INTEGRATION OF CLIMATE ACTION AND THE SUSTAINABLE DEVELOPMENT GOALS IN WORLD HERITAGE SITES.

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Abstract

The UN 2030 Agenda proposes 17 Sustainable Development Goals (SDGs) that aim to overcome the key challenges facing the world. Among these, SDG 13 addresses climate change and calls on nations to implement climate action. The ICOMOS SDGs Working Group has a mission to highlight the role cultural heritage in implementing the SDGs. However, climate change is among the most substantial threats the globe faces; it will affect every aspect of human life and have significant impacts on the implementation and outcome of all the SDGs. On the 20th General Assembly, ICOMOS declared the Climate and Ecological Emergency, which calls upon all ICOMOS members for urgent collective action to safeguard all types of heritage from the impacts of climate change. It also calls on the heritage community to identify climate actions and seek potential solutions to mitigate impacts of climate change and promote climate-resilient sustainable development. In line with such mobilisation efforts, this research examined how World Heritage Sites can be used to explore the nexus of climate action, cultural heritage, and the SDGs. This research studied four World Heritage Sites and their implementation of climate action and the SDGs. It then evaluated the actions written in their management plans and interviewed heritage practitioners and site managers to understand the implementation of the current policies and high-level discussions. This study concluded that climate action could be used as a framework to develop critical steps to achieve the 17 SDGs. It also identified the key role of leadership and governance as an important dimension in achieving concrete actions towards sustainable development.

Les dix-sept Objectifs de Développement Durable (ODD) de l'Agenda 2030 de l'ONU adressent les plus grands défis du monde actuel. Parmi eux, ODD Nº 13 se charge des mesures relatives à la lutte contre les changements climatiques. Le groupe de travail de l'ICOMOS sur les Objectifs de Développement Durable a pour mission d'expliquer le rôle que le patrimoine culturel peut jouer sur la mise en œuvre des ODD. Le changement climatique est une des plus grandes menaces auxquelles la planète doit faire face et affectera toutes les dimensions de notre vie sur la terre. Par ailleurs, le changement climatique impliquera la mise en œuvre et l'éventuel succès des ODD. Lors de la 20eme Assemblée Générale, ICOMOS déclara une urgence climatique et appela tous les membres de l'ICOMOS à contribuer à une action collective urgente pour protéger le patrimoine culturel et naturel du changement climatique. Cette déclaration demanda aussi à tous les acteurs concernés d'identifier des mesures relatives à la lutte contre les changements climatiques et de rechercher des solutions potentielles pour atténuer les effets du changement climatique, tout en encourageant le développent durable. Parmi ces efforts à faire contre le changement climatique, cette étude investiguera comment le patrimoine culture en général, et celui de Patrimoine Mondial en particulier, peut participer à la fusion des mesures relatives à la lutte contre les changements climatiques, les ODD, et le patrimoine culturel. Cette investigation compare les objectifs des Plans d'Actions de quatre cas d'études avec des entretiens de professionnels dans le secteur du patrimoine culturel pour examiner si les politiques actuelles reflètent les actions prises. Cette étude montre que la gouvernance et la visibilité du Patrimoine Mondial sont les dimensions les plus importantes pour mettre en place le développement durable. De plus, cette étude conclue que les mesures relatives à la lutte contre le changement climatique peuvent être utilisées comme cadre pour la mise en œuvre des 17 objectifs du développement durable

Keywords: Cultural Heritage – Sustainable Development Goals – SDGs – Climate Action – World Heritage

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LIST OF ABBREVIATIONS

ACP – African Caribbean and Pacific states

ICCA – International Consortium of Conservation Area

ICCROM – International Centre for the Study and the Preservation and Restoration of Cultural Property

IPCC – Intergovernmental Panel on Climate Change

IUCN – International Union for the Conservation of Nature

ISC – International Scientific Committee

MDG – Millennium Development Goals

OUV – Outstanding Universal Value

SDGs – Sustainable Development Goals

SOC – State of Conservation

UCLG – United Cities and Local Governments

UN – United Nations

UNDRR – United Nations Office for Disaster Risk Reduction

UNEP – United Nations Environment Programme

UNESCO – United Nations Educational Scientific and Cultural Organisation.

UNGA – United Nations General Assembly

OUV – Outstanding Universal Value

WG – Working Group

WHC – World Heritage Centre

WHSDP – World Heritage and Sustainable Development Policy

WHCCP – World Heritage Climate Change Policy

1. INTRODUCTION

The UN Sustainable Development Goals (SDGs) were put forward as part of the 2030 Agenda for a better and more sustainable future. These goals attempt to address the main issues facing our world and call on global partnership to promote prosperity and peace while protecting the planet and its people. This ambitious agenda is threatened by climate change, which will exacerbate the many current challenges the globe faces. Climate change is addressed in SDG 13, which encourages all parties to contribute to climate action. Yet climate change will hamper efforts to implement all of SDGs and needs to be addressed as an integral part of every SDG.

World Heritage Sites represent those places on the globe that are most treasured by humanity because of their Outstanding Universal Value (OUV). The protection of World Heritage Sites is included as part of Goal 11 on Sustainable Cities and Communities under Target 11.4, which calls to, 'strengthen efforts to protect and safeguard the world's cultural and natural heritage'. However, this target can also contribute to the achievement of all the SDGs (ICOMOS 2021b). World Heritage Sites are places of learning about and building awareness of climate change and where different adaptation strategies are being attempted. They are therefore important loci for innovative solutions toward addressing climate change, while encouraging sustainable development. In World Heritage Properties, practitioners and communities can come together to address the climate crisis and implement solutions harnessed from multi-disciplinary and cross-sector partnerships.

This research is presented in the context of ICOMOS' agenda to prioritise climate action within the remit of its activities as requested by Resolution 19GA 2017/30 (ICOMOS 2017), which was further strengthened with the declaration of the *Cultural Heritage and the Climate Emergency* as part of the 20GA 2020/15 (ICOMOS 2020). Furthermore, the recent ICOMOS Triennial Scientific Plan called upon all Working Groups, National Committees and International Scientific Committees to integrate climate action within their respective research, policies and guidance (ICOMOS 2021a). The Triennial Plan is a call for greater collaboration toward climate action, calling all members of the organisation to come together toward a single goal. Collaboration within ICOMOS is emblematic of a greater need for global collaboration to address the climate crisis.

This research responds to ICOMOS' call and examines the role of climate action within each SDG and how cultural heritage can contribute to their implementation. It examines current climate actions within the management plans of four World Heritage Sites and compares them to current policy frameworks and theories through the analysis of heritage practitioner and site manager interviews. The still ad hoc and grass-roots nature of climate actions at World Heritage indicates the need to strengthen the integration of climate action with the SDGs and their implementation.

2. RESEARCH PURPOSE AND QUESTION

This research aims to identify how the SDGs, climate action and cultural heritage interconnect, specifically through the lens of World Heritage. This study compares management plans with site manager and heritage practitioner interviews and reviews them into current policy frameworks to create a cohesive review of policy and action.

This research further aims to build upon ICOMOS' perspective on the role of heritage as a driver and enabler of sustainable development and complements the recent ICOMOS publication, *Heritage and the Sustainable Development Goals: Policy Guidance for Heritage and Development Actors* (ICOMOS 2021b). It also maps out climate actions using the ICOMOS Publication, *The Future of Our Pasts: Engaging Cultural Heritage in Climate Action* (ICOMOS 2019) in evaluating management plans of World Heritage Properties The research also aims to identify the linkages between two UNESCO documents: *Policy for the Integration of a Sustainable Development Perspective into the Processes of the World Heritage Convention* (WHSDP) (WHC 2015) and the *Draft updated Policy Document on the impacts of climate change on World Heritage properties* (WHCCP) (WHC 2021a).

