The Future of Our Pasts:

Engaging cultural heritage in climate action

Outline of Climate Change and Cultural Heritage

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Engaging Cultural Heritage in Climate Action

Climate change will increase desertification, which will in turn affect the use of traditional nomadic pastoral landscapes and will displace communities.

Shifting Sahara sand dunes near Zagora, Morocco (Photo credit R. Allaway, 2010)

Heritage and Climate Change Outline

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Copy Editor:
Helen Wilson,
Secretary, ICOMOS International Scientific Committee on Energy and Sustainability + Climate Change
Co-Convener, Australia ICOMOS National Scientific Committee on Energy and Sustainability
ICOMOS International Scientific Committee on Historic Towns and Villages
ICOMOS National Committee: Australia

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ICOMOS Climate Change and Heritage Working Group
Members

Elizabeth A. BRABEC, JD
Professor, Department of Landscape Architecture and Regional Planning, and
Director, Center for Heritage and Society University of Massachusetts Amherst
ICOMOS National Committee: United States

Sheridan BURKE
Scientific Council Officer, ICOMOS
Secretary, ICOMOS Twentieth Century Heritage ISC
ICOMOS National Committee: Australia

Peter COX
President, ICOMOS International Scientific Committee on Energy and Sustainability + Climate Change
ICOMOS National Committee: Ireland

Cathy DALY, PhD
Lecturer in Conservation, University of Lincoln
ICOMOS National Committee: Ireland

Alpha DIOP, PhD
Architecte
ICOMOS National Committee: Mali

Professor Jane DOWNES, PhD
Director, University of the Highlands and Island Archaeology Institute
ICOMOS National Committee: United Kingdom

Alvaro GÓMEZ-FERRER
Dr. Architect and Town Planner
Honorary Member of ICOMOS
ICOMOS National Committee: Spain

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ICOMOS National Committee: Mexico

Jørgen HOLLESEN, PhD
Senior Researcher, National Museum of Denmark
ICOMOS National Committee: Denmark

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Manager of International Affairs, Institut d'aménagement et d'urbanisme d'Ile-de-France ICOMOS National Committee: France

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ICOMOS National Committee: US and Hellenique

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Vice President, ICOMOS
Programme Officer, ICCROM Sharjah
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Distinguished Professor, Kyushu University (Japan)
ICOMOS National Committee: Japan

Professor Roger-Alexandre LEFÈVRE
Professor Emeritus, Université Paris-Est Créteil Val de Marne
ICOMOS National Committee: France

Adam MARKHAM
Deputy Director, Climate & Energy, Union of Concerned Scientists
ICOMOS National Committee: United States

William MEGARRY, PhD
Lecturer in Geographical Information Science, Queens University Belfast
ICOMOS National Committee: Ireland

Ishanlosen ODIAUA, PhD
ICOMOS National Committee: Nigeria

Peter PHILLIPS
Secretary-General, ICOMOS
ICOMOS National Committee: Australia

Andrew POTTS, JD
Coordinator, ICOMOS Climate Change and Heritage Working Group
ICOMOS National Committee: United States

Yves PRÉVOST, PhD
World Bank Retiree
ICOMOS National Committee: Canada

Marcy ROCKMAN, PhD, RPA
Former Climate Change Adaptation Coordinator for Cultural Resources, US National Park Service
ICOMOS National Committee: United States

Angela ROJAS, PhD
Professor, Technological University of Havana (CUJAE)
Honorary Member of ICOMOS
ICOMOS National Committee: Cuba

Mario SANTANA Quintero, PhD
Associate Professor and Director of the NSERC CREATE Program on Heritage Engineering
ICOMOS National Committee: Canada and Belgium

SU Bomin, PhD
Director, Conservation Institute of Dunhuang Academy
ICOMOS National Committee: China

Stacy VALLIS, PhD Candidate
(Emerging Professionals Working Group Liaison), School of Architecture and Planning, The University of Auckland
ICOMOS National Committee: New Zealand

Preface

In 2017, the 19th Triennial ICOMOS General Assembly meeting in New Delhi laid out a vision for mobilizing the cultural heritage community for climate action. Now we must accelerate putting those words into action. But how?

Of the many cultural dimensions of climate change, which have the greatest potential to support climate action and what elements of heritage practice are most relevant to these efforts? How is climate change impacting cultural heritage and what can be done about it? Building on work from numerous fields, ICOMOS's Outline of Climate Change and Cultural Heritage offers answers to these questions. In so doing, it takes an important step towards achieving the ambitions of New Delhi.

This is not ICOMOS's first engagement with the topic. Over a decade ago, an ICOMOS Workshop recommended that climate change adaptation strategies be mainstreamed into the existing methodologies for conservation of sites, buildings, landscapes, movable objects and living heritage. A landmark ICOMOS Scientific Council Symposium on Global Climate Change held in 2008 in Pretoria concluded ominously that climate change portended 'loss and destruction as much as preservation' for cultural heritage. Meeting in Quebec later that year furthered efforts to mainstream climate change into heritage practice.

These efforts were correct, even visionary – and yet their promise has not been realized. Today, many heritage managers still lack the capacity to downscale climate scenarios to inform site management. Many national climate adaptation plans still miss the potential of heritage. Despite profound connections between climate change and cultural heritage, there are too many heritage officials, professionals, organizations and advocates not yet engaged in climate action – even in frontline communities and even in cities and regions with robust climate action pledges.

This must change – and urgently. It would be foolish to imagine the practice of heritage remaining static while the world goes through the rapid and far-reaching transitions discussed in the IPCC's recent Special Report on Global Warming of 1.5°C. Responding requires adjustments in the aims and methodologies of heritage practice. Achieving the ambitions of the Paris Agreement requires dismantling the barriers to full recognition of the cultural dimensions of climate action.

The great value of the Outline is that it systematically catalogues the needs and opportunities for #climateheritage action. It leaves no doubt what must be done. So now is the time to act on climate. Now is that time for wisdom to be summoned, skills to be used, research to be applied. Succeeding is the shared responsibility of everyone who cares for the planet's communities and ecosystem and aspires to safeguard them in a changing climate.

Toshiyuki Kono
President of ICOMOS
Fukuoka, June 5, 2019

'Achieving the ambitions of the Paris Agreement requires dismantling the barriers to full recognition of the cultural dimensions of climate action.'

Photo: F.Rhodes/CEA

'...how cultural heritage can contribute to climate solutions through risk management, adaptation and resilience strategies, and mitigation, projecting from the past into the future.'

I would like to congratulate the ICOMOS Climate Change and Heritage Working Group for this outline and for the vision on how climate change can affect cultural heritage and how cultural heritage can contribute to climate solutions through risk management, adaptation and resilience strategies, and mitigation, projecting from the past into the future.

The recent Special Report of the Intergovernmental Panel on Climate Change (IPCC) on Global Warming of 1.5°C has highlighted that every half a degree and every fraction of global warming matters in terms of climate change impacts and risks; that every year matters for climate action; and that every choice matters to build ethical and fair transitions towards climate resilient, low carbon, sustainable development pathways.

There is an immense and untapped potential for mobilization of society through active engagement of local communities and visitors of cultural heritage sites – if these intersections are actively promoted, made visible and designed to be part of an ambitious education project. Education is crucial for the scale of societal transformation needed to address climate change. Designing education perspectives building on both cultural heritage and forward looking, based on climate and climate change sciences and grounded in the territory and cultural identity, could be instrumental in shaping climate action within community identity, through a 'sense of belonging'.

The vision developed by the Climate Change and Heritage Working Group also has the potential to provide major contributions to the agenda for research and action on cities and climate change science (https://citiesipcc.org/beyond/global-research-and-action-agenda-on-cities-and-climate-change-science/).
To address climate change challenges, we all need to think and act differently in order to support systemic and societal transformation. Cooperation, building on multiple forms of knowledge, will be essential. This vision document is also designed to help create bridges and cooperation between experts and decision makers involved in the sectors of heritage, culture, sustainability, climate science and climate action and to inspire and stimulate new approaches.
I hope that you will enjoy reading this document as much as I enjoyed reviewing it!

Valérie Masson-Delmotte
Paleoclimatologist, co-chair of IPCC Working Group I (physical sciences) for the 6th IPCC Assessment cycle
Saclay, June 5, 2019

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Concrete blocks acting as wave breakers are the only protection against rising sea-levels

15th century Qaitbey Castle, Alexandria, Egypt (Photo © Siam Diab)

Background

Climate Change was not on the agenda in 1966 when ICOMOS was founded with the mission to work for the conservation and protection of cultural heritage places. More traditionally understood threats to heritage, like conflict, rapid urban development and disasters loomed large then. Yet today, climate change has become one of the most significant and fastest growing threats to people and their cultural heritage worldwide (ICOMOS, 19GA 2017/30). Unequivocal scientific evidence shows that unprecedented concentrations of greenhouse gases (GHGs), driven by human activities such as burning of fossil fuels and deforestation, are contributing to climate changes including warming of the oceans and atmosphere, sea level rise and diminished snow and ice. The impacts of these changes are already damaging infrastructure, ecosystems, and social systems – including cultural heritage – that provide essential benefits and quality of life to communities.

The changing climate is creating new risks even while it exacerbates existing vulnerabilities and multiplies traditional threats. Rapid urbanization, wealth inequality, globalization and the attendant loss of cultural identity present grave threats to the well-being of communities. Excessive and insensitive development reflects the abandonment of sustainable patterns of land use, consumption and production, developed over centuries if not millennia of slow adaptation between communities and their environment. In tandem, the ecosystems that underpin human well-being are declining globally at rates unprecedented in human history. One million species are now threatened with extinction with grave impacts on people around the world, warned a landmark 2019 report from the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES).

The severity and urgency of the problem is underscored by the 2018 findings of the Intergovernmental Panel on Climate Change's (IPCC's) Special Report on Global Warming of 1.5°C. According to the IPCC, humankind has already made the climate 1 degree Celsius (C) warmer since pre-industrial times. Warming is likely to reach 1.5°C around 2040 and 2°C by 2065 if emissions continue unchecked. The report highlights multiple climate change impacts that could be avoided or made significantly less severe by limiting Global warming to 1.5°C compared to 2°C, or more. For instance, by 2100, with Global warming of 1.5°, global Sea level rise would be 10 cm lower than with Global warming of 2°C. The likelihood of an Arctic Ocean free of sea ice in summer would be once per century with global warming of 1.5°C, compared with at least once per decade with 2°C. Coral reefs would decline by 70-90 percent with Global warming of 1.5°C, whereas virtually all (> 99 percent) would be lost with a 2°C rise.

The 2015 Paris Agreement signed by 195 countries under the auspices of the United Nations Framework Convention on Climate Change (UNFCCC) seeks to keep global temperature rise well below 2°C this century, and to pursue efforts to limit it to 1.5°C. The IPCC report finds that limiting global warming to 1.5°C would require rapid and far-reaching transitions in the way we use land, energy, industry, buildings, transport, and cities. Global net anthropogenic emissions of carbon dioxide (CO2) would need to fall by about 45 percent from 2010 levels by 2030, reaching net zero emissions around 2050. This means that any remaining emissions would need to be balanced by decarbonization initiatives – by removing carbon dioxide (CO2) from the air.

This decarbonization imperative exists alongside the global aspiration for sustainable development embodied in the 2030 Agenda for Sustainable Development also adopted by the countries of the world in 2015. With its 17 Sustainable Development Goals (SDGs) and attendant 169 targets, these 'Global Goals' (as the SDGs are sometimes known) are arguably the most ambitious and holistic development framework ever conceived. The Sustainable Development Goals together with companion documents like the Sendai Framework for Disaster Risk Reduction and the Habitat III New Urban Agenda contemplate a paradigm shift to a concept of development that views sustainability in more humanistic and ecological terms. This vision embraces the reality that we live in a world of complex, interdependent systems and acknowledges that changes to these systems can either enhance or degrade our resilience in the face of these changes. As with the Paris Agreement, they point to the need for profound and urgent transitions in humankind's patterns of living, production and consumption.

These global documents also give unprecedented, explicit recognition to the fundamental role that culture and heritage can play in these transitions. The SDGs and the Paris Agreement recognize that cultural heritage can guide choices that promote human action in ways that support resilience and sustainability and by extension climate-resilient development pathways. Cultural factors shape the Enabling condition for adaptation and mitigation including whether and how people respond to appeals for Climate Action. The recognition given at the highest levels of policy making to the role of heritage, together with the urgency of the challenges of climate change, creates both a profound opportunity and a challenging responsibility for all those connected to heritage.

Key to understanding this potential is an appreciation of the breadth of the concept of cultural heritage. Over time, the meaning of cultural heritage in professional practice has expanded from single monuments and sites identified as objects of art to cultural landscapes, historic cities, and serial properties. Contemporary practice further extends the concept of heritage beyond 'tangible heritage', to the intangible dimensions of heritage as well. This means the entirety of knowledge derived from the development and experience of human practices, representations, expressions, knowledge and skills; and associated objects and spaces that communities recognise as part of their cultural heritage.

The unique power of exceptional, iconic heritage sites – including the tangible and intangible values they carry – to stir people's souls, drive human responses and galvanize public opinion cannot be doubted. The World Heritage program presents a high profile, global reach, integrated nature-culture approach and broad mix of heritage typologies. Adopted in 1972, the World Heritage Convention contemplates that the sites inscribed on the World Heritage List will act as laboratories of ideas with the potential to set international standards in heritage management. Developing responses to climate change is just such a case, where World Heritage Sites have an important role to demonstrate and share their climate action work with all communities. Indicative of this is the Policy Document for the Integration of a Sustainable Development Perspective into the Processes of the World Heritage Convention adopted by the General Assembly of States Parties to the World Heritage Convention in 2015, which recognized increasing disaster risks and the impact of climate change, and called on the member states to recognise that World Heritage represents both an asset to be protected and a resource to strengthen the ability of communities and their properties to resist, absorb, and recover from the effects of a hazard.

Cultural heritage is of course far more than World Heritage Sites. In order to understand the relationship between cultural heritage, climate action and resilience, the idea of heritage must be understood and acted upon in its broadest sense. Physical conservation of selected buildings and artefacts will not realize heritage's potential to catalyse climate action or promote social cohesion, inclusion or equity, but neither can the promotion of resilience and sustainability be removed from the conservation of these properties. Culture and place are often closely tied, and this remains so even as both have become increasingly trans-nationalized through globalization. Embracing in historic conservation practice the multiplicity of heritage values that support the attachment that people have to their places and community is one of the important predictors of how well our field responds to the responsibilities assigned to it in the Sustainable Development Goals (SDGs).

The cultural and social values carried by the planet's land and seascapes are closely interlinked with its natural values (and affiliated bio-cultural practices). Facing a changing climate puts a premium on bridging the divide between nature and culture practitioners and policies. It demands from conservation communities integrated nature-culture approaches on a global scale to help address the challenge of climate change and the planet's other looming crises. This imperative is given recognition in the Preamble to the Sustainable Development Goals which reads: We acknowledge the natural and cultural diversity of the world. This emphasis is borne out across the SDGs. In so doing, the SDGs recognize that integrated nature-culture approaches can advance sustainability objectives by improving conservation outcomes, fostering bio- and cultural diversity, and supporting the well-being of contemporary societies and future generations in both urban and rural areas.

The document *Malama Honua – To care for our island Earth* is one roadmap to realizing the promise these approaches hold. An outcome of the Nature-Culture Journey at the 2016 IUCN World Conservation Congress, *Malama Honua* includes a sobering recognition that cultural and natural diversity and heritage are seriously threatened around the world by a number of challenges including climate change. It goes further, arriving at the conclusion that the very culture/nature divide that has characterized some aspects of conservation practice is itself a symptom of larger processes that have put the Earth on an unsustainable path.

Climate change multiplies not only threats but also the urgency of enhancing good conservation practice. *Malama Honua* similarly called for new working methods that bring together nature and culture to achieve Conservation outcomes on a landscape scale, while promoting the leadership, participation, resilience and well-being of associated communities. Other innovations, including Historic Urban Landscape and rights-based approaches, also seek to make heritage practice more holistic, interdisciplinary and grounded in a concern for resilience and sustainability. Together, they lay the foundation for a new approach to heritage that responds to the unprecedented, systemic threat to people and their cultural heritage that is climate change.

Resolution 19GA 2017/30 ENCOURAGES all ICOMOS Members to strengthen their efforts to aid in implementing the Paris Agreement, emphasizing cultural heritage and landscape-based solutions, noting the need for rapid and deep reductions in emissions to reverse the increase in the global average temperature to well below 2°C; that adaptation efforts should take into consideration vulnerable communities and ecosystems, and enhance understanding and action with respect to loss and damage from climate change; and the need for solidarity with those nations most impacted by, or least able to bear the cost of, climate change to enable them to safeguard their heritage.

Boats on the Shoreline, Majuli, Assam, India.
Photo credit: W. Megarry, 2017

Introduction

Outlining the Intersection of Cultural Heritage and Climate Change: *An Urgent Need*

This *Outline of Climate Change and Cultural Heritage* aspires to do no more – and no less – than its name would suggest: to describe the intersection of climate change and cultural heritage. If one were to draw a box labelled *Places where climate change and cultural heritage interact* – what would be in it? The Outline endeavours to list the contents of that box and organize them using new hierarchies that draw from both climate change and heritage conservation practice and methodologies.

The Outline was initially developed by the ICOMOS Climate Change and Heritage Working Group (CCHWG) to define the scope of its own work. In December 2017, the Triennial ICOMOS General Assembly meeting in New Delhi, India adopted Resolution 19GA 2017/30 entitled 'Mobilizing ICOMOS and the cultural heritage community to help meet the challenge of climate change.' The Resolution states in part that ICOMOS:

ENCOURAGES all ICOMOS Members to strengthen their efforts to aid in implementing the Paris Agreement, emphasizing cultural heritage and landscape-based solutions, noting the need for rapid and deep reductions in emissions to reverse the increase in the global average temperature to well below 2°C; that adaptation efforts should take into consideration vulnerable communities and ecosystems, and enhance understanding and action with respect to loss and damage from climate change; and the need for solidarity with those nations most impacted by, or least able to bear the cost of, climate change to enable them to safeguard their heritage.

The CCHWG was formed to advance the Resolution's ambitious mandate. It soon became clear, however, that there was no ready map of this terrain.

To some, documenting the knowledge found in coastal archaeology sites threatened by sea level rise or conserving traditional wood, stone and earthen architecture facing changing temperature and precipitation patterns is paramount. Others are championing sensitively retrofitting historic buildings for energy efficiency to mitigate greenhouse gases (GHGs), or the role of culture in Disaster Risk Reduction to build adaptive capacity. Leveraging the attachment to place that heritage engenders to raise ambition and galvanize Climate Action is often mentioned. Valuing and promoting Indigenous Knowledge, Local Knowledge and the heritage of marginalised communities is also a core aim of heritage work. Indeed, culture touches every facet of human endeavour, and from these complex intersections flow a multiplicity of approaches.

As discussed in the Background section of this Outline, the ambitions of the Paris Agreement are similarly cross-cutting, giving voice to the imperative for society-wide transformation in order to address climate change. Transformational responses to environmental change are generally defined as change that, by its scale or reach, alters the interplay of a given system. Such significant levels of change are likely to involve multiple social processes. Assessing and understanding the capacity of various factors for driving transformative change is critical to designing effective climate action.

Theory and Practice: The Gap Between Heritage and Climate Change

ICOMOS believes that cultural heritage contributes both qualitatively and quantitively to Transformative Change. This view is supported by analysis from a range of disciplines, including environmental history, anthropology, geography, human ecology, and sociology. Even so, the relationship of heritage to climate action is not well developed in climate literature. Various explanations have been advanced for this, including that the methods for studying culture tend to be narrative-based and qualitative, often including ethnography and participant observation, and *data from these methods do not sit comfortably with the quantitative approaches prevalent in other social and natural science on climate change*. (Adger et al 2013)

Climate action methodologies, policy frameworks, financing mechanisms and networks have similarly sometimes not engaged cultural heritage, or have done so indirectly through proxies. These methodologies often characterize the need for transformative action as a social and technological problem whose solutions lie in individual behavioural change and innovation. Such approaches tend to ignore cultural or political considerations and often omit culture and heritage entirely.

The general absence of cultural heritage from the climate discourse has a practical, correlative reality: while the culture and heritage sectors are important institutions in most communities, they often are not directly engaged in the work of climate action (although there are notable exceptions). Despite the profound connections between climate change and natural and cultural heritage, today there are thousands of archaeologists, architects, historians, and engineers; scientists, researchers, teachers and scholars; carriers of Indigenous Knowledge and Local Knowledge, and heritage advocates, whose talents have not yet been mobilized on climate change issues. Perversely, this lost opportunity is often greatest in cities and regions with ambitious climate action pledges.

Responding to the Gap

This Outline responds to that gap. In so doing, it attempts to take account of all types of cultural heritage and to account for variations in approaches to heritage across different cultures and belief systems. While any taxonomy of cultural heritage is bound to have shortcomings, this Outline categorizes heritage into the following six typologies: (1) moveable heritage; (2) archaeological resources; (3) buildings and structures; (4) Cultural Landscapes; (5) associated and traditional communities, (6) intangible heritage.

The Outline is divided into two main parts. Part I is a 'sectoral' analysis that maps the core considerations and competencies of cultural heritage to the major sectors of climate action derived from the Paris Agreement. Part I aspires to be a heritage conversation in a climate change framework. Part II catalogues the ways that climate change drivers are impacting cultural heritage. It aspires to be a climate change conversation in a heritage framework. These two parts are preceded by a narrative discussion of various themes that cut across both these parts. A glossary of defined terms can be found in Appendix I. A short introduction explains how the glossary was developed.

Raising Ambition: Mobilizing for Climate Action

The Outline has two primary sets of audiences. It is addressed to heritage communities, including local, community, tribal and indigenous leaders; city, state, provincial and regional, and national heritage administrators and heritage organizations looking to understand the role of climate change in their heritage work; to heritage professionals and advocates exploring their relationship to climate change; and to heritage scholars. This Outline is equally addressed to climate scientists and Policy-makers; to climate change professionals and advocates exploring how collaboration with the heritage sector can deepen the impact of their work; and to public officials including Resilience and climate change officers looking to understand the role of heritage in their climate change work.

This Outline is not a scholarly research document or a professional guide. In the near term, ICOMOS intends to use this Outline to organize the inputs of ICOMOS constituencies into a proposed update of the World Heritage Committee's 2007 *Policy Document on the Impacts of Climate Change on World Heritage sites*, to develop a roadmap for heritage organizations to engage on climate change issues, to support the creation of new a doctrinal heritage text on climate change and cultural heritage, and to organize outreach to the scientific community on research gaps and opportunities. While the CCHWG has collected a vast quantity of both references and case studies, the publication of a bibliography and an atlas of good practice await a later phase of ICOMOS work.

Beyond these immediate programmatic uses, the members of the CCHWG hope the outline will feed the new interdisciplinary #ClimateHeritage movement that has begun to blossom:

- While the Outline aims to be as broad as possible, it is not an exhaustive accounting. We hope others will accept the challenge of building on this work and take this analysis forward.
- Climate change necessitates new approaches to heritage, and it is hoped this Outline will support such shifts.
- Climate change must become a baseline competency of heritage management; this Outline provides a benchmark against which heritage communities may measure their engagement.
- Equally, climate change actors are encouraged to use this Outline to increase their understanding of and engagement with cultural heritage.

The Outline is also addressed to policy-makers, scholars and scientists with the hope that it will stimulate attention to existing research gaps and promote opportunities for collaboration.

Cultural heritage is both impacted by climate change and a source of resilience for communities. This Outline endeavours to advance the understanding of those dynamics and in so doing to increase the ambition and effectiveness of diverse actors and constituencies in the urgent work of safeguarding our planet and its heritage amidst a changing climate.

Fort George, Scotland
(Photo credit A. Markham 2014)

Thematic Essays

Heritage, Climate Action and the Sustainable Development Goals

The United Nations 2030 Agenda for Sustainable Development, with its 17 Sustainable Development Goals (SDGs), is conceived as an evidence-based framework for promoting a systemic understanding of the synergies and dynamics between the economic, social and environmental dimensions of sustainable development. In this regard, nature and culture connect the various SDGs and aspects of sustainability to each other. Their integration often finds form in the rich biocultural diversity of the world's heritage, defining our spiritual and physical relationships with the planet in harmonious ways.

Goal 11 advocating for inclusive, safe, resilient and sustainable cities and human settlements and Goal 13 calling for urgent action on Climate Change are supported with their own global agreements and commitments. The New Urban Agenda, the Paris Agreement and the Sendai Framework for Disaster Risk Reduction, in their strategic arenas each consider the urban context and recognize the importance of heritage conservation. These instruments provide an unusually explicit alignment between heritage and these key policy areas. Heritage, however, is as diverse as its settings and linked to broader systems than cities alone. Rural areas, the polar regions and life underwater, are just a few examples of the variety of cultural heritage contexts. The breadth of the heritage sector allows for meaningful connections with all 17 SDGs. For instance, SDG7 (Affordable and Clean Energy), SDG14 (Life Below Water), SDG12 (Sustainable Consumption and Production Patterns) in reference to sustainable tourism, and SDG15 (Life on Land) have straightforward intersections with heritage, although this is not explicitly mentioned in the wording of the targets. Moreover, the integrated system expressed in the SDGs implies that the policies and resulting strategies are interdependent, thus discouraging their implementation within any single sector or discipline.

This important momentum in the shift of global development requires an expansion of current concepts in all disciplines and sectors impacting human life and the planet. In this regard, at a global level, heritage conservation practice is increasingly endorsing innovative tools that promote adaptive and systemic approaches to better manage change. Other sectors are advancing practices by widening their sustainability discourse to include heritage. For instance, good governance, impact assessment and the circular economy all emphasize the role of legal frameworks that ensure the conservation and regeneration of local resources, including heritage. As such approaches are increasingly localized across the globe, it should follow that the valuing and promoting of cultural heritage in sustainable development will also increase. Yet it remains challenging, particularly in those contexts where strong governance institutions, accountability and the rule of law and human rights are in early stages of development.

The urgency for Climate Action demands an assessment of the wider implications of heritage as a driver and/or constraint for development. This requires identifying, understanding and assessing those interactions between heritage and development sectors that contribute to positive or negative impacts on climate action.

Co-benefits arise from strategies that concurrently promote both mitigation or adaptation, and preservation of cultural significance. For example, mitigation can include the use of low-carbon, climate-adapted traditional agricultural knowledge to achieve food security, and the sensitive reuse and retrofitting of built heritage for energy efficiency. Negative trade-offs can arise when mitigation actions threaten traditional practices and cultural resources and undermine heritage protection as it has been conventionally understood. Examples of such tensions include banning the traditional harvesting of peat; retrofitting of historic buildings for energy efficiency in ways that disregard heritage values; destructive resource extraction for renewable energy arrays; and implementing carbon sequestration models without regard to local or indigenous forest management practices and land tenure. In some, but not all cases, these negative trade-offs will constitute Maladaptation.

Changing environments can also bring new development opportunities and expose new resources. For example, polar heritage, where melting ice and the degradation of polar cultural landscapes are negatively impacting traditional cultural practices and ways of life, at the same time facilitate access to natural resources for exploitation and tourism development (Barthel-Bouchier 2013, 115-7).

To achieve progress on the Sustainable Development Goals and climate action, the heritage sector must consider the whole picture and the nature of climate impacts and climate action imperatives through work in multiple development sectors at multiple scales. For example, heritage-driven tourism and urbanization, whilst providing opportunities for economic and social development, can also contain unsustainable practices including greenhouse gas emissions, which need modification.

The wide range of interactions taking place in a variety of settings creates both complexities and difficulties in determining the adaptation limits of heritage management systems and the threshold for recognizing losses and damages to cultural significance. To bridge these uncertainties, heritage management now more than ever needs to develop frameworks that allow for the identification, negotiation and reaching of consensus on co-benefits and trade-offs, in order to achieve 'win-win' outcomes whilst at the same time managing and minimizing conflicts between goals.

Incorporating heritage conservation into SDG implementation and localisation efforts and into updated Nationally Determined Contributions (NDC) under the Paris Agreement, presents particularly promising avenues for developing such policy frameworks. Even where such frameworks exist, failure is still possible, due to poor consultation and weak implementation which often contribute to setting up win-lose, 'heritage-versus-climate-action' dynamics.

To strengthen SDG implementation at the local level, climate change literacy needs to be improved and Participative Governance approaches need to be utilized to arrive at inclusive solutions supported by stakeholder consultation and adaptive management. Heritage practice makes the greatest contribution to these local efforts when it too partakes of these attributes. Developing countries can benefit from financial instruments available at international level to enhance any of the SDGs and this includes the incorporation of heritage-based development strategies in internationally funded projects, including climate finance. There is also a global need to develop professional competencies, policies, regulations and laws that allow for clearer engagement between climate action and the heritage sector and to underpin these with tools that ensure accountability.

Stronger partnerships are needed, not only with communities to facilitate participation, but also with government and the development sector to achieve climate-compatible development, this is systems in which the decarbonization imperative reflected in the Paris Agreement is accomplished in tandem with achievement of the global aspiration for sustainable development embodied in the 2030 Agenda for Sustainable Development. With cultural heritage's potential to support Sustainable Development increasingly well-established, the imperative exists to further elaborate the role of cultural heritage in delivering climate-resilient development pathways that strengthen sustainable development and efforts to eradicate poverty and reduce inequalities while promoting fair and cross-scalar adaptation to and resilience in a changing climate. This work will bring to the fore heritage methodologies and systems that address the ethical and equitable aspects of the deep societal transformation needed to drastically reduce emissions to limit global warming (e.g. to 1.5°C) and achieve desirable and liveable futures and well-being for all.

Heritage as a Climate Action Asset

As noted at the 2017 ICOMOS Triennial General Assembly, cultural heritage is both under threat from climate change, and an asset in our attempts to adapt to and mitigate its impacts. While the impacts of climate change on heritage are all too clear, the value of cultural heritage as an asset in the response is not. This short essay will explore this value under three headings: how cultural heritage can be utilised to stress urgency about climate change; what we can learn about adaptation and mitigation strategies from cultural heritage; and the role of cultural heritage to build community resilience to climate change.

Stressing Urgency

The Paris Agreement emphasises the need to stress urgency about climate change, and cultural heritage can play a central role in this exercise. Cultural heritage is embedded in nearly all aspects of our society. It is part of people's lives and identities at local, national and international levels and so is uniquely situated to communicate the myriad Impacts of climate change. As iconic places of 'outstanding universal value', World Heritage and other iconic heritage sites can stress this urgency of climate action to a global audience. In some cases, they can also be used to showcase effective adaptation and mitigation responses. Many of these sites and landscapes have been the subject of numerous recent media reports. These are a very effective tool to focus attention on the issue; however, the value of local heritage must not be overlooked. All over the world, climate change is impacting local cultural heritage and places of cultural significance, and these impacts are being acutely felt. Climate-induced migration is leading to the displacement of entire communities who are divorced from their tangible heritage and landscapes and at risk to losing their sense of place. These Impacts are both current and real, and require an urgent response. Cultural heritage can be utilised to stress urgency about the immediate and future Impacts of climate change, and to emphasise the importance of action at local, national and international levels.

Adaptation and Mitigation Strategies

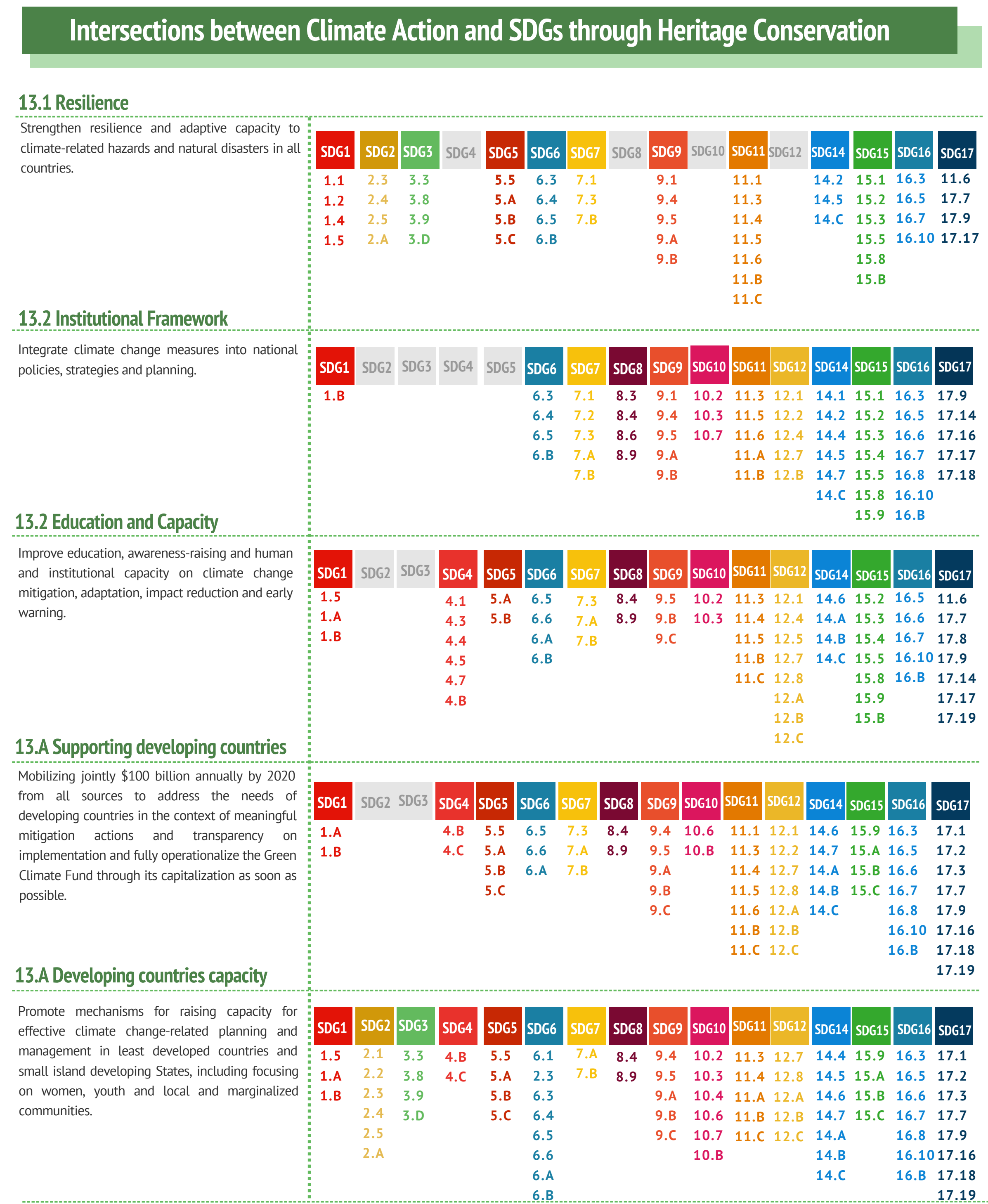
Through physical Impacts on places and people, the world's diverse cultures mediate our responses to climate change. Yet, much of contemporary adaptation and mitigation practice is most strongly influenced by the natural sciences. While very effective at identifying and quantifying the problem, these responses ignore the wealth of information and knowledge afforded to us by cultural heritage, and its value to help find solutions. Current IPCC reports underrepresent the role of culture in climate action, yet these reservoirs of past experience and knowledge, which have accumulated over time, are an untapped asset in developing both adaptation pathways and mitigation pathways. Interdisciplinary studies of past cultural adaptation to paleoenvironmental, climatic and landscape changes, can be used to set baselines and identify tipping points based on past evidence-based scenarios. Endogenous Ways of Knowing and past agricultural adaptations such as the utilisation of alternate environments or the adoption of more resilient crops feeds into climate-smart agriculture policy. Cultural heritage is a resource for the future. communities over time have developed strategies to respond to local conditions and landscape change including architectural and agricultural adaptations and settlement patterns. These Endogenous Ways of Knowing support contemporary mitigation options, from low-carbon, locally adapted approaches to decarbonizing buildings and cultural Landscapes to pointing the way to low-carbon models for developing peri-urban areas. The experience of communities living in marginal coastal and riverine areas feeds directly into current flooding adaptation strategies. Through recognition of Endogenous Ways of Knowing and by embracing past human experience, the direction of solution-making can be rooted in the value of communities, and bring it to the heart of decision and policy-making. Through this, culture and heritage become a powerful asset in developing contemporary adaptation and mitigation strategies.

Cultural Heritage and Social Resilience

As a tangible and intangible asset, cultural heritage offers climate services and can build resilience in the face of climate change. Community and societal responses to climate change vary widely, but all can benefit from the participatory governance models found in the cultural heritage field. In some cases, citizen science approaches utilise technology to deputise the public in the monitoring and recording of heritage at Risk. Cultural heritage inventories and participatory cultural mapping initiatives, serving as a knowledge-gathering process as well as a platform for citizen mobilisation. Both traditional approaches like oral histories and new technologies such as low cost non-invasive and non-destructive tools and technologies like photogrammetry and mobile GIS assist in this task.

In other cases, community engagement, participation and empowerment involving the transfer of Endogenous Ways of Knowing within and outside communities can invert traditional top-down Institutional capacity-building models and improve Climate Governance by placing communities at the heart of their own decision-making processes. In such cases, it is essential to acknowledge and respect traditional rights and to obtain free, prior and informed consent. In both cases, putting the values of communities at the core of the response, treating cultural heritage an asset, encourage community involvements and builds more durable outcomes in support of social resilience.

Figure 1. A map of the intersection between heritage conservation and the Sustainable Development Goals and Climate Action.



Integrating Cultural Heritage and Climate Science

Cultural heritage is a composite of human experience, developed over generations of trial and error, learning and successes. Science is governed by the same principles. To date, however, with respect to climate change, cultural heritage has had limited representation in the reports of the Climate Change IPCC, which are the world standard in climate science and research. Reasons for this disconnect are not yet fully described but appear to be diverse and deep. They come from how we use language, how we divide nature and culture in modern society, and how we allocate financial and social value. This means that fixing this situation will require appropriate and far reaching solutions. At the same time, climate change has developed from human activity and the solutions also clearly lie in the realm of human action. Correspondingly, the benefits of fully engaging with the range of human experience and related environmental information that is inherent in cultural heritage also appear diverse and deep. This essay briefly outlines points of connection between heritage, climate science, social science and the next steps for improving integration of heritage with the work of the IPCC.

All heritage, from well-visited World Heritage Sites to indigenous languages, and practices to small archaeological sites that may not yet have been recorded, holds information integral to understanding the climate system, environmental responses to change, and impacts of climate change. Cultural heritage sites hold materials that describe past climates. Sites, landscapes, and Endogenous Ways of Knowing hold information about past human understandings and uses of environments and past human impacts on environments. Combined, these help to describe the environmental baselines from which modern conditions are shifting. Further, as all communities hold some forms of tangible and intangible heritage, the scientific processes of identifying, tracking, and monitoring climate impacts on heritage are keys for understanding the effects of climate change on the components of human society.

In turn, collectively, cultural heritage tracks the social, political, economic, technological, and philosophical trends that have combined over time to create modern climate change. Heritage sciences and social sciences show what patterns of social change and development have looked like through time. Modern society is not the past, but the difference is of degree, not kind. Past societies did all the things that we do in our society – they had political structures, social relationships, trade, language, provided food and shelter, and senses of meaning. None of those societies is an exact replica of our own, but we can learn from how past societies organized and adapted the connections between parts of their societies. Therefore, evidence from the past and the diversity of living cultures today is an essential basis for analysis of modern assumptions about how societies can function and adapt in changing conditions.

