast majority of Europe's historic building stock does not have statutory protection yet these buildings are **central** to the character of **our cities, towns and rural settlements and of great value to communities**. These buildings, because of their materials and traditional construction, are vulnerable to damaging alterations which fail to take account of their hygrothermal properties, and their real rather than assumed, thermal transmission levels.

The modification of **building performance obligations** in its evolution is both a great **opportunity** to **ensure the enduring use of a building** but at the same time presents a risk of loss of heritage qualities. In fact, when deciding on energy-saving interventions, it is essential to define in advance the heritage values to be preserved. In this way the balance can be established between **energy gains** and **heritage importance**. To this equation can then be added the calculation of the **grey energy and the payback time of the investments**.

In order to obtain the most appropriate interventions, it will certainly be necessary to encourage Member States to initiate or pursue research programmes, technological solutions and methods that contribute to a more efficient use of energy in cultural and historical buildings without destroying or distorting their historical values, decoration, furniture or installations.

THE SPECIFICITY OF BUILT HERITAGE

It is essential that a **holistic approach is taken to the assessment of the energy quality of a building** and the considerations of the interventions to be carried out, take more into account the intrinsic thermal inertia of the building. It is known by climate predictions that in the coming years, the **cooling demand** in most parts of Europe will be **more energy intensive than the heating needs**. On this point, heritage properties have undeniable qualities which are sometimes lost by a reduction in access to thermal inertia when insulating from the inside to achieve prescribed energy standards.

With regard to energy performance certificates, we propose that the energy improvement measures suggested for historical buildings could take into account both their cultural values and well as their technological performance. This will make the recommendations more relevant and the energy **certificate will gain in quality and completeness**. Current software assessment systems which concentrate on the notional energy performance of the building fabric **fail** to include an assessment of the **actual energy used**, the contribution of the embodied, or grey, energy in an existing building and the **whole-life-cycle assessment** of the building's performance. Furthermore, the results of the certificate could integrate the possible access to public transport or green mobility as part of an overall energy balance.

It is also important to underline that the software for the energy label should better take into account the constructional specificities of old buildings which are generally of vapour-permeable, mass-walled (earth, stone, brick) or thin-walled (wood) construction. Indeed, it can be seen in the results on energy performance that **static simulation calculations**, as currently used in the certificates, give energy expenditure values between 10 and 20% (and sometimes 30%) higher than **dynamic calculation simulations**, which are **closer to reality**.

It could therefore be important to obtain the most realistic models possible for assets of heritage interest in order to avoid proposing inappropriate works to these buildings which could be damaging to the building and its contents the health and well-being of its occupants due to the creation of an unsuitable microclimate.

Following the draft proposals of the Energy Performance of Buildings Directive and the Energy Efficiency Directive, it seems important to insist on the possibility to keep exceptions for buildings with heritage value and this also for properties owned by public authorities, whatever the percentage targeted by the legislation. Many of Europe's most significant cultural heritage buildings are in public ownership such as government buildings, palaces, courthouses, museums and many others. The application of a **standardised measures** to such buildings risks causing **irreparable damage**. As mentioned above, it is important to take a holistic view of the situation in the energy approach. The presence of scientifically based exceptions is in no way a weakness of the legislation, but on the contrary demonstrates the ability of a standard to adapt to the realities on the ground and thus obtain the most effective results possible.

Recognising the specificity of built heritage in legislation is the best way to insure against the risk of cultural loss as a result of the application of standardised measures designed primarily for new buildings. The **historical building stock worth preserving requires a holistic and interdisciplinary approach that goes far beyond the search for purely technical solutions**. In the future, in order to determine the most suitable intervention for the old building stock, it will be necessary to promote further research programmes for innovative technical solutions. There is no doubt that **heritage is fully involved in the fight against climate change**. It will be able to do so thanks to its intrinsic qualities and its unifying cultural values.

We **note that Art. 5(3) of the draft EPBD removes the possibility** for EU Member States to exempt buildings that are officially protected as part of a designated environment or because of their special architectural or historical value. While it is accepted that all buildings are capable of some form of energy upgrading, this **proposed deletion must be accompanied by a balanced approach to buildings of cultural heritage significance**, correct assessment of their performance and the application of retrofitting techniques appropriate to their construction characteristics.