3. LITERATURE REVIEW

3.1. A brief history of sustainable development, climate action, and World Heritage

3.1.1. Connections between sustainable development and culture

The Universal Declaration on Cultural Diversity (UNESCO 2001) defines culture as 'the set of distinctive spiritual, material, intellectual and emotional features of society or a social group,' and clarifies 'that it encompasses, in addition to art and literature, lifestyles, ways of living together, value systems, traditions and beliefs.' Culture, therefore, plays a significant role in society; it provides a sense of place, identity and community, all of which contribute to a person's wellbeing, and to a more creative, cohesive and peaceful society (UCLG 2010, 2). As a critical part of society, cultural heritage plays a major role in sustainable development (ibid.). Sustainable development has been defined as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (UN 2021). It is a holistic approach that includes multiple facets of development and all its contributing factors, including culture.

3.1.2. Development of the UN 2030 Agenda

The idea of sustainable development was first defined in the 1987 Brundtland Report as composed of three pillars: economic, social and environmental, each working together in a more holistic approach to development. These ideas were then enshrined in the UN *Millennium Development Goals* (MDGs): eight goals that aimed to create a better world by reducing poverty, promoting equality and improving health (UN 2000). However, the MDGs did not take culture into consideration, prompting the publication of the *Agenda 21 for Culture* (UCLG 2004), which argued for the integration of culture into sustainable development. This idea was then supported by a later publication *Culture, the fourth pillar of sustainability* (UCLG 2010).

The evolution of a more holistic approach to development was also reflected in UNESCO's *Recommendations on the Historic Urban Landscape* (UNESCO 2011), which aimed to integrate urban conservation with sustainable development by understanding the urban context and all of the geomorphological, social, natural, economic and cultural influences on urban heritage.

The role of culture in sustainable development was further confirmed in a UN Resolution *Culture and Development* which acknowledged the role that culture played in the MDGs (UN 2011). UNESCO member states agreed in the *Hangzhou Declaration* to promote culture as a means of economic and social development to reduce poverty, foster peace and reconciliation, promote environmental sustainability and combat climate change (UNESCO 2013). A set of concrete actions of how to integrate culture into development was then set forth by *Agenda 21: Actions* (UCLG 2015) as a supplement to the original 2004 commitment by the United Cities and Local Governments.

In 2015, the United Nations proposed a new agenda for sustainable development – the Sustainable Development Goals (SDGs): 17 goals designed to be a 'blueprint to achieve a better and more sustainable future' (UN 2015a). These goals integrate five key themes: People, Planet, Prosperity, Peace and Partnership. Goal 11: Sustainable Cities and Communities is the only goal to specifically mention heritage in target 11.4, which aims to 'strengthen efforts to protect and safeguard the world's cultural and natural heritage' (ibid.). Several other goals also reference the important role culture plays in development. Following the 2030 Agenda, UN member states agreed to the *New Urban Agenda* after the UN Habitat III conference in Ecuador which encouraged more participatory, inclusive and sustainable urban policies in order to achieve SDG Goal 11 (UN 2016). This document followed the publication of UNESCO's *Culture, Urban, Future* (UNESCO 2016) which detailed the role that culture played in past urban development and how it could be harnessed for sustainable change in the future.

The role of culture in development was further highlighted by the *Brussels Declaration* (ACP 2017), which joined the *Buenos Aires Declaration* (ICOMOS 2018) in promoting the role of participatory and inclusive action to promote culture. Specific examples of how to foster inclusive and culturally relevant development were provided by UCLG in *Culture in the Sustainable Development Goals, a Guide for Local Actions* (UCLG 2018). A review of actions toward achieving the SDGs was put forward by the Culture 2030 Campaign (2019) *Culture in the implementation of the 2030 Agenda,* which examined how culture had been implemented in national development policies.

3.1.3. ICOMOS and sustainable development

Long before discussions of sustainable development began to take hold, ICOMOS was already encouraging a social 'revivification' (1967) around heritage and the wider 'possibilities of development on a humanist level (1971)' that heritage could provide (de Marco et al. 2018). Culture was anchored as a driving force for sustainable development by ICOMOS in the *Paris Declaration on Culture as a driver of Sustainable Development* (ICOMOS 2011), which addressed the many ways that culture contributed to sustainable development. Although this declaration acknowledges culture as a fourth pillar of sustainable development, it distinguishes cultural heritage from the general subject of culture as the a 'repository of historical, cultural, and social memory preserved through its authenticity, integrity and "sense of place"' (ibid.). This distinction is not necessarily evident in other texts on the subject of culture and development. Rather, cultural heritage is often discussed within the broader context of culture.

The Concept Note put forward by ICOMOS (2015) on *Cultural Heritage, the UN Sustainable Development Goals, and the New Urban Agenda* explores the role of cultural heritage as a key element of urban development and outlines the principal challenges cultural heritage faces along with the opportunities it presents for sustainable development. Specific actions of how to integrate cultural heritage into urban development are outlined in the *ICOMOS Action Plan: Cultural Heritage and Localizing the UN Sustainable Development Goals (SDGs)* (ICOMOS 2017). In 2021, ICOMOS published a comprehensive policy guidance *Heritage and the Sustainable Development Goals: Policy Guidance for Heritage and Developmen*t, which outlines the many ways in which culture contributes to each SDG alongside a case study for each (ICOMOS 2021b).

3.1.4. World Heritage and sustainable development

World Heritage Sites are properties considered to be of outstanding value to humanity and act as fertile ground for sustainable development policies. The confluence between the World Heritage Convention and sustainable development was first mentioned in 2002 in the *Budapest Declaration*, which sought to integrate communities as active participants of the Convention (WHC 2002). It further sought to ensure the equitable balance between conservation, sustainability, and development in World Heritage properties to ensure the social and economic development of communities (ibid.). Sustainable development was further explored in the *World Heritage Capacity Building Strategy (WHC 2011),* which espoused a transition from training to capacity building as a move toward more sustainable World Heritage management. This policy expressed the need to create a more dynamic relationship between heritage and its context and the reciprocal benefits that could be achieved by a more inclusive approach (Boccardi and Scott 2018).

Published parallel to the Sustainable Development Goals was the *Policy on the integration of a sustainable development perspective into the processes of the World Heritage Convention* (herein after referred to as WHSDP) (WHC 2015). This policy does not address the 17 goals but mentions most of the Goals by establishing a sustainable development policy based on four general themes: inclusive social development, environmental sustainability, inclusive economic development and peace and cohesion; these four themes coincide with those set forth by the UN 2030 Agenda. For the States Parties involved, the WHSDP addresses the necessary integration of heritage conservation and humanitarian and economic development. In recognising that the OUV of a World Heritage Site is intrinsic to the value humanity places on it, this policy aims to protect humanity and nature alike so that future generations can continue to enjoy these sites (Boccardi and Scott 2018).

In 2016, a workshop in Vilm, Germany was organised to explore an action plan and aspirational set of activities to engage stakeholders of the convention to apply the WHSDP (Engels & Badman 2016), an aim that was shared by a gathering of 50 civil society actors in 2019 (Europa Nostra et al. 2019). However, the application of the WHSDP still requires concrete implementation strategies to build capacity among practitioners, site managers and concerned communities toward documenting the policy's progress and identifying key indicators of success. Regional action plans are being developed by the Arab States and the African regions as part of the third cycle of Periodic Reporting for World Heritage Sites (WHC 2021a).

3.2. Climate change and climate action

Climate change and its effects has been discussed over a series of IPCC reports including the most recent published in 2021, which confirmed the dire state of current climate projections (IPCC 2021). This most recent report built on that published in 2015, which concluded that there are multiple pathways for climate mitigation and adaptation with no single option individually sufficient. It further stated that 'effective implementation depends on policies and cooperation at all scales and can be enhanced through integrated responses that link adaptation and mitigation with other societal objectives' (IPCC 2015). The report also discusses the various potential impacts of climate change on the world's people and biodiversity.

Adaptation and mitigation will both be required to counter climate change and are incorporated into a broader discussion of climate action. Adaptation involves preparing for and adjusting to current and future climate disasters and includes Disaster Risk Reduction. Mitigation encompasses any measures aimed at reducing greenhouse gas emissions (UNDRR 2009).