As well, all types of heritage have power to connect people to place, anchoring senses of identity and community. What climate science tells us is that adaptation and mitigation are necessary. What climate science cannot tell us is what adaptation options are most workable within any given human system. Cultural heritage is a source of creativity and inspiration that can answer this question including shaping the acceptability of policy or system change. In this way, cultural heritage is a source of creativity and inspiration for adaptation and mitigation actions that are responses to the findings of climate science.

To date, these connections of cultural heritage to climate change are not highly visible at the global scale of climate science as captured by reports of the IPCC. In 2018, an analysis by the Heritage Futures Programme of University College London identified 193 mentions of heritage and related concepts in the IPCC Fifth Assessment Report (AR5) (table 1). Without comparative data from other fields, this total has limited utility on its own, but does provide an important starting point for assessing: what can and should the incorporation and representation of cultural heritage in reports of the IPCC look like? What topics have been addressed and where are gaps? What is the nature of these gaps; for instance, are they due to lack of analysis and literature or other factors such as bias in report authorship, or a combination of these? How can these gaps best be filled?

As part of assessment and response to these questions, and in light of the urgency of human action detailed by The Special Report on Global Warming of 1.5°C, the following steps are proposed to build bridges between cultural heritage practice and climate science:

- ***Heritage support of IPCC reports.*** In this step, heritage experts are organized and encouraged to serve as peer reviewers for IPCC reports to ensure that a range of heritage fields support existing IPCC authors with relevant concepts, analyses and references. As future IPCC reports are scoped and prepared, heritage experts need to organize at a global scale to submit author nominations.
- ***Heritage-Climate Science Education and Outreach***. In this step, dialogue is fostered between the many areas of cultural heritage and climate science to identify common questions and build research and publications to connect or fill gaps in relevant literatures. Topics may include (see also High Ambition: Heritage Research and Climate Science) but are not limited to:
    - Documentation of climate Impacts on heritage and consequences for associated communities
    - Specific application of heritage experience and research findings to climate change challenges such as water management, fire management, drought response, Disaster Risk Reduction, conflict, and individual and community migration.
    - Connections of energy efficiency, embodied carbon, community cohesion and economic development in historic buildings and local and traditional land use practices
    - Heritage as a basis for sharing experiences of change, understanding roots of existing vulnerabilities, and source of inspiration for shaping meaningful responses to change.
- ***Direct heritage engagement with the IPCC.*** This step follows the 2016 adoption of a decision of the World Heritage Committee at its 40th annual meeting in Istanbul that requests the States Parties, the World Heritage Centre and the Advisory Bodies to work with IPCC with the objective of including a specific chapter on natural and cultural World Heritage in future IPCC assessment reports. Response to this request includes tasks such as coordination between supporting parties; an IPCC expert meeting to summarize key issues for and from heritage practice with respect to climate change and the state of relevant literature; organization of a request for an IPCC special report or chapter on heritage; and diverse additional activities that will support preparation of an IPCC special report or chapter on heritage and climate change.

Taken together, these steps will bring the current combined understandings we have of and from human experience through time, and the questions and methods used to explore that human experience inherent in heritage more fully into climate science, thereby improving the support IPCC reports provide to modern climate policy and response.

Table 1: Instances where cultural heritage is mentioned in the IPCC AR5

Themes Used for Analysis	*Heritage Mentions*
Limitations, barriers and cultural differences	36
Benefits of natural/cultural heritage	29
Risks	27
Practices and knowledge	38
Adaptation, assessments and responses	34
Prehistoric or past society references	7
Gaps in our understanding	22
TOTAL	**193**

Source: Morel, Hana (2018). Exploring Heritage in IPCC Documents. White paper. Heritage Futures Programme, Institute of Archaeology, University College London.

The Role of Good Conservation Practice

Climate Change will have unprecedented impact on what is now considered to be good Conservation practice. Modifications will be required, both to better position heritage as an asset in Climate Action and to address the anticipated Impacts of climate change – large scale human displacement and migration, loss of existing communities, flooding, desertification, wind damage and major changes to cityscapes, landscapes and all types of heritage buildings, sites and Places.

Many conservation management and assessment standards, such as the constructs of authenticity and integrity, will need to be rethought. As circumstances change and the world goes through rapid and far-reaching transitions in the environment, land area, land use, ecology, energy, economic, and political and social systems, alternative ways and means of sustaining the significance of heritage places will continue to evolve.

Climate change will take us beyond the delicate balance between Conservation and development, to fundamental questions of human rights and the role of culture in facilitating difficult social Transitions. Heritage practitioners, scholars, educators and civil society have a central role and urgent responsibility to support communities in safeguarding and advocating for the important roles of cultural heritage in climate action. The multiple and interconnecting layers of climate change Impacts must become a baseline competency of heritage management, as are sustainable development principles.

Identification and documentation

Identifying and documenting the full range of Places with heritage values has been at the core of heritage practice for decades, acknowledging that contested identities and diverse values form an integral part of that process. These practices will need to expand and modify to focus on values that support climate action and to improve support for traditional and associated communities as they prepare for losses and damage, making use of culturally appropriate documentation tools and searching traditional practices for wisdom and information about enhancing Resilience.

Conservation and protection

The consistent application of good basic conservation practices – especially routine maintenance, the continuous protective care of a place and its setting – is itself often an adaptation and/or mitigation strategy. Preparing and implementing preventive maintenance plans which have built into them an emphasis on adaptation and mitigation will provide owners and managers with the conservation actions, management decisions and required timing, of critical maintenance work.

Regular maintenance of heritage places can also ensure optimization of energy efficiency without negatively impacting heritage values, authenticity and integrity. Indeed, in most cases maintenance constitutes the simplest, most cost-effective and readily achievable energy conservation step. Well maintained buildings and landscapes are more resilient to frequent and intense rain events. Regular cleaning and maintenance of water and drainage systems and mechanical systems; regular painting of timber doors and frames; use of traditional construction methods and materials; maintenance of vegetation cover of urban areas and private lots; and afforestation all can contribute to adaptability to climate change.

Management and adaptation

Conservation management requires a clear understanding of the significance of a place to develop the right policies to conserve it. Proactive management in accordance with those policies will increasingly include adaptation to climate Impacts or modifications for carbon mitigation. These will become drivers of heritage conservation management policies.

Simple monitoring of change to provide data that can be used to achieve accountability in governance is a good starting point. Using and understanding the embodied energy and the carbon sink of existing heritage infrastructure; and adapting it rather than constructing new infrastructure is of fundamental importance, assisted by using tools like Life Cycle Assessment.

Presentation: telling climate stories

Every place has a climate change story and using heritage places to broadly communicate these stories to their communities – and indeed globally – is both an opportunity and a responsibility for promoting awareness. Best practice heritage conservation not only interprets and presents the many stories of heritage places, but also expands public understanding and engagement in issues.

The monitoring of sites and data gathering to establish the rate and extent of climate change Impacts on heritage places as they occur is vital for the analysis of Impacts and mitigation efforts. There will be cases where stabilizing, documentation, monitoring and acceptance of controlled decay of a heritage place may be the only valid conservation process: it will eventually be lost. The processes of farewell, valediction and documentation will increasingly be part of heritage practice, with digital recording techniques and virtual reality used to record and interpret heritage stories and convey them to future generations as places are progressively lost.

Advice and guidance

Globally, ICOMOS has developed a range of charters and good conservation practice guidance documents about heritage site management. Standard methodological approaches are useful reference points and can be regionally and locally adapted by associated communities, such as The Burra Charter: *The Australia ICOMOS Charter for Places of Cultural Significance* (ICOMOS 2013) and practice notes and the *Approaches for the Conservation of Twentieth Century Cultural Heritage* (ICOMOS ISC20C 2017). The European Committee for Standardisation (CEN) Technical Committee for Cultural Heritage (CEN/TC 346) established in 2003 has produced, and is continuing to produce, standards concerning specific items but also methodological approaches concerning conservation, refurbishment, energy efficiency and many other issues.

Moveable Heritage (including Museums & Collections)

In the field of museums and collections standard operating processes and best practices are being rapidly updated to face the challenges of climate change. Depending on the IPCC Emission Scenario, issues such as current object conservation standards based on target temperature and relative humidity level in climate-controlled buildings will change. Such impacts will be differentially felt in museums and collections which are not climate controlled.

Archaeological resources

All heritage places are vulnerable to sea level change and violent weather events, but perhaps archaeological sites are the most vulnerable of all. Archaeological sites which are exposed in areas which are particularly subject to severe winds/sun and sea spray/wave action will require documentation and active support up to salvage excavation as necessary.

Before excavation, most archaeological sites were in a naturally protected environment where they could survive for millennia. After excavation they are exposed to weather, or to minimal protection, e.g. a roof to protect against rain, but with impacts such as overheating their environmental conditions have been dramatically changed and thus their expectation of life has been dramatically shortened. The changing patterns of rain, storms and temperature will further impact exposed archaeological remains, and their stabilisation, protection and use by their associated communities and for research and cultural tourism faces many challenges.

Climate change is already having an impact on maritime heritage both beside and within inland and inshore waters, shallow seas and deep oceans. The *ICOMOS Charter on the Protection and Management of Underwater Cultural Heritage* (ICOMOS 1996) provides principles and guidance. Management orientated projects which monitor seabed change that negatively impact underwater cultural heritage have developed and utilized techniques of preservation (conservation) in situ, and the sharing of such experience internationally are welcome and needed.

Buildings and structures

Good heritage conservation practice always begins with a clear understanding of the cultural significance of the place, the needs of its stakeholders and includes the development of policies to both assess risks and manage change. This understanding goes beyond a physical condition and fabric analysis to understand the history of development of the site, to assess its associations, integrity and authenticity.

These assessments form the basis of Conservation Management Plans which are the standard methodological approach for systematically managing change to heritage places. Recording the conservation process and works are part of the archives for future reference.

Increasingly, those who care for built heritage will be required to understanding the carbon footprint of the resources they manage. Life Cycle Assessment tools should be promoted. The mitigation benefit of maximising the use of existing fabric and minimizing introduction of new and sometimes incompatible materials whose production requires additional carbon emissions will be key. Active engagement by heritage professionals in ensuring that GHG mitigation become a factor in heritage and heritage become a factor in GHG mitigation is critical, especially regarding building codes, Sustainability rating schemes and construction processes is an urgent task.

Cultural Landscapes

Cultural landscapes demonstrate an evolving land use that may be living or past, and perform a variety of functions: for example, some are managed to guarantee and sustain biological diversity, some embody the spiritual relationship of people with nature, some are religious sites or sites of prehistoric and historic landscape modification. Such values have over time promoted resilience, biodiversity, social identity, cohesion and community resilience, and these values can all be exercised to support local climate adaption and greenhouse gas mitigation.

The spirit, integrity and traditional uses of cultural landscapes are subject to subtle incremental alterations caused by local Impacts of climate change – from the distribution and intensity of rain, to the broader climate change Impacts, such as the pressure of tourism and urbanization.

As most cultural landscapes constitute critical resources for developing and sustaining local economics and communities, these communities may need support to develop and implement good conservation management and sustainability practices that are adapted to climate change, new landscape functions complementary with adaptation and mitigation may be necessary. For example, landscape managers should understand the carbon sequestration potential of the places they work with.

In historic urban landscapes, the practice of good conservation concerns in particular the administration of planning and development controls. The principles of Historic Urban Landscape (HUL) practice correlate well to the needs of climate action including Adaptation Planning should be adopted as part of urban policies.

Associated communities and traditional custodians

The role of associated communities and traditional custodians in best practice conservation management planning is fundamental, to ensure social inclusion and social cohesion and a full understanding of the values of the place. A key reference resource is the *Operational Directives for the Implementation of the Convention for the Safeguarding of the Intangible Cultural Heritage* (UNESCO 2018), which includes in a section on Environmental Sustainability and a subsection on 'Community-based resilience to natural disasters and climate change'.

Meaningful public participation is needed to ensure the legitimacy of climate change adaptation planning and implementation. Associated communities, and custodians who know in depth the historical roots and cultural tradition that sustain this heritage must be engaged. Similarly, administrators and town planners have the obligation to do good and comprehensive Conservation action plans, supporting the community and the surrounding historic urban landscape.

Intangible Heritage

Best conservation practice recognises the deep relationship between tangible and intangible cultural heritage; and that for intangible heritage places, the traditional custodians and associated communities of users must be involved in conservation action on multiple levels. Other stakeholders may be institutionally responsible for conserving intangible cultural heritage - curators, museums etc, who support recording, safeguarding, and fostering the performing arts, oral traditions, dances, stories, folklores, rituals, festive events, language and histories.

Intangible skills and techniques that support climate change action need to be highlighted while some traditions contrary to climate action (like burning peat) may need to be modified.

As governments accept their obligations to address the impact of climate change on heritage places, to identify where damage may be likely, to assist in building community resilience, implementation action will rest with multiple stakeholders. NGOs like ICOMOS, and civil society more generally, will have responsibilities to make powerful contributions through providing guidance, framing and implementing effective policies and action for best practice heritage management as climate change advances.

Equity and Climate Justice

Principles of Equity and Climate Justice are fundamental to understanding and addressing the challenges of climate change. Ethical and political considerations must guide Climate Action alongside environmental and natural science drivers. The centrality of these considerations is evidenced by the frequency with which they arise in the discussions under the United Nations Framework Convention on Climate Change (UNFCCC) and in other climate bodies. A growing amount of research also supports this conclusion. The 2017 *UNESCO Declaration of Ethical Principles in relation to Climate Change* provides that justice in relation to climate change requires fair treatment and meaningful involvement of all people. It calls for relevant actors at all levels to work together in a spirit of justice, global partnership, inclusion, and in particular in solidarity with the poorest and most vulnerable people.

While anthropogenic climate change has largely been caused by the cumulative greenhouse gas (GHG) emissions of Industrialized Countries over centuries, its impacts are affecting all the peoples of the world. Research shows that the poorest and most vulnerable groups will disproportionately experience the negative Impacts of climate change in this century. Often these frontline communities are among those who have contributed the least emissions, including marginalized urban communities, rural inhabitants and migrants.

Indigenous people are among the most vulnerable to the adverse effects of climate change because, among other reasons, their existence is often inextricably tied to the land. As a result, indigenous advocates have been among the first to make the point that climate change threatens not only landscapes but also cultural identity.

Inter-generation equity requires that all people take measures to safeguard and protect Earth's terrestrial and marine ecosystems, for present and future generations. The interaction of people and Ecosystems is particularly important given the high dependence of one upon the other. Fairness requires attention to principles of Distributive Justice and the notion that the benefits and burdens associated with climate change and its resolution be allocated fairly. This implies the acceptance of responsibilities for the reduction of Greenhouse Gas emissions. In addition, those who have benefited and still benefit from emissions in the form of continuous economic development and greater wealth, mainly in industrialized countries, noting agricultural emissions, and traditional operations as well (Cassar 2016), have an ethical obligation to share the benefits with those who now suffer the effects of these emissions, mainly people vulnerable in developing countries. At the same time, all countries should continue enhancing their mitigation efforts, including a focus on agricultural emissions and emissions from other activities like brick making.

Not only have indigenous or aboriginal people been poorly represented in climate action, but there are also other marginalized populations that should be better integrated into Adaptation and mitigation planning (Appler and Rumbach 2016). The UNFCCC's Local Communities and Indigenous Peoples Platform is one response to this gap.

Solidarity is needed from heritage professionals with those communities most Impacted by, or least able to bear the cost of, climate change, including communities in Least Development Countries and Small Island Developing States (SIDS), in order to enable them to safeguard their heritage. This solidarity must be a two-way process with all participants learning from each other's experiences. South-South and Triangular Cooperation should be supported.

Relevant actors should facilitate and encourage public awareness, and participatory governance and procedural equity in decision-making and actions touching upon climate action, including in heritage processes. This should occur by making information and knowledge on climate change, including how to pursue mitigation Pathways and adaptation Pathways, widely available. This should be done in a timely manner, taking into account the differentiated needs and access to resources of the most vulnerable. In this context, measures should take into account the contribution of women in decision-making, since women are disproportionately affected by climate change, tend to have lower access to resources and yet play a vital role in achieving inclusive sustainable development.

Populations in frontline and marginalized communities and in the global south must have access to opportunities to adapt to the impacts of climate change and to address loss and damage. Knowledge related to the causes, modalities and Impacts of climate change and responses to it should be shared equitably and in a timely manner in order to increase the adaptive capacity and improve the mitigation behaviours of all, and to increase the resilience of people and ecosystems. At the same time, every such community has a unique culture and heritage that represents Endogenous Ways of Knowing including Endogenous Capacities that can be leveraged for climate action. Valuing and promoting these capacities and supporting their ongoing, practical use should be encouraged. The development of Policies and plans related to climate change should be culturally appropriate and participatory, transparent and accountable to all voices.

Climate Justice links Human Rights and development to achieve a human-centred approach to climate action, safeguarding the rights of the most vulnerable; taking into account the needs of those at greatest Risk, particularly the poorest and the most vulnerable; and sharing the burdens and benefits of climate change and their resolution in an equitable and just manner. The growing field of Rights Based Approaches (RBAs) to heritage offers a useful set of tools for assuring that the cultural heritage considerations are incorporated into climate action in a manner consistent with these principles.

As noted in the Recommendations from the Scientific Council Symposium Cultural Heritage and Global Climate Change (GCC) held by the ICOMOS Scientific Council in Pretoria, South Africa on 7 October 2007, climate change requires difficult choices. The sheer scale of loss and damage threatened by climate change must be considered in the context of Climate Justice and Equity. For example, priorities must be established to determine which sites can be saved or protected and those in which documentation or archaeological salvage and research can be carried out. There is a danger that climate action may be undertaken in ways that perpetuate existing Inequalities, including in the context of heritage. There is also danger that climate impacts and response may be overly 'expert/scientific-driven' choices, imposed upon communities. There is a need to provide the resources and programs so that communities can take part equitably in discussions about these choices. Anchor points for cultural memory should be evaluated; there is a need to recognize that even after severe Impact or loss of place, 'memory' needs to be considered.

Heritage Tools and Methodologies

The intersection of Climate Change and heritage is complex and the scale and nature of impacts are uncertain. Although existing heritage methodologies may provide an effective response, in many cases it is likely that slight adaptations or entirely new multi and interdisciplinary approaches will be required (see table 2).

As climate change is a cross-cutting issue, adopted methodologies should, where possible, be able to be translated beyond the heritage sector allowing the swift and effective communication of information between individuals, countries and disciplines. For example, global approaches to assessing Disaster Risk Reduction (DRR) exist and are being applied to heritage resources (see Part I, Division 2: Adaptation). Exploring the use of open-access databanks, and links between existing tools should also be encouraged with a focus on increasing collaborations that cross disciplinary boundaries. Landscape-based management approaches may be particularly relevant for promoting Climate Action.

One of the complexities of climate change from a management perspective is that it involves multi-scale planning, from the global to the local. Tools and methodologies therefore need to be scale appropriate e.g. downscaling Climate Projections to the site level.

Monitoring is a key requirement for understanding both the impacts of climate change and the effectiveness of adaptation activities. Creating a data bank of Monitoring outputs and developing a suite of tools based on appropriate and sustainable monitors and indicators will require a coordinated and systematic approach. Data gathering across sites should be harmonised as much as possible so that analyses can be made and the rate of climate change can be demonstrated. In many but not all cases, this could be accomplished through either an addition to, or minor tweak of, current documentation systems and would enable the sharing of good practice and understanding of common hazards and impacts. Between natural and cultural heritage there is a wealth of data and experience in this arena.

Historic records, community stewardship, Palaeoenvironmental and archaeological Evidence also provide a wellspring of Evidence both of climate Impacts and coping mechanisms; and acquiring knowledge from the past is a well-honed skill within the sector. Possible fresh approaches should be constantly explored, embracing multi-disciplinary approaches and new technologies. Long-established archaeological techniques, encompassing excavation and post excavation methods used to create a record of physical remains before they are removed, are likely to become increasingly important alongside geospatial mapping and modelling. In addition, art-based methodologies may provide creative, holistic interpretations that can engage wider audiences.

In the face of uncertainty over climate change impacts, maintenance should always be the first line of defence for heritage managers, i.e. selecting actions that enhance resilience to a range of possible climatic outcomes that may have additional benefits. Existing tools and methods that enable adaptation and minimise loss of cultural significance need to be shared and promoted and new ones designed and tested. Despite uncertainty, difficult decisions will have to be made as climate change impacts outweigh our ability to protect some sites. There is an urgent need to survey and carry out assessment of cultural significance and environmental risks, to determine the scale of recording, salvage or conservation that might be needed. This process should fully involve, and ideally be driven by, the relevant communities in concert with experts in the relevant fields. As not everything can or needs to be saved, it is vital that the creation of priorities is informed and transparent.

Suitable approaches, both ethical and practical, are also needed to enable the heritage sector to play its part in mitigating climate change (i.e. reducing Greenhouse Gas emissions) without incurring an unacceptable loss of cultural significance. This requires processes to define what is unacceptable, both to stakeholders and within policy. New models should be developed to evaluate conservation and adaptation measures from the perspective of Circular

Economy processes, such as Life Cycle Assessments, which centre on materials, energy and waste minimization.

Management Plans may be the vehicle through which much of this work can be documented and achieved.

Table 2: Suggested requirements for a 'methodological toolkit.'

Methodology	Description
Heritage Inventory	Preparing an inventory of cultural heritage provides a basis for other methodological advances. Consequently, inventory preparation is in itself a climate strategy, especially when it takes account of heritage values as climate action assets and is sensitive to climate vulnerability and adaptive capacity. The level of detail will vary with the scale, nature and complexity of the heritage resource. For example, it could include participatory cultural mapping – identifying, documenting and recording tangible and intangible cultural heritage, place-based narratives of change, and local knowledge specific to lace and the communities who live there.
Heritage Values Assessment	Taking a values-based approach and incorporating tangible and intangible heritage throughout, including but not limited to statements of Cultural Significance (or Outstanding Universal Value if a World Heritage Site). Understanding current values is a prerequisite to assessing risk from Climate Change.
Impact Assessments (HIA)	Adopting/adapting existing methodologies for assessing the Impacts of Climate Change on cultural heritage and the effects of those impacts on associated communities. A revision of the Heritage Impact Assessment (HIA) process as proposed by ICOMOS in 2011 will support the evaluation of impacts focusing on heritage and Climate Change in the circular economy perspective.
Vulnerability Matrix	A matrix of possible climate change Impacts based on the best available climate science and established Cultural Significance/heritage value.
Vulnerability Indicators	A selection of indicators, quantifiable proxies measuring aspects of vulnerability to climate change, providing reference points at multiple scales to guide policy and planning.
Heritage Documentation and Monitoring	Gathering and sharing standardized data, both nationally and internationally, presents challenges but is highly desirable. Utilizing as appropriate the full range of traditional techniques and new technical solutions to enable multi-scale analysis of the progress of climate change.
Conservation Management Planning	Should include managing, adapting and mitigating climate change for sites through integrated Policies. Requiring short, medium and long-term perspectives and actions.
Risk Assessment (macro)	Considering likelihood vs severity of a potential hazard makes it possible to undertake Risk Assessment reasonably rapidly on a national and/or regional scale. This process can often utilize data from other sectors e.g. flood management, biodiversity etc. The information this provides can be utilized in setting priorities and developing Disaster Risk Management plans.
Vulnerability Assessment (micro)	Considering sensitivity, exposure and Adaptive Capacity of tangible and intangible heritage. Requiring a holistic local scale assessment of Impacts and Resilience that is best undertaken at site level. Tangible heritage tends to be static, however when analysed as part of a human system, Adaptive Capacity (largely residing in the human element) can be assessed.
Climate Vulnerability Index (CVI)	The CVI is a rapid assessment tool that focuses on climate Impacts to the Cultural Significance of a site (and can be done for a site or for a 'thematic group' of sites). It is currently being developed by a network of partners including ICOMOS.
Adaptation Planning	Based on an informed assessment of Vulnerability, Adaptation planning can be approached at site level in order to design adaptation Pathways that best protect the identified Cultural Significance. Inputs to regional/national level adaptation strategies in response to macro assessment of Risk will be important and should follow an established multi-sectoral, interdisciplinary methodology for planning which ensures that heritage is considered within the strategies of cross-cutting sectors e.g. agriculture, tourism etc.

Table 1 (continued): Suggested requirements for a 'methodological toolkit.'

Methodology	Description
Heritage Inventory	Preparing an inventory of cultural heritage provides a basis for other methodological advances. Consequently, inventory preparation is in itself a climate strategy, especially when it takes account of heritage values as climate action assets and is sensitive to climate vulnerability and adaptive capacity. The level of detail will vary with the scale, nature and complexity of the heritage resource. For example, it could include participatory cultural mapping – identifying, documenting and recording tangible and intangible cultural heritage, place-based narratives of change, and local knowledge specific to lace and the communities who live there.
Heritage Values Assessment	Taking a values-based approach and incorporating tangible and intangible heritage throughout, including but not limited to statements of Cultural Significance (or Outstanding Universal Value if a World Heritage Site). Understanding current values is a prerequisite to assessing risk from Climate Change.
Impact Assessments (HIA)	Adopting/adapting existing methodologies for assessing the Impacts of Climate Change on cultural heritage and the effects of those impacts on associated communities. A revision of the Heritage Impact Assessment (HIA) process as proposed by ICOMOS in 2011 will support the evaluation of impacts focusing on heritage and Climate Change in the circular economy perspective.
Vulnerability Matrix	A matrix of possible climate change Impacts based on the best available climate science and established Cultural Significance/heritage value.
Vulnerability Indicators	A selection of indicators, quantifiable proxies measuring aspects of vulnerability to climate change, providing reference points at multiple scales to guide policy and planning.
Heritage Documentation and Monitoring	Gathering and sharing standardized data, both nationally and internationally, presents challenges but is highly desirable. Utilizing as appropriate the full range of traditional techniques and new technical solutions to enable multi-scale analysis of the progress of climate change.

Sustainable drainage systems - SUDS - are flood defence measures that mimic natural processes. They are critical for protecting cultural heritage and communities in flood-prone areas.

(Photo credit: Associated Press, 2018 Press Association via AP Images)

Part I

Correlating Heritage to the Paris Agreement

Part I of this Outline provides a framework for systematically acknowledging the importance of the cultural heritage dimensions of responding to Climate Change. Responding to climate change is about adjusting to Risks, either in reaction to or in anticipation of a changing climate. Key elements of this response are referred to here as 'Climate Action'. But what specifically is the remit of cultural heritage practice in climate action?

Elsewhere in this Outline, some of the theoretical foundations for treating heritage as an asset in climate action are sketched, noting also how contemporary responses to climate change sometimes fail to address culture. This Part I outlines a positive, Policy-based vision of the role of cultural heritage in responding to climate change. Key categories or 'sectors' of climate action form the basic structure of this analysis. Those sectors of climate action are then correlated to the core competencies and considerations of cultural heritage. The intention is to discuss heritage using the logic and vocabulary of climate action and climate science.

Categorizing Climate Action

There are numerous ways to categorize the key elements of climate action. Mitigating Greenhouse Gases is a key – if not the – key priority. Climate change is largely a result of Anthropogenic Emissions. Mitigating these emissions has the potential to reduce the magnitude of future climate change. However, because the planet is already committed to a certain level of climate change, it is also important to address the negative consequences of climate change.
As a result, climate action priorities also include strengthening Resilience and Adaptive Capacity to climate-induced Impacts and preparing for Losses and Damages. Improving education, awareness-raising and building human capacity and Institutional Capacity with respect to climate change are important climate action tactics.

This outline categorizes climate action into four sectors: (1) High Ambition; (2) Greenhouse gas (GHG) Mitigation; (3) Adaptation; and (4) Loss and Damage. The Paris Agreement provided the starting point for the construction of these four sectoral categories. The Paris Agreement represents a global consensus on how to combat climate change and to accelerate and intensify climate action. It charts the course for global climate effort.

In order to arrive at these four sections, the contents of the Paris Agreement were synthesized and condensed. Greater attention was paid to those elements of the Paris Agreement deemed to correlate more strongly to cultural heritage. In other words, elements of climate action were weighted based on the perceived aptitude of cultural heritage actors to engage on them. For example, the topic of loss and damage is treated here as one of four sections of climate action although it does not enjoy such prominence in the Paris Agreement. The topic is given this elevated emphasis because of the strong correlation between its various dimensions and the concerns of cultural heritage.

The approach to climate action used here, also takes account of developments since the adoption of the Paris Agreement in 2015, many of which were themselves contemplated in the Paris Agreement. These include the publication in 2018 of The Special Report on Global Warming of 1.5°C by the IPCC and the rolling workplan of the Executive Committee of the Warsaw International Mechanism for Loss and Damage.

Each of the four sections of this Part I is preceded by a brief summary of the scope of that Section. The following table provides a concordance between those four sections and the Paris Agreement itself:

Establishing the Core Competencies of Cultural Heritage Practice

There are as many, if not more, ways to map the competencies and considerations of cultural heritage practice as there are ways to categorize climate action. Cultural heritage, in the expanded way it is used in this Outline, has various instrumental uses, as touristic marvel, creative industry, and commercial enterprise. Yet heritage discourse has often stressed its 'inherent' or 'intrinsic value', not linked to use or function. This is heritage as identity; embodiment of accumulated knowledge; the bonds of community to space, forging attachment to Place (Hosagrahar et al 2016, ICOMOS Concept Note, HABITAT III). Closely connected to this view is the idea of Inter-generational Equity and the interest of future generations in receiving the cultural inheritance left to them by previous generations.

This Outline draws on the analysis of the competencies and considerations of cultural heritage practice, especially those developed in the fields of sustainability and resilience. As discussed elsewhere, heritage is given explicit recognition in the Sustainable Development Goals, the New Urban Agenda and the Sendai Framework for Disaster Risk Reduction. Much promising work on the cultural heritage aspects of these documents by UNESCO, ICOMOS, and numerous other institutions and actors helps fill knowledge gaps surrounding the correlation of heritage practice and climate action.

The 2011 ICOMOS General Assembly Scientific Symposium entitled Heritage, driver of development represented a comprehensive effort to address the role of cultural heritage in human development. It resulted in the Declaration of Paris on Heritage as a Driver of Development that begins with the premise that heritage, with its value for identity and as a repository of historical, cultural and social memory, preserved through its authenticity, integrity and 'sense of place', forms a crucial aspect of the development process.

Table 3: The four sections of the Paris Agreement, and the Outline Report.

Outline of Climate Change and Cultural Heritage *Sectoral Outline Division*	*Paris Agreement Concordance*
High Ambition	Finance, technology and capacity-building support (Paris Agreement Articles 9, 10 and 11): International cooperation on climate-safe technology development and transfer, and building capacity in the developing world are strengthened; a technology framework is established and capacity-building activities will be strengthened. Climate Change education, training, public awareness, public participation and public access to information (Article 12) is to be enhanced.
Mitigation	Long-term temperature goal (Article 2): Reaffirms the goal of limiting global temperature increase to well below 2 degrees Celsius, while pursuing efforts to limit the increase to 1.5 degrees Celsius. Global peaking and Climate Neutrality (Article 4): Parties aim to reach global peaking of Greenhouse Gases (GHGs) as soon as possible, so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of GHGs in the second half of the century. Developed countries to undertake absolute economy-wide reduction targets, while developing countries should continue enhancing their mitigation efforts Sinks and reservoirs (Article 5): Encourages Parties to conserve and enhance, as appropriate, sinks and reservoirs of GHGs, including forests.
Adaptation	Adaptation (Article 7): Establishes a global goal on adaptation of enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change in the context of the temperature goal of the Agreement. It aims to significantly strengthen national adaptation efforts, including through support and international cooperation.
Loss and Damage	Loss and damage (Article 8): Recognizes the importance of averting, minimizing and addressing loss and damage associated with the adverse effects of climate change, including extreme weather events and slow onset events, and the role of sustainable development in reducing the risk of loss and damage. Parties are to enhance understanding, action and support with respect to loss and damage.

The symposium concluded that key roles of heritage in sustainable development include driving social cohesion, wellbeing, creativity, economic appeal, and understanding between communities.

Other heritage doctrines and texts have also been used to establish the relevant competencies of cultural heritage including those drawn from Historic Urban Landscape and (bio-) Cultural Landscape practice as well as Human Rights-based approaches (RBAs) and the principles of material science and the theory and practice of Conservation.

Correlating Heritage Competencies to Climate Action Priorities

At a basic level, the methodology of this Sectoral Outline consisted of moving section-by-section through the content of the Paris Agreement and correlating that content to the competencies of cultural heritage. As to the bases for those correlations (i.e. the cultural dimensions of climate action), the

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Correlating Heritage Competencies to Climate Action Priorities

At a basic level, the methodology of this Sectoral Outline consisted of moving section-by-section through the content of the Paris Agreement and correlating that content to the competencies of cultural heritage. As to the bases for those correlations (i.e. the cultural dimensions of climate action), the Paris Agreement itself provides a handful of clues, as when it calls out the role of landscapes, ecosystems and sustainable land use. The treatment of indigenous peoples provides an important entry point for culture won through the efforts of local communities and indigenous persons. Perhaps that the most explicit attention to heritage in the Paris Agreement comes in the section on adaptation which notes that adaptive action …

> *should be based on and guided by the best available science and, as appropriate, traditional knowledge, knowledge of indigenous peoples and local knowledge systems, with a view to integrating adaptation into relevant socioeconomic and environmental policies and actions, where appropriate.*

Culture is indeed central to understanding and implementing adaptation: the identification of Risks, decisions about responses, and means of implementation are all mediated by culture. Culture is important for understanding mitigation as well.

Culture is embedded in the dominant modes of production, consumption, lifestyles and social organization that either give rise to emissions of Greenhouse Gases (GHGs) or provide a blueprint for traditional, low-carbon technologies and lifestyles. Cultural interpretations of science and Risk frame the ways humans understand the causes and meaning of climate change and their response to calls for climate action (Adger et al 2013).

Each sector of climate Action was outlined by dividing the section into subsections using the following levels:

- 1. Key Concept/idea/theme
- 1.1. Significant issues/sub-topic
- 1.1.1. Relevant issues but of narrower significance/relevance

The broad categories of cultural heritage actions, investigations and connections relevant to advancing that subset of climate action are then summarized. Situations in which ignoring the cultural dimensions of a given climate action might cause the action to fail or lead to Maladaptive Actions were prioritized for treatment in the Outline.

It is possible with culture-based approaches to climate action to combine climate change mitigation and adaptation with heritage Conservation and the safeguarding of cultural values. Many such approaches reflect 'no-regret' or 'win-win' options. Heritage co-benefits are often present in climate action, as when the reuse of existing buildings is valorised. At the same time, not all cultural practices readily harmonize with Climate Action. Cultural patterns and practices give rise to Greenhouse Gas (GHG) emissions; some groups of people may have enhanced Adaptive Capacity as a result of factors like Inequality but also perhaps because of culture. This Sectoral Outline attempts to comprehensively address the intersection of climate change and cultural heritage, emphasizes win-win approaches that advance climate action and heritage safeguarding while also acknowledging areas of real or perceived conflict between the two.

Traditional building and construction materials will have to change as materials are either no longer available or not adapted to changing climate conditions.

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Cultural landscapes, particularly historic gardens, are vulnerable to changes in climate and the resulting loss of plants, many hundreds of years old.

Levens Hall in England's Lake District.
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Division 1

High Ambition

How do the core competencies and considerations of cultural heritage, including Endogenous Ways of Knowing, enhance ambition to Mitigate Greenhouse Gas (GHG) emissions and achieve global Climate Action targets? What are the cultural heritage dimensions of climate communication, research and education? Heightening the ambition of communities to act on climate, includes utilising the power of heritage to promote a sense of urgency by telling climate stories, involving and listening to communities and building relationships. It is about promoting interdisciplinary heritage research as an important part of climate science, and building knowledge exchange through communication, skills development and education. It is promoting a fundamental shift in Policy and professional practice to acknowledge the immense power of cultural heritage in raising awareness, developing Adaptation and Mitigation strategies and building Social Inclusion and cohesion in support of climate action. Cultural heritage competencies correlate to heightening climate ambitions in the following ways:

1.1 Heritage Places and climate action communication

Every place has a climate story. Some are positive, others not, but they are a powerful way to communicate urgency, build social cohesion and Resilience and communicate the significance of Climate Change Impacts on heritage places. Heritage actions include:

1.1.1 Using iconic heritage to promote a sense of urgency about climate change and climate action, relatable to other heritage sites, places and communities.

1.1.2 Using global and national stock-takes of the current state of World Heritage Sites to assess current status and future vulnerability.

1.1.3 Promoting the power of Place, past and narrative to enhance understanding of climate-society complexities and potentials; documenting and interpreting the heritage of the Anthropocene and the impacts of the Industrial Revolution.

1.1.4 Using heritage sites as exemplars of climate mitigation and adaptation.

1.1.5 Encouraging participatory, community-based prioritization, documentation and recording of Endogenous Ways of Knowing: Cultural Significance, Narratives of change, with related (tangible and intangible) cultural elements.

1.1.6 Establishing and maintaining connections between heritage Place managers and researchers in Climate science, adaptation, mitigation and communications fields.

1.1.7 With heritage as a base, building and maintaining means of listening to communities and providing open opportunities to inspire voluntary participation in advocacy, and collective climate action.

1.2 Heritage, research and climate science

Using the diverse physical sciences and humanities fields of heritage research and the distributed observing networks afforded by heritage sites to support climate science and understanding of short-term and long-term environmental change at local, regional, and global scales; using science, endogenous knowledge and history of heritage sites to track past human interactions with, and effects on environments, and to assess climatic, environmental and social baselines from which contemporary climate and society are shifting; establishing and upholding Ethical and just use of information from and about the past.

1.2.1 Using Palaeoenvironmental climate data from heritage sites, museums and other curated collections to explore climate trends and shifting climatic baselines.

1.2.2 Collating and synthesizing existing Palaeoenvironmental and archaeological data (from heritage sites, museums and other curated collections) to assess past baselines and tipping points of ecological and social change.

1.2.3 Promoting better understanding of existing Endogenous capacities and knowledge as a central part of heritage management, climate research and science.

1.2.4 Using archaeological data and other information from heritage places, museums and other curated collections to identify and explore past human impacts on environments over short, medium and long periods and at local, regional and global scales.

1.2.5 Exploring application of past adaptation and mitigation techniques to climate and landscape change, including agriculture and animal husbandry, architecture and land-use patterns, subsistence strategies, and use of material culture.

1.2.6 Promoting and encouraging interdisciplinary and projects and data synthesis to improve links between heritage research fields and other areas of climate science.

1.2.7. Promoting and upholding a body of Ethics with respect to just, appropriate, and equitable use of information, from and about the past, and from and with regard to Indigenous Knowledge, noting the 2017 UNESCO Declaration of Ethical Principles in relation to Climate Change.

1.3 Climate change, heritage and education

Emphasising the importance of education and knowledge exchange across a wide range of stakeholders including heritage management, transdisciplinary research, climate science and Endogenous Ways of Knowing about climate change.

1.3.1 Using heritage places as focal points tracking the Impacts and implications of climate change and training diverse student bodies in these Impacts and implications.

1.3.2 Promoting ongoing skills development and training for heritage professionals and communities about climate change.

1.3.3 Encouraging knowledge exchange as an ongoing process incorporating Endogenous Ways of Knowing, Cultural significance and climate science.

1.3.4 Promoting open access tools and approaches to vulnerability assessment, mitigation techniques, monitoring and damage assessment, Conservation and adaptation efforts.