The **OMC group welcomes the fact that Directive 2018/844 EU**, especially with paragraph 15, does not focus solely on the energy retrofitting of the building envelope, but includes in the **consideration all relevant elements and technical installations** in a building that are involved in **passive techniques** with which the demand for energy in the use phase can be reduced an thus the **thermal and visual comfort** is to be improved. In this context, we point out the special potentials with regard to indoor climate and room temperature control in monuments. Here, it can be shown how, by means of adapted utilisation scenarios and comfort requirements through e.g. buffering or the installation of unheated areas, regulators, heat recovery etc. **efficient basic concepts are already in place**. We recommend that such utilisation concepts aiming at **sufficiency** should also be taken into account in a **life cycle assessment**.

RECOMMENDATIONS

We **strongly recommend** that Articles 22 and 23 of the draft EPBD should recognise that there is a need for **targeted training** and a recognition of the **skills required to retrofit buildings of traditional** construction to ensure that there are no unintended consequences for the building such as would prejudice its cultural heritage values, risk long-term deterioration of the building fabric and contents, or jeopardise the health and well-being of occupants. Proposed one-stop shops (Article 26) should be equipped to provide the necessary advice on built heritage protection to those proposing works to traditional buildings.

In conclusion, **we recommend** that there should be a **holistic approach taken to the energy performance** of the built environment in order to reach Europe's **climate targets**, including actions such as:

- Promoting the continued appropriate **use and reuse of the building stock** as a priority over **demolition and new construction**. This avoids the green house gas emissions created by demolition and rebuilding and reduces waste and landfill;
- Developing **skilled and sympathetic retrofitting measures** which will prevent unintended consequences for the buildings and their occupants as a result of maladaptation;
- **EU Directives and grant aid** should prioritise assessment of **measured energy** use rather than **calculated energy** use to ensure that emissions reductions are actually achieved and that occupants are incentivised to reduce their energy usage through low-impact, everyday actions rather than invasive and carbon-intensive retrofitting works;
- Developing more **robust accounting methods, data**, etc. to assess the contribution of the historic building stock to climate action;
- Demanding and **enabling longer lifespans for buildings** and building elements. The historic building stock has proven **durability** which must be credited in assessments;
- Quantifying monuments always in terms of their evaluation, taking into account the **system boundary of the neighbourhood**. Many of the measures to increase energy efficiency can be realised simply by focusing on the potentials and networking of the energy supply in the neighbourhood;
- **Building capacity** through **training and upskilling** to ensure the construction industry is equipped to undertake upgrading works to the historic building stock.

ANNEX 4 – LIST OF PRESENTATIONS GIVEN BY EXTERNAL INSTITUTIONS AND ORGANISATIONS

- European Commission Directorate-General for Energy: proposals for the energy performance of buildings directive (EPBD) and the energy efficiency directive (EED): the role of protected buildings
- European Commission Directorate General for Education and Culture: presentation on education for the climate coalition initiative
- UNESCO: UNESCO World Heritage and climate change
- Italian Ministry of Culture: 2021 United Nations Climate Change Conference update from the Italian Ministry of Culture
- Italian Ministry of Culture: risk map of Italian cultural heritage
- ICOMOS: climate change action – latest developments and community involvement
- German Federal Environmental Foundation (Deutsche Bundesstiftung Umwelt, DBU): cultural heritage and the IPCC
- National Observatory of Athens: urban heritage climate observatory
- Handbook on the possibilities of financing climate adaptation measures for Adriatic cities and regions in Croatia and Italy
- Advisor to the Greek Prime Minister on Energy, Climate, Environment and Circular Economy Issues: addressing climate change impacts on cultural and natural heritage at United Nations level
- Foundation for Cultural Heritage Sciences (Fondation des Sciences du Patrimoine), Joint Programming Initiative Cultural Heritage Secretariat: joint programming initiatives cultural heritage and climate joined their forces and developed synergies
- European Commission Directorate-General for Environment: the EU flood directive
- European Commission Directorate-General for Research and Innovation: Horizon Europe research programme
- European Commission Directorate-General for Defence Industry and Space: the Copernicus programme
- European Investment Bank Institute: European Investment Bank Institute and climate action in the framework of a sustainable future (climate awareness bonds)
- European Commission Directorate-General Education and Culture: Work Plan for Culture
- European Commission Directorate-General for Climate Action: the European Green Deal
- European Commission Directorate-General for Energy: renovation wave across the EU
- Europa Nostra and ICOMOS: putting cultural heritage at the centre of the European Green Deal – a preview of the European Heritage Green Paper
- European Commission Directorate General for Education and Culture: presentation of the OMC group on high-quality architecture
- European Commission Directorate General for Education and Culture: presentation of the OMC group on sustainability
- European Commission Joint Research Centre: presentation of the adaptation pillar of the Global Covenant of Mayors initiative