Climate Action has five targets as part of SDG13 in the Agenda 2030:

13.1 RESILIENCE -Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries-

13.2 INSTITUTIONAL FRAMEWORK - Integrate climate change measures into national policies, strategies and planning.

13.3 EDUCATION & CAPACITY - Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning

13.a SUPPORTING DEVELOPING COUNTRIES - Implement the commitment. Undertaken by developed-country parties to the United Nations Framework Convention on Climate Change to a goal of mobilizing jointly $100 billion annually by 2020from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation and fully operationalize Green Climate Fund through its capitalization as soon as possible

13.b DEVELOPING COUNTRIES CAPABILITY - Promote mechanisms for raising capacity for effective climate change-related planning and management in least developed countries and small island developing States, including focusing on women, youth, and local and marginalized communities. Acknowledging that the United Nations Framework Convention on Climate Change is the primary international, intergovernmental forum for negotiating the global response to climate change.

3.2.1. Climate change and sustainable development

The integration of climate policy and sustainability was first discussed in the IPCC document *Perspectives on climate change and sustainability* (Yohe et al. 2007), which recognised the natural synergies between efforts to cope with climate change and the MDGs. The use of these strategies was further developed in the report on *Adapting to Climate Change - guidance for protected area managers and planners* (IUCN 2008), which walked practitioners through the various steps of encouraging climate change resilience. These methods were further expanded by UNESCO in

Weathering Uncertainty: Traditional knowledge for climate change assessment and adaptation by specifically highlighting the importance of indigenous and traditional knowledge for adapting to climate change (UNESCO 2012). The 2014 IPCC report certified that 'climate change is a threat to sustainable development. Nonetheless, there are many opportunities to link mitigation, adaptation and the pursuit of other societal objectives through integrated responses' (IPCC 2015).

In 2015, UN member state representatives convened in Paris to agree to limit global warming to 1.5° C (UN 2015b). In the same year, UN Member States also agreed to implement the *Sendai Framework on Disaster Risk Reduction* (UN 2015c) which outlined the importance of understanding the threats of future potential climate disasters before investing in disaster risk reduction policies and action. Above all, it encouraged states to 'build back better' in a more people-centred, inclusive and sustainable manner. These principles very much reflected those of the contemporaneously published Sustainable Development Goals (UN 2015a) which established that climate was all affecting and linked to all the SDGs.

3.2.2. ICOMOS and climate action

ICOMOS has engaged in several discussions on how to mitigate and adapt to climate change through the vector of cultural heritage. ICOMOS' *Resolution* GA2020/12–6 declared a climate emergency and called for collective action to safeguard cultural and natural heritage. Specifically, it called for ICOMOS to 'connect heritage responses to climate change with the UN Sustainable Development Goals, in particular SDG13 on climate action, in order to ensure these responses are holistic and include the social, economic, environmental and cultural dimensions of sustainability, as well as those of peace, justice and partnerships' (ICOMOS 2020). This declaration emphasised that heritage is impacted by climate change and will be a source of resilience for tackling its effects. It also highlights the important role that heritage, both tangible and intangible, plays as a repository of knowledge that can be used to inspire future climate adaptation and mitigation.

To further explore the heritage community's role in climate action, the ICOMOS Cultural Heritage and Climate Change Working Group produced *The Future of our Pasts: Engaging Cultural Heritage in Climate Action* (ICOMOS 2019). This document explores the intersection between climate action, cultural heritage and the SDGs by elaborating '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' (ibid., 10). This document maps where climate action and heritage conservation intersect by explaining in detail the various ways heritage can contribute to individual adaption and mitigation strategies. It also maps each of the SDGs to the individual targets of SDG 13 (Climate Action), but it does not expand upon their integration in the many actions the document enumerates. This table of mapped SDGs serves as a good example of how climate action can be integrated within all the SDGs (ibid., 13)

ICOMOS' position on heritage and climate change was reiterated by the current *Triennial Scientific Plan: Climate Change Action Reboot (draft)* (ICOMOS 2021a) which examines how to best integrate climate action into the organisation's cultural heritage protection activities. Specifically, it underlines the need to develop concrete climate actions through further research and observation and to demonstrate leadership in emerging cultural heritage issues.

3.2.3. World Heritage and climate change

Literature on the climate change and World Heritage Sites began with *Predicting and managing the effects of Climate Change on World Heritage,* which explored the benefits of information-sharing among stakeholders (UNESCO 2006). This document was followed by the *Strategy to Assist States Parties to the Convention to Implement Appropriate Management Responses* (WHC 2006), which outlined various adaptation strategies to be implemented in World Heritage Site management plans. This policy was later amended to include more of a focus on disaster risk reduction (WHC 2007). These two documents were then combined into a *Report on predicting and managing the impacts on climate change and World Heritage* (UNESCO 2007). A later *Policy Document on the Impacts of Climate Change on World Heritage Properties* (UNESCO 2008) integrated climate preparedness into the World Heritage Convention. With more information about the effects of climate change, UNESCO published another report, this one more specific to disaster risk preparedness: *Managing Disaster Risks for World Heritage* (UNESCO 2010).

The *World Heritage Sustainable Development Policy* (WHSDP) (WHC 2015) specifically integrates sustainable development with climate action. This policy explains the need to promote the role of World Heritage Sites and their settings in adapting to climate change as well as 'promot[ing] the social and economic resilience of local and associated communities to disaster and climate change through structural and non-structural measures, including public awareness-raising, training and education.' Climate action is not mentioned *per se* in the WHSDP (ibid), but it is integrated into the theme of environmental sustainability. It specifically mentions the need to 'strengthen the ability of communities and their properties to resist, absorb, and recover from the effects of a hazard' (ibid.).

To help inspire climate action through World Heritage, the World Bank published *Climate-resilient, Climate-friendly World Heritage Cities* (Bigio et al. 2014) with a variety of case studies of how cities have implemented climate action. This document was soon followed by UNESCO's *World Heritage and Tourism in a Changing Climate* (2016), which examined the effects of climate change on tangible and intangible heritage and included recommendations and case studies.

The current perspective toward World Heritage and climate action is clarified in the current *Draft updated Policy Document on the impacts of climate change on World Heritage properties (hereby WHCCP)* (WHC 2021a) which gives an updated look at integrating climate action into World Heritage management plans. The policy's guiding principles include minimising climate risks while protecting the OUV of a property through global and local, inclusive partnerships that integrate all stakeholders and their knowledge in a way that promotes sustainable development. The individual SDGs are not specifically mentioned in this policy, and the focus is primarily on creating an inclusive approach to climate action. Nevertheless, the document explicitly mentions that actions taken by States Parties will affect the implementation of the UN Sustainable Development Goals (WHC 2021a).

3.3. World Heritage State of Conservation Reports

World Heritage State of Conservation (SOC) reports show how many sites are affected by various climatic threats. The online database of SOCs classifies climate events as follows: changes to oceanic waters, desertification, drought, flooding, storms, temperature changes and other climate

change impacts. The category 'other climatic impacts' includes issues such as silting, general weathering, bleaching of corals and glacial outburst floods (Table 3.3.1). These threat categories on the SOC database are defined by the experts who review the SOC reports.

According to the recent IPCC report, climate change will include other threats, which were also identified on the SOC database such as temperature, water (rain/water table), wind, avalanches/landslides, and wildfires (Table 3.3.1). Climate change will cause more severe precipitation events, which can cause landslides. Evidence for changes in wind patterns is limited, yet the increased likelihood of wildfire weather, which includes wind, and the greater incidences of extreme weather conditions, means both threats were included. The difference between 'Temperature' and 'Temperature change' is based on expert classifications and is site specific, but the former is assumed to be affected by temperature variations from climate change and both were included in this study.