1.3.5 Embedding climate change and cultural heritage knowledge in schools and higher education.

1.3.6 Encouraging the intergenerational exchange of knowledge.

1.4 Integration of cultural heritage management with climate science in policy development

Creating synergies between heritage-based knowledge and Policy relating to climate change. Promoting integrated climate change and heritage-based policy decisions by understanding the contribution of heritage to society, and the Impacts of climate change on heritage places and values.

1.4.1 Developing and promoting clear principles of Cultural Significance and Conservation in relation to climate change, as a resource for legislators and organizations to assist their development of climate change related Policy.

1.4.2 Incorporating work on mitigation, adaptation, loss and damage, and partnerships with other social and physical sciences across national and global climate research into heritage Conservation practice and policy platforms.

1.4.3 Capturing and communicating contributions of heritage to measures such as quality of life, responsible tourism, Ecosystem Services, and Greenhouse Gas (GHG) emissions reductions, as a means to promote the value of the role of cultural heritage in climate action and influence Policy engagement and integration.

1.4.4 Supporting and expanding a body of Ethics, including the 2017 UNESCO Declaration of Ethical Principles in relation to Climate Change, to ensure consciousness of the ownership and appropriate engagement with Endogenous Ways of Knowing, including in the case of Indigenous Knowledge, prior, free and informed consent, as an essential resource for developing climate and heritage Policy.

Erosion gulley after heavy rain and wildfires in Valles Caldera National Preserve in New Mexico. Extreme erosion is threatening archaeological resources in the park, including evidence of obsidian workings.

©Adam Markham

Plants relied on by traditional craftsmen may be impacted by changes in the climate, or become vulnerable to new pests or invasive species. Manama, Bahrain.

Photo: ©Adam Markham

Division 2

Adaptation

Climate Change Adaptation in Human Systems aims to minimise the adverse consequences of actual or expected climate change and maximise the opportunities it presents. Both these aspects of adaptation are correlated to the core competencies and considerations of cultural heritage in this section of the Outline. adaptation actions can include Human Behavioural Change, Institutional change and technological adjustments.

Cultural heritage will be Impacted by climate change and therefore adaptation strategies are needed to manage the Risks. The selection and implementation of adaptation measures will require the integration of Cultural Significance assessments (both relative Significance and impacts to Significance from adaptation actions) together with Risk/Vulnerability Assessments, and feasibility studies. Adaptation activities are likely to require additional resourcing, however knowledge, understanding and the provision of sectoral leadership are possibly more crucial in the early stage of the process.

Cultural heritage also has immense potential to contribute to adaptation Pathways for Human Systems. The particular worth of cultural heritage is indicated within the Paris Agreement, which states that adaptation action should be based on and guided by the best available science and, as appropriate, traditional knowledge, knowledge of indigenous peoples and local knowledge systems (Article 7.5, 2015).

Knowledge and Understanding

1. Values-Based Approaches and People-Centred, Participatory Governance

Cultural heritage can support adaptation, especially when cultural Values are incorporated into adaptation Governance. Cultural Values can also guide adaptation Options and bolster the Enabling Conditions for adaptation Values-based Approaches to heritage should explore the notion of cultural and natural commons. It should be recognised that Cultural Significance reflected in different levels of designation does not necessarily provide an acceptable prioritisation for the management of heritage in the adaptation context. Also, different types of Cultural Significance (and different types of heritage) will need to be carefully considered. Links between organisations need to be developed. Ways that Values-Based Approaches can support adaptation planning and Governance include:

1.1. Using what people value about places as a guide to adaptation and Resiliency planning (see 1.3).

1.1.1. Leveraging heritage communities and methodologies for social/cultural/heritage Values and narrative mapping as an input into adaptation planning.

1.1.2. Using heritage Values assessment methods (e.g. World Heritage and ICOMOS) and capacity building with community, practitioners and Policy makers to support climate adaptation. Recognizing also that what people value may change with environmental vulnerability.

1.1.3. Actively considering and engaging with the full scale and spectrum of both Cultural Significance and communities.

1.1.4. Making holistic Cultural Significance analysis the basis of balanced decision making, where it is impossible to save everything.

1.1.5. Recognising and including under-represented heritage e.g. indigenous sites in colonised countries and areas. If sites of local and indigenous value are not given attention at this stage, the ability of heritage to promote the social cohesion that is needed for adaptation (as well a heritage sites) y may be lost.

1.2. Highlighting the role of heritage in social cohesion, Social integration and Equity; using cultural resources to conserve/re-establish sense of Place and inclusive community stewardship in support of Adaptation Pathways, especially through participatory, inclusive and fully transparent inventorying and cultural mapping processes that can mobilize communities, articulate sense of Place, and provide a knowledge base to inform public decision-making and Climate Governance.

1.2.1 Understanding Cultural Significance of sites to wider area, and social reaction to site being damaged.

1.2.2. Facilitating traditional resource management and other relevant cultural practices and values.

1.3. Examining the role of social psychology e.g. in relation to creating Acceptance of Policy or System Change and in building Adaptive Capacity. There is ample knowledge on how humans can deny Risk as a way to cope with anxiety. There is also a challenge associated with Indigenous knowledge related to Climate Variability, perceived to be part of a 'natural cycle', and how to communicate the changing and unprecedented challenges already at play or to come (the concepts of detection, attribution and/or time of emergence of a climate change signal or climate change Impacts).

1.4. Utilizing heritage methodologies to support people-centred approaches for adaptation Governance. Adaptation action should follow a country-driven, gender-responsive, participatory and fully transparent approach, taking into consideration vulnerable groups, communities and ecosystems, and should be based on and guided by the best available science and, as appropriate, Local Knowledge, knowledge of indigenous peoples and local knowledge systems, with a view to integrating adaptation into relevant socioeconomic and environmental policies and actions, where appropriate (Article 7 Paris Agreement 2015).

1.4.1. Improving and adapting existing methodologies, or developing new approaches, in order to ensure citizen participation. Recommendation of the Committee of Ministers to Member States on the European Cultural Heritage Strategy for the 21st century (CM/Rec(2017)1).

2. Using the Data-Collection Aspects of Heritage to Support Effective Adaptation

Before appropriate adaptation actions can be selected and applied, baseline information is required including: knowledge of projected climate change Hazards; understanding of the potential direct and indirect Impacts; understanding the type of heritage at Risk and its Cultural Significance, including movable, immovable and intangible; and assessment of vulnerability of this Cultural Significance to the predicted climate change Impacts. It is important that adaptation planning considers both slow onset (e.g. Sea level rise) and rapid onset (e.g. Extreme Weather Events) Impacts and the range in between (e.g. multi year Drought).

The exact nature of the baseline data required will vary with the prioritisation of Impacts and heritage types/Values. For example, island states may choose to focus on coastal and estuarine sites and cities. Education and training in climate heritage skills is necessary to ensure that this baseline can be achieved.

2.1. Data

Acquiring, managing and consolidating data relating to climate Risks and vulnerabilities. Climate change is a long-term and highly complex issue and there are challenges entailed that require strengthening of relevant systems. Ethical data use is essential e.g. for knowledge gathered from local communities. In many cases data collected by other sectors may be of use to cultural heritage.

2.1.1. Using climate science relevant to heritage: thresholds and combinations of environmental parameters implicated in specific effects.

2.1.2. Using existing data-sets that consider inter-sectoral possibilities such as tourism, agriculture, Disaster Risk Reduction etc.

2.1.3. Creating culturally specific data-sets e.g. a georeferenced database of the main territorial Migrations or narratives of traditional peoples and communities.

2.1.4. Creating predictive and preventive georeferenced methods that consider physical attributes and Risks to landscapes and traditional communities.

2.1.5. Creating and communicating indicators that can be used as proxies for climate change Impacts.

2.2. Selecting methodological approaches to assessing Risk and vulnerability that effectively inform adaptation. The appropriate methodology will depend on local factors and in some regions, and/or for certain types of heritage existing reporting mechanisms may be sufficient.

2.2.1. Using macro-scale Risk Assessments to gain a broad overview at a regional level often for a specific Risk such as Flooding.

2.2.2. Using micro-scale (place based) vulnerability assessment which tend to be holistic and site specific, to consider the Human Systems, including associated communities.

2.2.3. Using multi-scalar methodologies with imperfect datasets at varying scales to build up a more holistic picture than either macro or micro scale alone.

2.3. Analysing (as appropriate to the cultural context) the Sensitivity of Cultural Significance to the potential Impacts of climate change, on:

2.3.1. Physical characteristics e.g. materials composition, location, condition and communities.

2.3.2. Values e.g. socio-economic factors, community Resilience and Cultural significance.

2.3.3. Intangible factors associated with heritage places e.g. spirituality and traditional Livelihoods.

2.4. Analysing Exposure of heritage to the Hazards associated with climate change, including direct, indirect, physical and socio-economic, by:

2.4.1. Detailed mapping of current Hazards via regular monitoring.

2.4.2. Systems mapping to pick up interaction of multiple Hazards.

2.4.3. Mapping of future climate change Risk based on Projections.

2.5. Analysing Adaptive Capacity at a Human System level i.e. including the Adaptive Capacity of people (heritage professionals and local communities), as well as of Cultural Significance. Considering Enabling Conditions for adaptation including human and financial resources, protective legislation, services, infrastructure etc.

2.6. Analysing climate Impacts of recent or historic events (including damage done, costs of response, drivers and accelerants, Impacts on Livelihoods, cultural identity, etc.). Where possible identifying bench-lines, Tipping Point etc.

2.6.1. Learning from events around the world; with a shifting climate these may be new to one area but familiar to another.

3. Using Heritage Monitoring to Support Effective Adaptation

The collection of data using a wide range of monitoring techniques is vital - for understanding the rate and effect of climate change, for supporting decision making in relation to adaptation actions, and for assessing the effectiveness of adaptation interventions. Information gathered from monitoring activities is also valuable for communicating the issues and fostering engagement e.g. funding agencies and public. Climate change is measured over a minimum period of 30 years, therefore long-term monitoring projects are of particular importance.

3.1. Gathering data from long-term and short-term monitoring of climate and of climate Impacts on heritage places, artefacts, communities and traditional ways of life in ways that supports adaptation planning.

3.1.1. Difficulty/uncertainty of attributing Impacts on heritage to climate change. Often climate change is acting as one of many stressors in the system and direct attribution is not necessarily required when selecting an adaptation response.

3.1.2. Exploring the potential of new and developing technologies e.g. digital, social media, drones etc.

3.1.3. Exploring the potential of low-tech and interdisciplinary approaches e.g. biological indicators, anecdotal evidence, volunteer observations.

3.1.4. Prioritising monitoring where information gaps have been identified and/or vulnerability to Impacts is high e.g. there is a lack of data on the Preservation of archaeological remains in the burial environment and organic deposits in Permafrost or waterlogged environments will be especially vulnerable to environmental change.

3.2. Long-term and short-term monitoring of adaptation actions – success and failure

3.2.1. Indicators for measuring success are required to evaluate the implementation of adaptation plans (generally either output or outcome related).

3.3. Disseminating data as widely as possible, from local to regional and national networks and online 'big data' platforms, but data archiving remains a substantial challenge. Maintaining monitoring systems over a long term can be problematic due to human and financial costs, as can managing the data sustainably – solutions exist in terms of open data, inter-sectoral approaches, data archiving, training (where needed) and capacity building.

3.3.1. Data twinning – sharing data between areas with similar climates (past or future) or heritage typologies.

3.3.2. Citizen science, traditional peoples and community-based monitoring programs may not be self-sustaining without some management, but can achieve a lot with limited resources (e.g. ALERT France) and have additional social and educational benefits.

3.3.3. Standardising of approach and level of detail is necessary so that consistency can be achieved in the data from different places.

3.4. Recognizing and sharing diverse sources of knowledge on Impacts – local community, Indigenous knowledge, experts, Institutions, citizen science, etc.

3.4.1. Training with and inclusion of professionals in the traditional and indigenous communities.

4. Harnessing Heritage as an Asset for Climate Change Adaptation; Past, Present and Future

4.1. Identifying examples of past social adaptability to environmental change. Examples of historic or traditional: spatial Land Use, such as creating flood meadows or ponds; architecture, such as structures modified by local traditions in response to climatic characteristics e.g. traditional open walled housing in Samoa that performs well in high winds or pile dwellings in Cuba that function during Flooding and are relatively easy to rebuild; planning and development of cities and clusters of buildings; and changing systems of food production.

4.2. Relating past adaptability to current issues, methods, and decisions. Exploration of communities' responses to human/natural catastrophes, particularly war, mass displacement etc. in order to examine resilience and how cultural heritage has been sustained even through radical loss – e.g. colonisation, territorial annexation etc.

4.2.1. Interpretation of cultural heritage as inspirational evidence of repeated human adaptation to past change and transformation.

4.2.2. Climate change causes abnormal patterns that may not be predicted by local knowledge and experience; however, past adaptability may be transferable across regions as climatic conditions shift.

4.2.3. Cultural heritage has the potential to create a common Risk culture related to Climate extremes. historical Floods to be used as a warning for future generations. With respect to Disaster Risk reduction, historical examples of Early warning systems could be compared with today's methods.

4.3. Helping reduce people's vulnerability to climate change Impacts by valuing Local Knowledge, Indigenous Knowledge and other Endogenous Ways of Knowing, particularly as a resource for Ecosystem-based adaptation. Example include fire regimes that increase Biodiversity (Australia) or Forest management to reduce exposure to wildfires (Sweden). Endogenous Ways of Knowing are a dynamic and changing resource and can be reflected in contemporary practices such as co-management e.g. James Bay Cree Agreements, Canada. These approaches may also provide useful ways to help conceptualize resource management and use e.g. granting of personhood to Whanganui River New Zealand. Free, prior and informed consent should be obtained as appropriate.

4.4. Sharing heritage science and heritage Conservation methodologies with other sectors which might benefits from them (e.g. long-term monitoring of internal climate in buildings, techniques for sustainable re-use, knowledge of traditional materials and skills).

4.4.1 Building a database of embodied energy for traditional materials to allow comparison of traditional materials to modern ones, and to assess environmental impact of conserving cultural heritage using traditional skills vs. new 'green' materials.

5. Sharing Good Practice Examples

Sharing knowledge and information on climate change Impacts and adaptation solutions. Transfer of knowledge and practice across not only the heritage profession but also other disciplines and sectors (e.g. agriculture, tourism, Biodiversity) at local, national and international levels.

5.1. Choosing a thematic approach to sharing best practice between heritage sites. Useful themes could be physical characteristics (e.g. earthen architecture), heritage type (e.g. underwater archaeology), climate Risk factor (e.g. heritage at Risk of coastal erosion), or a combination of these. For example, the Venice Declaration Building Resilience at the local level towards Protected Cultural Heritage and Climate Change Adaptation Strategies (2012) actively encourages exchanges between cities facing

challenges posed by the protection of cultural heritage in a changing climate. Comparing between latitudes that will have equivalent past and future climates will be useful as climate zones shift.

5.2. Adopting Multi-Disciplinary Approaches and Considering Cross-Sectoral Synergies and Conflicts. May include establishing new networks and creating and promoting shared data sources. Public outreach and research with a multidisciplinary approach as a core tenant are a vital part of this. To the degree that effective adaptation requires new 'citizen skills', those areas where these new citizens are formed, i.e. the early learning and educational sectors, should be included.

5.3. Developing a toolbox of appropriate actions (see Tools and Methodologies Section). Tools and methodologies must allow for, and directly address, the uncertainty inherent in climate change. Additionally, they should embrace creative solutions and include consideration of the potential for positive change. They should harness social and technological developments (digital tools, social media, crowdsourcing, remote sensing etc.) and they should be environmentally sustainable (green ecological options, low carbon options). It is likely that a mix of actions will be appropriate and necessary, and also that some actions may address more than one Impact.

5.3.1. Dissemination and communication, including education and training, online database of tools.

Planning and Implementation

6. The Role of Heritage in Supporting Disaster Risk Reduction (DRR)

6.1. Linking climate change and Disaster Risk Reduction

The impacts of climate change on cultural heritage are largely experienced through Climate Variability and Climate Extremes, with both linking climate change to Disaster Risk Reduction. Climate change and Disaster Risk Reduction are also closely linked to other drivers of change such as urbanisation and water management. The combined Risk factors induced by climate and other Hazards and threats create a diverse range of vulnerabilities for cultural heritage. Disaster Risk Reduction should be recognised as a broader action methodology that encompasses the aspects of climate change.

6.1.1. Identifying existing critical disconnects between Policies for climate change adaptation and Disaster Risk Reduction (DRR); often centred in different government departments with little or no coordination. There may be incompatibilities between the agendas of different agencies which create major difficulties in Disaster Risk Management Risk, e.g. restricted access to heritage databases and resultant delay in supplying information to those responding to Disasters.

6.1.2. Assessing how slow acting deterioration and vulnerabilities accelerated by climate change will increase disaster risk for cultural heritage deserves more study.

6.2. Disaster Risk Reduction Planning

Planning for Disaster Risk Reduction should include prevention, preparedness, response (including planned retreat) and recovery, following an integrated multi-Hazard Risk Assessment of cultural heritage. Combinations of prevention and adaptation are increasingly necessitated for integrating climate change into Disaster Risk Reduction planning. However there has been little emphasis on these proactive pre-Disaster measures as the majority of Disaster Risk Reduction initiatives still focus on post disaster response and recovery. The development of Disaster Risk Reduction planning is critical in changing the emphasis for communities from being simply the recipients of climate change salvage efforts, to being able to proactively protect their heritage.

6.2.1. Addressing how vulnerability increases when considering indigenous or small/rural communities who may be disadvantaged in terms of connectivity.

6.2.2. Considering lessons for Disaster Risk Reduction, including climate change adaptation, that can be learnt from Local Knowledge as well as responses to recent Extreme Weather Events, when drawing up new policies and regulations.

6.2.3. Since biodiversity and cultural diversity are often subject to the same threats or require integrated Management Plans, linking the measures and plans to protect them e.g. an integrated approach such as Ecosystems-Based Disaster Risk Reduction for natural and cultural heritage could contribute to more comprehensive and effective Adaptation Pathways. Synergies with civil protection authorities and the incorporation of heritage into disaster training scenarios need to be developed.

6.2.4 Supporting as a mitigation measure the integration of cultural heritage in preparing local and national plans for emergency management and implementing emergency responses.

6.2.5 Emphasising the need for Disaster Risk Management planning to incorporate cultural heritage.

6.3. Implementing the Sendai Framework for Disaster Risk Reduction

The importance of addressing Disaster Risk Reduction and climate change adaptation together has been emphasized in the Sendai Framework for Disaster Risk Reduction introduced in 2015, implying that Projections of climate Impacts will be considered in Disaster Risk Reduction policies and programmes. The framework also puts emphasis on building resilience by investing in Disaster Risk Reduction, Disaster preparedness for effective response and 'Build Back Better' in recovery rehabilitation and reconstruction. For cultural heritage, this would imply reducing vulnerability with minimal impact on Cultural significance.

6.3.1. Ensuring that post-Disaster Needs Assessments cover the domain of culture as a prompt response after the Disaster is critical.

6.3.2. Coordinating internationally to ensure that poorer nations are protected, and to share specialist knowledge and capabilities.

7. Adaptation Planning for Heritage – Policy and Actions

Heritage is a resource for communities and must itself be included in Adaptation Pathway planning, along with other key community assets. Adaptation planning for heritage is required at multiple scales, from national level policy to site level Management Plans. The degree to which cultural heritage will be considered at national and regional level will vary. Ideally heritage should have a dedicated plan but consideration within cross-cutting sectoral plans (such as agriculture, transport, tourism) can also be valuable. Adapting to climate change may include making tough choices to achieve the best for communities and the economy.

7.1. Managing heritage requires adopting approaches to assessing Risk/vulnerability that effectively inform adaptation climate change (see 1.1).

7.1.1. Identifying 'new' and indirect Risks e.g. Drought in historically humid areas

7.1.2 Developing rapid assessment methodologies – such as the Climate Vulnerability Index (CVI) – which use best available information and are transparent, repeatable and applicable across all types of heritage at Risk.

7.1.3. Prioritizing Risks and responses (and allocation of resources) according to scale and severity of Impact.

7.2. Decision frameworks for adapting historic resources in the face of climate change.

There can be an imbalance between provisions for different heritage types especially where certain Values are poorly understood. This is often attributable to the number and expertise of management staff, but also to resourcing more broadly (all of which are related to the profile of these Values).

7.2.1. Taking an inter-sectoral approach: mapping and identifying relevant sectors and collaborating to reach shared understanding e.g. different authorities and experts such as planners, engineers, environmentalists and insurers.

7.2.2. Ensuring that heritage is considered as an important and integrated component for urban and territorial planning.

7.2.3. Using prioritization strategies and correlating to Cultural Significance and other factors e.g. prioritizing good examples from each of a diverse range of at-Risk resources.

7.2.4. Promoting heritage as a key component for social and institutional reconstruction after Disasters, representing the collective memory to be reconstructed through communities' efforts (see 8.2).

7.3. Methodologies for Developing Effective Adaptation Policies (macro).

Developing methodologies for implementing adaptation actions at a macro or strategic level to provide leadership and vision for the sector with Policies that are general in scope, detailed site level solutions being developed subsequently (see 7.4.). Multilevel Governance is vital to avoid conflict and identify mutual benefits.

7.4. Methodologies for Designing Adaptation Actions (micro).

Developing methodologies for implementing adaptation actions at site level, which requires support and training with more specific and targeted Policies. It should be built in tandem with other project/Policy goals as it can be a resource and time intensive action.

7.5. Evaluating Adaptation Plans.

Metrics should be representative with input from all levels and stakeholders.

7.5.1. Ensuring reduction in vulnerability (or, where inevitable, effective management of loss).

7.5.2. Learning from success and failure.

7.5.3. Ensuring accountability and Evidence-based Policy making – formal definition of criteria for measuring success and utilisation of transparent reporting systems.

7.6. Training and education for the implementation and monitoring of adaptation actions, Disaster planning and recovery. Training and capacity building to ensure the correct skills, materials and procedures (e.g. emergency evacuation of movable heritage) including inter-sectoral and inter-disciplinary cooperation. Training in recovery strategies could include heritage-based processes to foster social cohesion.

7.7. Avoiding or managing threats from Maladaptation by ensuring that heritage and impact to Cultural Significance are taken into consideration in works to adapt to climate change (e.g. Flood defence works, coastal defence works, retro-fitting of built heritage for comfort and Energy Efficiency). Requires coordinated efforts from all levels including communities and documenting and learning from instances of Maladaptation. Conserving heritage should be promoted as a viable option for ecologically sustainable design considering full Life Cycle Analysis. Maladaptation is not limited to physical interventions however, but also concerns people/Place bonds and ancestral connections.

8. Coordination of Heritage Adaptation within wider National / Regional / International Policies

Cross-cutting issues have been identified with Paris Agreement, the Sustainable Development Goals, Sendai Framework for Disaster Risk Reduction and New Urban Agenda, and at national level, climate change Mitigation Policy and adaptation planning will be relevant. Key issues are likely to be Energy Efficiency of historical buildings, design and transformation of the cultural landscape and safety of heritage under Climate Extremes (see point 6).

8.1. Benchmarking and exchanging good practices at regional, national and international level could promote the coordination of heritage adaptation within other sectoral Policies.

8.2. Considering that additional efforts may be needed for areas with shared values/history between different peoples/tribes/communities and for areas and sites that do not wish to divulge the full extent of information (related to data sovereignty) e.g. shared heritage, Transboundary Properties, Cultural Routes, Indigenous heritage.

8.3. Ensuring heritage is adequately factored into building and planning Policies, national building codes, and Sustainability rating schemes. These should also value the environmental benefit of conserving cultural heritage (see point 15).

Opportunities, Constraints and Challenges

9. Managing Change

Although the Values that make up Cultural Significance are dynamic and evolve over time, the speed of climate change and the potential requirement for radical interventions poses a challenge to current Conservation practice. The Sendai Framework for Disaster Risk Reduction emphasises 'Build Back Better' in post Disaster recovery but for heritage practitioners there are concerns around loss of Authenticity and Integrity such as avoiding replacement of traditional materials by modern materials. Taking a flexible and pragmatic approach to Conservation – such as empowering communities to record (or not) their heritage – is one way that the sector can adapt to climate change and look for new ways to bring people together.

9.1. Addressing how change and Conservation can be reconciled? The question of when interventions aimed at adaptation to environmental conditions exceed Adaptation Limits is a decision the whole community needs to participate in (see section 1 and figure 1).

9.1.1. Formulating a step-by-step approach, going from 'least impactful' to 'most impactful'.

9.1.2. Creating guidance for site managers, decision makers and community and civic leaders that is flexible and responsive.

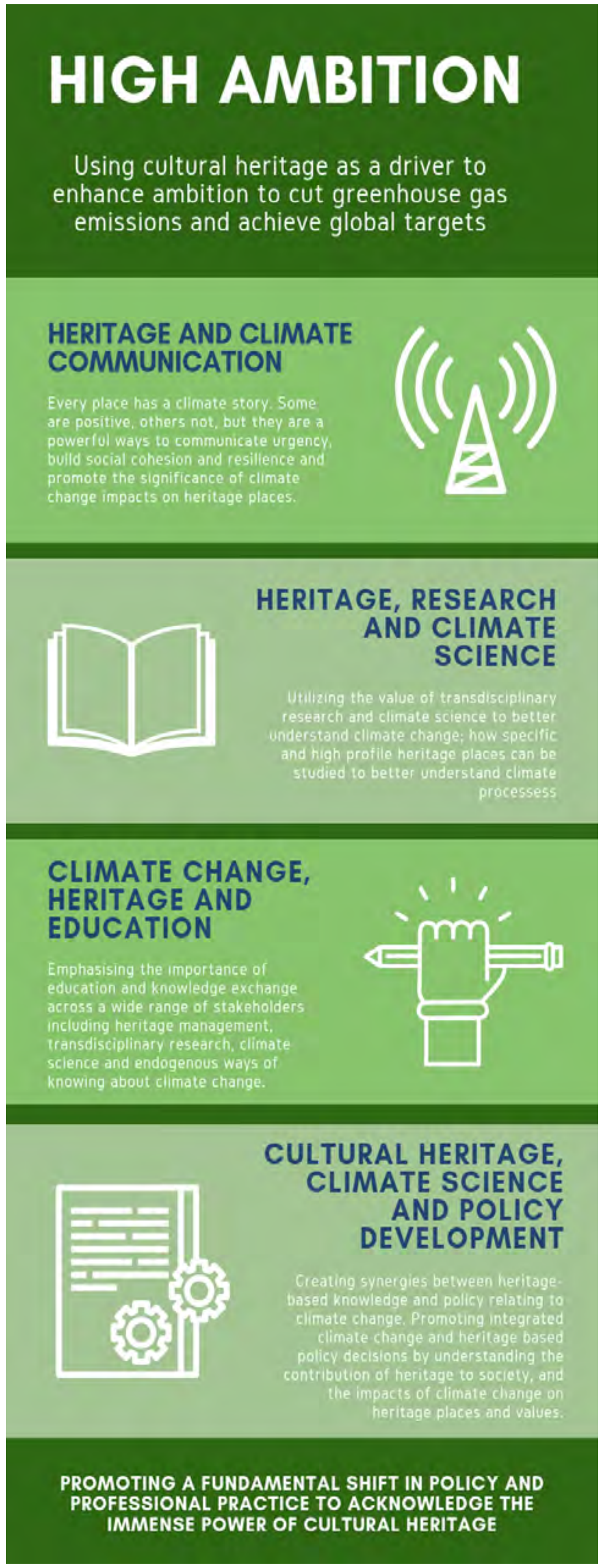
9.1.3. Utilizing the role of UNESCO World Heritage Sites as laboratories for heritage innovation to address how approaches to Outstanding universal value (OUV), Integrity and Authenticity may be updated due to climate change.

9.2. Preparing for loss when Adaptive Capacity is exceeded (e.g. when Conservation in situ is not possible or effective) (see Part I Division 2: Loss and Damage).

9.2.1. Developing strategies for Interpretation-presentation and other memory reservoirs (farewell ceremonies, opportunities for visiting submerged sites maintaining traditions and creating new traditions to maintain memories and lessons learned) especially where large scale losses are expected e.g. Pacific islands have strategies for maintaining living heritage even as populations become diasporic.

9.2.2. Considering expanded use of removal,

Figure 2. Conceptual relationship between different levels of adaptive intervention and the authenticity of heritage resources.



relocation and other ex-situ strategies for the Preservation of cultural heritage, including for iconic sites.

9.2.3. Ensuring that decisions to accept loss are transparent and take a people-centred approach and that local communities have a voice in deciding which sites should be prioritized and which losses are acceptable, and negotiating the loss of cultural/ natural heritage Values due to other prioritized needs (e.g. cultural landscape transitioned into intensive agriculture).

9.2.4. What happens when value is lost? Could sites be considered to have heritage value if they demonstrate climate change Impacts i.e. as exemplars of a significant stage in human history (World Heritage criteria (iv)).

9.3. Raising awareness, disseminating knowledge and building capacity among community, practitioners, Policy makers and network.

9.3.4. Preparing the public for inevitable losses and managing the reputational damage for heritage agencies when these occur.

9.4. Recording of sites under imminent threat of destruction. Utilising existing techniques (e.g. archaeological salvage) as well as developing new types of recording and archiving of resources. Allowing and facilitating communities to record and manage their own data e.g. recording of historical and indigenous recollections of areas and heritage sites from knowledge holders in communities.

9.5. Championing adaptive re-use. Ensuring, through careful adaptive reuse, that historic buildings and sites can evolve over time and retain their fitness-for-purpose and use value.

10. Opportunities

Adapting to take advantage of any positive Impacts from climate change.

10.1. Harnessing diverse knowledge systems (traditional, indigenous, spiritual and research), that present tools for climate response and provide a guide to climate adaptation as per Paris Agreement (Article 7.5) '…adaptation action…should be based on and guided by the best available science and, as appropriate, traditional knowledge, knowledge of indigenous peoples and local knowledge systems, with a view to integrating adaptation into relevant socioeconomic and environmental policies and actions, where appropriate.'

10.1.1. Using new technologies to improve adaptation strategies or procedures and the potential for developing these through experiments and research projects.

10.2. Iconic spiritual, cultural and natural values can play a role as a source of social cohesion, fostering a wider recognition of the relevance of heritage.

10.2.1. Harnessing the power of heritage to create public engagement/ education on climate change, creating dialogues within and between communities.

10.2.2. Promoting the ecological benefits in conserving cultural heritage.

10.2.3. For some countries, climate change may mean that heritage sites are more visited and more appreciated (although with resultant management implications from increased visitation).

10.2.4. The Position Paper of UNESCO and World Bank Group, Culture in City Reconstruction and Recovery (CURE) (2018) (9), declares Culture is a major source of resilience and stimulates other development sectors when integrated into the planning, financing and implementation process of post-disaster and post-conflict reconstruction and recovery.

10.3. New learning, discoveries, or appreciation of culture may be related to the direct and indirect Impacts of climate change. For example, sub-surface archaeology may be revealed by dry weather or exposed by soil erosion or the melting of snow and ice.

10.4. Engaging with citizen science and the opportunities for communities to take part in adaptation e.g. monitoring and recording. This also builds community awareness and active community engagement in supporting the responses developed.

11. Uncertainty

While uncertainty is inherent in climate change, both in terms of Emission scenarios and climate response, it cannot be used as an excuse for inaction. It requires flexible Policies and procedures as well as communication on the degree of uncertainty involved.

11.1. Because the uncertainty surrounding climate change can be a barrier to engagement and action, providing leadership and a clear vision is key to overcoming this.

11.2. Implementing flexible, resilient systems at management level to deal with uncertainty.

11.2.1. Choosing 'win whatever' solutions is often recommended as a way to cope with uncertainty e.g. Maintenance or repairs of benefit regardless of future change.

11.2.2. Planning for multiple Emissions scenarios – understanding all the possible futures.

11.2.3. Using Holistic decision making, inclusive of a wide range of knowledge sources and interdependencies.

11.2.4. Interpreting cultural heritage in terms of change and transformation.

11.3. Identifying areas where knowledge is insufficient for informed decision making. In these cases, the gaps in understanding and the risks of uninformed action vs. doing nothing should be articulated as early and as clearly as possible. This could lead to research and/or community-based decision making.

12. Costs and Benefits of Adaptation Activities

Financial and/or human resources will be required for most adaptation activities. Effective implementation is vital to ensure limited funds are not wasted. With increasing demands from all sectors for support to address the Impacts of climate change, heritage actors need to be clear on the Cost-effectiveness of proposed adaptation measures (including for example when it is not appropriate due to the inevitability of loss). The Co-benefits of heritage adaptation include building the resilience of Social-ecological systems, e.g. through Poverty Eradication, economic diversification and sustainable management of resources (as per Paris agreement 2015). Cost-effectiveness analysis and Life cycle assessment for Conservation interventions will help to ensure resources are allocated responsibly and to maximum effect.

12.1. Documenting the economic case for investing in adaptation in the built environment (e.g. US National Institute of Building Sciences estimated in 2017 that $1 spent on disaster resilience saves $6 in recovery).

12.2. Developing Cost-effectiveness methodologies for heritage adaptation interventions in order to assure sensible allocation of resources (e.g. EU project STORM). The benefits of adaptation for cultural or intangible values can be difficult to measure. For this reason, Cost-effectiveness is suggested (rather than Cost-benefit Analyses) as it focusses on assessing how effective an intervention is at reducing vulnerability.

12.3. Costing renovation rather than demolition of historic building stock, the environmental savings (including Energy Efficiency, embodied carbon, etc.) should be part of the analysis. Life Cycle Assessment should also be factored for Conservation materials and components (e.g. recirculating systems, waste design etc.).

12.4. Empowering indigenous communities, using co-management of resources in decision making.

12.5. Recognising and managing the risk that resources may be taken from wider heritage budgets to adapt the highest priority heritage places – reducing overall Maintenance capability.

12.6. Seeking alternative sources of support e.g. civil society mobilisation.

12.7. Addressing in adaptation planning the complex nature of tourism, as both a Risk factor and a potential source of funding for heritage adaptation.

12.8. Applying Circular Economy models in order to utilise resources more efficiently and effectively.

13. Existing Management and Conservation Methods and Approaches May Need to Change to Meet the Challenge of Climate Change

Climate change is an existential issue for all societies. Dramatic losses, including heritage losses, are inevitable (see Losses and Damages). Although this chapter has focused on adapting resources for the future, inevitably the profession itself will also have to adapt. Methods of organising and undertaking heritage Conservation will need to adapt, and in some cases a fundamental shift in approach may be needed. The adaptation of the heritage field in the face of climate change includes:

13.1. Aiding communities in preparing for Losses and Damages by accepting that preservation in situ may no longer be feasible for all sites. This is particularly problematic for buried archaeology and underwater heritage as changing 'in situ' conditions are not visible.

13.2. Supporting adaptation by addressing the fact that accepted treatments for increasingly frequent and/or severe Impacts of climate may be inadequate.

13.2.1. Increasing need to be more flexible about building elevation, sheltering, relocation and reconstruction.

13.2.2. Creating innovative Policy tools such as rolling conservation protections that shift with Impacts like Sea Level Rise or planning requirements/building listings designed to protect heritage that allow for future adaptation.

13.2.3. Covering sites or introducing landscaping e.g. protective banks and other non-conventional methods will need to be explored and result widely disseminated.

13.2.4. Emphasising documentation as a management and Conservation tool of first and last resort.

13.3. Addressing the possibility that Conservation materials, including traditional constituents, may become unreliable/ineffective under new environmental conditions (e.g. increased temperatures affecting the working and long-term properties of polymers) by adapting existing Conservation practice alongside research and experimentation.

13.4. Reducing the environmental impact of both interventive and preventive Conservation measures will require modification in heritage methods and materials. Materials in Conservation may need to be replaced with more environmentally compatible options; museums may be restricted in their energy consumption and storage facility expansion as the profession Decarbonizes. Greater emphasis on preventive Maintenance and the increasing use of local materials are two likely solutions.

13.5. Moving towards a more integrated recognition of tangible heritage with intangible heritage practices in management as institutionalised and centralised heritage management systems can increase vulnerability to climate change and Disasters. Similarly, there is an urgent need to introduce safe working practices among cultural bearers who are engaged in crafts and practices which in turn increase their vulnerability to the negative Impacts of climate change.

13.5.1. Building traditional skills as Climate Extremes means more frequent damage which requires fast and affordable repair. The current global trend in loss of traditional trades is problematic.

14. Existing Barriers to Adaptive Management of Heritage That May Limit Attempts to Address Climate Change

Recognising and addressing the institutional, financial, technical, social barriers and needs that will limit the sector's ability to adapt quickly and effectively. These include differences between stakeholders, lack of sectoral engagement, inadequate understanding, ineffective technical approaches, lack of resources, lack of political will, lack of public awareness etc. Communicating between different groups and decision makers is vital, as lack of communication can cause or increase these and other barriers.

14.1. Addressing the ways in which the complexity of heritage Values and Cultural Significance, including differing stakeholders and Place attachment, may undermine the Enabling Conditions for adaptation.

14.2. Entering into open dialogue about the fact that Policies and regulations, both those aimed at protecting heritage and those aimed at mitigation (including Energy Efficiency e.g. building codes, planning Policies and sustainability rating schemes), can create barriers to adaptation. Cross border heritage, subject to Policies from more than one jurisdiction, is subject to additional barriers.

15. Sustainability

Sustainability is a key issue for addressing climate change and has been discussed elsewhere in this Outline, including in relation to the Sustainable Development Goals and heritage. It provides an important 'cross over' with other climate-related motivations as the sustainable reuse of structures also has economic and social implications. In relation to heritage adaptation there are two parts to this issue. Firstly, building an awareness in society of the sustainability of traditional and historic ways of living. Secondly, ensuring that any actions taken to conserve heritage are themselves sustainable.

15.1. Emphasizing the long-term view relevant to heritage, sustainable tradition of stewardship and reuse e.g. 'kaitiakitanga' in New Zealand (cultural responsibility to the environment). Recognising that in some places, climate change is challenging traditional ways of life dependent on specific Ecosystems.

15.2. Calculating and communicating the contribution of historic buildings to mitigation in terms of embedded carbon and avoided carbon and the benefits of sustainable re-use and sensitive adaptive reuse.

15.3. Researching and communicating information on historic adaptation and response pathways that may provide lessons in sustainability for modern societies (see section 4).

15.4. Utilizing heritage methodologies to help communities develop people centred/Human Systems-based approaches to adaptation planning and implementation.

15.5. Giving importance and value to tried-and-tested approaches.

15.6. Evaluating the acquisition of collections and data from a sustainability perspective and considering Policies on storage, deaccessioning and repatriation.

15.7. Addressing tourism development with the aim of creating sustainable growth and minimizing the environmental impacts. Infrastructure associated with use of sites (particularly for tourism) to be sustainable in all regards.

Without care in siting, mitigation efforts can have negative effects on cultural heritage resources.

Photo: © Associated Press, 2016 AP Photo / Matt O'Brien

Division 3

Mitigation

Cultural heritage with its embedded intangible and tangible values intersects both directly and indirectly with the Paris Agreement's Decarbonisation imperative to mitigate Greenhouse Gas emissions. In its Special Report Global Warming of 1.5˚C, the IPCC found that although the world will face severe climate Impacts with 1.5˚C of Global Warming, the effects will be significantly worse with 2˚C of warming. To limit warming to 1.5˚C (with no or low Temperature Overshoot) annual emissions need to be about half their current rate by 2030. Net Greenhouse Gas emissions will on average need to be reduced to zero by mid-century. The sooner emissions peak before 2030 and the lower the level at which they do so, the more manageable the challenge of Climate Change will be to people and communities.