Presentation of projects

- Meteorological and Hydrological Service (Croatia): state of the art in climate change modelling
- National Research Council, Institute of Atmospheric Sciences and Climate (Italy): the ProteCHt2save project (Interreg)
- National Research Council, Institute of Nanostructured Materials (Italy): the Heracles project (Horizon 2020)
- Directorate for Cultural Heritage (Norway): the Adapt Northern Heritage project (European Regional Development Fund)

ANNEX 5 – LIST OF RESEARCH PROJECTS RELATED TO CLIMATE CHANGE IMPACTS ON CULTURAL HERITAGE UNDER THE EU RESEARCH PROGRAMMES (FRAMEWORK PROGRAMME 6, FRAMEWORK PROGRAMME 7, HORIZON 2020 AND HORIZON EUROPE)

- Noah's Ark: global climate change impact on built heritage and cultural landscapes (2004–2007)
- Sustaining heritage: sustaining Europe's cultural heritage: from research to policy (2004–2005)
- Climate for culture: damage risk assessment, economic impact and mitigation strategies for sustainable preservation of cultural heritage in the times of climate change (2009–2014)
- Firesense: fire detection and management through a multi-sensor network for the protection of cultural heritage areas from the risk of fire and extreme weather conditions (2009–2013)
- CHEF: cultural heritage protection against flood (2007–2010)
- Wreckprotect: strategies for the protection of shipwrecks in the Baltic Sea against forthcoming attack by wood degrading marine borers – a synthesis and information project based on the effects of climatic changes (2009–2011)
- Effesus: energy efficiency for EU historic districts sustainability (2012–2016)
- Hercules: sustainable futures for Europe's heritage in cultural landscapes – tools for understanding, managing, and protecting landscape functions and values (2013–2016)
- Fragsus: fragility and sustainability in restricted island environments – adaptation, cultural change and collapse in prehistory (2013–2018)
- Coordinating for life: success and failure of western European societies in coping with rural hazards and disasters, 1300–1800 (2014–2019)
- Memola: Mediterranean montainous landscapes – an historical approach to cultural heritage based on traditional agrosystems (2014–2017)
- Iperion CH: integrated platform for the European research infrastructure on cultural heritage (2015–2019)
- Heracles: heritage resilience against climate events on site (2016–2019)
- STORM: safeguarding cultural heritage through technical and organisational resources management (2016–2019)
- Warmest: warmest low altitude remote sensing for the monitoring of the state of cultural heritage sites – building an integrated model for maintenance (2017–2021)
- Hyperion: development of a decision support system for improved resilience and sustainable reconstruction of historic areas to cope with climate change and extreme events based on novel sensors and modelling tools (2019–2020)
- Shelter: sustainable historic environments holistic reconstruction through technological enhancement and community based resilience (2019–2023)
- ARCH: advancing resilience of historic areas against climate-related and other hazards (2019–2022)
- Heriland: cultural heritage and the planning of European landscapes (2019–2023)
- PRO-Heritage: protect traditional built heritage skills (2019–2022)
- CHICC: culture, heritage and identities – impacts of climate change in north west Europe (2020–2022)
- YADES: improved resilience and sustainable reconstruction of cultural heritage areas to cope with climate change and other hazards based on innovative algorithms and modelling tools (2020–2024)
- EU-MACS: European market for climate services; EU-MACS in tourism: the use of climate services in tourism – strengthening climate resilience (2016-2018)

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