Table 3.3.1. List of climatic threats found in the SOC database according to the categories listed on the database

Climate change and severe weather events	Local conditions affecting physical fabric	Sudden ecological or geological events
Changes to oceanic waters	Temperature	Fire (wildfires)
Desertification	Water (rain/water table)	Avalanche/ landslides
Drought	Wind	
Flooding		
Storms		
Temperature change		
Other climate change impacts		

These categories are defined by the experts who review the SOC reports and are relative to each site and are not defined on the SOC database. It is therefore unknown if their definitions are similar to those defined by the *Future of our Pasts* (p.68-69). The *Future of our Pasts* has set definitions for each of these threats, and it would be beneficial for future collaboration and clarity if terminologies could be standardised or linked to those of the *Future of our Pasts.*

The literature review of SOC reports revealed that 145 sites were found to be threatened by climatic events, which represents about 13% of all World Heritage Sites (Table 3.3.2). A full table of climate threats to World Heritage Sites can be found in Appendix A.

Table 3.3.2. Percent of World Heritage Sites affected by climatic events recorded in 2021

	Cultural	Mixed	Natural	Total
Sites threatened by climate change	102	6	37	145
Total World Heritage Sites	897	39	218	1154
Percentage of sites threatened (threatened/total)	11%	15%	17%	13%

Many of the 145 sites were affected by more than one hazard. Five sites were threatened by 4 hazards, and eight sites were threatened by three hazards. To this list, Sagarmatha National Park,

Nepal (2 threats) and Cliffs of Bandiagara, Mali and Mosi-oa-Tunya/Victoria Falls, Zambia/ Zimbabwe (each with one threat) were included to ensure that each of the threats in Table 3.3.1 was investigated in at least two sites. The SOC reports for each site were examined for a more thorough investigation of climate actions taken for each the threat in Table 3.3.1. The result of these investigations can be found in Table 3.3.3.

The SOC reports show actions that were largely reactive, not only in terms of repair but in future prevention. For the most part, actions following high winds and storms involved structural maintenance to repair the site, and flooding was addressed through improvements to site drainage. For instances where rain was a significant threat, artifacts were either moved or placed under a canopy. However, this approach cannot be applied over a large site, and continued maintenance and monitoring becomes the preferred approach. Vegetation was also used as strategy to reduce the effects of desertification and wind.

The nature of the SOC reports is one of reactivity; the reports are not used to address pre-emptive actions taken by World Heritage Sites, but to address current threats and encourage future action. However, some actions that address ongoing issues can act as pre-emptive measures toward climate change adaptation. For example, local authorities involved in the protection of the Great Barrier Reef have made significant improvements in water quality, which if unattended would have exacerbated bleaching events occurring from changing water temperatures. In Machu Picchu, wildfires started from campsites were prevented through stricter governance and the use of certain herbicides to limit fire-prone vegetation growth close to the monument. Such reactive solutions contribute to reducing future climate disasters related to wildfires and drought.

In the case of slow onset changes, the actions taken were largely restricted to research and monitoring. For those sites suffering from increased incidences of drought, research and outreach into water saving practices were undertaken. The Great Barrier Reef and Sagarmatha National Park are both threatened by rising temperatures with the only possible solutions being those of monitoring and encouraging greater global action toward climate change mitigation.

The emphasis on disaster risk reduction is also prevalent, particularly with regards to flooding and landslides. In high-risk areas like Machu Picchu, populations were moved, and extensive studies were performed to identify high risk areas. These studies inform the drafting of a disaster risk management plan.

Table 3.3.3. List of actions undertaken at 16 World Heritage Sites.

Name	Impact	Detected - resolved	Actions recommended or taken
Ancient Ksour of Ouadane, Chinguetti, Tichitt and Oualata *Cultural - Mauritania*	Desertification	2001 – 2013	None mentioned
	Storms	2002 - 2003	Storm in 1999 - need to implement WHC action plan to rebuild from storm.
	Other climate change impacts	2009 - 2010	None mentioned
Archaeological Park and Ruins of Quirigua *Cultural - Guatemala*	Wind	1994 -1998	Extend thatch roof canopy to protect statues or remove to museum - confer with Copan after their successful efforts
	Water (rain/water table)	1994 -1998	
	Storms	1998 -1998	Incorporate risk preparedness into site activities.
Archaeological Site of Cyrene *Cultural - Libya*	Temperature	2004 -2004	Encourage the creation of shelters for conservation measures.
	Water (rain/water table)	2004 - 2004	
	Flooding	2006 - 2019	Develop maintenance plan to mitigate floods
	Wildfires	2019 – present	Is applying for funding to address the problem
Chavin (Archaeological Site) *Cultural - Peru*	Other climate change impacts	1998 -2003	Actions taken to protect against rain
	Water (rain/water table)	2004 - 2007	None mentioned
	Temperature	2006 -2009	Emergency maintenance works and preparedness actions (improved drainage and covering fragile areas) and capacity building all undertaken. Recommended moving some artefacts to the museum and building up of mud barriers
	Wind	2006 - 2009	Brace structurally fragile elements
Churches of Chiloé *Cultural - Chile*	Wind	2002 - 2004	Rebuilt churches in conjunction with capacity building trainings
	Storms	2004 - 2004	
	Water (rain/water table)	2004 - 2004	None mentioned
Cliff of Bandiagara (Land if the Dogons) *Mixed - Mali*	Drought	2003 - 2003	Recommended improvement of management plans to implement protection of site and rehabilitate locals in site protection
Fortifications on the Caribbean Side of Panama: Portobelo-San Lorenzo *Cultural - Panama*	Avalanche/ landslide	2003 - 2004	Improved drainage and constructed an emergency roof. Reinforced landslide prone areas and reforestation. Lack of emergency or management plan
	Storms	2011 - 2011	None mentioned
	Flooding	2012 – 2012	None mentioned
	Flooding	2010 – present	None mentioned. Flooding was before 1990

Name	Impact	Detected - resolved	Actions recommended or taken
Gebel Barkal and the Sites of the Napatan Region *Cultural - Sudan*	Wind	2010 – present	A fence was erected to protect one of the pyramids. Environmental monitoring in place.
	Desertification	2016 – present	Took actions to green the area
Great Barrier Reef *Natural - Australia*	Changes to oceanic waters	2011 – present	Reactive monitoring
	Storms	2011 - present	Successful efforts toward cleaner water to prevent pollution during large storm including through catchment management. Plan to reduce run-off pollution by 80% by 2025
	Temperature change	2011 - present	Requires global action.
	Other climate change impacts	2011 - present	Significant bleaching event in 2016 and 2017 for a number of factors
Historic Sanctuary of Machu Picchu *Mixed – Peru*	Wildfires	1987 - 2003	Implemented plan for the prevention of fires and the use of herbicide to keep fire-prone plants from growing.
	Avalanche/ landslide	2003 - present	First investigated in 2000 in conjunction with Kyoto University. Resettled any residences at risk of landslides. Lack of plan to prevent fires and landslides. Need to create public awareness campaign. Created a warning system to facilitate evacuation along with training in disaster risk management and simulations with villagers. Buildings in high risk areas will need to be removed.
	Flooding	2011 - present	
Historical Monuments of Makli, Thatta *Cultural - Pakistan*	Water (rain/water table)	2006 - 2007	Encroachment of property by displaced people due to floods now prevented through fencing and emergency relief. Drainage repair and general maintenance
	Wind	2006 - 2007	Has been monitoring of cracks in building fabric. Wind-borne salinity is not addressed. General conservation works to stabilise buildings. Plan to increase vegetation on site.
	Temperature	2007 - 2007	Creation of weather stations
	Other climate change impacts	2012 - present	Execution of disaster risk study. Recording of structures. Creation of a Disaster Contingency Plan.
Jelling Mounds, Runic Stones and Church *Cultural - Denmark*	Temperature	2009 – 2009	Built an environmentally appropriate building to protect the stones from further weathering. Generally affected by weathering and may not be climate change related.
	Wind	2009 - 2009	
	Water (rain/water table)	2009 - 2009	
Mosi-oa-Tunya/Victoria Falls *Natural – Zambia/ Zimbabwe*	Drought	2006 - present	Has varied water use at the hydroelectric dam based on water levels. Study into the reasons for declining water levels. Have created 9 solar-powered wells to increase water for wildlife. Have taken some measures toward fire control. Continue to monitor water flows
National History Park - Citadel, Sans Souci, Ramiers	Flooding	1991 -1991	Reconstruction of original floor to prevent flooding. Erection of water and humidity level monitoring systems
	Storms	1991 – 1991	General emergency repairs following storms