Neither climate change Impacts nor the opportunity to contribute to Greenhouse Gas Mitigation are evenly distributed across populations. While the poorest and most vulnerable groups will often disproportionately experience the negative Impacts of climate change, in many cases these frontline communities are among those contributing the least Greenhouse Gas emissions. The Paris Agreement asks developing countries to continue enhancing their mitigation efforts, while calling upon developed countries to undertake absolute economy-wide reduction targets.

Limiting temperature rise to 1.5˚C will, the IPCC said, require widespread and rapid transitions across energy, land, industrial, urban and other systems, as well as across technologies and geographies. They expressed the view that there is no precedent in documented history for this rate of change at the scale required, and without these transformations, limiting warming to 1.5˚C while achieving Sustainable Development will be exceedingly difficult, if not impossible.

Accomplishing Decarbonisation in tandem with achieving Sustainable Development goals requires pursuit of Climate-resilient Development Pathways that strengthen Sustainable Development in both rural and urban contexts while addressing the ethical and equitable aspects of the deep societal transformation needed to limit Global Warming to 1.5°C.

In many cases, win-win strategies that showcase the Social Value of Mitigation Activities (SVMA) associated with cultural heritage-based Mitigation Measures will be available. In other cases, real and perceived tensions between GhG mitigation and heritage Conservation will need to be mediated. This Division seeks a wide perspective on the intersections between the core competencies and considerations of cultural heritage Conservation and Greenhouse Gas mitigation goals, which include:

3.1 Living Sustainably

Culture is embedded in the patterns of production, consumption, lifestyles and social organisation that give rise to Anthropogenic Greenhouse Gas emissions. To varying degrees across the globe, traditional patterns of social organisation, often developed over centuries if not millennia of slow co-evolution of human communities and their environment, are being supplanted by contemporary patterns which tend to be swifter, less place-adapted and more carbon-intensive. Approaches such as Circular Economy and Life Cycle Assessment seek to restore balance and extend the time horizon in which resource uses are considered. Cultural heritage practice intersects very directly with these approaches, and integrating heritage Values can contribute to more sustainable models for living, both from a resource efficiency perspective and in terms of Social-Ecological Systems, thus supporting both mitigation and Climate Resilience Development Pathways by:

- Emphasising aspects of heritage practice that align with Circular Economy approaches including a focus on multi-generational time scales and horizons; integrating an ethic of stewardship, reuse and conservation; and utilising people-centred approaches.
- Identifying, documenting and interpreting traditional, resource and energy-efficient patterns of production, consumption, lifestyles and social organisation as templates for contemporary living.
- Educating consumers on the cultural heritage dimensions of sustainable consumption patterns and lifestyles, providing them with adequate information through standards and labels and other appropriate messaging.
- Utilising the competencies of heritage to refine and promote Life Cycle Assessment methodologies to provide systematic evaluation of the environmental impact caused throughout the life cycle of products or services.
- Analysing and promoting the contemporary relevance of traditional wisdom, including Endogenous Ways of Knowing, that emphasises frugality versus waste, and which centres the non-material dimensions of human Well-being.
- Emphasising integrated nature-culture approaches that highlight the linkages between the ecological and social values and functions of land and other natural resources, and the connections between production and consumption, in ways that promote low carbon, healthy lifestyles in harmony with nature.
- Embracing, in line with guidelines for local action produced by the United Cities and Local Governments (UCLG) Culture Committee, heritage approaches for the promotion of local and traditional products that are suited to sustainable consumption and production, including gastronomy.

3.2 Carbon Mitigation Through Demand-Side Measures: Built Environment

The IPCC Special Report makes clear that the built environment, including the entire building and construction supply chain, must decarbonise. Demand-side energy measures for the built environment aim to reduce demand for electricity and other forms of energy that are required to deliver energy services for buildings. Studies indicate that while global energy-related emissions from building operations are responsible for approximately 28% of global energy-related carbon emissions, a further 11% is incurred through the materials and construction process. Thus, while 'operational' carbon emissions (the carbon emissions through the operational or in-use phase of a building) are important, wider carbon lifecycle impacts must also be addressed if the sector is to reach Net Zero Emissions by 2050. This includes 'Embodied Carbon' which at the building-level takes account of the Greenhouse Gas emissions related to extraction, transport of materials, the construction process, maintenance and eventual demolition and waste management of the built environment. Cultural heritage considerations are involved in a wide range of Mitigation Measures applicable to a variety of built environment assets and processes including:

3.2.1 Monitoring, measuring and methodology. Using heritage expertise and perspectives to contribute to the development of accurate methodologies for monitoring and measuring the Greenhouse Gas implications of interventions in the built environment in order to gather the widest possible evidence to guide mitigation by:

3.2.1.1 Developing and widely disseminating models for use in policy processes that quantify the Embodied Carbon costs of construction versus potential operational carbon savings, including addressing the so-called time-value of carbon (e.g. embodied carbon of new construction is front-loaded while operational carbon (savings) are spread over time); and that also calculate the environmental impact of demolition versus reuse of existing buildings.

3.2.1.2 Evaluating and quantifying 'Avoided Carbon' (the carbon cost of new construction avoided through the use/reuse of vacant and underutilised existing buildings) in methodologies for assessing the Greenhouse Gas implications of new construction or rehabilitation projects at urban and building scales.

3.2.1.3 Expanding the use of carbon budgeting in the management of the historic built environment and scientifically calibrating the energy retrofitting of historic buildings to relevant Greenhouse Gas reductions targets, including understanding the contributions and conflicts of recommended historic treatments and heritage standards to mitigation objectives.

3.2.2 Life Cycle Assessment. Achieving 1.5°C Pathways require a focus on 'embodied carbon' and this focus will become even more relevant as the electrical grid becomes 'greener', thereby reducing the significance of operational carbon. The evolving discipline of Life Cycle Assessment can quantify these aspects. Heritage conservation professionals, having years of experience identifying existing resource values and leveraging these values to help guide interventions, can lead in this process by utilising the

competencies of heritage to refine and promote Life Cycle Assessment methodologies.

3.2.3 Avoided Carbon. Promoting, in a manner that safeguards heritage values, the use and adaptive reuse of existing buildings in order to avoid the carbon cost of new construction and steering activity to vacant and underutilised buildings – including time shifting (i.e. addressing building use for only part of the day), in order to reduce Greenhouse Gas emissions while producing Co-Benefits associated with heritage Conservation by:

3.2.3.1 Developing clear and effective guidance in the context of Historic Urban Landscape and other appropriate methodologies and doctrines, to facilitate adaptive reuse of existing buildings while conserving heritage values.

3.2.3.2 Researching and developing economic indicators to promote awareness and evaluation of benefits of adaptive reuse and regeneration projects including catalytic effects on future development.

3.2.3.3 Introducing and enhancing the use of criteria for conserving and encouraging the reuse of built heritage in already established green building/site standards and certifications systems, e.g. LEED, BREAMS, SITES, BEAM, etc.

3.2.3.4 Using the outcomes of Life Cycle Assessment and other data to promote building codes and energy codes that encourage the adaptive reuse of historic buildings in a manner that conserves their heritage values, as well as to guide the design of alternative code compliance regimes.

3.2.3.5 Researching and implementing effective financial incentives for adaptive reuse and for heritage-based urban regeneration projects including grants, tax credits and other incentives.

3.2.3.6 Promoting research and professional education on the performance of traditional building methods and techniques in order to encourage the continued use or reuse of existing buildings.

3.2.3.7 Linking inside and outside air quality and health to conservation of existing buildings and the mitigation of non-CO2 emissions such as Methane (CH4) and Black Carbon.

3.2.4 Decarbonising the supply chain for building renovation/rehabilitation including:

3.2.4.1 Addressing the Embodied Carbon associated with the production, transportation and disposal of building materials related to rehabilitation processes through Life Cycle Assessment and other methods, and discouraging unsuitable carbon-intensive approaches to rehabilitation.

3.2.4.2 Promoting research and development to bring more alternative and environmentally friendly products to the building rehabilitation and retrofit marketplace, noting that many products used in historic rehabilitation now use plastic in the fabrication and come wrapped in plastic, practices which should be reduced.

3.2.4.3 Improving monitoring and measuring of building materials' waste generated through rehabilitation and minimising waste of material.

3.2.4.4 Emphasising reuse and repurposing of building materials (many of which in heritage buildings are now rare or no longer available) to achieve near zero waste. Promoting salvage and recycling of heritage materials which will no longer be used in situ.

3.2.5 Reducing Operational Carbon of Older and Historic Buildings. Reducing emissions from existing buildings typically has a more favourable and more immediate Greenhouse Gas mitigation impact than building new, high efficiency –buildings – even Near Zero Energy Buildings (Nzeb). This is because of the comparatively large upfront expenditure of Embodied Carbon associated with new construction. As a result, increasing the energy efficiency of existing buildings and reducing their operational carbon is an important component of Decarbonising the building sector.

Institutions and organisations across the world are taking up this challenge by developing education and training opportunities in building sector carbon reduction, especially by educating trades and professionals in the Nzeb approach. While the contribution of the historic built environment to overall building sector operational carbon differs significantly from region to region, in many areas it is considerable. Studies carried out in Europe indicate that 30% of existing housing stock was constructed prior to 1945. Adding all other construction areas and moving the date forward to 1970 increases the percentile to over 50%. As a result, the operational carbon used by older and historic building must be addressed, including by retrofitting many buildings for energy efficiency. Win-win solutions that safeguard heritage values and reduce emissions typically exist, but where conflicts occur the broader Co-Benefits associated with conserving cultural heritage resources must be considered. Thermal massing and other features of some traditional building systems are inherently efficient, making wholesale energy retrofitting unnecessary and even wasteful. Interventions that fail to understand how older buildings 'behave' can degrade traditional climate-friendly features and waste precious materials and can lead to other forms of Maladaptation. Rehabilitation and renovation projects contemplated for built heritage present the opportunity to incrementally introduce Nzeb approaches. Key ways in which the competencies and considerations of cultural heritage practice intersect with the ambition to decrease the operational carbon of the built environment include:

3.2.5.1 Promoting an understanding of the operational Greenhouse Gas emissions associated with the historic built environment, including the thermal behaviour of each type of existing building system, through the development and use of adequate energy modelling and audit software (noting that some current software misrepresents the energy efficiency of historic buildings and the performance of historic building systems).

3.2.5.2 Developing and disseminating research on energy efficiency strategies and solutions for the renovation of historic buildings. Excellent studies include NOAH's Ark, Climate for Culture, Effesus, 3encult, RIBuild and PPP (EeB).

3.2.5.3 Increasing engagement on the implications of operational carbon in the built environment as part of cultural heritage policy and practice, and increasing education on the subject at all levels with appropriate projects and curricula.

3.2.5.4 Developing, enhancing, implementing and promoting energy efficiency certification, labelling, commissioning, and monitoring methodology, standards and criteria that are adapted to historic buildings and traditional building systems, including through renovation and new-build building codes and other reporting systems.

3.2.5.5 Actively contributing cultural heritage perspectives to the broader conversation about Nzeb approaches and methodologies, including promoting an understanding of the inherent efficiency of some existing traditional building systems; sharing how the Nzeb approach has been implemented around the world (for example, Nzeb will feature in Ireland's building regulations for the first time); promoting information sessions at public and professional events (for instance, at the IPCC Cities Conference in Edmonton, Alberta, Canada in March 2018, a session on retrofitting existing buildings was included for the first time).

3.2.5.6 Developing and identifying criteria and standards for retrofitting older and historic buildings for operational energy efficiency, including providing methodologies for mediating conflicts between efficiency outcomes and the conservation of heritage values. Addressing appropriate energy retrofitting of built heritage in legislative and code frameworks; and developing, adapting and adopting Nzeb national policy frameworks standards to the historic built environment.

3.2.5.7 Encouraging and facilitating individuals and developers undertaking energy retrofitting of older and historic buildings in ways that also conserve heritage values, including implementing effective financial initiatives that utilise appropriate qualifying criteria; analysing and disseminating capital cost recovery and payback information.

3.2.5.8 Utilising the competencies of heritage conservation practice to refine and promote the incorporation of Circular Economy considerations into the building sector.

3.2.5.9 Utilising culture and heritage approaches to address the ways in which buildings are used and addressing perceptions of comfort.

3.2.5.10 Reducing Greenhouse Gas emissions (as distinguished from energy demand) through fuel switching to cleaner sources of fuel (see Section 3.6.5).

3.2.5.11 Analysing and promoting an understanding of the critical role of routine maintenance and good conservation in reducing the carbon footprint of built heritage (e.g. 'green maintenance' – maintenance that incorporates practices that prioritise the health and safety of the users and the protection of the environment).

3.2.6 Monitoring insensitive retrofitting and Maladapted mitigation strategies that can lead to loss of cultural heritage values as well as increasing carbon emission:

3.2.6.1 Helping projects avoid insensitive retrofits and Maladapted mitigation strategies by developing guidelines and collecting best practice approaches and examples (for example, see Historic England's Guidance Wheel and the Association for Preservation Technology (APT)'s OSCAR project).

3.2.6.2 Guarding against ill-conceived energy retrofits, including promoting and implementing evaluation and design methods that utilise the actual values of traditional buildings, over computer-based modelling analyses using inappropriate inputs. For example, the BER (Building Energy Rating) or the EPC (Energy Performance Certificate) for solid wall construction gives a standard default U Value of 2.2 but in research and monitoring of similar solid wall construction, most will perform at about 1 U Value or below. This results in over specifying insulation thicknesses to achieve a B1 rating or better.

3.2.6.3 Increasing understanding of the negative consequences of Maladapted mitigation strategies and promoting approaches to avoid them, including in government-sponsored efficiency initiatives. In the example above, not only does over-specification of insulation waste the Greenhouse Gases used to produce the insultation material, but it can negatively impact the performance of the building and accelerate the decay of existing, heritage materials, representing a loss of Embodied Energy. In addition, using non-suitable and unbreathable insulations on an open and breathable structure can trap moisture and create unsuitable internal conditions such as mould and other health risks.

3.2.6.4 Increasing awareness of situations in which building performance can be improved by reversing earlier, inappropriate interventions that undermined the inherent energy efficiency of original building systems.

3.2.7 Promoting the use of traditional, low-carbon, climate-adapted building technologies and other Endogenous Ways of Knowing, including in new construction. Traditional buildings have characteristics, sometimes called 'inherently sustainable features' (ISFs), that maintained occupant comfort before mechanical hardware e.g. HVAC became commonplace. Today, the use of such technologies in construction is declining in many areas and is being replaced with building approaches and construction methods that are typically more carbon intensive (for example, relying on air conditioning) but are perceived to be cheaper (especially when the Social Costs of Carbon are excluded). Heritage contributions to Decarbonisation include identifying and assessing Local Knowledge relating to buildings that has contemporary use as Greenhouse Gas mitigation technology; supporting Technology Transfer of heritage building technologies; supporting further work on research and development (of the scalability of heritage knowledge as climate technology), especially in areas experiencing high rates of new construction, including by:

3.2.7.1 Prioritising the identification, documentation and preservation of learning from time-tested low-carbon, historic building and landscape technologies and techniques suited to local environments, especially those with the relevance to new construction and contemporary building management; and emphasising in the interpretation and presentation of those technologies and techniques their relevance to Mitigation Pathways.

3.2.7.2 Showcasing innovations and Adaptations from the past that used or use lower inputs of energy; exploring culturally specific mitigation techniques in traditional societies and their value to the wider climate change dialogue, with a particular focus on building techniques and settlement decisions, including databases of different techniques used in similar climates and addressing whether these can be adapted to different regions.

3.2.7.3 Encouraging a popular re-evaluation of traditional approaches to building, considering the benefits of conserving heritage and the Social Cost of Carbon associated with contemporary siting, design and construction methods.

3.2.7.4 Developing methods to optimise hybrids of traditional passive design with contemporary technologies to find better performing low-emissions solutions for new construction and additions that promote ISFs and minimal intervention new technologies, while honouring local cultures.

3.2.7.5. Prioritising in heritage trades, education and research, an understanding of building materials through material analysis that is linked to Greenhouse Gas Mitigation goals, including earth-related building materials, thatched roofs and lime.

3.2.7.6 Promoting traditional approaches to building design, orientation and spatial arrangements that possess ISFs, including energy-saving features such as eaves, verandas, shutters, cross-ventilation and other passive ventilation approaches, shading devices and use of water and vegetation screens to reduce heat, sun or wind load; narrow floor plates for natural light penetration; chimney-effect natural ventilation and features found in traditional Islamic architecture.

3.2.8 Linking heritage trades, skills and education to the demands of Decarbonisation to ensure that that there is a sufficient supply of skills in traditional building methods to support the roles which these methods can play in Mitigation. Addressing the availability of raw materials, such as thatch and timber, to maintain traditional buildings and approaches and assessing the carbon impact of these materials.

3.3 Carbon Mitigation Through Demand Side Management in Agriculture, Land Use, and other Sectors.

The IPCC report finds that limiting Global Warming to 1.5°C would require rapid and far-reaching transitions in the way we use land, energy, industry, transport and cities. Traditional, low-carbon, climate-adapted Endogenous Ways of Knowing can support Decarbonisation across sectors by:

3.3.1 Prioritising the identification, documentation and preservation of learning from time-tested low-carbon technologies and techniques suited to local environments, that have contemporary uses as Greenhouse Gas mitigation technology in all sectors; promoting Technology Transfer of heritage technologies; supporting further work on research and development of the scalability of heritage knowledge as climate technology; and developing and enhancing application of traditional knowledge and heritage values as endogenous climate capacities and technologies, and in the interpretation and presentation of those technologies and techniques, emphasising their relevance to Mitigation Pathways.

3.3.2 Recognising that not all traditional practices contribute positively to Climate Action (e.g. traditional cutting of peat bogs) and developing heritage methodologies to assess the climate compatibility of heritage practices; mediate real and perceived conflicts between heritage conservation and carbon mitigation goals; and develop alternate means to memorialise practices that will be altered by Mitigation Measures.

3.3.3 Emphasising traditional systems of governance that have proved successful at promoting people-centred approaches, and encourage pride of place and social cohesion in ways that support Mitigations Pathways and focus on the long-term sustainability, including the sustainable use of resources such as water.

3.3.4 Promoting the use of appropriate traditional and historic settlement patterns as a Mitigation Measure by:

3.3.4.1 Prioritising the identification, documentation and preservation of learning about the Mitigation aspects of historic settlements patterns including in the urban context – patterns that promote dense, walkable, mixed use communities and reduce distances travelled, especially vehicle miles travelled (VMTs), encourage public transit, and make walking and cycling more attractive options; and emphasising their relevance to Mitigation Pathways as part of good urban and territorial planning.

3.3.4.2 Supporting traditional, sustainable uses of public spaces in cities and human settlements, including proximity of food production to habitation.

3.3.4.3 Promoting traditional approaches to water management and flood risk including traditional approaches to land use that mitigated flooding risks through efficient land use, utilised nature-based solutions, and reduced associated Greenhouse Gas emissions by avoiding cycles of building, destruction and rebuilding.

3.3.4.4 Supporting as a Mitigation Measure the localisation of Section 97 of the New Urban Agenda which calls for the promotion of planned urban extensions and infill, prioritising renewal, regeneration and retrofitting of urban areas, as appropriate, including upgrading slums and informal settlements; providing high-quality buildings and public spaces; promoting integrated and participatory approaches involving all relevant stakeholders and inhabitants; and avoiding spatial and socioeconomic segregation and gentrification, while preserving cultural heritage and preventing and containing urban sprawl.

3.3.4.5 Developing and implementing methodologies to facilitate sensitive increase of the population density of the historic built environment especially in connection with Transit Oriented Development (TOD), to mediate conflicts between heritage conservation and densification, including through Historic Urban Landscape methodologies.

3.3.4.6 Emphasising the cultural and creative dimensions of mobility and the value of local and traditional practices of providing basic infrastructural services for promoting urban sustainability, including traditional movement and transport routes on land and water.

3.3.4.7 Encouraging regional and territorial planning that supports traditional boundaries between rural and urban places, facilitates urban-rural interactions and connectivity, and values traditional low-carbon approaches to production, storage, transport and marketing of food to consumers in adequate and affordable ways.

3.3.5 Showcasing innovations and adaptations from the past that used or use lower inputs of energy; exploring culturally specific mitigation techniques in traditional societies and their value to the wider climate change dialogue, including databases of different techniques used in similar climates and whether these can be adapted to different regions; and promoting South-South and other forms of collaboration, in connection with:

3.3.5.1. Traditional agricultural practices such as for fertilising, irrigation, tillage, arboriculture, crop rotation/companion planting and 'green manuring'; supporting and expanding systems like the FAO Globally Important Agricultural Heritage Systems (GIAHS) programme, as part of Climate-smart Agriculture.

3.3.5.2. Traditional soils management (no-till farming, mulching, cover cropping, crop rotation), use of native plants where appropriate to reduce water use and enhance pest control, and traditional livestock management and animal husbandry approaches that contribute to Decarbonisation.

3.4 Heritage and Carbon Dioxide Removal.

The IPCC Special Report indicates that limiting

warming to 1.5˚C will require the use of Carbon Dioxide Removal – methods that remove Carbon Dioxide (CO2) from the Atmosphere – and the amount of CO2 that will need to be removed depends on how quickly and effectively cuts are made to global Greenhouse Gas emissions. Even with rapid mitigation efforts, research suggests that Carbon Dioxide Removal will be likely to be required to offset emissions from sectors that cannot easily reduce their emissions to zero, including air travel. Several approaches to Carbon Dioxide Removal have significant implications for heritage. Deployed at large scale, these techniques may compete with other land uses and may have significant impacts on agricultural and food systems, Biodiversity and other Ecosystem Services, including culture. Concerns also exist that a focus on Carbon Dioxide Removal could delay or replace efforts to cut Greenhouse Gas emissions. Because of their looming necessity and unknown scales, heritage practice around Carbon Dioxide Removal includes:

3.4.1 Undertaking research that allows for an effective cost benefit analysis of varying Carbon Dioxide Removal approaches weighing Carbon Sequestration values against impacts to social systems, heritage values, governance and just land use (for example, impacts of Carbon Sequestration in Forests on indigenous land tenure; impacts of Afforestation on archaeological sites).

3.4.2 Developing capabilities within the heritage sector to assess the relevance of Local Knowledge, Indigenous Knowledge and other Endogenous Ways of Knowing to various Carbon Dioxide Removal approaches.

3.4.3 Developing heritage methodologies to mediate real and perceived conflicts between heritage Conservation and Carbon Dioxide Removal, and developing alternate means to memorialise practices that will be altered. For example, in many places bog lands have traditionally been used as a source of fuel. Banning the harvesting of peat, repatriating and recovering bog lands by re-wetting and growing certain grasses and plants with a view to slowing the release of GHGs and over time becoming carbon neutral before becoming a Sink is widely viewed as positive step, but has heritage conservation dimensions.

3.4.4 In general, Carbon Dioxide Removal approaches that increase Carbon Sequestration in natural systems and that have other benefits which together outweigh the costs, should be prioritised provided they adhere to strict environmental and social safeguards, including safeguarding of heritage values, and consider storage permanence – i.e. they have benefits for nature, people and climate including:

3.4.4.1 Enhancement of Forest carbon stocks through restoration of ecological functioning of degraded Forest landscapes – comprising peatlands, mangroves, coastal wetlands/ecosystems or low productive land – by promoting multifunctional landscapes, including Reforestation and Afforestation, taking into account the evolutions of the landscapes in question and past human activity to make informed decision about future land-use; and natural regeneration of Forests, assisted or otherwise; noting that if source trees are sustainably managed and harvested, the resulting timber used in construction has the potential to be a Sink.

3.4.4.2 Enhancement of soil carbon through Carbon Sequestration in agricultural soils, which also enhances soil health and productivity; soil sequestration using sustainable production of Biochar.

3.4.4.3 Carbon Sequestering in building materials including bio-based-straw, wood, hemp, thatch, and potentially materials made from industrial Carbon Dioxide emissions, i.e. aggregates and cements made from power plant emission gases.

3.4.5 For the following approaches the balance between costs and benefits and the implications for cultural heritage is not yet clear. Further research and development are needed:

3.4.5.1 Afforestation at scale on non-degraded land, which may not compensate the opportunity costs of land conversion, and may produce negative social impacts, including on cultural heritage values.

3.4.5.2 Bioenergy with Carbon Dioxide Capture and Storage (BECCS) is land-intensive and limited in spatial suitability but could, in appropriate circumstances and with adequate safeguards, provide Carbon Dioxide Removal.

3.4.5.3 Direct air capture and storage is expensive and energy intensive but has large potential and fewer and less severe land-competition impacts.

3.4.5.4 Enhanced weathering of minerals on land requires large volumes of materials implying negative impacts, but could permanently store a sizeable amount of Carbon Dioxide.

3.5. Carbon Mitigation Through Supply-Side Measures: Renewable Energy

In general, Supply-side Measures are policies and programmes for influencing how a certain demand for goods and/or services is met. In the energy sector, Supply-side Mitigation Measures aim at reducing the amount of Greenhouse Gas emissions released per unit of energy produced, generally through the transition to renewable energy sources. Transitioning to renewable energy is an important Decarbonisation strategy. Sustainable Development requires making 'green' energy available to rural, urban and Peri-urban communities. Intersections between cultural heritage considerations and the aim to increase the production and transmission of renewable energy include:

3.5.1 Fostering a willingness to accommodate renewable energy installations and projects, including by actively aiding in the mapping of rural and urban locations best suited to accommodating such projects while lessening the impact on heritage Values.

3.5.2. Contributing cultural heritage perspectives to the broader conversation about renewable energy. Proactively developing guidelines, standards and best practices for accommodating renewable energy installations (e.g. solar panels, wind turbines) while avoiding or lessening material impacts to heritage Values. This can include supporting the siting of microgeneration facilities on or in historic buildings and in historic urban landscapes, some of which provide community-based renewable energy options that address income equality and other community issues, and industrial scale installations which may impact cultural landscapes. Methodologies for mediating conflicts between the siting of renewable energy installations and transmission facilities, and Conservation should be provided.

3.5.3 Prioritising the identification, documentation and preservation of learning from traditional knowledge about renewable energy production (for example, Local Knowledge about geothermal, water/hydroelectric and wind power), especially those relevant to contemporary energy needs; emphasizing in the interpretation and presentation of those technologies and techniques their relevance to Mitigation Pathways.

3.5.4 Encouraging rapid electrification of older and historic buildings in tandem with decarbonisation of electricity grids. Because electricity is the key means of powering buildings with renewable energy, switching Demand-Side sources to electricity (or other renewable sources) is a key strategy to reduce Greenhouse Gas emissions and other sources of air pollution (provided that the electrical grid is itself decarbonising). Intersections with cultural heritage include:

3.5.4.1 Developing and identifying criteria and standards for electrification of historic buildings, including providing methodologies for mediating conflicts with the Conservation of heritage values.

3.5.4.2 Designing and implementing effective financial incentives for electrification that utilise appropriate heritage criteria.

3.5.4.3. Promoting research on the feasibility and comparative affordability of electrification and other decarbonised energy sources for historic buildings.

3.6 Cultural Tourism

As one of the world's largest and fastest growing industries, tourism's carbon footprint is an expanding component of global Greenhouse Gas emissions. A complete Life Cycle Assessment of global tourism conducted in 2018 found that between 2009 and 2013, tourism's annual global carbon footprint increased from 3.9 to 4.5bn tonnes of CO_2 equivalent (CO_2-eq) emission and now accounts for 8% of global emissions. (The carbon footprint of global tourism, Manfred Lenzen et al, Nature Climate Change 8, 522-528, 2018) International tourist arrivals have increased 300% over the past twenty-five years, with cultural tourism being one of the leading drivers. At the same time, cultural destinations, if appropriately managed through sustainable tourist strategies, can generate positive economic and social benefits for local communities. Tourism can raise visitors' understanding of different history, cultures and environments and has the potential to promote empathy with communities on the frontlines of climate change. Tourism destinations have the possibility of demonstrating and publicising climate Impacts and sustainability practices. Cultural heritage considerations associated with tourism implicate a wide range of Mitigation Measures including:

3.6.1 Updating cultural tourism development and management strategies by incorporating Climate Compatible Development principles into sustainable tourism models.

3.6.2 Developing guidance on the ethical dimensions of cultural tourism in the face of climate change, including tourism aimed at sites on the frontlines of climate change, like the polar regions, which require long-distance travel and concentrate visitors in ways that increase the vulnerability of sites to climate Impacts. Luxury travel, travel involving multiple air segments and long-haul travel, including to many small islands, accounts for a disproportionate share of carbon emissions. At the same time, tourism revenues in some cases are a source of funding for climate adaptation, mitigation and sustainable development, and can be particularly important in the global south.

3.6.3 Developing and implementing methodologies for monitoring and measuring the Greenhouse Gas emissions attributable to cultural tourism, including through Life Cycle Assessment, and addressing questions about allocation principles for tourism-related emissions.

3.6.4 Mitigating Greenhouse Gas emissions of the contributing service components of the cultural tourism industry, including access/transport; accommodation; food and beverage; and souvenirs, clothing and goods. Air transport remains a key challenge with long-haul air travel being particularly problematic. At a wider urban scale, promoting implementation of appropriate and more sustainable means of transportation, allowing for equitable access and use of public transport.

3.6.5. Engaging in discussions on various financing schemes related to tourism and Greenhouse Gas mitigation including emissions trading, carbon offsets, incentives and taxes. Exploring the use of tourism revenues as a dedicated funding source for climate change mitigation and adaptation actions. Showing solidarity by supporting financial and technical assistance to cultural destinations on the front lines of Sea Level Rise and other climate Impacts.

3.6.6 Promoting offsetting of GhG emissions associated with cultural tourism by purchasing certified carbon credits or supporting offset projects such as tree planting, renewable energy, energy conservation and environmental education, recognizing that offsetting is sometimes seen as controversial where it is not appropriately calibrated to attendant Greenhouse Gas emissions, takes the place of efforts to first reduce emissions through behaviour or operational change, or shifts burdens inequitably.

3.6.7 Leveraging cultural tourism destinations and attractions to increase mitigation ambitions by:

3.6.7.1 Using destinations as living laboratories to implement mitigation strategies and highlight better mitigation and adaptation practices.

3.6.7.2 Improving understanding of climate change by offering climate change education and awareness, including climate change stories in destination interpretation and visitor experiences; promoting the power of Place, past and narrative to enhance understanding of climate change; and better informing tourists about the Greenhouse Gas emissions associated with tourism.

3.6.7.3 Using iconic heritage sites to promote a sense of urgency about climate action, relating climate change Impacts and mitigation approaches to cultural tourism sites and destinations.

3.6.8 Implementing planning and management policies that would foster the use of renewable energy sources at cultural tourism destinations, consistent with the conservation of Cultural Significance.

3.7 Heritage Sector as Driver of Mitigation Ambitions

Cultural heritage agencies, organizations, sites and constituencies can lead by example:

3.7.1 Harnessing the creativity and visibility of the heritage sector to innovate on mitigation and showcase Mitigation Measures by:

3.7.1.1 Incorporating climate action considerations into cultural heritage governance, and enhancing participation in climate change networks and policy and planning processes.

3.7.1.2 Calculating and publicising the Greenhouse Gas emissions associated with cultural heritage sites, activities and organizations.

3.7.1.3 Adding climate change-related topics to cultural heritage curricula at all levels; and undertaking capacity building related to climate change, climate action and the intersection of cultural heritage and climate change for cultural heritage officials, professionals, staffs, volunteers and constituencies.

3.7.1.4 Conducting environmental analyses of heritage tours, events and exhibitions and identifying energy-saving opportunities; adopting green procurement (energy, waste and water) and carbon offsetting strategies; emphasising green products, services and business models, following examples like the Arts Council of England's Environmental Programme and Julie's Bicycle Accelerator Programme.

3.7.1.5 Incorporating Mitigation Measures into heritage site management and interpretation, energy efficient visitor infrastructure and sustainable site management.

3.7.2 Increasing messaging on climate change matters by cultural heritage agencies, organizations, sites and constituencies, including developing climate change communications strategies; showcasing case studies and better conservation practices related to climate action and climate change; and leveraging the visibility of cultural heritage by, for example, publicising energy efficiency measures undertaken by museums and cultural institutions or the retrofitting of iconic heritage buildings for energy efficiency, thereby sending a signal on addressing climate change beyond the energy conserved through conservation processes and retaining the embodied energy of heritage sites.

3.7.3 In view of the outstanding universal value, high profile, global reach, and broad mix of heritage typologies included within the World Heritage programme; and the programme's stated goal of acting as a 'laboratories of ideas' with the potential to set international standards in heritage management, addressing climate change through the World Heritage programme by:

3.7.3.1 Fostering the incorporation of mitigation considerations based on science into World Heritage site management planning.

3.7.3.2 Working at different levels to implement policy frameworks that accounts for carbon mitigation, renewable energy and protection of cultural heritage in World Heritage sites and their buffer zones.

3.7.3.3 Supporting state parties to the World Heritage Convention implementing effective carbon mitigation strategies compatible with the Outstanding Universal Value at World Heritage sites.

3.7.3.4 Leveraging World Heritage Sites to demonstrate how cultural heritage can be an asset in climate action; establishing targeted programmes to raise awareness among tourists, guides, site managers and local communities about climate change, including the Greenhouse Gas implications of cultural tourism and the capacity of World Heritage sites to contribute to Carbon Sequestration and other Mitigation Measures.

3.7.3.5 Leveraging the role of World Heritage Sites as exceptional case studies, in educating public, professionals and trades on appropriate Mitigation Measures.

3.7.3.6 Enhancing solidarity by undertaking climate action collaboration with World Heritage sites in the Global South, Small Island Developing States and other sites on the frontlines of climate action.

Sandbags being used to reduce the rate of erosion and protect from storms at a medieval cemetery, Orkney, Scotland.

© Adam Markham

Coastal flooding driven by sea level rise is increasing and increasingly affecting residents, businesses and tourists.

The Historic center of Annapolis, Maryland, USA (Photo © A. Markham 2018)

Division 4

Loss and Damage

This division correlates the core competencies and considerations of cultural heritage to the key elements of Losses and Damages, which is one of the workstreams of the UNFCCC's Adaptation and Resilience topic. The 2013 Warsaw International Mechanism for Loss and Damage associated with Climate Change impacts, is subject to and guided by the Paris Agreement. The Warsaw Mechanism addresses loss and damage associated with Impacts of climate change, including Climate Extremes and slow onset events, in developing countries that are particularly vulnerable to the adverse effects of climate change. By promoting approaches to address Losses and Damages in general, its principles are applicable to cultural heritage around the world.

The scope of the topic of Losses and Damages used in this division aligns with the strategic workstreams of the Warsaw International Mechanism for Loss and Damage identified in the rolling workplan of the Executive Committee of the Warsaw Framework. In so doing, this Divisions intersects with Division 2 of this Outline on Adaptation, particularly in terms of managing change, and is applicable in cases where adaptation is no longer an option and loss occurs or where Maladaptation could lead to loss.

Climate change-related Losses and Damages are experienced at the local level as the outcomes of Climate Extremes or slow-onset events arising from climate change processes. These Hazards and the projected Impacts are detailed in Part II of this Outline. Losses and Damages include not only specific material Impacts to heritage resources, but also Impacts to intangible heritage, most significantly through the process of climate-related displacement and human mobility.

1. Slow Onset Events

The UNFCCC Warsaw Framework identifies slow onset events as desertification, glacial retreat and related Impacts, land and Forest Degradation, loss of Biodiversity, Ocean Acidification, increasing temperatures and Sea Level Rise. The Impacts of slow onset events differ significantly from rapid onset Impacts such as Flooding, windstorms (hurricane/typhoons/cyclones) or mudslides caused by heavy rainfall. The frequency and intensity of such rapid onset events may be increased, however, by conditions associated with slow onset events. For example, when Sea Level Rise suddenly turns into Flooding, when desertification turns into wildfires, or when temperature increase turns into heat waves. In all cases, the Disasters that come about as a result of slow or rapid onset events could cause irreversible damage to, and ultimately loss of, cultural heritage and associated communities. Cultural heritage methodologies and practices can support response to slow onset events in the following ways:

1.1 Identifying events to be addressed within the context of the relevant cultural heritage typologies (see Part II, table 3).

1.1.1 Identifying the type of Hazard – desertification, glacial retreat, loss of Biodiversity etc. and the likely Impacts on heritage in its tangible and intangible forms (see Part II).

1.1.2 Identifying scale of event (in magnitude, spatial and temporal terms) and areas most at Risk (coastal, savannahs, mountain areas, deltas, etc.).

1.1.3 Defining the Risks related to the identified event and likely Impacts, including determining any Risks related to sudden or catastrophic loss or loss by attrition.

1.2 Identifying heritage most at Risk from slow onset events.

1.2.1 Identifying how slow onset events could impact the environment and identified cultural heritage;

1.2.2 Distinguishing between cultural heritage typologies – archaeological, urban, rural, landscape, etc. including any associated intangible heritage such as language, cultural practices and place names.

1.2.3 With respect to tangible heritage, identifying the key material elements (wood, stone, etc.) and how changing climate conditions specifically affect these materials. Also noting nuances related to loss of cultural memory, knowledge and management systems, as well as lifestyle changes and other Impacts on living heritage. Materials used to make heritage objects/structures are often sourced from the immediate surroundings; they could also serve as good indicators of local weather and climate conditions. For example, Indian Buddhist Thankas that survived through hundreds of years in the dry high-altitude climate of Ladakh are now experiencing rapid deterioration due to a combination of increased humidity and poor maintenance due to loss of Local Knowledge.

1.3 Utilising citizen science, community observations and knowledge of the interactions between climate and weather events and their cultural resources/ practices, including:

1.3.1 Citizen monitoring of impacts of slow onset events on their cultural heritage, and the loss and damage issues arising thereof.

1.3.2 Acquiring local knowledge inputs on the interactions between slow-onset events and cultural practices, and consequent loss and damage.

1.3.3 Identifying, mapping and assessing condition and Vulnerability of areas exposed to slow onset events, and populations living in these areas and using historical precedence to assist with the identification of those areas particularly exposed, rather than relying exclusively on existing databases and Climate Projections (UNFCC 2019f).

2. Non-economic losses

The United Nations Framework Convention on Climate Change (UNFCCC) makes the distinction between economic and non-economic losses. Economic losses can be understood as the loss of resources, goods and services that are commonly traded in markets. Non-economic losses are those that are not commonly traded in markets, including losses of, inter alia, life, health, displacement and human mobility, cultural heritage, indigenous/local knowledge, biodiversity and ecosystem services. (UNFCCC 2013). Many countries and organizations currently do not have robust methods for assessing Losses and Damages and this is particularly the case for non-economic losses including loss of Cultural Significance. The development of methodological approaches that identify and measure what is damaged by Climate Impacts advances the understanding of the vulnerability of communities and clarifies the dynamic and complex interaction between adaptation and other preventive and reactive measures. In also illuminates the cost of Climate inaction. The Sendai Framework for Disaster Risk Reduction embodies a similar concern for accounting for disaster losses. Heritage practice addresses non-economic loss and damage by:

2.1 Developing methodologies and mechanism to systematically identify, evaluate, record, share and publicly account for Loss and Damage to cultural heritage from Climate Impacts.