Name	Impact	Detected - resolved	Actions recommended or taken
Cultural - Haiti	Water (rain/water table)	1991 -2014	General conservation work to reduce the infiltration of rainwater and emergency repairs to seal damaged walls and repair ceilings. Recommend ensuring proper evacuation of reservoir and rainwater
Sagarmatha National Park *Natural - Nepal*	Temperature change	2006 - 2010	Study on rising melt from glaciers,
	Other climate change impacts	2012 - present	Report used WHS as example of threat of climate change and importance of properties protecting glaciers. Implementation of Community Based Flood and Glacial Lake Outburst Risk Reduction project. Is working with local communities to prevent forest fires.
Timbuktu *Cultural - Mali*	Desertification	1990 - 1997	Capacity training of local population on maintenance. Recommended planting trees and training population in vegetation management.
	Wind	1990 - 1997	
	Water (rain/water table)	1990 - 1997	
	Flooding	2004 - 2012	Management plan developed to include emergency measures. Buildings and fountains restored with foreign aid.

4. METHODOLOGY

This study aimed to gather a holistic view of current conservation and management policies at World Heritage Sites. It used two types of data to analyse the intersection of climate action and sustainable development at four World Heritage Site case studies. The first data set was taken from heritage practitioner and World Heritage Site manager interviews to get a holistic view of current conservation theories and how they are implemented on site. The second set of data evaluated the four World Heritage Site case study management plans which prescribed climate actions.

4.1. Practitioner interviews

To attain a holistic perspective, researchers conducted a range of interviews with heritage practitioners. The profile of each interviewee is described in the table below. Interviewee names have not been given for privacy. These interviewees were chosen based on knowledge and their respective expertise.

Table 4.1.1. Heritage experts interviewed.

Interviewee 1	**Interviewee 2**	**Interviewee 3**
Associated with UCLG, this person has a background in the integration of culture as a key component of the achievement of the SDGs.	This person has extensive knowledge of the intersection of sustainable development, disaster risk reduction, and the effects of climate change in World Heritage Sites.	This person is a member of ICOMOS and both the SDGWG and the Climate Change and Heritage Working Group.
Interviewee 4	**Interviewee 5**	**Interviewee 6**
This person is a researcher and part of the Our World Heritage Foundation who has a focus on World Heritage Sites in Latin America.	This person is a researcher and part of the Our World Heritage Foundation who has a focus on African World Heritage.	Based in South-East Asia, this person conducts research and advises on flooding and climate change adaptation for built heritage.

The aim of these interviews was to receive as complete a picture as possible of general perspectives, theories, policies, and known actions that are taken relevant to the intersection of climate action and the Sustainable Development Goals.

Each interviewee was asked a variation of the following questions, covering key themes of inquiry:

1. ENABLING FACTORS - How are World Heritage Sites achieving the targets of the Sustainable Development Goals? What are their enabling factors?
2. IMPLEMENTED SDGs - Do some SDGs contribute to World Heritage more than others? Why? Is it being tracked by site managers and the focal points?

3. SDGs IN THE MANAGEMENT PLAN - How are the SDGs incorporated into the management plans of World Heritage Sites? Are the goals and targets localised within the existing World Heritage frameworks, reporting mechanisms or nomination procedures?
4. CLIMATE ACTION - How do you incorporate climate action into site management of World Heritage Sites? What are the steps being taken to minimise impacts of climate change?
5. HIGH AMBITION - What role can World Heritage play in promoting the high ambition goals of the Paris Climate Accord?
6. MITIGATION - What role do you see World Heritage playing in climate mitigation? What specific actions do you know of that speak to this role?
7. ADAPTATION - What role do you see World Heritage playing in adaptation? What specific actions do you know of speak to this role?
8. LOSS AND DAMAGE- How should heritage managers best prepare for site damage and loss?

The first half of the questions aim to identify how the SDGs were integrated into management plans and whether some SDGs were more implemented more than others. The second half aimed to identify the main themes behind heritage and climate change according to the ICOMOS document *The Future of our Pasts* (ICOMOS 2019).

Each interview was transcribed using a transcription software. The relevant ideas and responses to each question where then tabulated together to create a full table of answers to all questions by individual interviewees. This table can be found in Appendix B. The main themes and ideas were then extracted and tabulated to then be analysed and colour-coded based on reoccurring themes. The table of themes is included and discussed in the results section.

4.2. Case studies

A call for World Heritage case studies was made within the ICOMOS network, with particular focus on sites that have implemented activities related to climate action. Through this call, and from other available research, four sites were selected, based on the availability of site managers. For each site, the relevant management plan was reviewed. In the case where more than one management plan existed, the management plan most related to climate action or the environment was reviewed. Site managers were then interviewed about any clarifications to the management plans and were asked the same 8 questions as the heritage practitioners. These questions were meant to clarify the role of the SDGs and climate action in site management. The sites and associated management plans are listed in Table 4.2.1. Like the heritage practitioners, the names of the site managers have not been disclosed. Instead, they will be referred to in terms of their respective sites. A brief description of the sites and their climate threats is included below.

Table 4.2.1. World Heritage Site case studies and their respective management plans reviewed.

Name	Type	Country	Management Plan
Historic Site of Lyon	Cultural	France	Le Plan Climat Air Energie 2020-2026
Sydney Opera House	Cultural	Australia	Environmental Action Plan 2020-2023
Historic Sanctuary of Machu Picchu	Mixed	Peru	Plan Maestro 2015-2019
Pimachiowin Aki	Mixed	Canada	Management Plan

Historic Site of Lyon

The city of Lyon was first founded in the Roman period and has grown to become the third largest city in France. Located at the confluence of the Saone and Rhone Rivers, the historic city centre is a testament to the continuity of urban development with buildings spanning from the Medieval period to the present (WHC 2021b). Lyon is one of the cities that is heating up the most in France and is therefore under significant threat of heat waves. The two rivers that flow through can cause flooding. Neither of these threats have been reported on SOC reports.

Sydney Opera House

The Sydney Opera House opened in 1973 and has since become an iconic part of Sydney Harbour. It is a masterpiece of 20th century architecture and is an extraordinary response to the setting of Sydney's harbour (WHC 2021b). Surrounded on three sides by water, the Opera House is at risk of sea level rise and severe storm surges.

Machu Picchu

Machu Picchu is a spectacular example of the urban ingenuity of the Inca Empire. Built atop a tropical mountain, the now ruined Incan sanctuary contains thick walls, terraces, temples, and ramps. The surrounding area contains a rich variety of flora and fauna as part of the Upper Amazon River Basin (WHC 2021b). According to SOC reports, Machu Picchu has previously been threatened by landslides and flooding along with wildfires. The site is also at risk from the retreat of the Incachiriasca Glacier and any glacial outburst floods that may ensue.

Pimachiowin Aki

Pimachiowin Aki is a mixed site that protects rivers, wetlands, and boreal forests in a large area of protected land north of Winnipeg, Canada. The site forms part of the ancestral home of the Anishinaabeg who are intimately involved in the governance of the site and in maintaining the cultural practice of Ji-ganawendamang Gidakiiminaan ('keeping the land'), which has allowed

them to protect and thrive off the land for generations (WHC 2021b). As a large natural landscape, the site has innate resiliency and has yet to report any threats on the SOC documents. However, the site will still be affected by climate change including greater incidences of wildfires and the arrival of invasive species.