2.2 Identifying and documenting knowledge systems likely to be lost or damaged due to climate change. This includes loss of Local Knowledge and Indigenous Knowledge and measurement of associated Impacts. The disappearance of landscape features and relative elements on which knowledge systems are based could lead to the loss of cultural practices. Further, intangible heritage such as language could be affected through the loss of words or expressions linked to elements of landscape. Other points to identify loss of pride of Place, consequent rise in vandalism and anti-social behaviours; loss of historic character and Setting.

2.3 Improving the measurability of Impacts and eventual loss of cultural heritage – tangible and intangible – and improving understanding of the economic, social, health, education, and environmental cost of losses and damages to cultural heritage, in the context of specific Hazard, Exposure and Vulnerability information (including effects on social cohesion and identity).

2.3.1 Defining or clarifying the measurable, non-monetary values that make up the Cultural Significance of a given heritage resource in order to determine the Adaption Limits of that resource or system, including the acceptable and non-acceptable levels of change, loss and irreplaceability.

2.3.2 Identifying any impact on intangible heritage, including on belief systems.

3. Comprehensive Risk Management approaches

The Warsaw Framework identifies four comprehensive Risk Management approaches: emergency preparedness, including Early Warning Systems; measures to enhance recovery and rehabilitation; social protection instruments, and transformational approaches (UN Climate Change 2019e). These can be operationalized through heritage in the following ways:

3.1 Identifying and prioritising the various Risks to heritage resources from climate change according to the typology of resources.

3.2 Mobilising Indigenous Knowledge and Local Knowledge (with prior, free and informed consent as appropriate) to manage risks to cultural heritage associated with climate extremes and slow onset events.

3.3 Building long-term resilience by learning from cultural practices/vulnerable populations and communities, including:

3.3.1 Developing recovery plans built on cultural precedents while also employing the tools of digital technology.

3.3.2 Learning from similar experiences elsewhere in the world.

3.3.3 Developing the role of heritage in community-based strategies for enhancing coping capacity and developing stakeholder-driver strategies for managing climate risk to heritage resources, including trade-offs.

3.4 Expanding engagement with insurance sector to identify how insurance and other risk ring transfer mechanisms could be deployed for cultural heritage. This would build upon recent attempts in places like New Orleans (USA) and Christchurch (New Zealand).

3.5 Managing climate risks to heritage through impact assessment and associated regulatory frameworks.

3.6 Addressing heritage in national (regional and local, as applicable) strategies for Disaster Risk Management and national adaptation plans and other related plans.

Working with disaster response authorities (local, regional, national): to make them aware of heritage sites and issues and discuss appropriate response plans and coordinated Risk Assessments; to develop protocols for risk preparedness and responses to events on heritage sites and to reduce adverse effects from the response i.e. wholesale demolition in response to earthquake and fire damage; to plan risk preparedness. While historical data and past experiences could be helpful, they may not be enough in the face of the speed of Global Warming and the associated climatic changes. Thus, modelling projected climate change Impacts needs to be carried out at heritage sites (particularly iconic sites such as World Heritage Sites) to identify risks and allow for planning for Risk Mitigation, especially within the framework of Risk Management. For example, heritage identification and vulnerability assessment are addressed in the 2016 National Adaptation Plans of Sri Lanka and Palestine.

4. Migration, displacement and human mobility

While estimates vary, credible studies indicate that millions of people will face multi-faceted challenges associated with climate change-related migration and displacement in the coming decades. A number of communities are already seeing these impacts with Small Island Developing States and other Indigenous and marginalized communities often on the frontlines. Some climate impacts, such as sea level rise, can put land completely underwater, making it uninhabitable. Others, like drought, make it impossible for people to support themselves. The systemic nature of the problem points to the need to supplement emphases on individual resettlement and humanitarian concerns with planning for the relocation of entire at-risk communities. The Paris Agreement recognized this and assigned one of the Warsaw International Mechanism for Loss and Damage, to develop recommendations for integrated approaches to avert, minimize and address displacement related to the adverse impacts of climate change. Although displacement and human mobility appear as a non-economic loss, the Warsaw Framework Executive Committee established a separate Task Force on Displacement (TFD) to develop recommendations for integrated approaches to avert, minimize and address displacement related to the adverse impacts of climate change (UN Climate Change 2019c).

4.1 Role of Heritage before displacement in climate contexts. As people lose their lands, what becomes of their historic and sacred sites? When whole communities are displaced, how can their cultures be conserved? How can their traditional knowledge be retained? How can heritage support individuals and communities that are facing climate mobility? A starting point involves developing heritage methodologies to identify at-risk communities and populations and to assess likely Impacts to their heritage as a result of disruption due to displacement and human mobility.

4.1.1 Creating frameworks for identifying communities at risk for displacement into heritage planning and for engaging culturally adaptive strategies for managing the change brought about by displacement and Migration. Measures taken should address the need to conserve and perpetuate the collective scientific and intangible heritage Values of displaced communities amidst relocated populations and the diaspora.

4.1.2 Using collaborative community processes to: identify heritage Conservation priorities; and develop strategies for reducing the rate of deterioration, recording, minimizing loss of important scientific information, preserving examples of past technologies, and commemorating, representing and interpreting the sites, places and cultural land and seascapes left behind for future generations.

4.1.3 Identifying sites most at risk of abandonment and developing proactive resettlement strategies, which incorporate cultural issues. Recording heritage that would most likely be left behind and developing priorities for managing heritage in displacement and human mobility, especially permanent displacement, through consultation with relevant stakeholders.

4.1.4 Bringing a cultural heritage perspective to the process of identifying sites to welcome displaced communities. For some Small Island Developing States (SIDS), cultural considerations have been cited in the choice of relocation sites.

4.1.5 Considering climate Risk Perception of communities facing climate change Impacts likely to lead to significant population displacement.

Some communities may value maintaining their social and cultural capital higher than the possible loss in Livelihoods and related distress. For example, despite experiencing total land subsidence probably greater than the central value of the climate change IPCC's Fifth Assessment Report's projected Sea Level Rise by 2100 (0.28 m-0.98 m), some small-island communities in the Philippines, with medium Flooding severity, are refusing to relocate, contradicting the Sea Level Rise mass Migration theory that suggests that worsening Floods will always lead to Migration.

4.1.6 Developing implementation guidelines to include heritage considerations, related to climate-related displacement, in national adaptation plans and in alignment with the Sendai Framework for Disaster Risk Reduction.

4.2 Recognizing the role that culture and heritage play during displacement and in planning effective resettlement strategies.

4.2.1 Maintaining heritage, tangible and intangible, throughout the moving process.

4.2.2 Developing engagement strategies that consider the impacts on the cultural heritage of receiving communities that arise from receiving displaced communities, as well as the impact on the cultural heritage of the displaced community on the relocation and resettlement process.

4.3 Role of Heritage after displacement in climate contexts

This includes the use of heritage to help displaced communities, whether temporary or permanent, to create a sense of the familiar, and maintain familiar practices and social relationships by modifying their environment; and the use of the heritage associated with the place of relocation to help create inclusion for the new arrivals.

4.3.1 Identifying and implementing heritage-based emplacement strategies, such as reuse of names of landmarks.

4.3.2 Using heritage to support Social Integration.

4.3.3 Considering heritage and identity of the displaced community in its new location.

4.3.4 Consulting traditional owners of lands and other stakeholders of host communities, before, during and after the resettlement process, to ensure Equity and Justice for all.

5. Action and Support

Cultural heritage perspectives and methodologies can be contributed to broader initiatives to provide action and support around Loss and Damage.

5.1 Incorporating heritage considerations including accessing finance to support loss and damage strategies for cultural heritage e.g. green climate fund (GCF).

5.2 Providing Capacity Building support, skills transfer and knowledge sharing regarding the cultural heritage dimensions of Loss and Damage, with an emphasis on Least Developed Countries (LDCs), Small Island Developing States (SIDs) and other front-line and vulnerable communities.

5.3 Leveraging and enhancing heritage methodologies to support culturally appropriate, stakeholder engagement with relevant parties around loss and damage issues.

Climate change may affect the ability of farmers to grow traditional varieties of crops such as these bananas for sale at a roadside market in southern Uganda.

Photo Credit: © A. Markham

Part II

Part II of this Outline provides a framework for systematically cataloguing the impacts of climate change drivers on six cultural heritage typologies. As noted in the Introduction to Part I, responding to climate change is about adjusting to risks, either in reaction to or in anticipation of a changing climate. Understanding the impact of climate change on natural and physical systems, human communities and cultural heritage is essential in evaluating and managing not only the risks to cultural heritage and its adaptive capacity, but also the positive role cultural heritage can play as a source of resilience for ecosystems, cities, neighbourhoods, sites and cultural landscapes.

While climate change is already impacting communities and heritage globally, these trends are predicted to worsen; and the adverse Impacts to greatly increase (ICOMOS, 19GA 2017/30). Part II focuses primarily on physical climate drivers and their Impacts on heritage, but it is key to recognize that climate change is a threat multiplier that aggravates other stressors such as poverty, environmental degradation, political instability and social tensions. Conflict, displacement and famine are all Impacts that can be driven, or exacerbated, by climate change, and they will increasingly challenge cultural heritage. Perhaps most stark among these is the prospect of displacement, either through the process of planned relocation/retreat or other forms of climate mobility, such as population Migration as a result of Drought or desertification. When people are displaced and disconnected from places that they value, there is strong evidence that their cultures are diminished, and in many cases endangered.

Heritage may also be Impacted by well-intended Climate Action (e.g. Adaptation and Mitigation measures), in some cases as a result of considered balancing of needs and values and in other cases through Maladaptive Actions or ill-conceived responses. Maladaptation is more likely to occur when the cultural dimension of climate action is not taken account of and thus can at least partially be combatted by the engagement in broader climate change work by heritage actors.

No community, culture, region or type of heritage is immune from climate Risks. Climate change will test in profound ways the Adaptive Capacity of diverse management and cultural systems. There are often no effective substitutions or adequate compensation for lost Cultural Significance (Adger op cit.) Part I, Division 4 Loss and Damage speaks further to this challenge.

In most cases climate change Impacts on cultural heritage are likely to be perceived as negative (although such assessments themselves are culturally contingent). These Impacts result in damage and degradation, and in many cases loss and destruction of monuments, historic sites, museums, collections, libraries, archaeological resources, cultural landscapes, intangible heritage and associated and dependent communities. However, in some cases there could also be some positive Impacts (e.g. decreased stone erosion resulting from reduced rainfall; higher crop yields resulting from increased temperature).

Responding to the unprecedented, systemic threat of climate change calls for adjustments in the aims and methodologies of all stages of heritage practice. As discussed in the 'Heritage Tools and Methodologies' essay earlier in this Outline, climate change will require reassessments of most heritage methodologies including the preparation of inventories, heritage Values assessments, documentation and monitoring, impact assessments (e.g. Heritage Impact Assessment or HIA), vulnerability matrices, conservation management planning, risk assessment, vulnerability assessment and adaptation planning. Key to all of these is the ability to evaluate climate risk, which thus must become a baseline competency of all those who care for heritage.

Evaluating climate risk in the heritage context requires managers to develop an understanding of how the main physical climate drivers (e.g. temperature, precipitation, humidity, etc.) interact with each other in causing Impacts such as sea-level rise, coastal erosion, Flooding, aridification and worsening wildfires. And also, how these impacts affect Cultural Significance and the carriers of heritage values, be they human (as with intangible heritage), flora and fauna (as with landscapes) or materials (e.g. stone, timber, plaster, earthen architecture, ceramics, stained glass, paper, etc.). Common geographies and ecosystems (e.g. tropical, temperate or polar regions; coastal, marine, montane, desert or riverine locations) often create common risk profiles, creating opportunities for heritage managers to reach across political boundaries and professional disciplines to seek mutual support from those similarly affected.

As a starting point, heritage management can no longer be predicated solely on historical climate or weather records. A changing climate means changing weather. Predictions of future climate change Impacts and cultural heritage responses need to be developed using recent and current observations as proxies for future change, integrated with the range of climate and Emissions scenarios developed in the most recent Assessment Reports of the IPCC. The ability to Downscale 20- and 30-year climate Scenarios will be a necessary skill of every heritage manger.

In describing climate Impacts and their effects on cultural heritage, it is useful to distinguish between rapid-onset and slow-onset events:

- 'Rapid-onset' events are short-lived, acute, intensive, recurrent, highly damaging and uncontrollable. They include extreme winds, hurricanes, typhoons, storm surge, extreme precipitation, hail storms, flash Floods, landslides, heat waves, and wildfires. Climate change is expected to increase the frequency and intensity of many of these types of events through much of the world.
- 'Slow-onset' events are long-lived, progressive and potentially permanent transitions that are less damaging in the short-term, but which may have profound consequences over the longer-term. They include Glacier melt, Sea Level Rise, aridification, desertification and changes in seasonality and species distribution. For built heritage and materials, longer-term interactions of climate change with air pollution are of concern (e.g. degradation of limestone and marble façades, soiling of stone surfaces, chemical leaching of medieval stained glass and metal corrosion) as well as salt crystallization in porous walls (e.g. stone, brick, plaster, mosaics, wall paintings, etc.),

UNESCO's 2007 publication Climate Change and World Heritage: Report on predicting and managing the impacts of climate change on World Heritage and strategy to assist States Parties to implement appropriate management responses was the first attempt to present an overview of the threat to cultural heritage from climate change. Table 4 in the present report attempts to summarize and update material from the 2007 report, identifying some of the physical and biological mechanisms by which aspects of climate change (and climate in combination with air pollution) can affect materials, artefacts, collections and Cultural Landscapes.

In 2016, UNESCO, UNEP and UCS published a new assessment of climate impacts to World Heritage (World Heritage and Tourism in a Changing Climate), which included recommendations for monitoring, actions and policy responses. Table 5 draws from the analysis and case studies in that report, and from the most recent IPCC reports, to provide an updated overview summary of the main types of climate change impacts that will affect cultural heritage together with illustrative examples. Also, in 2016, the U.S. National Park Service published its Cultural Resources Climate Change Strategy which included a detailed matrix of climate impacts on various types of cultural heritage. Table 3 builds upon and expands on this matrix. Its goal is to highlight potential climate impacts to cultural heritage in five key categories – museums and collections; archaeological resources; buildings and structures; cultural landscapes; associated communities; and intangible heritage.

For the sake of simplicity, individual climate drivers (such as increased temperatures and increased storminess) have been highlighted in the table, but it is recognized that many of these climate drivers act in combination, and that the complexity of these interactions has been difficult to capture here. For example, wildfire intensity and frequency are driven by a combination of changes in temperature, precipitation change, rainfall and relative humidity (and wildfire is also related to land-use management changes); storm damage results from a complex dynamic of Sea Level Rise, storm surge, winds, waves (and coastal development); and coastal erosion on sensitive coasts is driven by Sea Level Rise, storminess, wave height, wind direction and storm surge (and in some cases in the Arctic, loss of seasonal Sea Ice and Permafrost thaw). As a result of these complex interactions there may be some repetitiveness in the table, because Impacts are covered under multiple climate drivers.

Table 6 is not meant to be an exhaustive review of all climate Impacts on every aspect of cultural heritage, but rather a reasonably comprehensive indicative guide to the many ways in which cultural resources will be impacted. The reader of these tables should keep in mind that they represent only the state of current knowledge and provide qualitative information without any ranking of severity or priority.

Together, the materials in Part II of the Outline provide an initial overview of the myriad ways in which climate change will affect heritage across all categories.

Table 4: Summary of key climate factors and mechanisms of impact on heritage materials, sites and landscapes.

Climate Driver	*Mechanism of Impact*
Increased Temperature	• Influence on risks linked to frost • Heat-waves and days of extreme heat • Urban Heat Island Effect • Thawing of permafrost (destabilization of buildings, foundations and infrastructure) • In cold and wet regions, the risk of damage to materials by chemical degradation is weak, while the risk of mechanical degradation is relatively high. • In warm and dry regions, there would be a high risk of chemical degradation, but the mechanical degradation would be reduced.
Sea Level Rise	• Coastal erosion leading to the destruction of landscapes, structures and archaeological sites. • Submersion of the littoral zone by over Flooding, crossing and rupture of protective structures. • Invasion and salt inundation of continental zones by marine waters.
Climate Change (e.g. temperature, precipitation, humidity and wind) and air pollution combined (outdoor)	• Erosion of façades in stone, rendering and brick. • Degradation of concrete: carbonation, corrosion of steel rebars. • Soiling and colour change of façades • Alteration of ancient stained-glass windows • Corrosion of metals • Biodegradation of façades • Wind damage
Climate Change (e.g. temperature and humidity) and air pollution combined (indoor)	• Biodegradation of wood. • Bio-infestation and chemical degradation of collections and archives. • Bio-infestation and chemical degradation of decorated caves • Degradation of polymers, papers, films and contemporary artworks
Precipitation and humidity	• Intensity and duration of extreme precipitation events or Droughts • Recurrent fluvial flows and flash-Floods: damages by the force of Flood water, debris, sediments; release of pollutants • Rising of salt loaded moisture (i.e. efflorescence) by capillary action in walls, frescoes, wall paintings, mosaics and statues • Effects of wet-frost on porous materials • Swelling-shrinkage of clay minerals in soils endangering the stability of buildings. • Landslides

Table 5: Summary of the types of climate impacts which can be expected to affect heritage and some examples of those effects.

Climate Impacts	*Examples of expected effects on heritage*
Sea level rise	Sea level rise worsens coastal flooding, storm surge and coastal erosion (see below). Threats include permanent inundation of low-lying coastal communities and displacement of populations. Rising sea levels can cause freshwater drinking supplies for traditional communities to become salinized, especially on islands; rising water tables can cause underground archaeology to be damaged; and buildings and statues may be damaged by capillary action in porous materials. Permanent inundation of low-lying coastal cave art and tidal zone archaeology is likely.
Coastal flooding	Flooding exacerbated by sea-level rise will permanently inundate some areas and increase storm surge damage in others, resulting in damage to or loss of historic buildings and districts, cultural landscapes, archaeology and sacred sites.
Coastal erosion	Coastal erosion Impacts are also increased by sea level rise and more intense or more frequent storms, resulting in damage to or loss of historic buildings and districts, cultural landscapes, archaeology and sacred sites.
Loss of sea ice	Culturally important ice-dependent species may lose habitat and their populations decline; shipping access to sensitive areas may increase. Loss of seasonal ice can expose erodible coasts to winter storm damage, accelerating loss of archaeological resources.
Glacial melt	Glacial melt lakes can overflow, threatening villages and communities; Loss of glaciers jeopardizes vital water supplies for cities, villages and rural areas.
Permafrost thaw, ice patch melt and warming soils	Melting permafrost in mountain or polar environments exposes frozen archaeology to erosion. Warmer soil temperatures accelerate microbial decay of buried organic materials; melting ice patches may expose previously frozen archaeology. Foundations of buildings and structures in permafrost areas will be damaged by softening and subsidence of substrate.
Changed freeze/thaw cycles	Warmer winters increase the frequency of freeze/thaw cycles in some areas thereby increasing likely structural damage to materials such as brick and stone.
Increased ocean temperatures	Increased ocean temperatures affect ecosystems that form important parts of cultural landscapes and provide livelihoods for coastal communities and traditional practices. Warmer seas also have implications for underwater archaeology, for example the increased prevalence of organisms that damage wooden structures, such as shipworm species.
Increased storm intensity and/or frequency	More intense or more frequent storms increase rates of coastal erosion and damage to or loss of historic buildings and districts, cultural landscapes, archaeology and sacred sites. Risk from flooding and wind damage increases.
More extreme rainfall	Worse and more damaging floods and landslides are caused by more rain falling in shorter periods of time. Historic buildings can be damaged or completely lost. Tourist footfall at high visitation heritage sites can cause more damage and erosion in wet conditions.
Increased humidity	Increased humidity is a major threat to indoor collections unprotected by air conditioning or dehumidifying technology; humidity in caves and semi-enclosed archaeological sites can damaged pigmented rock art and plastered surfaces.
Increased wind or changes in wind direction	Wind can increase abrasion and degradation of rock art and underwater archaeological sites, cause damage to historic buildings, changes in the dynamics of sand dune systems, loss of agricultural topsoil, and increased wave height and erosion at the coast.
Drought	Drought affects agro-ecological cultural landscapes, may cause loss of forests important for traditional foods or building materials, and may also cause damage to built structures due to cracking or splitting. Drought exacerbates issues of water scarcity and conflict, and it causes internal displacement and migration.

Table 5 continued: Summary of the types of climate Impacts which can be expected to affect heritage and some examples of those effects.

Climate Impacts	*Examples of expected effects on heritage*
Aridification	Long-term transformation of regions to drier conditions alters cultural landscapes, often drives internal displacement, Migration and abandonment, and can drive conflict. Culturally important species can be lost and water and irrigation systems and structures lose effectiveness.
Heatwaves	Heatwaves are an increasing threat to human health in all types of communities, especially when accompanied by increased relative humidity. Heatwaves can affect agricultural productivity and disrupt traditional festivals.
Changes in seasonality	Changes in season affect agriculture and traditional management in cultural landscapes, disrupt traditional festivals and planting cycles and affect the migration and breeding of culturally important species. Longer summers combined with drier conditions can cause more and larger wildfires. Shorter winters can enable pests to more successfully survive cold spells. Historic gardens and plantings may lose the coherence of their planting plans.
Changes in species distribution driven by climatic changes	Culturally important species used for traditional building, food or spiritual practices may become scarce or be lost. Pests, invasive weeds and insect-borne diseases may move into new areas. Planned landscapes and gardens may lose important species.

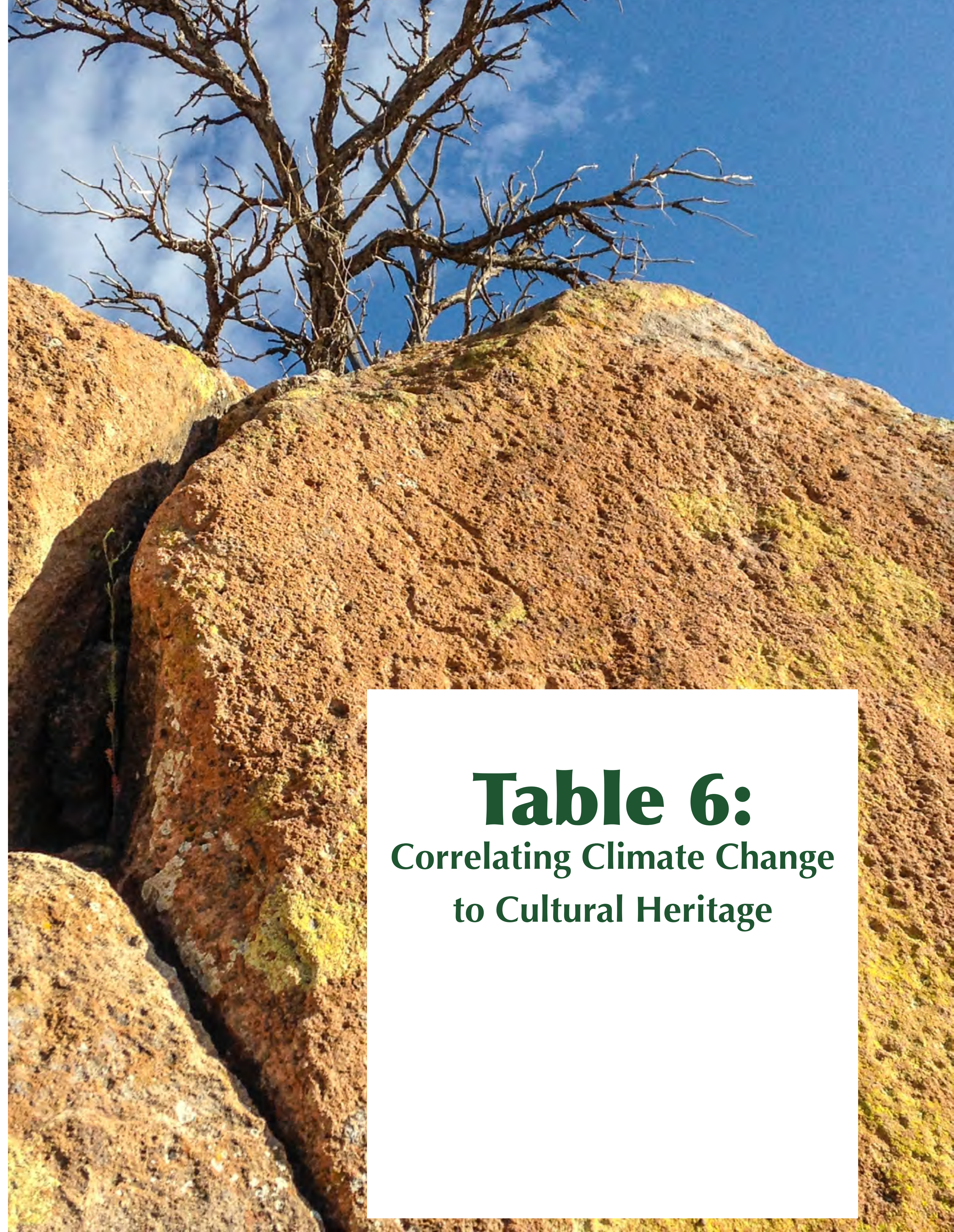


Table 6:
Correlating Climate Change to Cultural Heritage

The main columns in the Table represent six categories of cultural heritage: moveable heritage; archaeological resources; buildings and structures; cultural landscapes; associated and traditional communities; and intangible heritage. The rows describe the primary climate change impacts (e.g. temperature and precipitation changes, climate-influenced wildfires, changes in seasonality, etc) as well as some compounding related stressors (e.g. pollution and ocean acidification). The reader can look across the rows to see how any particular Impact may affect particular aspects of cultural heritage but should also bear in mind that many climate drivers act in combination with each other, or with other social and environmental impacts (such as land-use, pollution and tourism). Many climate impact consequences for heritage appear in multiple rows in the table, and although this leads to some repetition (i.e. especially in the acute and chronic flooding, and storm surge columns), the authors felt it was necessary to structure the table to ensure that readers looking at only one or a small number of types of impact will not miss key potential consequences. It should also be noted that there is no attempt here to rank the relative magnitude or importance of the Impacts described. Source studies and references were omitted in the interests of available space in the Outline, but will be included in a future, stand-alone version of the table.

Climate Change Impacts	Moveable Heritage (including Museums & Collections)	Archaeological Resources (including underwater archaeology)	Buildings & Structures	Cultural Landscapes (including submerged cultural, landscapes and Historic Urban Landscapes, parks and gardens)	Associated & Traditional Communities	Intangible Cultural Heritage
Increased Temperature	***Facilities*** • Increased stress on HVAC systems in storage facilities • Increased space constraints due to more items requiring protection in storage facilities • Increased need for environmental controls in facilities/house collections • Increased insect pest problems ***Collections (without appropriate climate controls)*** • Increased rate of chemical decay • Increased stress due to fluctuations in environmental conditions	• Micro-cracking of site contexts from thermal stress • Faster deterioration of newly exposed artefacts and sites • Deterioration of newly exposed materials from melting alpine ice and snow patches • Accelerated rusting in submerged and littoral resources from warmer ocean temperatures • More rapid decay of organic materials below and above ground • Damage from increased biological activity at shallow (~<100m) underwater sites • Increased risk of damage due to decline/loss of protective sea grass or nearby coral reefs • Increased tree and vegetation growth with associated root or other damage • Greater tidal movement and associated currents would have significant impacts on shallow-water and intertidal sites • Looting and the dispersal of the site during subsequent tidal or sediment movement • Increased risk of fire • Desiccation of waterlogged deposits; loss of Palaeoenvironmental information • Changes in plant growth on archaeological sites (e.g. lichens on Neolithic megaliths)	***Structural deterioration or degradation*** • Increased crystallization of efflorescent salts due to increased evaporation rates, leading to increased rates of structural cracking and deterioration • Change in dwelling characteristics that would differ from the traditional ones • Increased risk of fire • Increased risk of insect pests damaging building fabric ***Utility Infrastructure*** • Increased demand for complex air conditioning systems that can add stress to the building envelope and often requires significant alterations to a structure (including insulation, routing of extensive ducts and pipes, etc.). (NB. Increased demand for cooling systems increases energy demand and potentially increases CO2 emissions) • Inadequacy of current guidelines for rehabilitation of monuments for addressing temperature changes	• Decline or local disappearance of some plant or animal species. Increase of different species. • Global extinctions • Heat stress on culturally significant plant or animal species • Changes in the capacity to grow traditional crop varieties/animal husbandry • Loss of specimen plantings in designed landscapes, parks and gardens • Lower crop yields • Increased risk of fires and longer wildfire season • Increased stress (e.g. desiccation, warping, cracking, etc.) on constructed landscape features • Change of behaviour in using public spaces, parks and gardens, housing and facilities due to heat waves; • Change hours of visitation (seasonal shift, daily shift) • Increase of A/C equipment on buildings resulting in changed external appearance	• Loss of food security leading to increased migration • Increased heat leading to decreased agricultural and economic productivity • Increased impacts of heat leading to migration to more temperate areas • Increased impacts of heat leading to loss of population (death) and weakening of health in remainder • Increased stress, loss of population leading to fewer resources to expend on maintaining cultural resources	• Culturally relevant species • Loss of ecosystem for the support of culturally significant species • Potential loss of culturally significant species due to increased disease threat, or loss of local climatic range • Changes in prevalence of culturally relevant plant and animal species • Cancellation of traditional cultural activities • Local knowledge, practices and rituals • Inability to engage in traditional practices to store food frozen in Arctic communities (e.g. seal meat, fish) • Limited winter hunting from increased winter snows • Limited access to hunting areas due to reduced sea ice at high latitudes • Loss of traditional harvesting (e.g. traditional fisheries practices in Hawaii due to erosion of traditional structures; • Limits to shellfish harvest periods due to neurotoxins linked with increased water temperature) • Altered place meaning due to loss of snow pack, significant vegetation such as heritage trees, spatial definition due to loss of tree stands, etc. • Impediment to the development or practice of traditions (e.g. wearing traditional costumes, performing dances, etc.) • Loss of Arctic and Antarctic ice masses as cultural concepts • migration of rural populations to urban areas resulting in lost, altered or forgotten cultural practices

Climate Change Impacts	Moveable Heritage (including Museums & Collections)	Archaeological Resources (including underwater archaeology)	Buildings & Structures	Cultural Landscapes (including submerged cultural, landscapes and Historic Urban Landscapes, parks and gardens)	Associated & Traditional Communities	Intangible Cultural Heritage
Changed Freeze/Thaw Cycles	***Facilities*** • Surface cracking, flaking, and sugaring of building stone, masonry and spalling of brick due to increase in wet-frost • Greater structural damage due to fluctuating environment, causing cracks in building that allow more access for pests to invade and damage collections • Required changes in access roads/paths required, including changes in the historical topography • Drastic temperature fluctuations require more need for indoor climate control	• More rapid decay of organic materials • Disruption of soil structure, especially in permafrost (leading to loss of stratigraphy, exposed artefacts and damage to archaeological mounds/structures from expanded thaw regions) • Destruction of archaeological deposits due to increased solifluction (downhill flow of saturated soil) activity • Increased rates of deterioration in metals from thermal stress • Increased mobile ice physically scouring shallow submerged landscapes, buildings and shipwrecks	***Structural Deterioration*** • Surface cracking, flaking, and sugaring of building stone, masonry and spalling of brick due to increase in wet-frost • Damage to foundations due to increased frost heave action • Spalling and collapse of caves and bedrock alcoves onto structures inside them • Increased absorption of salts from road and sidewalk treatments which can lead to efflorescence, cracking and spalling, etc. • Structural damage to roofs	• Decline/disappearance of some vegetation species due to recurrent freezing, and loss of plants susceptible to frost heaving • Increase of some pests due to lack of *killing freeze* over a long period or entire winter, but instead a winter with several freeze/thaw cycles • Food stress or starvation of foraging animals (horse, caribou) from impenetrable ice layers more likely to form on grazing fields or habitat • Loss of historic, specimen plantings in designed landscapes, parks and gardens, or of traditional cultural plantings • More rapid deterioration of constructed materials of landscape features (e.g. corrosion, decay, desiccation) • Increased infrastructure investments particularly pavements and other hard surfaces which rely on stable sub-surface support.	• Potential increases in crop failures, including for example, fruit trees (due to early warming followed by late frost) • Increased pest damage to traditional crops that in turn drive up costs that may surpass community resources • Loss of Food Security leading to increased migration	***Culturally relevant species*** • Loss of ecosystem for the support of Culturally Significant species • Potential loss of Culturally Significant species due to increased pathogens • Changes in prevalence of culturally relevant plant and animal species ***Local Knowledge, Practices and Rituals*** • Change in traditional practices for storing food frozen in Arctic communities (e.g. seal meat, fish) • Limited winter hunting • Limited access to hunting areas due to reduced Sea Ice in northern areas • Loss of local languages/words specific to elements and interactions in the natural and cultural environments • Introduction of new words in local languages to describe changes in the natural environment ***Place Attachment*** • Altered place meaning due to loss of snow pack, significant vegetation such as heritage trees, spatial definition due to loss of tree stands, etc.

Climate Change Impacts	Moveable Heritage (including Museums & Collections)	Archaeological Resources (including underwater archaeology)	Buildings & Structures	Cultural Landscapes (including submerged cultural, landscapes and Historic Urban Landscapes, parks and gardens)	Associated & Traditional Communities	Intangible Cultural Heritage
Permafrost Thaw	***Facilities*** • Destabilization of buildings from cracks in foundations and other infrastructure • Change in use, abandonment of lower floors and/or total abandonment due to changes in access as the surrounding ground becomes boggy • Changes in access roads/paths required, including changes in the historical topography	• Loss of artefacts and contexts from increased erosion • More rapid decay and loss of organic materials (e.g. fabrics, animal skins, wood, seeds etc.) • Disruption of stratigraphy from changed soil structure, solifluction, leading to loss of context and dating capabilities • Appearance of vegetation (e.g. trees expanding into the tundra) with deep roots that can destroy sites) • Increased looting and/or collection of newly exposed or washed out artefacts	***Structural Deterioration*** • Destabilization of buildings; settlement into the ground • More rapid decay of organic building materials • Risk of damage to Antarctic Historic Sites and Monuments from seismic and glaciological tsunamis induced by calving ice sheets ***Use*** • Change in use or abandonment due to changes in access as the surrounding ground becomes boggy and/or ground water levels rise ***Utilities Infrastructure*** • Required changes in access roads/paths required, including changes in the historical topography	• More rapid decay, desiccation of constructed materials and/or landscape features • Destruction of land and buildings due to increased coastal and riverine erosion • Change in hydrologic system resulting in drainage of lakes and loss of associated species • Decline/disappearance of key plant or animal species	• Relocation of communities • Increased disease risk from previously frozen waste dumps or graves of people or livestock that died from disease (e.g. anthrax, flu) • Loss of access to roads and tracks used as emergency evacuation routes for l Disasters or medical emergencies	***Culturally Relevant Species*** • Loss of access to wildlife corridors due to terrain that can no longer be traversed by foot or vehicle ***Local Knowledge, Practices and Rituals*** • Traditional knowledge of wildlife corridors and locational cycles no longer applies as species find new corridors/ locations • Traditional rituals no longer possible or will have to change due to loss of materials endemic to the ritual • Traditional food sources change, leading to food systems and recipe changes • Loss of local languages/words specific to nutrition • Introduction of new words in local languages to describe changes in the natural environment ***Place Attachment*** • Traditional stories no longer have an identifiable place in the changed cultural landscape

Climate Change Impacts	Moveable Heritage (including Museums & Collections)	Archaeological Resources (including underwater archaeology)	Buildings & Structures	Cultural Landscapes (including submerged cultural, landscapes and Historic Urban Landscapes, parks and gardens)	Associated & Traditional Communities	Intangible Cultural Heritage
Increased Water Vapour Content in the Air (leading to changes in relative humidity in combination with temperature change)	***Facilities*** • Increased wear on HVAC systems, and energy use to stabilize drastic changes in humidity ***Collections (without appropriate climate controls)*** • Increased rusting/ corrosion of metals • Damage to paintings • Warping, cracking of wood • Damage to archival, paper, book, and photo collections • Increased risk of mould, especially organic collections • Increased salt damage to ceramics with humidity fluctuations • Increase in pest populations and infestation • Degradation of polymers, papers, films, and contemporary artworks • Accelerated deterioration of museum items exhibited outside	• More rapid decay of organic materials • Increased damage/decay of cave art, murals (e.g. frescoes) • Increased corrosion of vulnerable/less stable metals • Increased mould, especially in enclosed sites (e.g. vaults, tumuli, and caves)	• For brick and porous stone, increased moisture absorption, leading to increased risk of frost damage, mould growth, and stress from salt crystallization • Damage to lime-base mortar from salt crystallization and recrystallization • Decrease/increase in crystallization and dissolution action of salts within stone and masonry • Sulphur dioxide deposits on wet/damp surfaces, corroding stone, metal and glass • Swelling and cracking of wooden building materials and architectural features • Increased insect activity (e.g. termites), and growth of destructive organisms (e.g. mould, algae) for wood, stone, and masonry • Increased potential for rot in wood and other organic material • Damage to plaster and stone surfaces • Damage to interiors of rock hewn structures	• More rapid decay of constructed materials and/or landscape features • Increased desiccation, warping and cracking of constructed landscape features • May lead to a change in urban typologies, in looking for shadow and breeze • Higher incidence of pathogens leading to decline/ disappearance of key plant and animal species • Decline/disappearance of critical vegetation species • Increase/spread of some vegetation species • Loss of specimen plantings in designed landscapes, parks and gardens	• Increased lethal impacts of heat in high humidity conditions. Some areas may become practically uninhabitable because heat/humidity threshold is surpassed • Reduced food security	***Culturally relevant Species*** • Decline/disappearance of vegetation species important to cultural practices, other species favoured ***Local Knowledge, Practices and Rituals*** • Cultural practices modified by inclusion of new species • Traditional food sources change, leading to food systems and recipe changes • Loss of local languages /words specific to elements and interactions in the natural and cultural environments • Introduction of new words in local languages to describe changes in the natural environment ***Place Attachment*** • Traditional stories no longer have an identifiable place in the changed cultural landscape

Climate Change Impacts	Moveable Heritage (including Museums & Collections)	Archaeological Resources (including underwater archaeology)	Buildings & Structures	Cultural Landscapes (including submerged cultural, landscapes and Historic Urban Landscapes, parks and gardens)	Associated & Traditional Communities	Intangible Cultural Heritage
Increased Wind	***Collections*** • Damage to wooden, paper, textile and organic objects from increased water loss from objects ***Facilities*** • Renovations required to accommodate increased wind load	• Increased penetration of salts and rain into stone and porous materials, where growing crystals or freeze/thaw can start to break material apart • Site burial through redistribution of soil or sand • Abrasion of petroglyphs, pictoglyphs and pigmented artwork or surfaces • Erosion and Deflation of archaeological deposits • Direct lifting or moving of stone or wood materials (even very heavy objects)	• Direct wind damage and increased horizontal loading on structures not designed for this • Direct damage from wind-blown rain • Scouring/abrasion of exterior surface • Increased cracking, spalling, splintering, weathering of buildings due to accelerated drying • Damage from wind borne debris • More penetration of wind-driven rain into porous materials and leakage to interior through gaps and cracks • Burial through redistribution of soil or sand • Direct damage from waves due to increased storminess	• Increase in need for protective structures that shelter landscapes • Loss of weak traditional structures in those Cultural Landscapes. • Increased tree throws especially when associated with wetter soils • Erosion of beach sand, leading to beaches disappearing together with associated beach towns/communities • Damage or loss of Culturally Significant plants • Change in historic/Culturally Significant vegetation patterns • Increased tree throws especially when associated with wetter soils • Loss of traditional grazing areas due to shifting dunes or wind erosion of soil • Reduced access to animals in open spaces due to wind chills that drop temperatures • If increase in wind occurs without precipitation, then increased evaporation from surface water and evapotranspiration from vegetation occurs. The latter may serve as fuel for subsequent fire	• Reduced food security • Changes in grazing patterns destabilize transhumant societies • Increased sand storms lead to higher incidence of respiratory illness and death	***Local Knowledge, Practices and Rituals*** • Traditional knowledge of marine hunting grounds no longer applicable due to stronger/ unusual wind patterns and shifting Sea Ice • Traditional knowledge of grazing areas creates changes in transhumant societies • Loss of local languages/words specific to elements and interactions in the natural and cultural environments • Introduction of new words in local languages to describe changes in the natural environment