4.2.1. Case study rationale

These sites were chosen because of their geographic and typological diversity. Lyon and the Sydney Opera House are both cultural sites, but the former is a city, and the latter is a single building within its setting. Machu Picchu and Pimachiowin Aki, although both cultural landscapes, offer very different typologies, with the former being a cultural site within a broad and biodiverse landscape, and the latter being a natural landscape intrinsically interwoven with the cultural practices of the community. These sites are also very geographically diverse; each site is on a different continent with two from the northern hemisphere and two from the southern hemisphere. These sites represent a broad variety of cultural and mixed world heritage. These sites were also chosen because of known actions toward sustainability and climate change.

4.2.2. Case study management plan mapping

The management plan of each case study was reviewed and mapped according to which of the plan's objectives corresponded to the relevant SDG, if applicable. These objectives were then correlated to the corresponding priorities in the *Future of our Pasts* (ICOMOS 2019).

As an ICOMOS document, the *Future of our Pasts* was written to systematically catalogue actions that can be taken against climate change. These actions are clearly specified in Part I, Divisions 1-4. As a document aimed at outlining the intersection of climate change and cultural heritage, it enumerates a range of measures that the heritage community can take to promote climate action according to the main themes of the Paris Climate Accord. It therefore provides a thorough catalogue of heritage-related climate actions. The objectives described in the case study management plans were mapped according to associated SDGs and actions in the *Future of our Pasts* to see how well these objectives matched prescribed climate actions. The results of this mapping exercise can be found in Appendix C and are discussed below.

The results of the case studies were used as a counterbalance to the practitioner interviews with the aim to confirm or expand upon the main themes expressed in said interviews. These actions are later discussed based on related SDGs and heritage policy.

5. RESULTS

5.1. Case studies management plan mapping

The mapping of management plans against the SDGs and prescribed climate actions indicated a clear intersection between both agendas. Most sites targeted a majority of the SDGs, with some SDGs more applicable than others. However, not all the management plan actions translated directly to those mentioned in the *Future of our Pasts*. For many of the management plans, actions were mapped only to the broad, higher-level statements of the *Future of our Pasts.* Others were mapped to paragraphs that were similar but not directly associated. Despite these complications, the persistent connections between *Future of our Pasts* actions and management plan objectives are a clear indication of the potential for integrating these two agendas.

The 17 SDGs are listed in Figure 5.1.1. The various action categories of the *Future of our Pasts* can be found in Figure 5.1.2. The total number of management plan objectives that were mapped to each SDG and correlated *Future of our Pasts* actions can be found in Table 5.1.3.

Table 5.1.1. The 17 SDGs

1 – No Poverty
2 – No Hunger
3 – Good Health and Well-being
4 – Quality Education
5 – Gender Equality
6 – Clean Water and Sanitation
7 – Affordable and Clean Energy
8 – Decent Work and Economic Growth
9 – Industry, Innovation and Infrastructure
10 – Reduced Inequalities
11 – Sustainable Cities and Communities
12 – Responsible Consumption and Production
13 – Climate Action
14 – Life Below Water
15 – Life on Land
16 – Peace, Justice and Strong Institutions
17 – Partnerships for the Goals

Table 5.1.2. Future of our Pasts action categories.

Each of the categories had individual actions used to map to the management plans.

Division 1: High Ambition

1.1 Heritage Places and climate action communication
1.2 Heritage, research and climate science
1.3 Climate change, heritage and education
1.4 Integration of cultural heritage management with climate science in policy development

Division 2: Adaptation

Knowledge and Understanding

1. Values-Based Approaches and People-Centred, Participatory Governance
2. Using the Data-Collection Aspects of Heritage to Support Effective Adaptation
3. Using Heritage Monitoring to Support Effective Adaptation
4. Harnessing Heritage as an Asset for Climate Change Adaptation; Past, Present and Future
5. Sharing Good Practice Examples

Planning and Implementation

6. The Role of Heritage in Supporting Disaster Risk Reduction (DRR)
7. Adaptation Planning for Heritage – Policy and Actions
8. Coordination of Heritage Adaptation within wider National/Regional/International Policies

Opportunities, Constraints and Challenges

9. Managing Change
10. Opportunities
11. Uncertainty
12. Costs and Benefits of Adaptation Activities
13. Existing Management and Conservation Methods and Approaches May Need to Change to Meet the Challenge of Climate Change
14. Existing Barriers to Adaptive Management of Heritage That May Limit Attempts to Address Climate Change
15. Sustainability

Division 3: Mitigation

3.1 Living Sustainably
3.2 Carbon Mitigation Through Demand-Side Measures: Built Environment
3.3 Carbon Mitigation Through Demand Side Management in Agriculture, Land Use, and other Sectors.
3.4 Heritage and Carbon Dioxide Removal.
3.5 Carbon Mitigation Through Supply-Side Measures: Renewable Energy
3.6 Cultural Tourism
3.7 Heritage Sector as Driver of Mitigation Ambitions

Division 4: Loss and Damage

1. Slow Onset Events
2. Non-economic losses
3. Comprehensive Risk Management approaches
4. Migration, displacement and human mobility
5. Action and Support

Table 5.1.3. Number of management plan objectives that corresponded to both *Future of our Pasts* actions and individual SDGs.

SDGs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
City of Lyon	1	1	3	11	0	1	3	3	8	0	8	5	4	0	4	5	1
Sydney Opera House	0	0	0	11	0	1	4	1	3	1	0	2	5	1	2	2	5
Machu Picchu	0	1	0	4	0	0	2	0	2	1	2	1	1	0	1	1	3
Pimachiowin Aki	2	2	0	10	0	2	1	5	1	3	7	6	6	4	6	12	6
Total	3	4	3	36	0	4	10	9	14	5	17	14	16	5	13	20	15

Clear trends are visible among the four sites as to which SDGs are primarily addressed. There is a very strong focus both in management plans and in the *Future of our Pasts* as to the importance of educating local communities and the heritage community at large on the significance of the climate crisis (SDG4). Education goals in management plans were twofold: firstly, to encourage local knowledge of the importance of heritage conservation and protecting the site from climate change, secondly, to promote the site's importance in advancing knowledge about climate change and fostering actions to mitigate it.

The importance of governance (SDG16) was highlighted in the management plans as the most important factor to enabling both climate action and the SDGs. Lyon and the Sydney Opera House included actions that increased the accountability of existing management systems whereas Pimachiowin Aki and Machu Picchu both emphasised participatory governance in climate resilient management. Governance is mentioned in the *Future of our Pasts* in terms of the importance of producing management plans and creating incentives for climate change planning.

It comes as no surprise that SDG 11 was also frequently addressed, partially due to the relevance of target 11.4 to the protection of cultural and natural heritage. Most of the management plans also had a significant focus on the importance of community involvement and fostering a sense of action among the community. This notion is one that is often visited in the *Future of our Pasts.*

Despite the relevance of climate action (SDG 13) to all the SDGs and management plan goals, those goals that were primarily associated with climate change, such as promoting climate-related policies (Lyon), implementing disaster risk reduction plans (Machu Picchu), or maintaining carbon-neutral status (Sydney Opera House) were mapped to SDG 13 along with any other associated SDGs, where possible.

The role of partnerships (SDG17) in understanding climate risks was a theme visited by three of the four management plans. Machu Picchu, Sydney Opera House, and Pimachiowin Aki all emphasised the importance of partnering with research institutions to increase preparedness for

climate change by better understanding the risks. The importance of partnerships for studying and preparing for climate change is a key theme in the *Future of our Pasts*.

Those sites with a built heritage component all spoke to the importance of promoting climate resilient infrastructure (SDG 9). In the case of Lyon and the Sydney Opera House, the focus was on building maintenance and promoting more efficient infrastructure, very much in line with actions described by the *Future of our Pasts*. Machu Picchu also identified the importance of maintenance in the face of environmental threats as a key part of its management plan.

SDG 7 was mentioned in most of the sites. Both urban sites, Lyon and Sydney Opera House, emphasised the importance of promoting alternative energy. Machu Picchu also encouraged alternative modes of transport to the historic citadel. The renewable energy aspects of both built heritage infrastructure and the tourism industry are mentioned in the *Future of our Pasts*.

The importance of sustainable procurement and consumption (SDG 12) was one that was visited by all management plans both with regards to both promoting local and efficient procurement and reducing waste. Waste is only considered in the *Future of our Pasts* with regards to building material or energy inefficiency. However, waste management and the proper disposal of waste was a key issue for several sites and is not addressed in the *Future of our Pasts.* Excess waste can have effects on the environment and decrease its resilience to climate change.

The other SDGs are also integrated into site management plans in ways that are more site-specific. Generally, there is very little mention of the role of inclusive gender policies in any of the management plans with the exception of Pimachiowin Aki's brief mention of the role of women in the site's governance, but not within specific actions or objectives. Poverty and well-being are also ill-represented among the management plans with some passing references. Specific actions toward implementing the SDGs are discussed in more detail according to each SDG in the discussion section.

5.2. Practitioner and Site Manager interviews

This study aimed to develop an understanding of how climate action and sustainable development theoretically could be and are integrated, based on the feedback of heritage practitioners and site managers. As heritage practitioners, Interviewees 3and 4 noted, there is often a gap between high level discussions and understanding at the site level. This study served as a preliminary investigation of whether the integration of these two themes is merely theory espoused by experts or whether the implementation on the ground follows the high-level discussions. For this reason, case study interviews were analysed alongside practitioner interviews.

The main themes expressed in response to the questions asked are summarised in Table 5.2.1. Interviewee numbers line the y-axis, with questions asked along the x-axis. Key points are mapped according to each interviewee. The main themes addressed by interviewees are represented in various colours, assigned at random, but used to highlight concurrent responses.

Table 5.2.1. Summary remarks of practitioner interviews and interconnecting themes.

	Themes if inquiry 1 – What are enabling factors? 2 – Are some SDGs more implemented?			3 – Are SDGs in management plans? 4 – General role of World Heritage in climate action 5 – World Heritage and mitigation			6 – World Heritage and adaptation 7 – World Heritage and High Ambition targets 8 – Risk and loss	
	Brown – importance of governance Red – importance of risk reduction Orange – lack of understanding of CC Ochre – sustainability, not SDGs			Yellow – help within heritage network Light green – climate action over SDGs Dark green – environmentalism more important Teal – improve scientific knowledge			Light blue – World Heritage visibility Dark blue – lack of translatability Purple – mitigation as natural carbon sink Pink – importance of traditional knowledge	
	Theme 1	Theme 2	Theme 3	Theme 4	Theme 5	Theme 6	Theme 7	Theme 8
Interviewee 1	•11.4	•11.4 often entry point	•No explicit mention of SDGs in VNRs	•Awareness •Own resources •Local participation	--	--	•Greater scientific understanding	--
Interviewee 2	•Depends on site	•All SDGs with a social dimension (16, 11)	•General lack of SDGs in plans but tracking to WHSDP	•Can contribute to NDCs in natural dimension •Climate action above all.	•Heritage can be model	•Need to know risks. •Traditional knowledge can help	•Greater scientific understanding	•Need to change definitions of heritage to be more resilient
Interviewee 3	•Transversal	•All applicable.	•Depends on the site	--	--	•Retrofitting buildings	•WH politically important	--
Interviewee 4	•Governance	•Many SDGs being implemented but considers SDG 17 to be most important	•Aiming to implement more inclusive management	•Visibility •WH will have small impact. •Is model for vernacular heritage and other WH	•Renewable energy more for urban sites •Consumption, and better urban planning need to be addressed.	•Need to know risks in risk management plans •Traditional knowledge can help	•Include community and civil society •Greater scientific knowledge •Help among heritage sector •Look at environment for holistic approach	•Local context is different than theory •Site dependent •Sites serve as pilot projects for future interventions.
Interviewee 5	•Governance	•Environmental SDGs more often addressed	•Not in plans but indirectly addressed	•Most sites have taken action	•Often addresses carbon sink in natural sites	•Adaptation is site dependent	•Local knowledge key •Will become own heritage	•Site can only do so much – depends on governments
Interviewee 6	•SDGs not easy to translate	•SDG 4	•Not in plans but indirectly addressed	•More CC understanding •Locals unaware of CC – not enough info	•Green transport and solar energy	•Urban planning important •Need to assess risks	•Promoting to public. •Reactive actions	•Currently no discussion of loss, but more concern •More concern as risks become clearer

Table 5.2.2. Summary of remarks of site manager interviews and interconnecting themes.

	Themes if inquiry 1 – What are enabling factors? 2 – Are some SDGs more implemented?		3 – Are SDGs in management plans? 4 – General role of World Heritage in climate action 5 – World Heritage and mitigation			6 – World Heritage and adaptation 7 – World Heritage and High Ambition targets 8 – Risk and loss		
	Brown – importance of governance Red – importance of risk reduction Orange – lack of understanding of CC Ochre – Sustainability, not SDGs		Yellow – help within heritage network Light green – climate action over SDGs Dark green – environmentalism more important Teal – improve scientific knowledge			Light blue – World Heritage visibility Dark blue – lack of translatability Purple – mitigation as natural carbon sink Pink – Importance of traditional knowledge		
Interviewee	Theme 1	Theme 2	Theme 3	Theme 4	Theme 5	Theme 6	Theme 7	Theme 8
City of Lyon Site Manager	•Public acceptance	--	•Mapping to SDGs in yearly report	•Climate action addressed above all else	•Public funding, •Transport •Lighting	•Building renovations •Tree planting,	•Heritage can be a model. •Promote among public.	--
Sydney Opera House Site Manager	•Governance	•9 of the 17	•SDGs tracked in plan	•CC will exacerbate sustainability issues	•PPA and sustainability certified – is carbon neutral	•Safety protocols for disaster risk. •Emergency and disaster risk management	•Help other sites •Promote among public	--
Machu Picchu Site Manager	•Cultural and Natural conservation first	--	•Sustainability not SDGs	•CC action is balance of efforts •Locals unaware of CC. •Monitoring	•Electric transport to site	•Disaster risk management. •Early warning system	•Monitoring for better knowledge	--
Pimachiowin Aki Site Manager	•Transversal based on 5 blocks •Not easy to translate	•Transversal	•Sustainability, not SDGs	•Data collection and monitoring. •Reactive monitoring	•Acts as carbon sink	•Large site is more adaptable. •Local involvement	•Monitoring for better knowledge, •Help other sites	•Community efforts to prevent disaster

Analysis of the practitioner and site manager interviews revealed a clear emphasis on the role of governance (in brown) as the principal enabler of sustainable development. Fifty percent of interviewees indicated the superlative role of governance over that of any other enabling factors. None of the other interviewees' answers pointed to a single theme. Instead of being seen as a fourth pillar, some saw it as the base on which the pillars of sustainability were set. Governance and partnership go hand in hand, as the latter is an extension of the former. It is important that sustainable development be included in management plans and related governance structures for it to be implemented

Sustainable development is not a universally understood concept. One of the key issues raised both by the Pimachiowin Aki Site Manager and Interviewee 6 is that of the cultural translatability of sustainability (dark blue). Because sustainability is such a holistic concept, it can often be difficult to translate locally. This confusion is indicative of the duality of sustainability; its holistic approach makes it easy to integrate into projects, yet at the same time difficult to approach because it is so all-encompassing.

Sustainable development, as a high-level discussion, is still somewhat absent from local actions. Fifty percent of interviewees indicated that the SDGs are not specifically enumerated in management plans and are not being tracked as such (ochre). Indeed, of the four case studies, the Sydney Opera House Environmental Action Plan was the only plan to specifically address the SDGs, whereas others instead referenced the pillars of sustainability. Yet due to their transversal nature, most of the SDGs were addressed in some form within management plans.