Climate Change Impacts	Moveable Heritage (including Museums & Collections)	Archaeological Resources (including underwater archaeology)	Buildings & Structures	Cultural Landscapes (including submerged cultural, landscapes and Historic Urban Landscapes, parks and gardens)	Associated & Traditional Communities	Intangible Cultural Heritage
Climate Influenced Wildfires	***Facilities*** • Damage to storage facilities and contents • Increased strain on existing museum facility and staff due to increased advance preparation and salvage operations • Smoke damage, strain on HVAC systems; risk to staff health • Flash Flood risk post-fire in watersheds denuded of vegetation ***Collections*** • Damage to items and disassociation of materials and records during emergency evacuations • Loss of collections and records to fire • Smoke damage • Damage from water or fire retardant	***During Fire*** • Damage or destruction of associated structure • Heat alteration of artefacts • Heat fracturing of stone artefacts • Discoloration, exfoliation, spalling, and smudging of Culturally Significant rock images, geoglyphs • Paint oxidation, colour change • Physical damage from firefighting efforts (e.g. fire lines, bulldozers or staining from retardants) • Decreased accuracy of carbon-14 dating due to carbon contamination • Burning tree roots damaging below-ground structures and artefacts ***Post-Fire*** • Damage from fire-killed tree fall • Soil toxicity and chemical changes (e.g. ash) impacting subsurface resources • Increased susceptibility to erosion and Flooding • Increased looting after fire exposure • Danger of destruction of archaeological resources during creation of fire-breaks, or whilst fire-fighting	***During Fire*** • Damage or loss of whole structures, or combustible components • Damage to building component materials and contents (e.g. roof, mortar, windows, doors, stained glass, furniture) • Cracking, physical damageof masonry components from extreme thermal stress • Discoloration caused by smoke and/or heat • Damage from fire-killedtree fall • Damage to structure and/or associated cultural landscape from fire retardants • Damage from ash • Damage from water for suppression, fire retardants ***Post-Fire*** • Buildings may shift or settle due to associated erosion • Pressure to change character-defining features such as wood shake roofing to fire resistant alternatives • Increased risk of Flooding from run-off in fire zone • Need to evaluate the resistant structural alternatives with some loss of Cultural significance, Integrity or to be willing to accept the total loss of the building • Disappearance of trees and other plant species used in traditional construction	***During Fire*** • Damage to structure and/or associated cultural landscape from fire retardants • Loss or damage of associated structures • Loss of towns, neighbourhoods, parks and gardens ***Post-Fire*** • Change in vegetation density and composition • Changes in traditional burning practices and impacts caused by larger and/or more extreme fires and changes in length of wildfire season (e.g. *mosaic burning* in Australia) • Increased susceptibility to erosion and Flooding • Loss of soil fertility due to high heat	***During Fire*** • Loss of life leading to lowered population and reduced community resources dedicated to maintenance of cultural resources • Increased particulates in the air lead to higher incidence of respiratory illness and death • Displacement and dispersion of communities ***Post-Fire*** • Loss of food security • Short-term loss and/or long-term impairment of water and air quality, including soil erosion, ash and smoke contamination • Change in availability of subsistence materials over large areas • Change in subsistence resources over large areas • Removal of historic plantings to protect buildings • Loss of historic or cultural plantings that do not regenerate after fire • Post-fire loss/impairment of infrastructure (e.g. power lines, transport etc.) • Post-fire social and psychological impact on humans (including those who have been displaced from the heritage resource, and those in associated communities	***Local Knowledge, Practices and Rituals*** • Loss of sacred groves and culturally important plants such as food and medicinal plants • Altered migratory patterns of traditionally hunted animals negates Local Knowledge • Loss of Culturally Significant species due to decreased soil fertility from high heat and ash/soil toxicity leading to changes in traditional practices and rituals • Change in traditional food systems • Loss of Culturally Significant species due to decreased soil fertility ***Place Attachment/Sense of Place*** • Significant alteration of landscape features critical for navigating during foraging, hunting, or other necessary movements • Loss of local knowledge due to change/loss of culturally significant resources • Loss of the image of these landscapes • Loss of local languages/words specific to elements and interactions in the natural and cultural environments

Climate Change Impacts	Moveable Heritage (including Museums & Collections)	Archaeological Resources (including underwater archaeology)	Buildings & Structures	Cultural Landscapes (including submerged cultural, landscapes and Historic Urban Landscapes, parks and gardens)	Associated & Traditional Communities	Intangible Cultural Heritage
Changes in Seasonality & Phenology	***Facilities*** • Increased stress on buildings and materials due to increased range of temperature swings during seasonal transitions • **Collections** (without appropriate climate control systems) • Increased stress on artefacts and materials due to increased range of temperature swings during seasonal transitions	• Site disruption from longer growing seasons and/or Land-use Change (irrigation use, harvest times) • Changes in site or regional accessibility • Reductions or alterations in length and timing of archaeological field seasons • Possible reductions in site visibility • Changes to length of visitor season and patterns of visitation • Increased damage from burrowing animals	***Structural Deterioration*** • Longer growing seasons lead to increased growth of invasive vegetation ***Infrastructure*** • Changes to length peak visitor season, alterations to visitor patterns, including increased visitor pressure and footfall damage	• Loss of synchronicity between species • Altered landscapes due to shifts in blooming times • Fundamental changes in species and flowering patterns for historic plantings, parks, gardens and arboreta • Loss of pollinators reducing plant fertility in historic agricultural Cultural Landscapes • Potential increase in invasive and pest species • Shifts in migratory patterns of significant marine animals due to changes in Sea Ice • Food sources and traditional crops threatened by shifts in harvest time (esp. feed for herd animals) • Changes to length of visitor season and patterns of visitation • Loss of specimen plantings in designed landscapes, parks and gardens • Migration of vineyards in latitude and altitude and changes in cultivated grape types	• Changes in crops that can be grown and crop productivity • Increased risk to trees and crops from pests and invasive species • Loss of food security • Changes in grazing patterns destabilizing transhumant societies	***Culturally relevant species*** • Loss of synchronicity between culturally important species • Loss of synchronicity of seasons with fixed date traditional ceremonies • Potential loss or reduction of plants used for medicine and seasonal ceremonies ***Local Knowledge, Rituals and Practices*** • Loss of plants used for ceremonies, medicine, and food due to early frosts • Limited access to traditional winter marine hunting areas due to longer summers • Changes in the ability to grow traditional crop varieties • Loss of traditional food systems • Loss of *terroir* (e.g. in viticulture) • Loss of local languages/words specific to elements and interactions in the natural and cultural environments • Introduction of new words in local languages to describe changes in the natural environment

Climate Change Impacts	Moveable Heritage (including Museums & Collections)	Archaeological Resources (including underwater archaeology)	Buildings & Structures	Cultural Landscapes (including submerged cultural, landscapes and Historic Urban Landscapes, parks and gardens)	Associated & Traditional Communities	Intangible Cultural Heritage
Spread of Invasive Species & Pests	***Facilities*** • Invasion of pests via new routes created by thermal stress on facility ***Collections*** • Increase in pest populations that damage organic materials (animal skins, wool)	• Physical damage, loss of integrity and spatial coherence from altered habitat structure • Data loss, subsidence, feature collapse, structural damage from invasive plants consuming organics • Damage from new and increased number of burrowing animals • Damage to underwater archaeology from migration of invasive species (e.g. blacktip shipworm)	***Structural Deterioration*** • New threats to wood structures and wooden architectural features as termites and other pests expand range due to warmer, longer summers	• Potential loss of significant plants due to introduction of new pests • Potential biological selection pressure for incompatible vegetation or other biotic species • Spread of destructive vegetative species into new areas • Changes in viewsheds and Settings • Increased pest damage to historic gardens	• Loss of food security • Changes in grazing patterns destabilize transhumant societies	***Culturally relevant species*** • Damage to distribution of subsistence crops, culturally significant plants • Loss of culturally important animals due to changes in habitat from invasive plant species • Loss of culturally important animals due to increased parasites and disease vectors • Loss of local languages/words specific to elements and interactions in the natural and cultural environments • Introduction of new words to describe new phenomena of spread of invasive species and pests
Changes in Range & Distribution & Populations of Species	***Collections*** • Increased need to expand voucher specimens (used for reference) in collection • Increased need to identify existing voucher specimens, many uncatalogued in non-federal repositories, to serve as baselines	• Physical damage, loss of integrity and spatial coherence from new and increased plant growth • Physical impacts from associated adaptive behaviour of animals following plant species movements • Disruption from new foraging or nesting animals, including insects • Changes in soil chemistry due to root penetration of new vegetation • Increased shrub growth on former tundra, may obscure features and artefacts • Possible reductions in site visibility	***Structural Deterioration*** • Increased growth of destructive organisms as temperatures warm (e.g. mould, algae) • New threats to fabric and materials in historic structures from incoming/colonizing species, including bacteria, fungi, plants, insects • Spread of destructive vegetation into new areas • Loss of species that are necessary for historically appropriate repairs • New/different micro-organisms cover surfaces of stone buildings • May reduce deterioration (possible benefit) • In Antarctica, threat to historic buildings as burgeoning seal populations enter and damage buildings	***Ecosystems*** • Changes in historic/Culturally Significant vegetation patterns • Local extinction of Culturally Significant species • Changes in landscape appearance from altered growth patterns of lichen • Exposure to new pests and invasive species	• Loss of major food sources and species important for subsistence cultures • Loss of food security • Changes in grazing patterns destabilizing transhumant societies • Changes in distribution of disease vectors	• Loss or decline of culturally Significant plant and animal species • Loss of pollinators for traditional crops ***Local Knowledge, Practices and Rituals*** • Altered appearance of important ceremonial sites • Breaks in memory and context due to loss of species, species access, resource predictability • Loss of local languages/words specific to elements and interactions in the natural and cultural environments

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Less Precipitation/Drought	***Facilities*** • Limited water supply for cooling, landscaping, other equipment • Reduced humidity stress on building (possible benefit) ***Collections (without appropriate climate controls)*** • Damage to wooden, paper, textile and organic objects from drying due to increased water loss from materials	• Loss of stratigraphic integrity due to crack/heave damage in drier soils • Destabilization of wetland or waterlogged sites • Exposure of submerged sites due to lower water levels in lakes • Sites more vulnerable to fire and wind • Increased exposure from vegetation loss and erosion • Discovery of new sites (crop marks) • Decrease in soil water content results in more oxygen in soil - increased decay of organic materials • Possible damage to foundations on wooden pilings	• Increase in dry salt deposits near masonry and porous stone which hydrate and infiltrate during infrequent rain events causing spalls and fractures • Reduced humidity stress on buildings (possible benefit) • Cracking and splitting of wooden/organic features due to complete drying • Loss of water supply for water dependent buildings and traditional water management systems (e.g. mills, acequias) • Changes in growth, properties and performance of timber used for building and Maintenance	• Water stress may inhibit growth of some species • Decline/disappearance of some vegetation species; other species favoured • Soil infertility due to decreased microbial activity • Limited water supply inhibits established Maintenance practices • Increased soil erosion • Challenges to current irrigation practices • Loss of some harvestable animals • Drought stress on trees, dieback and changes to landscape appearance • Loss of specimen plantings in designed landscapes, parks and gardens • Increased risk of fire	• Limitation on travel due to loss of water sources • Changes in grazing patterns destabilizing transhumant societies • Stress of food and water insecurity leading to higher levels of illness and disease. • Increased sand storms leading to higher incidence of respiratory illness and death • Loss of Livelihood due to loss of crop or livestock	***Culturally Relevant Species*** • Stress on culturally significant species impacts traditional subsistence practices • Loss of culturally relevant plants and animals ***Local Knowledge, Practices and Rituals*** • Indirect effects on ceremonial cycles and religious practices involving weather control • Loss of traditional sources of water for drinking, medicine, ceremony, paints, etc. • Loss of local languages/words specific to elements and interactions in the natural and cultural environments • Drought damage to streams, rivers and lakes may be tied to loss of indigenous sacredness and/or impact a sentient personhood of waterways
Desertification	***Facilities*** • Limited water supply for cooling, landscaping, other equipment • Reduced humidity stress on building • Increased stress on climate control maintenance ***Collections (without appropriate climate controls)*** • Damage to wooden, paper, textile and organic objects from drying due to lower relative humidity	• Loss of stratigraphic integrity due to crack/heave damage in drier soils • Destabilization of wetland or waterlogged sites • Exposure of submerged sites due to lower water levels in lakes • Sites more vulnerable to fire and wind • Increased exposure from vegetation loss and erosion • Decrease in soil water content results in more oxygen in soil - increased decay of organic materials • Possible damage to foundations on wooden pilings	• Scarcity or disappearance of certain plant species used in traditional constructions leading to abandonment of traditional construction practices (including loss of Local Knowledge and techniques) • Sites and structures lost to shifting sands and dune systems	• Water stress will increase and inhibit growth of species, increase loss • Decline/disappearance of some vegetation species; other species favoured • Soil infertility increases due to decreased microbial activity • Limited water supply inhibits established Maintenance practices • Limited water supply inhibits landscape management • Increased soil erosion • Challenges to current irrigation practices Loss of some harvestable animals • Rapid changes in urban Biodiversity, affecting parks and gardens	• Increased migration • Community resources for heritage management depleted • Limitation on travel due to loss of water sources • Changes in grazing patterns destabilizing transhumant societies • Stress of food and water insecurity leads to higher levels of illness disease • Increased sand storms leads to higher incidence of respiratory illness and death • Loss of grazing land to shifting sands and dune systems	• Loss of traditional species necessary for rituals and practices • Traditional landscape knowledge is no longer valid • Traditional rituals may no longer have a place in the landscape • Sense of place is broken • Loss of local languages/words specific to elements and interactions in the natural and cultural environments • Loss of local languages due to migration and displacement • Scarcity or disappearance of certain plant species used in traditional constructions leading to abandonment of traditional construction practices (including loss of local knowledge and techniques)

Climate Change Impacts	Moveable Heritage (including Museums & Collections)	Archaeological Resources (including underwater archaeology)	Buildings & Structures	Cultural Landscapes (including submerged cultural, landscapes and Historic Urban Landscapes, parks and gardens)	Associated & Traditional Communities	Intangible Cultural Heritage
Increased Precipitation and more intense Rainfall Events	***Facilities*** • Potential leaks in collection storage areas and potential wetting of museum objects • Increased cracking associated with ground heave and subsidence; destabilization of buildings and pipes; basements or underground storage sites at increased risk of flooding • Staff at health risk from mould and toxic pollution from flooding • Damage to utilities, generators and electrical systems Staff at increased risk of exposure to unhealthy mould ***Collections*** • Increased risk of mould, especially organic collections • Increased rusting/ corrosion of metals • Humidity damage to paintings • Warping and cracking damage to wood • Humidity damage to archival, paper, book and photo collections	• Site erosion from overflow and new Flood channels • Soil (and sediment underwater) destabilization/shifting (ground heave, landslide, subsidence) • Damage to unexcavated artefact and site integrity from direct force of water • Erosion and run-off damage at riverine and estuarine sites • Increased sedimentation at estuarine and coastal underwater sites • Risk of damage to sites from interventions to re-channel Floodwaters • Flash flood run-off to the marine environment may increase tidal currents, increasing risk of underwater site degradation	• Swelling/distortion of wooden building materials and architecture features due to wetness and damp • Increased risk of rot and fungal/insect attack • Historic building drainage systems unable to cope with downpours • Erosion of supporting ground around structure • Sewage backup and overflow leading to saturation and related Flooding, contamination and damage • Increased hail damage to roofs, windows and decorative elements • Overflowing gutters and drains back-flowing into buildings, leaking roofs and chimneys • Accelerated decay of masonry units and mortars due to increased extremes of wetting and drying • Cracks in building infrastructure and associated destabilization of buildings and pipes due to ground heave and subsidence/shrink swell soils • Severe damage and loss of historic structures made of adobe and other earthen structures • Change in rainfall patterns could affect cyclical traditions of maintaining earth buildings • Spalling, weathering of wood, brick and stone materials due to salt infiltration during drying • Corrosion of external masonry from agricultural runoff • Increased pressure to relocate or elevate structures, and/or surrounding structures • Landslides causing loss of buildings on slopes or burial and damage of structures under rocks, mud and debris • Adaptive capacity of buildings to serve as shelters in vulnerable zones	• Increased tree-fall due to waterlogging • Limited ability to plant in waterlogged soil • Loss of historical Integrity with improved drainage systems • Decline/disappearance of some vegetation species • Decreased soil fertility from erosion, waterlogging, leaching • Loss of landscape features • Increased susceptibility to destructive fungi and other pathogens that are enhanced by wet environments • Erosion of earthworks and damage to terraces or other landscape features due to landslides and erosion • Disruption or delay of traditional Maintenance practices (e.g. burning) • Destruction of Historic Urban Landscapes due to erosion, soil movement, plantation stress, Flooding in historical precincts • Waterlogging of historic gardens and orchards • Loss of various types of towns, especially those built in earthen materials • Not possible to maintain beaches in current form • Loss of specimen plantings in designed landscapes, parks and gardens	• Loss of life, homes and critical infrastructure • Displacement of inhabitants and communities • Altered harvest times and more frequent crop spoil and losses, due to changes in precipitation patterns	***Local Knowledge, Practices and Rituals*** • Indirect impacts to ceremonial cycles and religious practices involving weather control • Increasing difficulty in predicting storms • Delays in planting cycles, shifting whole agricultural calendar • Impact on participative activities such as festivals • Adaptation of functions in buildings to serve as shelters in vulnerable zones • Loss of traditional language/words specific to elements and interactions in the natural and cultural environments

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Acute **Coastal, Estuarine & Freshwater Flooding Events**	***Facilities*** • Damage to items and disassociation of materials and records during emergency evacuations • Structural collapse from moving force of floodwaters, particularly from flash floods • Sewage backup and overflow leading to saturation and related flooding, contamination and damage • Walls implode from hydrostatic force of standing water • Damage to utilities, generators and electrical systems • Ingress of salts which lead to salt damage of buildings **Collections** • Direct damage and destruction by floodwater • Increased rusting/ corrosion of metals • Increased risk of rot/ insect attack, mould and mildew • Swelling/distortion of absorbent objects (such as wood) due to wetting • Ingress of salts which lead to salt damage of objects	***During Flood*** • Direct physical damage to site, from floating materials • Destruction and/or loss of artefacts • Movement of artefacts and loss of context • Site erosion from overflow and new Flood channels ***Post-Flood*** • Increased risk of post-flood subsidence • Impacts from post-flood mitigation (clean up, construction)	***During Flood*** • Structural collapse from moving force of floodwaters particularly during flash floods • Subsidence of foundations • Physical damage from debris carried by flood • Sewage backup and overflow leading to saturation and related flooding, contamination and damage • Walls implode from hydrostatic force of standing water • Damage to composite, friable or laminated wall linings • Damage to utilities, generators and electrical systems ***Post-Flood*** • Increased risk of rot, fungal/insect attack, mould and mildew • Swelling/distortion of wooden building materials and architecture features due to inundation • Spalling, weathering of wood, brick and stone materials due to salt infiltration during drying • Corrosion of external masonry from agricultural runoff • Increased pressure to relocate or elevate structures, and/or surrounding structures (may also be pre-flood)	***During Flood*** • Loss of particular landscapes (such as beaches, or urban, suburban areas) • Wash out or damage to roads, trails, and landscape features • Loss of historic beaches and beach towns • Loss of vulnerable urban typologies such as structures built on wooden piles in lakes (palafitic) • Erosion of urban seashores and river fronts • Lowered capacities of historic and traditional ports to face sea-storms • Loss of specimen plantings in designed landscapes, parks and gardens due to increasing salinity ***Post-Flood*** • Decline/disappearance of important vegetation species-other species favoured • Increased soil salinity leading to loss of historic plant specimens, species and ultimately total loss of fertility	• Loss of traditional housing and dwelling systems and associated communities and traditions, particularly for the vulnerable sectors of society (low income and disadvantaged neighbourhoods in historic quarters) • Post-flood social and psychological impacts on humans, including those displaced from heritage resource and those in associated communities • Seasonal loss of traditional crops in the case of river flooding of fields or deposition of sediment on floodplains cultivated for crops	• Loss of cultural places due to inundation/ saturation • Loss/disruption of the use of foraging grounds • Loss of both plant and animal species for subsistence, medicine, ceremonies, etc. • Increased sedimental discharge can lead to degradation of important coral reefs, shellfish beds, fish spawning areas or seagrass habitats from increased sediment discharge, therefore loss of traditional and subsistence food sources • Loss of traditional language/words specific to elements and interactions in the natural and cultural environments • Loss of traditional place as living links between ancestors as land are severed

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Chronic Coastal, Estuarine & Freshwater Flooding & Inundation	***Facilities*** • Increased cracking associated with ground heave and subsidence • Potential leaks in collection storage areas and potential wetting of museum objects ***Collections*** • Increase risk of mould • Increase rusting/ corrosion of metals • Damage and destruction post-flood from humidity and moisture	***During Flood*** • Total submersion of coastal sites (e.g. rock art, structures, campsites) • Inundation and loss of access to cave sites • Downstream movement of items due to undercut shoreline sediments • Changes in pH of buried artefacts and/or buried environments • Reduced site integrity due to ground heave and subsidence ***Post-Flood*** • Increased risk of looting from exposure • Increased erosion of sites due to encroaching water levels, wave action • Exposure, and increased exposure to wet/dry cycles • Destabilization/damage to underwater sites through movement of sediment and/or protective vegetation • Alteration of preservation conditions due to saline intrusion • Increased corrosion of iron due to chloride in sea water • sulphate from the seawater may contribute to the degradation of the organic materials	***During Flood*** • Submersion of coastal sites • Increase in nuisance flooding leading to problems of access and higher likelihood of range of Flood damage • Damage to or overwhelming of drainage systems, leading to associated building damage ***Post-Flood*** • Deterioration/corrosion of infrastructure not designed for inundation or salt water exposure • Increased cracking due to associated ground heave and subsidence • Crystallization of salts introduced to buildings by seawater • Disassociation of historic districts, Settings due to increased pressure to relocate or elevate structures or surrounding structures • Loss of access leading to loss of use • Damage to historic infrastructure	***During Flood*** • Variable damage/loss of organic and inorganic materials and landscape features • Decline/disappearance of some vegetation species, other species favoured • Soil erosion • Loss of beaches and beach towns ***After-Flood*** • Soil infertility due to waterlogged, anaerobic conditions • Inundation and/or salinization damaging historic and cultural plantings	***During Flood*** • Displacement of people and livestock • Pollution from overflow of wastewater, sewage, etc. • Salt contamination of water supplies • Flooding of roads, railways and airports • Failure of critical infrastructure including electricity supply and communications networks ***Post-Flood*** • Abandonment of communities and agricultural lands • Total inundation and loss of island nations and communities resulting in need to transfer cultural heritage	• Loss of or limited access to traditional places and culturally important sites (e.g. burial grounds, subsistence areas) • Loss of plant and animal species for subsistence, medicine, ceremony, etc. • Salinization of coastal or island aquifers and traditional croplands • Submersion of homelands in island and coastal communities and corresponding stresses to and loss of social connections and interaction • Loss of the beach as a cultural concept

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Intensified Storms, (including Hurricanes & Cyclones) and Storm Surge	***Facilities*** • Damage to utilities, generators and electrical systems • Structural collapse from moving force of storm surge • Changes to surrounding landforms or vegetation, which may affect future drainage ***Collections*** • Damage to items and disassociation of materials and records during emergency evacuations • Risk of rot, fungal/ insect attack, mould and mildew • Rusting/corrosion of metals	***During Surge*** • Destruction - total site loss • Erosion of coastal sites due to higher, stronger storm surges • Erosion from wave action • Disturbance/exposure/burial due to stronger wave action ***After Surge*** • Disturbance or removal during response and clean-up	***During Surge*** • Structural damage or collapse from moving force of storm surge • Damage to infrastructure including access roads, docks, utilities, generators, electrical systems and sewage treatment plants • Increased range of hurricanes and cyclones will expose buildings and structures not designed for their impact ***Post-Surge*** • Cracks in building and associated destabilization of buildings and pipes due to ground heave and subsidence/shrink-swell soils • Erosion of supporting ground around structures • Changes to surrounding landforms, which may affect future drainage • Increased pressure to relocate or elevate structures, and/or surrounding structures (may also be pre-flood) • Water damage to building materials including wood, adobe, plaster, brick etc.	***During Surge*** • Immediate alteration/ destruction of historic landscape • Decline/disappearance of some vegetation species, other species favoured • Soil infertility from soil erosion, loss of topsoil, salinity, released contaminants • Loss of landscape features • Loss of specimen plantings in designed landscapes, parks and gardens	***During Surge*** • Displacement of people and livestock • Pollution from overflow of wastewater, sewage, etc. • Salt contamination of water supplies • Flooding of roads, railways and airports • Failure of critical infrastructure including electricity supply and communications networks ***Post-Surge*** • Abandonment of communities and agricultural lands • Total inundation and loss of island nations and communities resulting in need to transfer cultural heritage	• Loss of local knowledge associated with natural and cultural resources • Changed relationships with places lost, damaged or re-shaped

Climate Change Impacts	Moveable Heritage (including Museums & Collections)	Archaeological Resources (including underwater archaeology)	Buildings & Structures	Cultural Landscapes (including submerged cultural, landscapes and Historic Urban Landscapes, parks and gardens)	Associated & Traditional Communities	Intangible Cultural Heritage
Increased Coastal Erosion	***Facilities*** • Limited storage capacity to protect growing numbers of at-Risk artefacts	• Full and partial loss of coastal sites and artefacts • Exposure of new and known archaeological sites • Altered erosion patterns from reduction/ changes in Arctic Sea Ice • Increased risk of looting from exposure • Possible damage to underwater archaeology through mobile ice flows in shallow marine and intertidal zones	• Loss or compromise of structures • Increased pressure to relocate or elevate structures, and/or surrounding structures • Increased rusting, corrosion and salt deposits due to increased salt in the environment as the coastline encroaches	• Decline/disappearance of some vegetation species, other species favoured • Soil infertility from loss of topsoil • Loss or compromise of associated structures • Loss or damage to historic graveyards and burial grounds	• Damage to historic beaches and loss of tourism revenue • Abandonment of coastal homes and neighbourhoods at risk • Reputational damage to heritage agencies, responsible site managers, UNESCO etc. if there is a perceived failure to manage, respond or prepare adequately	• Loss of cultural memory and connections to homeland due to increased migration and splitting of traditional communities • Loss of culturally significant symbols, plants, and animals • Increased risk of loss of local knowledge associated with both natural and cultural resources
Rising Water Table	***Facilities*** • Potential for higher water vapour in air surrounding collections in storage areas • Increased risk of rising damp/rot from higher water tables ***Collections*** • Damage to statuary (from capillary action and rising damp), organic materials, etc. in basements and crypts	• Damage to artefacts, stratigraphy, soil features from saturation of site from below	• Rising damp, often marked by efflorescence/salt deposits • Rot of subsurface components from higher water table • Flooding damage in basements and other below grade features • Structural damage due to buoyant forces	• Decline/disappearance of important vegetation species, or other species favoured • Soil infertility due to waterlogged, anaerobic conditions • Decrease in productivity of agricultural land • Loss of specimen plantings in designed landscapes, parks and gardens	• Salinization of shrinking water supplies • Waterlogging or salinization of agricultural lands	• Loss of or limited access to culturally important sites (e.g. burial grounds)
Salt Water Intrusion	***Collections*** • Increased risk of corrosion/rusting	• Deterioration of some artefacts due to change in surrounding soil and water chemistry • Compromise of the site due to changes in soil and water chemistry	• Increased risk of corrosion/rusting • Introduction of additional salts into the ground and into building materials • Difficulty in evacuating rain water according to pre-existent ground level and slope conditions	• Decline/disappearance of important vegetation species • Soil infertility	• Salinization of aquifers and loss of drinking water supplies	• Reduction in or loss of habitat for culturally significant plants and animals • Loss of land for growing crops • Loss of some harvestable animals

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Ocean Acidification (direct impact of increased CO2)	• Salt and VOC (volatile organic compound) contamination of objects from ingress of water and increased acid rain • Faster deterioration of stone, metal and calcareous structures, materials and objects • Traditional objects made with extinct, increasingly rare or endangered species may become more costly to acquire into a collection (e.g. coral-based objects)	• Metal corrosion in submerged resources • Degradation of stonework, especially limestone and mortar in coastal areas • Possible acceleration in cliff erosion where cliffs have lime or shell components • Increased risk of damage to shipwrecks due to loss/decline of protective concretions and/or nearby coral reefs	• Degradation of stonework and masonry especially limestone, shell materials and mortar in coastal areas	• Coastal soil erosion/ infertility • Loss or deterioration of Culturally Significant landscape features • Loss of protection for heritage sites from offshore nature-based Ecosystems that dampen storm waves, and lessen storm surge (e.g. loss of wetlands or offshore coral reef)	• Weakened/destroyed local economies dependent on shellfish or sensitive fisheries	• Decline in reefs, vital to subsistence cultures, from coral bleaching • Physical abnormalities, including weakened shells, in traditional food sources • Possible increased degradation of rock art along shorelines sacred to and visited by contemporary peoples • Breakdown in critical food webs (e.g. loss of pteropods, krill and bivalves) providing critical resources for species traditionally hunted, including whales, fish, seabirds and ducks
Pollution (Secondary stressor)	***Facilities:*** • Increased need for special air filtration for repositories ***Collections:*** • Corrosion of metal objects and films: pitting and perforation, deterioration/loss of coating • Degradation of polymers, papers, films, and contemporary artworks • Increased deterioration of stone – gypsum crust formation, increase of VOCs and hygroscopic properties due to contamination from pollutants of cultural heritage objects	• Damage due to increased acidity resulting from fossil fuel combustion • Artefacts threatened by pesticides used to combat invasive species	• Erosion of stone due to increased acidity resulting from fossil fuel combustion • Effects of pollution and changing patterns of precipitation on erosion and colour of facades of monuments (including biological growth) • Damage to historic stained-glass windows	• Damage from increased acidity resulting from fossil fuel combustion • Decline/disappearance of some vegetation species including favoured • Soil infertility due to toxicity and depletion of nutrients • Loss of landscape features, especially plantings, buildings • Reduction or loss of culturally significant view sheds	• Health risks from contaminated air, soils and water	• Increased difficulty for young and elderly people to perform outdoor harvesting tasks • Indigenous considerations of pollution as the killing of the life-force of a place which is considered to be a natural sentient being

Climate Change Impacts	Moveable Heritage (including Museums & Collections)	Archaeological Resources (including underwater archaeology)	Buildings & Structures	Cultural Landscapes (including submerged cultural, landscapes and Historic Urban Landscapes, parks and gardens)	Associated & Traditional Communities	Intangible Cultural Heritage
Climate Driven Development (Secondary stressor)		• Disruption/damage from fire management (e.g. fire lines) • Disruption/damage from Land-use Change • Disruption/damage from changing water use • Impact of climate-induced displacement, migration and resettlement • Increased risk of looting/ artefact collection/ vandalism/graffiti because of easier access to sites or artefacts (e.g. melting ice patches, polar sites) • More access and disturbance from tourism, recreation, urban development, military activities and resource extraction in the Arctic • More access and disturbance from recreation, and possible fisheries conflict due to increase abundance of fish in Antarctic, as stocks decline due to overfishing elsewhere	• Increased land-use conflicts due to demographic change and urbanization • Loss of historic character due to changes to the site or Setting	• Spread of invasive species along roadways • Degraded Integrity of historic viewsheds • Loss of undeveloped buffer areas around cultural landscapes • Loss of landscapes associated with traditional land use e.g. hedgerows • Loss of culturally significant plants from soil compaction, limited root zones, temperature stress from heat island effect and high urban soil temperatures	• Reduction or loss of adaptive capacity due to development encroachment	• Increased development in Arctic subsistence areas due to warmer conditions • Loss of food sources due to habitat loss, fragmentation, over-exploitation • Loss of access to traditional cultural places, including landscapes • Loss of coral reefs critical for tropical fish habitats needed for local

Climate Change Impacts	Moveable Heritage (including Museums & Collections)	Archaeological Resources (including underwater archaeology)	Buildings & Structures	Cultural Landscapes (including submerged cultural, landscapes and Historic Urban Landscapes, parks and gardens)	Associated & Traditional Communities	Intangible Cultural Heritage
Risks from climate mitigation actions Mitigation & Adaptation Strategies (Secondary Stressor)	• Seawalls built in one place may expose other nearby localities to increased flood risk • Facilities may have to be moved in order to accommodate coastal engineering structures such as seawalls, berms and drainage channels • Investment in staff expertise to decrease on site and supply chain emissions • Costs associated with transition away from plastic for services associated with visitor experience • Adaptation to protect one area redirects excess water toward museum and collections	• Flooding or loss of river flow and lake level changes due to hydroelectric dam projects • Damage to archaeological sites from construction of renewable energy facilities • Damage to archaeological sites from construction of coastal or riverine flood defences	• Flooding or loss of river flow and lake level changes due to hydroelectric dam projects • Pressure to change defining features (materials maintenance, foundations etc.) to fire or flood resistant alternatives	• Hydroelectric dam projects leading to flooding or loss of traditional lands • Changed view-sheds as a result of construction of renewable energy projects, such as wind turbines • Land Use and Forest species changes e.g. biomass production and afforestation • Inappropriate changes to historic buildings and sites	• Hydroelectric dam projects causing displacement from traditional lands or loss of hunting/ fishing grounds • Migration from and depopulation of communities due to changed property insurance policies in at-risk areas	• Changes in estuarine, river or lake ecology in traditional hunting and subsistence areas as a result of tidal power or hydroelectric projects

Glossary

This report uses two sets of terms: one from the climate change field and one from the heritage field. The climate change terms in the Outline are drawn from *IPCC, 2018: Annex I: Glossary.* Heritage terms used in the Outline are drawn from the Burra Charter and the ICOMOS Madrid-New Delhi Document and. Note that the sub-terms in this glossary are listed immediately below the main terms.

IPCC. 2018. Annex 1: Glossary. In Matthews, J.B.R. (ed.) Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of Climate Change, Sustainable Development, and efforts to eradicate poverty.

The Burra Charter: The Australia ICOMOS Charter for Places of Cultural Significance, 2013. (Burra Charter)

ISC20C ICOMOS Approaches to the Conservation of Twentieth Century Cultural Heritage, 2017. (Madrid New Delhi Document)

Heritage terms used in the Outline are drawn from *The Burra Charter: The Australia ICOMOS Charter for Places of Cultural Significance,* 2013. (Burra Charter) and the ISC20C ICOMOS *Approaches to the Conservation of Twentieth Century Cultural Heritage* 2017 (Madrid New Delhi Document).

The sources of other terms are noted with each reference. Words capitalised within the text are defined in the glossary, however the most commonly occurring terms – climate change, climate action, adaptation, mitigation and resilience – are only capitalised at the first mention in each part of the Outline and not thereafter.

1.5°C Pathway See Pathways.

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

Acceptability of policy or system change - The extent to which a policy or system change is evaluated unfavourably or favourably, or rejected or supported, by members of the general public (public acceptability) or politicians or governments (political acceptability). Acceptability may vary from totally unacceptable/ fully rejected to totally acceptable/fully supported; individuals may differ in how acceptable policies or system changes are believed to be.

Acequias - Systems of communally managed surface irrigation ditches or channels that originated around 10,000 years ago in the Middle East, were taken to Spain by the Moors and then introduced in the Americas by Spanish settler-colonialists.

Adaptability - See adaptive capacity.

Adaptation in human systems - The process of adjustment to actual expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate and its effects. In heritage practice, the word 'adaptation' typically means changing a place to suit the existing use or a proposed use. Use means the functions of a place, including the activities and traditional and customary practices that may occur at the place or are dependent on the place. (Burra Charter). In this Outline, unless expressly noted, adaptation is used in its IPCC sense.

Transformational adaptation - Adaptation that changes the fundamental attributes of a socioecological system in anticipation of climate change and its Impacts.

Adaptation Limits - The point at which an actor's objectives (or system needs) cannot be secured from intolerable risks through adaptive actions.

- Hard adaptation limit: No adaptive actions are possible to avoid intolerable risks.
- Soft adaptation limit: Options are currently not available to avoid intolerable risks through adaptive action.

See also adaptation options, adaptive capacity and maladaptive actions (maladaptation).

Human behaviour adaptation limits - See adaptation.

Adaptation options - The array of strategies and measures that are available and appropriate for addressing adaptation. They include a wide range of actions that can be categorized as structural, institutional, ecological or behavioural. See also adaptation, adaptive capacity and maladaptive actions (maladaptation).

Adaptation pathways - See pathways.

Adaptive capacity - The ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences. This glossary entry builds from definitions used in previous IPCC reports and the millennium.

Ecosystem assessment - (MEA, 2005). See also adaptation, and maladaptive actions (maladaptation).

Aerosol - A suspension of airborne solid or liquid particles, with a typical size between a few nanometres and 10 μm that reside in the atmosphere for at least several hours. The term aerosol, which includes both the particles and the suspending gas, is often used in this report in its plural form to mean aerosol particles. aerosols may be of either natural or anthropogenic origin. aerosols may influence climate in several ways: through both interactions that scatter and/or absorb radiation and through interactions with cloud microphysics and other cloud properties, or upon deposition on snow- or ice-covered surfaces thereby altering their albedo and contributing to climate feedback.

Atmospheric aerosols - whether natural or anthropogenic, originate from two different pathways: emissions of primary particulate matter (PM), and formation of secondary PM from gaseous precursors. The bulk of aerosols are of natural origin. Some scientists use group labels that refer to the chemical composition, namely: sea salt, organic carbon, black carbon (BC), mineral species (mainly desert dust), sulphate, nitrate, and ammonium. These labels are, however, imperfect as aerosols combine particles to create complex mixtures. See also black carbon (BC).

Afforestation - Planting of new forests on lands that historically have not contained forests. For a discussion of the term forest and related terms such as afforestation, reforestation and deforestation, see the IPCC Special Report on Land Use, Land-Use Change, and Forestry (IPCC, 2000), information provided by the United Nations Framework Convention on Climate Change (UNFCCC, 2013) and the report on Definitions and Methodological Options to Inventory Emissions from Direct Human induced Degradation of Forests and Devegetation of Other Vegetation Types (IPCC, 2003). See also reforestation, deforestation, and Reducing Emissions from Deforestation and Forest Degradation (REDD+).

Agreement - In this report, the degree of agreement within the scientific body of knowledge on a particular finding is assessed based on multiple lines of evidence (e.g., mechanistic understanding, theory, data, models, expert judgment) and expressed qualitatively (Mastrandrea et al., 2010). See also evidence, likelihood and uncertainty.

Air pollution - Degradation of air quality with negative effects on human health or the natural or built environment due to the introduction, by natural processes or human activity, into the atmosphere of substances (gases, aerosols) which have a direct (primary pollutants) or indirect (secondary pollutants) harmful effect.

Albedo - The fraction of solar radiation reflected by a surface or object, often expressed as a percentage. Snow-covered surfaces have a high albedo, the surface albedo of soils ranges from high to low, and vegetation-covered surfaces and the oceans have a low albedo. The Earth's planetary albedo changes mainly through varying cloudiness and changes in snow, ice, leaf area and land cover.

Anthropocene - The 'Anthropocene' is a proposed new geological epoch resulting from significant human-driven changes to the structure and functioning of the Earth system, including the climate system. Originally proposed in the Earth system science community in 2000, the proposed new epoch is undergoing a formalization process within the geological community based on the stratigraphic evidence that human activities have changed the Earth system to the extent of forming geological deposits with a signature that is distinct from those of the Holocene, and which will remain in the geological record. Both the stratigraphic and Earth system approaches to defining the Anthropocene consider the mid-20th century to be the most appropriate starting date, although others have been proposed and continue to be discussed. The Anthropocene concept has been taken up by a diversity of disciplines and the public to denote the substantive influence humans have had on the state, dynamics and future of the Earth system. See also Holocene.

Anthropogenic - Resulting from or produced by human activities. See also anthropogenic emissions

Anthropogenic emissions - Emissions of greenhouse gases (GHGs), Precursors of GHGs and aerosols caused by human activities. These activities include the burning of fossil fuels, deforestation, land use and land-use changes (LULUC), livestock production, fertilisation, waste management and industrial processes. See also anthropogenic and anthropogenic removals.

Atmosphere - The gaseous envelope surrounding the earth, divided into five layers – the troposphere which contains half of the Earth's atmosphere, the stratosphere, the mesosphere, the thermosphere, and the exosphere, which is the outer limit of the atmosphere. The dry atmosphere consists almost entirely of nitrogen (78.1% volume mixing ratio) and oxygen (20.9% volume mixing ratio), together with a number of trace gases, such as argon (0.93 % volume mixing ratio), helium and radiatively active greenhouse gases (GHGs) such as carbon dioxide (CO2) (0.04% volume mixing ratio) and ozone (O3). In addition, the atmosphere contains the GHG water vapour (H2O), whose amounts are highly variable but typically around 1% volume mixing ratio. The atmosphere also contains clouds and aerosols. See also troposphere, stratosphere, greenhouse gas (GHG) and hydrological cycle.

Authenticity is the ability of a heritage place or site to express its cultural significance through its material attributes and intangible values in a truthful and credible manner. It depends on the type of cultural heritage place and its cultural context (ICOMOS Madrid New Delhi Document, 2017)

Avoided carbon - the carbon cost of new construction avoided through the use/reuse of vacant and underutilised existing buildings.

Baseline scenario - In much of the literature the term is also synonymous with the term business-as-usual (BAU) Scenario, although the term BAU has fallen out of favour because the idea of business as usual in century-long socio-economic projections is hard to fathom. In the context of transformation pathways, the term baseline scenarios refers to scenarios that are based on the assumption that no mitigation policies or measures will be implemented beyond those that are already in force and/or are legislated or planned to be adopted. Baseline scenarios are not intended to be predictions of the future, but rather counterfactual constructions that can serve to highlight the level of emissions that would occur without further policy effort. Typically, baseline scenarios are then compared to mitigation scenarios that are constructed to meet different goals for greenhouse gas (GHG) emissions, atmospheric concentrations or temperature change. The term baseline scenario is often used interchangeably with reference scenario and no policy scenario. See also emission scenario and mitigation scenario.

Biochar - Stable, carbon-rich material produced by heating biomass in an oxygen-limited environment. Biochar may be added to soils to improve soil functions and to reduce greenhouse gas emissions from biomass and soils, and for carbon sequestration. This definition builds from IBI (2018).

Biodiversity - Biological diversity means the variability among living organisms from all sources, including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems (UN, 1992).

Bioenergy - energy derived from any form of biomass or its metabolic by-products. See also biomass and biofuel.

Bioenergy with carbon dioxide capture and storage (BECCS) - Carbon dioxide capture and storage (CC&S) technology applied to a bioenergy facility. Note that depending on the total emissions of the BECCS supply chain, carbon dioxide (CO2) can be removed from the atmosphere. See also bioenergy and carbon dioxide capture and storage (CC&S).

Biofuel - A fuel, generally in liquid form, produced from biomass.

Biofuels - currently include bioethanol from sugarcane or maize, biodiesel from canola or soybeans, and black liquor from the paper-manufacturing process. See also biomass and bioenergy.

Biomass - Living or recently dead organic material. See also bioenergy and biofuel.

Black carbon (BC) - Operationally defined aerosol species based on measurement of light absorption and chemical reactivity and/or thermal stability. It is sometimes referred to as soot. BC is mostly formed by the incomplete combustion of fossil fuels, biofuels and biomass but it also occurs naturally. It stays in the atmosphere only for days or weeks. It is the most strongly light-absorbing component of particulate matter (PM) and has a warming effect by absorbing heat into the atmosphere and reducing the albedo when deposited on snow or ice. See also aerosol.

Blue carbon - Blue carbon is the carbon captured by living organisms in coastal (e.g., mangroves, salt marshes, seagrasses) and marine ecosystems, and stored in biomass and sediments.

Build Back Better - The use of the recovery, rehabilitation and reconstruction phases after a disaster to increase the resilience of nations and communities through integrating disaster risk reduction measures into the restoration of physical infrastructure and societal systems, and into the revitalization of livelihoods, economies and the environment. (UNISDR 2009)

Burden sharing (also referred to as effort sharing) - In the context of mitigation, burden sharing refers to sharing the effort of reducing the sources or enhancing the sinks of greenhouse gases (GHGs) from historical or projected levels, usually allocated by some criteria, as well as sharing the cost burden across countries.

Business as usual (BAU)- See baseline scenario.

Carbon auditing- Evaluating the embodied carbon in a product or a building so it can be understood the value of active carbon in building products and or buildings themselves. In relation to a traditional or heritage building then the embodied energy is negative as it has been in existence for a long time. Evaluating the carbon value of products, systems or transporting materials to become an extension to a retrofit project and/or to be used in actual retrofit of a project.

Carbon budget - This term refers to three concepts in the literature: (1) an assessment of carbon cycle sources and sinks on a global level,through the synthesis of evidence for fossil fuel and cement emissions, land-use change emissions, ocean and land CO2 sinks, and the resulting atmospheric CO2 growth rate. This is referred to as the global carbon budget; (2) the estimated cumulative amount of global carbon dioxide emissions that is estimated to limit global surface temperature to a given level above a reference period, taking into account global surface temperature contributions of other GHGs and climate forcers; (3) the distribution of the carbon budget defined under (2) to the regional, national, or sub-national level based on considerations of equity, costs or efficiency.

Carbon cycle - The term used to describe the flow of carbon (in various forms, e.g., as carbon dioxide (CO2), carbon in biomass, and carbon dissolved in the ocean as carbonate and bicarbonate) through the atmosphere, hydrosphere, terrestrial and marine biosphere and lithosphere. In this report, the reference unit for the global carbon cycle is GtCO2 or GtC (gigatonne of carbon = 1 GtC = 1015 grams of carbon. This corresponds to 3.667 GtCO2).

Carbon dioxide (CO2) - A naturally occurring gas, CO2 is also a by-product of burning fossil fuels (such as oil, gas and coal), of burning biomass, of land-use changes (LUC) and of industrial processes (e.g., cement production). It is the principal anthropogenic greenhouse gas (GHG) that affects the Earth's radiative balance. It is the reference gas against which other GHGs are measured and therefore has a global warming potential (GWP) of 1. See also greenhouse gas (GHG).

Carbon dioxide removal (CDR) - Anthropogenic activities removing CO2 from the atmosphere and durably storing it in geological, terrestrial, or ocean reservoirs, or in products. It includes existing and potential anthropogenic enhancement of biological or geochemical sinks and direct air capture and storage, but excludes natural CO2 uptake not directly caused by human activities. See also mitigation (of climate change) and sink.

Carbon sequestration - The process of storing carbon in a carbon pool. See also blue carbon, carbon dioxide capture and storage (CC&S), uptake and sink.

Carbon sink - See sink.

Carbon capture and storage (CC&S) - Carbon capture and storage is when a situation such as a factory producing high levels of carbon, captures the carbon and stores it, rather than release it into the atmosphere. This can be stored in soils, oceans and or bedrock.

Carbon footprint - A measure of the total amount of CO2 (carbon dioxide) and CH4 (methane) emissions of a defined population, system or activity, considering all relevant sources, sinks and storage within the spatial and temporal boundary of the population, system or activity of interest. Calculated as CO2 e (estimated) using the relevant 100-year global warming (GWP100). https://s3.amazonaws.com/academia.edu.documents/33416950/cmt-C-footprint-defn-LW-2011.pdf?

Circular economy - Circular economy is an economic system aimed at minimising waste and making the most of resources. In a circular system resource input and waste, emission and energy leakage are minimized by slowing, closing, and narrowing energy and material loops; this can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing and recycling. This regenerative approach is in contrast to the traditional linear economy, which has a 'take, make, dispose' model of production. https://en.m.wikipedia.org/wiki/Circular_economy

Climate - Climate in a narrow sense is usually defined as the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization. The relevant quantities are most often surface variables such as temperature, precipitation and wind. Climate in a wider sense is the state, including a statistical description, of the climate system.

Climate change - Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings such as modulations of the solar cycles, volcanic eruptions and persistent anthropogenic changes in the composition of the atmosphere or in land use. Note that the Framework Convention on Climate Change (UNFCCC), in its Article 1, defines climate change as: 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.' The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition and climate variability attributable to natural causes. See also climate variability, global warming, ocean acidification (OA) and detection and attribution.

Climate-compatible development (CCD) - A form of development building on climate strategies that embrace development goals and development strategies that integrate climate risk management, adaptation and mitigation. This definition builds from Mitchell and Maxwell (2010).

Climate extreme (extreme weather or climate event) - The occurrence of a value of a weather or climate variable above (or below) a threshold value near the upper (or lower) ends of the range of observed values of the variable. For simplicity, both extreme weather events and extreme climate events are referred to collectively as 'climate extremes'. See also extreme weather, extreme weather event.

Climate governance - See governance.

Climate justice - See justice.

Climate model - A numerical representation of the climate system based on the physical, chemical and biological properties of its components, their interactions and feedback processes, and accounting for some of its known properties. The climate system can be represented by models of varying complexity; that is, for any one component or combination of components a spectrum or hierarchy of models can be identified, differing in such aspects as the number of spatial dimensions, the extent to which physical, chemical or biological processes are explicitly represented, or the level at which empirical parametrizations are involved. There is an evolution towards more complex models with interactive chemistry and biology. Climate models are applied as a research tool to study and simulate the climate and for operational purposes, including monthly, seasonal and interannual climate predictions.

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

Climate-resilient development pathways (CRDPs) - Trajectories that strengthen sustainable development and efforts to eradicate poverty and reduce inequalities while promoting fair and cross-scalar adaptation to and resilience in a changing climate. They raise the ethics, equity and feasibility aspects of the deep societal transformation needed to drastically reduce emissions to

limit global warming (e.g., to 1.5°C) and achieve desirable and liveable futures and well-being for all.

Climate services - Climate services refers to information and products that enhance users' knowledge and understanding about the impacts of climate change and/or climate variability so as to aid decision-making of individuals and organizations and enable preparedness and early climate change action. Products can include climate data products.

Climate-smart agriculture (CSA) is an approach that helps to guide actions needed to transform and reorient agricultural systems to effectively support development and ensure food security in a changing climate. CSA aims to tackle three main objectives: sustainably increasing agricultural productivity and incomes, adapting and building resilience to climate change, and reducing and/or removing greenhouse gas emissions, where possible (FAO, 2018).

Climate system - The climate system is the highly complex system consisting of five major components: the atmosphere, the hydrosphere,the cryosphere, the lithosphere and the biosphere and the interactions between them. The climate system evolves in time under the influence of its own internal dynamics and because of external forcings such as volcanic eruptions, solar variations and anthropogenic forcings such as the changing composition of the atmosphere and land-use change.

Climate variability - Climate variability refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all spatial and temporal scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing (external variability). See also climate change.

Climate Vulnerability Index (CVI) - A rapid assessment methodology that focuses on climate risks to the Outstanding Universal Value (OUV) of World Heritage sites, and is being developed with the support of ICOMOS. The CVI is a transparent, repeatable methodology that uses best available information and can be undertaken in a two-day workshop and is applicable across all types of heritage sites.

CO2 equivalent (CO2-eq) emission - The amount of carbon dioxide (CO2) emission that would cause the same integrated radiative forcing or temperature change, over a given time horizon, as an emitted amount of a greenhouse gas (GHG) or a mixture of GHGs. There are a number of ways to compute such equivalent emissions and choose appropriate time horizons. Most typically, the CO2-equivalent emission is obtained by multiplying the emission of a GHG by its global warming potential (GWP) for a 100-year time horizon. For a mix of GHGs it is obtained by summing the CO2-equivalent emissions of each gas. CO2-equivalent emission is a common scale for comparing emissions of different GHGs but does not imply equivalence of the corresponding climate change responses. There is generally no connection between CO2-equivalent emissions and resulting CO2-equivalent concentrations.

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

Conference of the Parties (COP) - The supreme body of UN conventions, such as the United Nations Framework Convention on Climate Change (UNFCCC), comprising parties with a right to vote that have ratified or acceded to the convention. See also United Nations Framework Convention on Climate Change (UNFCCC).

Conservation - In heritage terms, conservation means all the processes of looking after a place so as to retain its cultural significance. (Burra Charter)

Conservation Management Plan is a document that is used as the framework for managing a heritage place including any future change. It includes identifying the cultural significance of the place, and constraints, how that significance is vulnerable to change and identifies policies to conserve that significance into the future. In some countries, the term conservation plan is also used. (ICOMOS Madrid New Delhi Document 2017)

Coping capacity - The ability of people, institutions, organizations, and systems, using available skills, values, beliefs, resources, and opportunities, to address, manage, and overcome adverse conditions in the short to medium term. This glossary entry builds from the definition used in UNISDR (2009) and IPCC (2012a). See also resilience, risk.

Capacity assessment is the process by which the capacity of a group, organization or society is reviewed against desired goals, where existing capacities are identified for maintenance or strengthening and capacity gaps are identified for further action. (UNISDR 2017; https://www.unisdr.org/we/inform/terminology)

Capacity development is the process by which people, organizations and society systematically stimulate and develop their capacities over time to achieve social and economic goals. It is a concept that extends the term of capacity-building to encompass all aspects of creating and sustaining capacity growth over time. It involves learning and various types of training, but also continuous efforts to develop Institutions, political awareness, financial resources, technology systems and the wider enabling environment. (UNISDR 2017; https://www.unisdr.org/we/inform/terminology)

Cost–benefit analysis - Monetary assessment of all negative and positive impacts associated with a given action. Cost–benefit analysis enables comparison of different interventions, investments or strategies and reveals how a given investment or policy effort pays off for a particular person, company or country. Cost–benefit analyses representing society's point of view are important for climate change decision-making, but there are difficulties in aggregating costs and benefits across different actors and across timescales. See also discounting.

Cost-effectiveness - A measure of the cost at which policy goal or outcome is achieved. The lower the cost the greater the cost-effectiveness.

Cultural Landscapes represent the combined works of nature and of humankind, illustrative of the evolution of human society and settlement over time, in response to physical constraints and/or opportunities presented by their natural environment and of successive social, economic and cultural forces, both external and internal. There are three categories of cultural landscapes, designed (such as a historic garden), evolving (such as an agrarian landscape or townscape) and associative (where the natural landscape is associated with spiritual or artistic or social Values) (Madrid-New Dehli Document, 2017).

Cultural route is any route of communication, be it land, water, or some other type, which is physically delimited and is also characterized by having its own specific dynamic and historic functionality to serve a specific and well determined purpose (ICOMOS Charter on Cultural Routes, 2008).

Cultural significance (also shortened to significance) means aesthetic, historic, scientific, social and/or spiritual value for past, present or future generations. Cultural significance is embodied in the heritage place or site itself, its attributes, its setting, fabric, use, associations, meanings, records, related places and related objects. Heritage places may have a range of significances for different individuals or groups (Madrid-New Delhi Document, 2017).

Decarbonization - The process by which countries, individuals or other entities aim to achieve zero fossil carbon existence. Typically refers to a reduction of the carbon emissions associated with electricity, industry and transport.

Deflation is when wind blows soil or sand away from a site, leaving objects exposed. It is a geomorphological term used by archaeologists.

Deforestation - Conversion of forest to non-forest. For a discussion of the term forest and related terms such as afforestation, reforestation and deforestation, see the IPCC Special Report on Land Use, Land-Use Change, and Forestry (IPCC, 2000). See also information provided by the United Nations Framework Convention on Climate Change (UNFCCC, 2013) and the report on Definitions and Methodological Options to Inventory Emissions from Direct Human-induced Degradation of Forests and Devegetation of Other Vegetation Types (IPCC, 2003). See also afforestation, reforestation and Reducing Emissions from Deforestation and Forest Degradation (REDD+).

Demand- and supply-side measures -

- Demand-side measures - policies and programmes for influencing the demand for goods and/or services. In the energy sector, demand-side management aims at reducing the demand for electricity and other forms of energy required to deliver energy services.
- Supply-side measures - Policies and programmes for influencing how a certain demand for goods and/or services is met. In the energy sector, for example, supply side
- Mitigation Measures aim at reducing the amount of greenhouse gas emissions emitted per unit of energy produced. See also Mitigation Measures.
- Demand-side measures - See Demand- and Supply-side Measures.
- Detection See Detection.

Detection and Attribution - Detection of change is defined as the process of demonstrating that climate or a system affected by climate has changed in some defined statistical sense, without providing a reason for that change. An identified change is detected in observations if its likelihood of occurrence by chance due to internal variability alone is determined to be small, for example, <10%. Attribution is defined as the process of evaluating the relative contributions of multiple causal factors to a change or event with a formal assessment of confidence.

Disaster - Severe alterations in the normal functioning of a community or a society due to hazardous physical events interacting with vulnerable social conditions, leading to widespread adverse human, material, economic or environmental effects that require immediate emergency response to satisfy critical human needs and that may require external support for recovery. See also hazard and vulnerability.

Disaster risk management (DRM) - Processes for designing, implementing, and evaluating strategies, policies, and measures to improve the understanding of disaster risk, foster disaster risk reduction and transfer, and promote continuous improvement in disaster preparedness, response, and recovery practices, with the explicit purpose of increasing human security, well-being, quality of life, and sustainable development.

(Internal) displacement - Internal displacement refers to the forced movement of people within the country they live in. Internally displaced persons (IDPs) are 'Persons or groups of persons who have been forced or obliged to flee or to leave their homes or places of habitual residence, in particular as a result of or in order to avoid the effects of armed conflict, situations of generalized violence, violations of human rights or natural or human-made disasters, and who have not crossed an internationally recognized State border.' (UN, 1998). See also Migration.

Disruptive innovation - Disruptive innovation is demand-led technological change that leads to significant system change and is characterized by strong exponential growth.

Downscaling - Downscaling is a method that derives local- to regional-scale (up to 100 km) information from larger-scale models or data analyses. Two main methods exist: dynamical downscaling and empirical/statistical downscaling. The dynamical method uses the output of regional climate models, global models with variable spatial resolution, or high-resolution global models. The empirical/statistical methods are based on observations and develop statistical relationships that link the large-scale atmospheric variables with local/regional climate variables. In all cases, the quality of the driving model remains an important limitation on quality of the downscaled information. The two methods can be combined, e.g., applying empirical/statistical downscaling to the output of a regional climate model, consisting of a dynamical downscaling of a global climate model.

Drought - A period of abnormally dry weather long enough to cause a serious hydrological imbalance. Drought is a relative term, therefore any discussion in terms of precipitation deficit must refer to the particular precipitation-related activity that is under discussion. For example, shortage of precipitation during the growing season impinges on crop production or Ecosystem function in general (due to soil moisture drought, also termed agricultural drought), and during the runoff and percolation season primarily affects water supplies (hydrological drought). Storage changes in soil moisture and groundwater are also affected by increases in actual evapotranspiration in addition to reductions in precipitation. A period with an abnormal precipitation deficit is defined as a meteorological drought. See also soil moisture.

Megadrought - A megadrought is a very lengthy and pervasive drought, lasting much longer than normal, usually a decade or more.

Early warning systems (EWS) - The set of technical, financial and institutional capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by a hazard to prepare to act promptly and appropriately to reduce the possibility of harm or loss. Dependent upon context, EWS may draw upon scientific and/or Indigenous Knowledge. EWS are also considered for ecological applications e.g., conservation, where the organization itself is not threatened by hazard but the ecosystem under conservation is (an example is coral bleaching alerts), in agriculture (for example, warnings of ground frost, hailstorms) and in fisheries (storm and tsunami warnings). This glossary entry builds from the definitions used in UNISDR (2009) and IPCC (2012a).

Ecosystem - An ecosystem is a functional unit consisting of living organisms, their non-living environment and the interactions within and between them. The components included in a given ecosystem and its spatial boundaries depend on the purpose for which the ecosystem is defined: in some cases they are relatively sharp, while in others they are diffuse. Ecosystem boundaries can change over time. Ecosystems are nested within other ecosystems and their scale can range from very small to the entire biosphere. In the current era, most ecosystems either contain people as key organisms, or are influenced by the effects of human activities in their environment. See also ecosystem services.

Ecosystem services - Ecological processes or functions having monetary or non-monetary value to individuals or society at large. These are frequently classified as (1) supporting services such as productivity or biodiversity maintenance, (2) provisioning services such as food or fibre, (3) regulating services such as climate regulation or carbon sequestration, and (4) cultural services such as tourism or spiritual and aesthetic appreciation. The most obvious ecosystem services include the food we eat, the water we drink and the plant materials we use for fuel, building materials and medicines. There are also many less visible ecosystem services such as the climate regulation and natural flood defences provided by forests, the billions of tonnes of carbon stored by peatlands, or the pollination of crops by insects. Even less visible are cultural ecosystem services such as the inspiration we take from wildlife and the natural environment. https://naturalcapitalforum.com/about/

Embodied carbon (kg CO2equivalents/kg) is the amount of carbon consumed to extract, refine, process, transport and fabricate a material or product.

Emergency management is also used, sometimes interchangeably, with the term disaster management, particularly in the context of biological and technological hazards and for health emergencies. While there is a large degree of overlap, an emergency can also relate to hazardous events that do not result in the serious disruption of the functioning of a community or society. (UNISDR 2017)

Emplacement refers to a perspective in which the subject is inextricably situated in a historically and existentially specific Place; gaining new territories, as opposed to losing old habitats (Bjarnesen and Vigh (2016:13), from Eglund (2002), and Zhuo Ban (2018:3986)).

Enabling condition - Conditions that affect the feasibility of adaptation and mitigation options, and can accelerate and scale-up systemic transitions that would limit temperature increase to 1.5°C and enhance capacities of systems and societies to adapt to the associated climate change, while achieving sustainable development, eradicating poverty and reducing Inequalities. Enabling conditions include finance, technological innovation, strengthening policy instruments, institutional capacity, multilevel governance, and changes in human behaviour and lifestyles. They also include inclusive processes, attention to power asymmetries and unequal opportunities for development and reconsideration of values. See also feasibility.

Endogenous capacities - the initiative of local people using local resources based on local culture, traditions, and skills. Select elements that may be relevant in the context of technology development and transfer include innovation systems, local/national ownership, human capital, local/national knowledge, local/national economies, external resources that best fit the local/national conditions, participatory approach, Institutional infrastructures and policy mechanisms that boost internal developments. This definition builds on a preliminary study development and enhancement of endogenous capacities and technologies, UNFCCC Secretariat, March 2017.

Endogenous Ways of Knowing - refers collectively to Local Knowledge, Indigenous Knowledge, traditional ways and other ecological knowledge and practices of indigenous and local cultures. It is often acquired over hundreds or thousands of years through direct contact with the environment. It is an accumulated knowledge base which is handed down through generations by cultural transfer.

Energy Efficiency - The goal of a given country, or the global community as a whole, to maintain an adequate, stable and predictable energy supply. Measures encompass safeguarding the sufficiency of energy resources to meet national energy demand at competitive and stable prices and the resilience of the energy supply; enabling development and deployment of technologies; building sufficient infrastructure to generate, store and transmit energy supplies; and ensuring enforceable contracts of delivery.

Equality - A principle that ascribes equal worth to all human beings, including equal opportunities, rights, and obligations, irrespective of origins.

Inequality - Uneven opportunities and social positions, and processes of discrimination within a group or society, based on gender, class, ethnicity, age, and (dis)ability, often produced by uneven development. Income inequality refers to gaps between highest and lowest income earners within a country and between countries. See also equity, ethics and fairness.

Equity - Equity is the principle of fairness in burden sharing and is a basis for understanding how the Impacts and responses to climate change, including costs and benefits, are distributed in and by society in more or less equal ways. It is often aligned with ideas of equality, fairness and justice and applied with respect to equity in the responsibility for, and distribution of, climate impacts and policies across society, generations, and gender, and in the sense of who participates and controls the processes of decision-making.

Inter-generational equity - Equity between generations that acknowledges that the effects of past and present emissions, vulnerabilities and policies impose costs and benefits for people in the future and of different age groups.

Procedural equity - Equity in the process of decision-making, including recognition and inclusiveness in participation, equal representation, bargaining power, voice and equitable access to knowledge and resources to participate. See also equality, ethics and fairness.

Ethics - Ethics involves questions of justice and value. Justice is concerned with right and wrong, equity and fairness, and, in general, with the rights to which people and living beings are entitled. Value is a matter of worth, benefit, or good. See also equality, equity and fairness.

Evidence - Data and information used in the scientific process to establish findings. In this report, the degree of evidence reflects the amount, quality and consistency of scientific/technical information on which the lead authors are basing their findings. See also agreement, likelihood and uncertainty.

Exposure - The presence of people; livelihoods; species or Ecosystems; environmental functions, services, and resources; infrastructure; or economic, social, or cultural assets in places and settings that could be adversely affected. See also hazard, risk and vulnerability.

Extreme weather, extreme weather event - An extreme weather event is an event that is rare at a particular place and time of year. Definitions of rare vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile of a probability density function estimated from observations. By definition, the characteristics of what is called extreme weather may vary from place to place in an absolute sense. When a pattern of extreme weather persists for some time, such as a season, it may be classed as an extreme climate event, especially if it yields an average or total that is itself extreme (e.g., drought or heavy rainfall over a season). See also heatwave and climate extreme (extreme weather or climate event).

Extreme weather or climate event - See climate extreme (extreme weather or climate event).

Fairness - Impartial and just treatment without favouritism or discrimination in which each person is considered of equal worth with equal opportunity. See also equity, equality and ethics.

Feasibility - The degree to which climate goals and response options are considered possible and/or desirable. Feasibility depends on geophysical, ecological, technological, economic, social and Institutional conditions for change. Conditions underpinning feasibility are dynamic, spatially variable, and may vary between different groups. See also enabling condition, enabling conditions.

Flood - The overflowing of the normal confines of a stream or other body of water, or the accumulation of water over areas that are not normally submerged. Floods include river (fluvial) floods, flash floods, urban floods, pluvial floods, sewer floods, coastal floods, and glacial lake outburst floods.

Food Security - A situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO, 2001).

Forcing - See radiative forcing.

Forest - A vegetation type dominated by trees. Many definitions of the term forest are in use throughout the world, reflecting wide differences in biogeophysical conditions, social structure and economics. For a discussion of the term forest and related terms such as afforestation, reforestation and deforestation, see the IPCC Special Report on Land Use, Land-Use Change, and Forestry (IPCC, 2000). See also information provided by the United Nations Framework Convention on Climate Change (UNFCCC, 2013) and the Report on Definitions and Methodological Options to Inventory Emissions from Direct Human-induced Degradation of Forests and Devegetation of Other Vegetation Types (IPCC, 2003). See also afforestation, deforestation and reforestation.

Fossil fuels - Carbon-based fuels from fossil hydrocarbon deposits, including coal, oil, and natural gas. Framework Convention on Climate Change See United Nations Framework Convention on Climate Change (UNFCCC).

General purpose technologies (GPT) - General purpose technologies can be or are used pervasively in a wide range of sectors in ways that fundamentally change the modes of operation of those sectors (Helpman, 1998). Examples include the steam engine, power generator and motor, ICT, and biotechnology.

Geoarchaeology - A multi-disciplinary approach which uses the techniques and subject matter of geography, geology, geophysics and other Earth sciences to examine topics which inform archaeological knowledge and thought (Wikipeadia).

Glacier - A perennial mass of ice, and possibly firn and snow, originating on the land surface by the recrystallisation of snow and showing evidence of past or present flow. A glacier typically gains mass by accumulation of snow, and loses mass by melting and ice discharge into the sea or a lake if the glacier terminates in a body of water. Land ice masses of continental size (>50,000 km2) are referred to as ice sheets. See also ice sheet.

Global Climate Model (also referred to as general circulation model, both abbreviated as GCM) - See climate model.

Global mean surface temperature (GMST) - Estimated global average of near-surface air temperatures over land and sea-ice, and sea surface temperatures over ice-free ocean regions, with changes normally expressed as departures from a value over a specified reference period. When estimating changes in GMST, near-surface air temperature over both land and oceans are also used. See also sea surface temperature (SST) and global mean surface air temperature (GSAT).

Global mean surface air temperature (GSAT) - Global average of near-surface air temperatures over land and oceans. Changes in GSAT are often used as a measure of global temperature change in climate models but are not observed directly. See also global mean surface temperature (GMST).

Global Warming - The estimated increase in global mean surface temperature (GMST) averaged over a 30-year period, or the 30-year period centered on a particular year or decade, expressed relative to pre-industrial levels unless otherwise specified. For 30-year periods that span past and future years, the current multi-decadal warming trend is assumed to continue. See also climate change and climate variability.

Governance - A comprehensive and inclusive concept of the full range of means for deciding, managing, implementing and monitoring policies and measures. Whereas government is defined strictly in terms of the nation-state, the more inclusive concept of governance recognizes the contributions of various levels of government (global, international, regional, sub-national and local) and the contributing roles of the private sector, of nongovernmental actors, and of civil society to addressing the many types of issues facing the global community.

Climate governance - Purposeful mechanisms and measures aimed at steering social systems towards preventing, mitigating, or adapting to the risks posed by climate change (Jagers and Stripple, 2003).

Multilevel governance - Multilevel governance refers to negotiated, non-hierarchical exchanges between Institutions at the transnational, national, regional and local levels. Multilevel governance identifies relationships among governance processes at these different levels. Multilevel governance does include negotiated relationships among institutions at different institutional levels and also a vertical 'layering' of governance processes at different levels. Institutional relationships take place directly between transnational, regional and local levels, thus bypassing the state level (Peters and Pierre, 2001)

Participatory governance - A governance system that enables direct public engagement in decision making using a variety of techniques for example, referenda, community deliberation, citizen juries or participatory budgeting. The approach can be applied in formal and informal institutional contexts from national to local, but is usually associated with devolved decision-making. This definition builds from Fung and Wright (2003) and Sarmiento and Tilly (2018).

Green Infrastructure - The interconnected set of natural and constructed ecological systems, green spaces and other landscape features. It includes planted and indigenous trees, wetlands, parks, green open spaces and original grassland and woodlands, as well as possible building and street-level design interventions that incorporate vegetation. Green infrastructure provides services and functions in the same way as conventional infrastructure. This definition builds from Culwick and Bobbins (2016).

Greenhouse gas (GHG) - greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of terrestrial radiation emitted by the Earth's surface, the atmosphere itself and by clouds. This property causes the greenhouse effect. Water vapour (H2O), carbon dioxide (CO2), nitrous oxide (N2O), methane (CH4) and ozone (O3) are the primary GHGs in the Earth's atmosphere. Moreover, there are a number of entirely human-made GHGs in the atmosphere, such as the halocarbons and other chlorine- and bromine-containing substances, dealt with under the Montreal Protocol. Beside CO2, N2O and CH4, the Kyoto Protocol deals with the GHGs sulphur hexafluoride (SF6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs). See also carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O) and ozone (O3).

Gross domestic product (GDP) - The sum of gross value added, at purchasers' prices, by all resident and non-resident producers in the economy, plus any taxes and minus any subsidies not included in the value of the products in a country or a geographic region for a given period, normally one year. GDP is calculated without deducting for depreciation of fabricated assets or depletion and degradation of natural resources.

Halocarbons - A collective term for the group of partially halogenated organic species, which includes the chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), halons, methyl chloride and methyl bromide. Many of the halocarbons have large global warming potentials. The chlorine and bromine-containing halocarbons are also involved in the depletion of the ozone layer.

Hazard - The potential occurrence of a natural or human-induced physical event or trend that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, Livelihoods, service provision, ecosystems and environmental resources. See also disaster, exposure, risk, and vulnerability.

Heatwave - A period of abnormally hot weather. Heatwaves and warm spells have various and in some cases overlapping definitions. See also extreme weather event.

Heating, ventilation, and air conditioning (HVAC) - Heating, ventilation and air conditioning technology is used to control temperature and humidity in an indoor environment, be it in buildings or in vehicles, providing thermal comfort and healthy air quality to the occupants. HVAC systems can be designed for an isolated space, an individual building or a distributed heating and cooling network within a building structure or a district heating system. The latter provides economies of scale and also scope for integration with solar heat, natural seasonal cooling/heating etc.

Historic Urban Landscape - an urban area understood as the result of a historic layering of cultural and natural values and attributes including the broader urban context and its geographical setting. The context includes the site's topography, geomorphology, hydrology and natural features, its built environment, both historic and contemporary, its infrastructures above and below ground, its open spaces and gardens, its land use patterns and spatial organization, perceptions and visual relationships, as well as all other elements of the urban structure. It also includes social and cultural practices and values, economic processes and the intangible dimensions of heritage as related to diversity and identity (UNESCO Recommendation on the Historic Urban Landscape, 2011).

Holocene - The Holocene is the current interglacial geological epoch, the second of two epochs within the Quaternary period, the preceding being the Pleistocene. The International Commission on Stratigraphy defines the start of the Holocene at 11,650 years before 1950.

Human behaviour - The way in which a person acts in response to a particular situation or stimulus. Human actions are relevant at different levels, from international, national, and sub-national Actors, to NGO, firm level actors, and communities, households, and individual actions.

Mitigation behaviour - Human actions that directly or indirectly influence Mitigation.

Human behavioural change -A transformation or modification of human actions. Behaviour change efforts can be planned in ways that mitigate Climate Change and/or reduce negative consequences of climate change Impacts.

Human rights - Rights that are inherent to all human beings, universal, inalienable, and indivisible, typically expressed and guaranteed by law. They include the right to life; economic, social, and cultural rights; and the right to development and self-determination. Based upon the definition by the UN Office of the High Commissioner for Human Rights (UNOHCHR, 2018).

Procedural rights - Rights to a legal procedure to enforce substantive rights.

Human system - Any system in which human organizations and Institutions play a major role. Often, but not always, the term is synonymous with society or social system. Systems such as agricultural systems, urban systems, political systems, technological systems and economic systems are all human systems in the sense applied in this report.

Hydrological cycle - The cycle in which water evaporates from the oceans and the land surface, is carried over the earth in atmospheric circulation as water vapour, condenses to form clouds, precipitates as rain or snow, which on land can be intercepted by trees and vegetation, potentially accumulates as snow or ice, provides runoff on the land surface, infiltrates into soils, recharges groundwater, discharges into streams, flows out into the oceans, and ultimately evaporates again from the ocean or land surface. The various systems involved in the hydrological cycle are usually referred to as hydrological systems.

Ice sheet - A mass of land ice of continental size that is sufficiently thick to cover most of the underlying bed, so that its shape is mainly determined by its dynamics (the flow of the ice as it deforms internally and/or slides at its base). An ice sheet flows outward from a high central ice plateau with a small average surface slope. The margins usually slope more steeply, and most ice is discharged through fast flowing ice streams or outlet glaciers, in some cases into the sea or into ice shelves floating on the sea. There are only two ice sheets in the modern world, one on Greenland and one on Antarctica. During glacial periods there were others. See also glacier.

(Climate Change) Impact Assessment - The practice of identifying and evaluating, in monetary and/or non-monetary terms, the effects of climate change on natural and human systems.

Impacts (consequences, outcomes) - The consequences of realized risks on natural and human systems, where risks result from the interactions of climate-related hazards (including extreme weather and climate events), exposure, and vulnerability. Impacts generally refer to effects on lives; livelihoods; health and well-being; ecosystems and species; economic, social and cultural assets; services (including ecosystem services); and infrastructure. Impacts may be referred to as consequences or outcomes, and can be adverse or beneficial. See also adaptation, exposure, hazard, loss and damage, and vulnerability.

Indigenous Knowledge - Indigenous Knowledge refers to the understandings, skills and philosophies developed by societies with long histories of interaction with their natural surroundings. For many indigenous peoples, Indigenous Knowledge informs decision-making about fundamental aspects of life, from day-to-day activities to longer term actions. This knowledge is integral to cultural complexes, which also encompass language, systems of classification, resource use practices, social interactions, values, ritual and spirituality. These distinctive ways of knowing are important facets of the world's cultural diversity. This definition builds on UNESCO (2018).

Industrial Revolution - A period of rapid industrial growth with far reaching social and economic consequences, beginning in Britain during the second half of the 18th century and spreading to Europe and later to other countries, including the United States. The invention of the steam engine was an important trigger of this development. The industrial revolution marks the beginning of a strong increase in the use of fossil fuels, initially coal, and hence emission of carbon dioxide (CO_2). See also pre-industrial.

Industrialized/developed/developing countries - There are a diversity of approaches for categorizing countries on the basis of their level of development, and for defining terms such as industrialized, developed, or developing. Several categorizations are used in this report. (1) In the United Nations system, there is no established convention for designation of developed and developing countries or areas. (2) The United Nations Statistics Division specifies developed and developing regions based on common practice. In addition, specific countries are designated as Least Developed Countries (LDC), landlocked developing countries, Small Island Developing States, and transition economies. Many countries appear in more than one of these categories. (3) The World Bank uses income as the main criterion for classifying countries as low, lower middle, upper middle and high income. (4) The UNDP aggregates indicators for life expectancy, educational attainment, and income into a single composite Human development Index (HDI) to classify countries as low, medium, high or very high human development.

Inequality - See equality.

Inherently sustainable features (ISFs) - the traits of traditional buildings that maintained occupant comfort before industrialised heating, ventilation, and air conditioning (HVAC) and other mechanical hardware became commonplace.

Institution - Institutions are rules and norms held in common by social actors that guide, constrain and shape human interaction. Institutions can be formal, such as laws and policies, or informal, such as norms and conventions. Organizations – such as parliaments, regulatory agencies, private firms and community bodies – develop and act in response to institutional frameworks and the incentives they frame. Institutions can guide, constrain and shape human interaction through direct control, through incentives, and through processes of socialization. See also institutional capacity.

Institutional Capacity - Institutional capacity comprises building and strengthening individual organizations and providing technical and management training to support integrated planning and decision making processes between organizations and people, as well as empowerment, social capital, and an enabling environment, including the culture, values and power relations (Willems and Baumert, 2003).

Integrated Assessment - A method of analysis that combines results and models from the physical, biological, economic and social sciences and the interactions among these components in a consistent framework to evaluate the status and the consequences of environmental change and the policy responses to it. See also Integrated Assessment Model (IAM).

Integrated Assessment Model (IAM) - Integrated assessment models (IAMs) integrate knowledge from two or more domains into a single framework. They are one of the main tools for undertaking Integrated Assessments. One class of IAM used in respect of climate change mitigation may include representations of: multiple sectors of the economy, such as energy, land use and land-use change; interactions between sectors; the economy as a whole; associated GHG emissions and sinks; and reduced representations of the climate system. This class of model is used to assess linkages between economic, social and technological development and the evolution of the climate system. Another class of IAM additionally includes representations of the costs associated with climate change impacts, but includes less detailed representations of economic systems. These can be used to assess impacts and mitigation in a cost–benefit framework and have been used to estimate the social cost of carbon.

Integrity is a measure of the wholeness and intactness of a heritage places or site, its attributes and values. Examining the conditions of integrity therefore requires assessing the extent to which the Place or site:

- Includes all elements necessary to express its value
- Ensures the complete representation of the features and processes which convey the property's significance
- Suffers from adverse effects of development and/or neglect. (ICOMOS Madrid-New Delhi Document, 2017)

Inter-generational equity - See equity.

Interpretation refers to all the ways of presenting the cultural significance of a place. Interpretation may be a combination of the treatment of the fabric (e.g. maintenance, restoration, reconstruction); the use of and activities at the place; and the use of introduced explanatory material. (Burra Charter)

Irreversibility - A perturbed state of a dynamical system is defined as irreversible on a given timescale, if the recovery time scale from this state due to natural processes is substantially longer than the time it takes for the system to reach this perturbed state. See also tipping point.

Justice - Justice is concerned with ensuring that people get what is due to them, setting out the moral or legal principles of fairness and equity in the way people are treated, often based on the Ethics and values of society.

- Climate justice - Justice that links development and human rights to achieve a human-centred approach to addressing climate change, safeguarding the rights of the most vulnerable people and sharing the burdens and benefits of climate change and its impacts equitably and fairly. This definition builds upon the one used by the Mary Robinson Foundation – Climate Justice (MRFCJ, 2018).
- Distributive justice - Justice in the allocation of economic and non-economic costs and benefits across society.
- Inter-generational justice - Justice in the distribution of economic and non-economic costs and benefits across generations.

Kyoto Protocol - The Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) is an international treaty adopted in December 1997 in Kyoto, Japan, at the Third Session of the Conference of the Parties (COP3) to the UNFCCC. It contains legally binding commitments, in addition to those included in the UNFCCC. Countries included in Annex B of the Protocol (mostly OECD countries and countries with economies in transition) agreed to reduce their anthropogenic greenhouse gas (GHG) emissions (carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6)) by at least 5% below 1990 levels in the first commitment period (2008–2012). The Kyoto Protocol entered into force on 16 February 2005 and as of May 2018 had 192 Parties (191 States and the European Union). A second commitment period was agreed in December 2012 at COP18, known as the Doha Amendment to the Kyoto Protocol, in which a new set of Parties committed to reduce GHG emissions by at least 18% below 1990 levels in the period from 2013 to 2020. However, as of May 2018, the Doha Amendment had not received sufficient ratifications to enter into force. See also United Nations Framework Convention on Climate Change (UNFCCC) and Paris Agreement.

Land Use - Land use refers to the total of arrangements, activities and inputs undertaken in a certain land cover type (a set of human actions). The term land use is also used in the sense of the social and economic purposes for which land is managed (e.g., grazing, timber extraction,conservation and city dwelling). In national greenhouse gas inventories, land use is classified according to the IPCC land use categories of forest land, cropland, grassland, wetland, settlements, other. See also land-use change (LUC).

Land-use change (LUC) - Land-use change involves a change from one Land Use category to another. Land use, land-use change and forestry (LULUCF) In the context of national greenhouse gas (GHG) inventories under the UNFCCC, LULUCF is a GHG inventory sector that covers Anthropogenic Emissions and removals of GHG from carbon pools in managed lands, excluding non-CO_2 agricultural emissions. Following the 2006 IPCC Guidelines for National GHG Inventories, 'anthropogenic' land-related GHG fluxes are defined as all those occurring on 'managed land', i.e., 'where human interventions and practices have been applied to perform production, ecological or social functions'. Since managed land may include CO_2 removals not considered as 'anthropogenic' in some of the scientific literature assessed in this report (e.g., removals associated with CO_2 fertilization and N deposition), the land-related net GHG emission estimates included in this report are not necessarily directly comparable with LULUCF estimates in National GHG Inventories. See also afforestation, deforestation, reforestation, and the IPCC Special Report on Land Use, Land-Use Change, and Forestry (IPCC, 2000).

Land use, land-use change and forestry (LULUCF) - See land-use change (LUC).

Life Cycle Assessment (LCA) - Compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product or service throughout its life cycle. This definition builds from ISO (2018).

Likelihood - The chance of a specific outcome occurring, where this might be estimated probabilistically. Likelihood is expressed in this report using a standard terminology (Mastrandrea et al., 2010). See Section 1.6 for the list of likelihood qualifiers used. See also agreement, evidence and uncertainty.

Livelihood - The resources used and the activities undertaken in order to live. Livelihoods are usually determined by the entitlements and assets to which people have access. Such assets can be categorised as human, social, natural, physical or financial.

Local Knowledge - Local Knowledge refers to the understandings and skills developed by individuals and populations, specific to the places where they live. Local Knowledge informs decision-making about fundamental aspects of life, from day-to-day activities to longer-term actions. This knowledge is a key element of the social and cultural systems which influence observations of, and responses to climate change; it also informs governance decisions. This definition builds on UNESCO (2018).

Lock-in - A situation in which the future development of a system, including infrastructure, technologies, investments, institutions, and behavioural norms, is determined or constrained ('locked in') by historic developments.

Loss and damage - Loss and damage to refer to political debate under the UNFCCC following the establishment of the Warsaw Mechanism on Loss and Damage in 2013, which is to 'address loss and damage associated with impacts of climate change, including extreme events and slow onset events, in developing countries that are particularly vulnerable to the adverse effects of Climate Change.' Loss and damage is used here to refer broadly to harm from (observed) impacts and (projected) risks (see Mechler et al. in press).

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

Maintenance - the continuous protective care of a place, and its setting. Maintenance is to be distinguished from repair which involves restoration or reconstruction. Maintenance is fundamental to conservation. Maintenance should be undertaken where fabric is of cultural significance and its maintenance is necessary to retain that cultural significance. (Burra Charter)

Management plan - a document that, like a conservation plan, is used as a framework for managing a place including any future change but may be broader in scope including operational issues. Management plans are commonly used for Cultural Landscapes where ongoing active management is a primary conservation action (ICOMOS Madrid-New Delhi Document, 2017). See also conservation management Plan.

Methane (CH_4) - One of the six greenhouse gases (GHGs) to be mitigated under the Kyoto Protocol and is the major component of natural gas and associated with all hydrocarbon fuels. Significant emissions occur as a result of animal husbandry and agriculture, and their management represents a major mitigation option.

Migrant - See migration.

Migration - The International Organization for Migration (IOM) defines migration as 'The movement of a person or a group of persons, either across an international border, or within a State. It is a population movement, encompassing any kind of movement of people, whatever its length, composition and causes; it includes migration of refugees, displaced persons, economic migrants, and persons moving for other purposes, including family reunification.' (IOM, 2018).

Migrant - The International Organization for Migration (IOM) defines a migrant as 'any person who is moving or has moved across an international border or within a State away from his/her habitual place of residence, regardless of (1) the person's legal status; (2) whether the movement is voluntary or involuntary; (3) what the causes for the movement are; or (4) what the length of the stay is.' (IOM, 2018). See also (internal) displacement.

Mitigation (of climate change) - A human intervention to reduce emissions or enhance the sinks of greenhouse gases.

Mitigation behaviour - See human behaviour.

Mitigation measures - In climate policy, mitigation measures are technologies, processes or practices that contribute to mitigation, for example, renewable energy (RE) technologies, waste minimization processes and public transport commuting practices. See also mitigation option, and policies (for climate change mitigation and adaptation).

Mitigation option - A technology or practice that reduces GHG emissions or enhances sinks.

Mitigation pathways - See pathways.

Mitigation scenario - A plausible description of the future that describes how the (studied) system responds to the implementation of mitigation policies and measures. See also emission scenario, pathways, and socio-economic scenario.

Monitoring and evaluation (M&E) - Monitoring and evaluation refers to mechanisms put in place at national to local scales to respectively monitor and evaluate efforts to reduce greenhouse gas emissions and/or adapt to the Impacts of climate change with the aim of systematically identifying, characterizing and assessing progress over time.

Motivation (of an individual) - An individual's reason or reasons for acting in a particular way; individuals may consider various consequences of actions, including financial, social, affective and environmental consequences. Motivation can come from outside (extrinsic) or from inside (intrinsic) the individual.

Multilevel governance - See governance.

Narratives - Qualitative descriptions of plausible future world evolutions, describing the characteristics, general logic and developments underlying a particular quantitative set of scenarios. Narratives are also referred to in the literature as 'storylines'. See also scenario, scenario storyline and pathways.

Natural capital can be defined as the world's stocks of natural assets which include geology, soil, air, water and all living things. It is from this natural capital that humans derive a wide range of services, often called ecosystem services, which make human life possible.

Nature Culture Journey - The nature culture /culture nature journey highlights the interconnectedness of nature and culture. It is an approach to heritage that has emerged based on the understanding that relationships between people and the natural environment have worked to shape both our physical environment and belief systems. It embraces the complexity of our heritage, which includes biological resources, genes, landscapes, geological diversity, cultural places and practices, and traditional knowledge systems. The IUCN and ICOMOS joint project, Connecting Practice, explores new methods and practical strategies for recognising the connection between natural and cultural heritage in World Heritage sites. https://www.iucn.org/news/world-heritage/201712/hawai%E2%80%98i-delhi-iucn-congress-nature-culture-journey-continues-icomos-general-assembly

NZEB - Near zero energy buildings

Net Zero CO_2 Emissions - Net zero carbon dioxide (CO_2) emissions are achieved when anthropogenic CO_2 emissions are balanced globally by anthropogenic CO_2 removals over a specified period. Net zero CO_2 emissions are also referred to as carbon neutrality. See also net zero emissions.

Net zero emissions - Net zero emissions are achieved when anthropogenic emissions of greenhouse gases to the atmosphere are balanced by anthropogenic removals over a specified period. Where multiple greenhouse gases are involved, the quantification of net zero emissions depends on the climate metric chosen to compare emissions of different gases (such as global warming potential, global temperature change potential, and others, as well as the chosen time horizon).

New Urban Agenda (NUA) has been developed by UN member states to serve as a guideline for urban development, utilising four key mechanisms: National urban policies promoting integrated systems of cities and human settlements for sustainable integrated urban development; stronger urban governance that empowers and includes urban stakeholders and environmental protection; reinvigorated long-term and integrated urban and territorial planning and design and effective financing frameworks. https://en.wikipedia.org/wiki/Habitat_III#New_Urban_Agenda

Nitrous oxide (N_2O) - One of the six greenhouse gases (GHGs) to be mitigated under the Kyoto Protocol. The main anthropogenic source of N_2O is agriculture (soil and animal manure management), but important contributions also come from sewage treatment, fossil fuel combustion, and chemical industrial processes. N_2O is also produced naturally from a wide variety of biological sources in soil and water, particularly microbial action in wet tropical Forests.

Non-CO_2 emissions and radiative forcing - Non-CO_2 emissions included in this report are all anthropogenic emissions other than CO_2 that result in radiative forcing. These include short-lived climate forcers, such as methane (CH_4), some fluorinated gases, ozone (O_3) precursors, aerosols or aerosol precursors, such as black carbon and sulphur dioxide, respectively, as well as long-lived greenhouse gases, such as nitrous oxide (N_2O) or other fluorinated gases. The radiative forcing associated with non-CO_2 emissions and changes in surface albedo is referred to as non-CO_2 radiative forcing.

Ocean Acidification (OA) - Ocean acidification refers to a reduction in the pH of the ocean over an extended period, typically decades or longer, which is caused primarily by uptake of carbon dioxide (CO_2) from the atmosphere, but can also be caused by other chemical additions or subtractions from the ocean. Anthropogenic ocean acidification refers to the component of pH reduction that is caused by human activity (IPCC, 2011, p. 37).

Outstanding Universal Value (OUV) - Cultural significance and/or natural significance which is so exceptional as to transcend national boundaries and to be of common importance for present and future generations of all humanity. (Operational Guidelines World Heritage Convention, 2017 Art 49)

Ozone (O_3) - Ozone, the triatomic form of oxygen (O_3), is a gaseous atmospheric constituent. In the troposphere, it is created both naturally and by photochemical reactions involving gases resulting from human activities (smog). Tropospheric ozone acts as a greenhouse gas. In the stratosphere, it is created by the interaction between solar ultraviolet radiation and molecular oxygen (O_2). Stratospheric ozone plays a dominant role in the stratospheric radiative balance. Its concentration is highest in the ozone layer.

Paris Agreement - The Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC) was adopted on December 2015 in Paris, France, at the 21st session of the Conference of the Parties (COP) to the UNFCCC. The agreement, adopted by 196 Parties to the UNFCCC, entered into force on 4 November 2016 and as of May 2018 had 195 Signatories and was ratified by 177 Parties. One of the goals of the Paris Agreement is 'Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels', recognising that this would significantly reduce the risks and impacts of climate change. Additionally, the Agreement aims to strengthen the ability of countries to deal with the impacts of climate change. The Paris Agreement is intended to become fully effective in 2020. See also United Nations Framework Convention on Climate Change (UNFCCC), Kyoto Protocol and Nationally Determined Contributions (NDCs).

Participatory governance - See governance.

Pathways - The temporal evolution of natural and/or human systems towards a future state. Pathway concepts range from sets of quantitative and qualitative scenarios or narratives of potential futures to solution oriented decision-making processes to achieve desirable societal goals. Pathway approaches typically focus on biophysical, techno-economic, and/or socio-behavioural trajectories and involve various dynamics, goals and actors across different scales.

- 1.5°C pathway - A pathway of emissions of greenhouse gases and other climate forcers that provides an approximately one-in-two to two-in-three chance, given current knowledge of the climate response, of global warming either remaining below 1.5°C or returning to 1.5°C by around 2100 following a temperature overshoot.
- Adaptation pathways - A series of daptation choices involving trade-offs between short-term and long-term goals and values. These are processes of deliberation to identify solutions that are meaningful to people in the context of their daily lives and to avoid potential maladaptation.
- Mitigation pathways - A mitigation pathway is a temporal evolution of a set of mitigation scenario features, such as greenhouse gas emissions and socio-economic development.
- Transformation pathways - Trajectories describing consistent sets of possible futures of greenhouse gas (GHG) emissions, atmospheric concentrations, or global mean surface temperatures implied from mitigation and adaptation actions associated with a set of broad and irreversible economic, technological, societal and behavioural changes. This can encompass changes in the way energy and infrastructure are used and produced, natural resources are managed and institutions are set up and in the pace and direction of technological change.

Palaeoenvironmental - The study of past landscape and environmental change. It examines environmental evidence to assess the impact of natural events and human activities on landscapes, climate and changing environments.

Peri-urban areas - Peri-urban areas are those parts of a city that appear to be quite rural but are in reality strongly linked functionally to the city in its daily activities.

Permafrost - Ground (soil or rock and included ice and organic material) that remains at or below 0°C for at least two consecutive years.

pH - pH is a dimensionless measure of the acidity of a solution given by its concentration of hydrogen ions ($[H^+]$). pH is measured on a logarithmic scale where pH = $-\log_{10}[H^+]$. Thus, a pH decrease of 1 unit corresponds to a 10-fold increase in the concentration of H^+, or acidity.

Phenology - Periodic biological life-cycle phenomena (e.g. flowering, reproduction, migration, hibernation) the timing of which are tied to or influenced by climate factors including seasonal changes and interannual variations.

Place is used in this document to describe a geographically defined area of cultural significance. It includes objects, spaces and views, monuments, buildings, structures, archaeological sites, historic urban landscapes, cultureal landscapes, cultural routes and industrial sites. It may have tangible and intangible dimensions. Site is a sub-set of place (ICOMOS Madrid-New Delhi Document, 2017).

Policies (for climate change mitigation and adaptation) - Policies are taken and/or mandated by a government – often in conjunction withbusiness and industry within a single country, or collectively with other countries – to accelerate mitigation and adaptation measures. Examples of policies are support mechanisms for renewable energy supplies, carbon or energy taxes, fuel efficiency standards for automobiles, etc.

Poverty - Poverty is a complex concept with several definitions stemming from different schools of thought. It can refer to material circumstances (such as need, pattern of deprivation or limited resources), economic conditions (such as standard of living, Inequality or economic position) and/or social relationships (such as social class, dependency, exclusion, lack of basic security or lack of entitlement). See also poverty eradication.

Poverty eradication - A set of measures to end poverty in all its forms everywhere. See also sustainable development goals (SDGs).

Precursors - Atmospheric compounds that are not greenhouse gases (GHGs) or aerosols, but that have an effect on GHG or aerosol concentrations by taking part in physical or chemical processes regulating their production or destruction rates. See also aerosol and greenhouse gas (GHG).

Preservation means maintaining a place in its existing state and retarding deterioration. (Burra Charter)

Pre-industrial - The multi-century period prior to the onset of largescale industrial activity around 1750. The reference period 1850–1900 is used to approximate pre-industrial global mean surface temperature (GMST). See also Industrial Revolution.

Preparedness - The knowledge and capacities developed by governments, response and recovery organizations, communities and individuals to effectively anticipate, respond to and recover from the Impacts of likely, imminent or current disasters. (UNISDR 2017)

Prevention - Activities and measures to avoid existing and new disaster risks. (UNISDR 2017)

Projection - A projection is a potential future evolution of a quantity or set of quantities, often computed with the aid of a model. Unlike predictions, projections are conditional on assumptions concerning, for example, future socio-economic and technological developments that may or may not be realized. See also climate projection, scenario and pathways.

Radiative forcing - Radiative forcing is the change in the net, downward minus upward, radiative flux (expressed in $W\ m^{-2}$) at the tropopause or top of atmosphere due to a change in a driver of climate change, such as a change in the concentration of carbon dioxide (CO_2) or the output of the sun. The traditional radiative forcing is computed with all tropospheric properties held fixed at their unperturbed values, and after allowing for stratospheric temperatures, if perturbed, to readjust to radiative-dynamical equilibrium. Radiative forcing is called instantaneous if no change in stratospheric temperature is accounted for. The radiative forcing once rapid adjustments are accounted for is termed the effective radiative forcing. Radiative forcing is not to be confused with cloud radiative forcing, which describes an unrelated measure of the impact of clouds on the radiative flux at the top of the atmosphere.

Reconstruction - The medium- and long-term rebuilding and sustainable restoration of resilient critical infrastructures, services, housing, facilities and livelihoods required for the full functioning of a community or a society affected by a disaster, aligning with the principles of sustainable development and "Build Back Better", to avoid or reduce future disaster risk. (UNISDR 2017)

Recovery - The restoring or improving of livelihoods and health, as well as economic, physical, social, cultural and environmental assets, systems and activities, of a disaster-affected community or society, aligning with the principles of sustainable development and "Build Back Better", to avoid or reduce future disaster risk. (UNISDR 2017

Reducing Emissions from Deforestation and Forest Degradation-(REDD+) - An effort to create financial value for the carbon stored in forests, offering incentives for developing countries to reduce emissions from forested lands and invest in low-carbon paths to sustainable development (SD). It is therefore a mechanism for mitigation that results from avoiding deforestation. REDD+ goes beyond deforestation and forest degradation, and includes the role of conservation, sustainable management of forests and enhancement of forest carbon stocks. The concept was first introduced in 2005 in the 11th Session of the Conference of the Parties (COP) in Montreal and later given greater recognition in the 13th Session of the COP in 2007 at Bali and inclusion in the Bali Action Plan, which called for 'policy approaches and positive incentives on issues relating to reducing emissions from deforestation and forest degradation in developing countries (REDD) and the role of conservation, sustainable management of forests and enhancement of forest carbon stock in developing countries.' Since then, support for REDD has increased and has slowly become a framework for action supported by a number of countries.

Reference period - The period relative to which anomalies are computed.

Reforestation - Planting of forests on lands that have previously contained forests but that have been converted to some other use. For a discussion of the term forest and related terms such as afforestation, reforestation and deforestation, see the IPCC Special Report on Land Use, Land-Use Change, and Forestry (IPCC, 2000), information provided by the United Nations Framework Convention on Climate Change (UNFCCC, 2013), the report on Definitions and Methodological Options to Inventory Emissions from Direct Human-induced Degradation of Forests and Devegetation of Other Vegetation Types (IPCC, 2003). See also deforestation, afforestation and reducing emissions from deforestation and forest degradation (REDD+).

Region - A region is a relatively large-scale land or ocean area characterized by specific geographical and climatological features. The climate of a land-based region is affected by regional and local scale features like topography, land use characteristics and large waterbodies, as well as remote influences from other regions, in addition to global climate conditions. The IPCC defines a set of standard regions for analyses of observed climate trends and climate model projections (see Figure 3.2; AR5, SREX).

Resilience - The capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure while also maintaining the capacity for adaptation, learning and transformation. This definition builds from the definition used by Arctic Council (2013). See also hazard, risk and vulnerability.

Response - Actions taken directly before, during or immediately after a disaster in order to save lives, reduce health Impacts, ensure public safety and meet the basic subsistence needs of the people affected.

Disaster response - Predominantly focused on immediate and short-term needs and is sometimes called disaster relief. Effective, efficient and timely response relies on disaster risk-informed preparedness measures, including the development of the response capacities of individuals, communities, organizations, countries and the international community. (UNISDR 2017)

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

Risk assessment - The qualitative and/or quantitative scientific estimation of risks. See also risk, risk management and risk perception.

Risk management - Plans, actions, strategies or policies to reduce the likelihood and/or consequences of risks or to respond to consequences. See also risk, risk assessment and risk perception.

Risk perception - The subjective judgment that people make about the characteristics and severity of a risk. See also risk, risk assessment and risk management.

Risk transfer - In the context of disaster risk reduction, risk transfer is the process of formally or informally shifting the financial consequences of particular risks from one party to another, whereby a household, community, enterprise or State authority will obtain resources from the other party after a disaster occurs, in exchange for ongoing or compensatory social or financial benefits provided to that other party. https://www.unisdr.org/we/inform/terminology#letter-r

Runoff - The flow of water over the surface or through the subsurface, which typically originates from the part of liquid precipitation and/or snow/ice melt that does not evaporate or refreeze, and is not transpired. See also hydrological cycle.

Scenario - A plausible description of how the future may develop based on a coherent and internally consistent set of assumptions about key driving forces (e.g., rate of technological change, prices) and relationships. Note that scenarios are neither predictions nor forecasts, but are used to provide a view of the implications of developments and actions. See also baseline scenario, emission scenario, mitigation scenario and pathways.

Sea ice - Ice found at the sea surface that has originated from the freezing of seawater. Sea ice may be discontinuous pieces (ice floes) moved on the ocean surface by wind and currents (pack ice), or a motionless sheet attached to the coast (land-fast ice). Sea ice concentration is the fraction of the ocean covered by ice. Sea ice less than one year old is called first year ice. Perennial ice is sea ice that survives at least one summer. It may be subdivided into second-year ice and multi-year ice, where multi-year ice has survived at least two summers.

Sea level change (sea level rise/sea level fall) - Sea level can change, both globally and locally (relative sea level change) due to (1) a change in ocean volume as a result of a change in the mass of water in the ocean, (2) changes in ocean volume as a result of changes in ocean water density, (3) changes in the shape of the ocean basins and changes in the Earth's gravitational and rotational fields, and (4) local subsidence or uplift of the land. Global mean sea level change resulting from change in the mass of the ocean is called barystatic. The amount of barystatic sea level change due to the addition or removal of a mass of water is called its sea level equivalent (SLE). Sea level changes, both globally and locally, resulting from changes in water density are called steric. Density changes induced by temperature changes only are called thermosteric, while density changes induced by salinity changes are called halosteric. Barystatic and steric sea level changes do not include the effect of changes in the shape of ocean basins induced by the change in the ocean mass and its distribution.

Sea surface temperature (SST) - The sea surface temperature is the subsurface bulk temperature in the top few meters of the ocean, measured by ships, buoys, and drifters. From ships, measurements of water samples in buckets were mostly switched in the 1940s to samples from engine intake water. Satellite measurements of skin temperature (uppermost layer; a fraction of a millimeter thick) in the infrared or the top centimeter or so in the microwave are also used, but must be adjusted to be compatible with the bulk temperature.

Sendai Framework for Disaster Risk Reduction - The Sendai Framework for Disaster Risk Reduction 2015–2030 outlines seven clear targets and four priorities for action to prevent new, and to reduce existing, disaster risks. The voluntary, non-binding agreement recognizes that the State has the primary role to reduce disaster risk but that responsibility should be shared with other stakeholders, including local government and the private sector. Its aim is to achieve 'substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries.'

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

Setting - the immediate and extended environment of a place that is part of or contributes to its cultural significance and distinctive character. Conservation requires the retention of an appropriate setting. This includes retention of the visual and sensory setting, as well as the retention of spiritual and other cultural relationships that contribute to the cultural significance of the place. (Burra Charter)

Sequestration - See uptake.

Sink - A reservoir (natural or human, in soil, ocean, and plants) where a greenhouse gas, an aerosol or a precursor of a greenhouse gas is stored. Note that UNFCCC Article 1.8 refers to a sink as any process, activity or mechanism which removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas from the atmosphere. See also uptake.

Small Island Developing States (SIDS) - Small island developing states (SIDS), as recognised by the United Nations OHRLLS (Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States), are a distinct group of developing countries facing specific social, economic and environmental vulnerabilities (UN-OHRLLS, 2011). They were recognized as a special case both for their environment and development at the Rio Earth Summit in Brazil in 1992. Fifty-eight countries and territories are presently classified as SIDS by the UN OHRLLS, with 38 being UN member states and 20 being Non-UN Members or Associate Members of the Regional Commissions (UN-OHRLLS, 2018).

Social cost of carbon (SCC) - The net present value of aggregate climate damages (with overall harmful damages expressed as a number with positive sign) from one more tonne of carbon in the form of carbon dioxide (CO2), conditional on a global emissions trajectory over time.

Social costs - The full costs of an action in terms of social welfare losses, including external costs associated with the impacts of this action on the environment, the economy (GDP, employment) and on the society as a whole.

Social-ecological Systems - An integrated system that includes human societies and ecosystems, in which humans are part of nature. The functions of such a system arise from the interactions and interdependence of the social and ecological subsystems. The system's structure is characterized by reciprocal feedbacks, emphasising that humans must be seen as a part of, not apart from, nature. This definition builds from Arctic Council (2016) and Berkes and Folke (1998).

Social inclusion - A process of improving the terms of participation in society, particularly for people who are disadvantaged, through enhancing opportunities, access to resources, and respect for rights (UN DESA, 2016).

Social value of mitigation activities (SVMA) - Social, economic and environmental value of mitigation activities that include, in addition to their climate benefits, their co-benefits to adaptation and sustainable development objectives.

Societal (social) transformation - See transformation.

Socio-economic scenario - A scenario that describes a possible future in terms of population, gross domestic product (GDP), and other socio-economic factors relevant to understanding the implications of climate change. See also baseline scenario, emission scenario, mitigation scenario and pathways.

Socio-technical transitions - Socio-technical transitions are where technological change is associated with social systems and the two are inextricably linked.

Soil carbon sequestration (SCS) - Land management changes which increase the soil organic carbon content, resulting in a net removal of CO2 from the atmosphere.

Soil moisture - Water stored in the soil in liquid or frozen form. Rootzone soil moisture is of most relevance for plant activity.

Solar radiation management - See solar radiation modification (SRM).

Solar radiation modification (SRM) - Solar radiation modification refers to the intentional modification of the Earth's shortwave radiative budget with the aim of reducing warming. Artificial injection of stratospheric aerosols, marine cloud brightening and land surface albedo modification are examples of proposed SRM methods. SRM does not fall within the definitions of mitigation and adaptation (IPCC, 2012b, p. 2). Note that in the literature SRM is also referred to as solar radiation management or albedo enhancement.

South-South Cooperation - South-South Cooperation is a broad framework for collaboration among so-called developing countries in the political, economic, social, cultural, environmental and technical domains. South-South cooperation is initiated, organized and managed by developing countries themselves; often, governments play a lead role, with active participation from public- and private-sector Institutions, non-governmental organizations and individuals. It involves different and evolving forms, including the sharing of knowledge and experience, training, technology transfer, financial and monetary cooperation and in-kind contributions. South-South cooperation can include different sectors and be bilateral, multilateral, subregional, regional or interregional in nature. http://unossc1.undp.org/sscexpo/content/ssc/about/what_is_ssc.htm

Stratosphere - The highly stratified region of the atmosphere above the troposphere extending from about 10 km (ranging from 9 km at high latitudes to 16 km in the tropics on average) to about 50 km altitude. See also atmosphere and troposphere.

Sub-national actor - Sub-national actors include state/provincial, regional, metropolitan and local/municipal governments as well as nonparty stakeholders, such as civil society, the private sector, cities and other sub-national authorities, local communities and indigenous peoples.

Supply-side measures - See demand- and supply-side measures.

Surface temperature - See global mean surface temperature (GMST), global mean surface air temperature (GSAT) and sea surface temperature (SST).

Sustainability - A dynamic process that guarantees the persistence ofnatural and human systems in an equitable manner.

Sustainable development (SD) - Development that meets the needsof the present without compromising the ability of future generations to meet their own needs (WCED, 1987) and balances social, economic and environmental concerns. See also sustainable development goals (SDGs)

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

Technology transfer - The exchange of knowledge, hardware and associated software, money and goods among stakeholders, which leads to the spread of technology for adaptation or mitigation. The term encompasses both diffusion of technologies and technological cooperation across and within countries.

Temperature overshoot - The temporary exceedance of a specified level of global warming, such as 1.5°C. Overshoot implies a peak followed by a decline in global warming, achieved through anthropogenic removal of CO2 exceeding remaining CO2 emissions globally.

Tipping point - A level of change in system properties beyond which a system reorganizes, often abruptly, and does not return to the initialstate even if the drivers of the change are abated. For the climate system, it refers to a critical threshold when global or regional climate changes from one stable state to another stable state. See also irreversibility.

Transformation - A change in the fundamental attributes of natural and human systems.

- Societal (social) transformation - A profound and often deliberate shift initiated by communities toward sustainability, facilitated by changes in individual and collective values and behaviours, and a fairer balance of political, cultural, and Institutional power in society.
- Transformation pathways - See pathways.
- Transformational adaptation - See adaptation.
- Transformative change - A system-wide change that requires more than technological change through consideration of social and economic factors that, with technology, can bring about rapid change at scale.

Transhumant (societies)- Transhumance describes the seasonal movement of livestock (such as sheep) between mountain and lowland pastures either under the care of herders or in company with the owners. (Merriam-Webster)

Transit-oriented development (TOD) - An approach to urbandevelopment that maximizes the amount of residential, business and leisure space within walking distance of efficient public transport, so as to enhance mobility of citizens, the viability of public transport and the value of urban land in mutually supporting ways.

Transition - The process of changing from one state or condition to another in a given period of time. Transition can be in individuals, firms, cities, regions and nations, and can be based on incremental or transformative change.

Triangular cooperation is a collaboration in which traditional donor countries and multilateral organizations facilitate South-South Cooperation through the provision of funding, training, and management and technological systems as well as other forms of support. http://unossc1.undp.org/sscexpo/content/ssc/about/what_is_ssc.htm

Tropical cyclone - The general term for a strong, cyclonic-scale disturbance that originates over tropical oceans. Distinguished from weaker systems (often named tropical disturbances or depressions) by exceeding a threshold wind speed. A tropical storm is a tropical cyclone with one-minute average surface winds between 18 and 32 m s-1. Beyond 32 m s-1, a tropical cyclone is called a hurricane, typhoon, or cyclone, depending on geographic location.

Troposphere - The lowest part of the atmosphere, from the surface to about 10 km in altitude at mid-latitudes (ranging from 9 km at high latitudes to 16 km in the tropics on average), where clouds and weather phenomena occur. In the troposphere, temperatures generally decrease with height. See also atmosphere and stratosphere.

Uncertainty - A state of incomplete knowledge that can result from a lack of information or from disagreement about what is known or even knowable. It may have many types of sources, from imprecision in the data to ambiguously defined concepts or terminology, incomplete understanding of critical processes, or uncertain projections of human behaviour. Uncertainty can therefore be represented by quantitative measures (e.g., a probability density function) or by qualitative statements (e.g., reflecting the judgment of a team of experts) (see Moss and Schneider, 2000; IPCC, 2004; Mastrandrea et al., 2010). See also likelihood.

United Nations Framework Convention on Climate Change (UNFCCC) - The UNFCCC was adopted in May 1992 and opened for signature at the 1992 Earth Summit in Rio de Janeiro. It entered into force in March 1994 and as of May 2018 had 197 Parties (196 States and the European Union). The Convention's ultimate objective is the 'stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.' The provisions of the Convention are pursued and implemented by two treaties: the Kyoto Protocol and the Paris Agreement. See also Kyoto Protocol and Paris Agreement.

Uptake - The addition of a substance of concern to a reservoir. See also carbon sequestration and sink.

AI alues - See cultural significance.

Values-based approach or values-based management - The coordinated and structured operation of a heritage site with the primary purpose of protecting its cultural significance as defined by designation criteria, government authorities or owners, experts of various kinds, and other citizens with legitimate interests in that place. (Cultural Landscapes: Balancing Nature and Heritage in Preservation Practice, R. Mason, 2008, p.184)

Vulnerability - The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt. See also exposure, hazard and risk.

Vulnerability assessment - See Climate Vulnerability Index.

Well-being- A state of existence that fulfills various human needs, including material living conditions and quality of life, as well as the ability to pursue one's goals, to thrive, and feel satisfied with one's life. Ecosystem well-being refers to the ability of ecosystems to maintain their diversity and quality.

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Invited Reviewers

Eman A.A. Ahmad
General Organization for Physical Planning (GOPP) - Cairo, Egypt; The National Committee for Environmental Issue, the Academy of Scientific Research & Technology (ASRT) Cairo, Egypt; Consultant, Climate Change & Environment Studies UN-Habitat

René Attard
Malta Chamber of Planners

Dorcas Ayeni
Department of Architecture, Federal University of Technology, Akure, Nigeria

Erica Bower
Climate Change and Human Mobility Specialist, Independent Consultant

Astrid Brandt-Grau
Department for Research, Higher Education and Technology, French Ministry of Culture

Tor Broström
Building Conservation, Uppsala University

Dario Camuffo
National Research Council (CNR) - Institute of Atmospheric Sciences and Climate (ISAC), Padua, Italy

Carole Crumley
University of North Carolina-Chapel Hill (USA) and Swedish Agricultural University (SLU) Uppsala, Sweden

Tom Dawson
University of St. Andrews

M. Moussa Diarra
Département Information Environnementale à l’Agence de l’Environnement et du Développement Durable (AEDD), Bamako, Mali

Nancy Duxbury
Centre for Social Studies, University of Coimbra, Portugal

Peter Elias
Department of Geography, University of Lagos

Brenda Ekwurzel
Union of Concerned Scientists

T□manako Fa’aui
Department of Civil and Environmental Engineering, Faculty of Engineering, University of Auckland

Sandra Fatori□
Delft University of Technology, Faculty of Architecture and the Built Environment

Hanna Fluck
Historic England

Catherine Forbes
GML Heritage, Australia ICOMOS, ICORP, Australia ICOMOS National Scientific Committee on Energy, Sustainability and Climate Change; Australia ICOMOS and ICOMOS New Zealand Joint Working Group on Cultural Heritage Risk Preparedness

Oscar J. Guevara
WWF-Colombia

George Hambrecht
Anthropology Department, University of Maryland, College Park, MD, USA

Alberto José Herrera Diaz
Jorge Tadeo Lozano University

Shikha Jain
DRONAH (Development and Research Organisation for Nature, Arts and Heritage) and Visiting Fellow, UNESCO C2C at WII, Dehradun, India

Eugene Jo
World Heritage Leadership Programme, ICCROM

Alice R. Kelley
Climate Change Institute, University of Maine, Orono, Maine, USA

M. Satish Kumar
School of Natural and Built Environment; Senator George J Mitchell Institute for Global Peace, Security and Justice, Queen’s University Belfast, Northern Ireland

Johanna Leissner
Fraunhofer-Gesellschaft, Brussels Office, German Research Alliance Cultural Heritage and Fraunhofer Sustainability Network

Jane Lennon
Australia ICOMOS, International Scientific Committee on Cultural Landscapes (ISCCL)

Sofie Linder,
Swedish National Heritage Board

Valerie Masson-Delmotte
IPCC Working Group I/Climate Scientist (IPSL/SLCE, France)

Seamus McGreal
Halifax Regional Municipality, Halifax, Canada

Beatriz Menéndez
Géosciences et Environnement Cergy – Cergy-Pontoise University

Filipa Neto
Portuguese Directorate-General for Cultural Heritage

Julianne Polanco
State Historic Preservation Office, State of California

Ryan Rabett
School of Natural and Built Environment, Queen’s University Belfast

Dr Felix Reide
Department of Archaeology and Heritage Studies
Laboratory for Past Disaster Science | Centre for Environmental Humanities | Materials, Culture and Heritage Research Programme
BIOCHANGE - Center for Biodiversity Dynamics in a Changing World
School of Culture & Society
Aarhus University Moesgård

Jennifer Rubis
Local and Indigenous Knowledge Systems, UNESCO

Dr Matthew Saunders
Trinity College Dublin

Erminia Sciacchitano
Directorate-General for Education, Youth, Sport and Culture, European Commission

Erin Seekamp
Department of Parks, Recreation and Tourism Management, North Carolina State University (USA), 2019 ICCROM Research Fellow

Caitlin Southwick
Sustainability in Conservation

Larry Strain
Siegel & Strain Architects; Carbon Leadership Forum; Reuse Task Force, Embodied Carbon Network; Materials Knowledge Working Group, American Institute of Architects

Aparna Tandon
Disaster Risk Management Programme, ICCROM

Val Turner
Shetland Amenity Trust, Association of Local Government Archaeological Officers: Scotland (ALGAO:S)

Anthony Veerkamp
National Trust for Historic Preservation (U.S.)

Meredith Wiggins
Historic England, UK

Daniel Young-Torquemada
ICOMOS Panama (former ICOMOS Executive Member)

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William Megarry

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Marilyn Truscott

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Sue Hodges

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International Scientific Committee on Cultural Landscapes (ISCCL)
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Ana Pereira Roders
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Roberta Mallia

ICOMOS Australia National Scientific Committee on Energy and Sustainability (NSCES)
Helen Wilson
Noni Boyd
Ken Horrigan
Ruth Redden

ICOMOS Ireland National Scientific Committee on Energy, Sustainability & Climate Change
Caroline Engel Purcell
Leila Budd
Joseph Little
David Hughes

ICOMOS Sustainable Development Goals Working Group
Ege Yildirim
Deirdre McDermott

ICOMOS National Committees (followed by the names of the NC members who coordinated their NC's review)

Australia ICOMOS
Ian Travers

ICOMOS Belgium
Tim De Kock

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Silvio Mendes Zancheti
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