Climate change will have drastic effects on the implementation of sustainable development in World Heritage Sites. Yet Interviewees 4 and 5 both indicated that, to their knowledge, climate actions in World Heritage Sites remain largely ad hoc. Interviewee 6 explained that climate change is not clearly connected in the mind of locals and site managers with current weather patterns (orange). Rather, climate action is largely relegated to reactive monitoring and adapting to any perceived changes. Monitoring was one of the key ways World Heritage Sites prepared for climate change, as is the case with Pimachiowin Aki. Monitoring can contribute to a greater understanding of climate risks and is the first step toward creating disaster risk management plans. These plans were identified by many interviewees as one of the principal methods sites can use to adapt to climate change (red).

An important contribution to drafting disaster risk management plans and other adaption methods is involving the local community (pink), which can lend viability to adaptation methods. Local, traditional knowledge was identified by 5 interviewees as one of the significant contributions World Heritage can make to climate change. This theory was put into practice in several sites. Pimachiowin Aki used traditional conservation methods to protect and monitor the site. Both Machu Picchu and the city of Lyon emphasised local participation in adaptation methods.

With regards to climate mitigation, practitioner interviews and policy both seem to indicate a divide between cultural and natural sites and rural and urban sites. Three interviewees explained

that natural sites are appreciated for their potential as carbon sinks (purple). Urban sites are understood to have a greater facility with implementing renewable energies and transport infrastructure. However, there is little discussion of mitigation for sites that do not fall into either category. Of the four case studies, the two urban sites were taking significant steps to become carbon neutral. The other two sites had much less of an emphasis on mitigating climate change. The WHCCP draft did acknowledge a perceived conflict between renewable energy and World Heritage, but also specified that where relevant, renewable energy should be explored within World Heritage Sites so long as it does not conflict with preserving OUV (WHC 2021a, 19). Clarification was sought from the World Heritage Centre, who clarified the need for a stronger link between World Heritage and SDG 7.

Aside from adaptation and mitigation, another important climate action is preparing for disaster and loss. This subject has not received much attention. The new draft of the WHCCP addresses this possibility and its effects on OUV and the UNESCO World Heritage Centre confirmed that it is a discussion that is ongoing. Much of the difficulty of this question relates to the unknown of what climate change will do. It is for this reason that half of the interviewees focussed on understanding the science (teal). Indeed, most of the case studies included liaising with scientists to study and understand the site. However, the divide between site managers and scientists is still wide. Just as sustainable development is transversal and addresses multiple sectors, so too should climate action. There needs to be greater knowledge sharing among site managers, scientists, and any partners involved in sustainable development on site.

One of the most salient themes discussed by interviewees is that of the role World Heritage can play in raising awareness of climate change (light blue). Six of the interviewees addressed the significant political and cultural visibility of World Heritage. This visibility can highlight the importance of climate action for protecting these sites and can promote a greater consciousness toward the severity of the challenge. World Heritage can also serve as a model of adaptive practices that can be used more locally. Creating network of heritage sites can foster greater cooperation and knowledge sharing (yellow). According to site managers, both Pimachiowin Aki and the Sydney Opera House are involved in collaborating with other heritage sites to help them implement sustainable practices.

One of the themes addressed by three interviewees was a focus on the environmental benefits of conserving heritage (green). Interviewees 2 and 4 remarked on the important role World Heritage Sites can play in environmental sustainability, which is often seen as a site's largest contribution to climate action. Interviewee 4 noted that there was a particular focus on environmental sustainability first and foremost. This opinion was supported by the site manager of Machu Picchu, who stipulated that cultural and natural conservation were the main enablers of sustainability on the site. This focus on the superlative importance of environmentalism speaks to an inclination toward protecting the environment and communities from climate change as a critical priority. Indeed, several interviewees pointed to the greater importance of tackling the climate crisis over that of enabling sustainable development (light green).

6. DISCUSSION

6.1. World Heritage and climate action

The analysis of heritage practitioner and site manager interviews revealed a general consensus along several broad themes. Sustainable development was integrated in all four management plans, whether referring to the SDGs directly or to the pillars more generally. All the plans also included a strong focus on involving the community and raising awareness of sustainable development practices. All plans incorporated some aspect of monitoring for and adapting to climate change.

Half of the practitioners interviewed referred to the still ad hoc nature of climate action within sites, and the broad variety of actions taken in the case study sites speaks to this theme. In terms of preparing for future disasters, Lyon, the Sydney Opera House, and Machu Picchu all have a disaster risk management plan, Pimachiowin Aki does not, and the Sydney Opera House is in the process of drafting an adaptation plan. However, management plans need to be implemented to prevent future risks not simply to react to disasters. Machu Picchu has taken steps to reduce landslip around roads and improved the drainage of its rivers. Lyon does have a disaster risk management plan, but it is only related to flooding. Instead, it is taking many steps outside of that plan to increase the city's resilience to heat and storms. Such is also the case for the Sydney Opera House; their disaster risk management plans deal with risk of extreme events, and their forthcoming adaptation looks at future actions to not only reduce these risks, but adapt to them, The variety of these management plans indicates the still very ad hoc nature of responses to climate change.

Climate action is not limited to disaster risk prevention but also involves reducing greenhouse gases and creating innovative methods of operating under greater climate pressures. Within the capacity of the site, all case studies were taking actions toward climate change, whether it be through promoting green infrastructure, encouraging alternative transportation infrastructure, or reactive monitoring to protect the natural biodiversity of a site. Site managers were aware of the risks and worked within their capacities to enforce climate action within a sustainable development framework.

6.2. Linking climate action and the Sustainable Development Goals at World Heritage Sites

Climate change will affect all aspects of human life and will create significant barriers to accomplishing the SDGs. None of the SDGs stand alone; achieving one goal will depend on and affect the outcome of the other goals. However, achieving one of the goals should never come at the expense of other goals; climate action should facilitate the implementation of other SDGs. Because climate change is all-affecting, however, it is critical that climate action be addressed by all the SDGs as it is the one with the most power to affect the wellbeing of future citizens. At the 2019 UN Climate Action Summit, the Secretary General acknowledged the tangible effects that climate change would have on the world's citizens and called for greater alignment between the

Paris Climate Agreement and the 2030 Agenda (UN Secretary General 2019, 5). Interviewees generally agreed with this principle and spoke to the need for greater interdisciplinarity in the field with increased collaboration between scientists and heritage practitioners and managers. Better climate literacy and participative approaches 'need to be utilised to arrive at inclusive solutions supported by stakeholder consultation and adaptive management' in order to increase SDG and climate action implementation (ICOMOS 2019, 10).

The WHCCP clearly states that 'Actions taken by States Parties to address climate change impacts can also contribute to the implementation of the Sustainable Development Goals (SDGs), in line with the 2015 Sustainable Development Policy through adoption of mutually reinforcing, inclusive and adaptive approaches' (WHC 2021, 21a). The integration of these two themes is therefore clearly set out in policy. In a discussion with the UNESCO World Heritage Centre, they confirmed this connection between both policies and that the WHSDP should act as an umbrella framework for the WHCCP.

Although practitioners in the field agreed to the inherent interconnection between sustainable development and climate action, some World Heritage managers and interviewees indicated that climate action should not be seen within a sustainable development framework but rather that it should be inverted; climate action should lead the way for sustainable development. Rather than implementing the SDGs, the city of Lyon is directing its efforts instead on an 'ecological transition' which focuses on climate change by addressing the social, economic and environmental facets of the problem.

Sustainable development, as Interviewee 4 explained, will perpetually remain a goal. There are always more efforts to be done. The same is true of climate action; both will perpetually remain as subjects of improvement. However, the SDGs have a defined timeframe whereas climate action does not. This dichotomy again indicates the importance of integrating both agendas, so that the SDGs can be used to facilitate climate action. As we continue to strive for sustainable development beyond the 2030 Agenda, climate action will continue to be an integral, if not superlative, subject for future discussions of sustainable development.

6.3. Embedding climate action into the achievement of the SDGs

The theoretical links between climate action and sustainable development are clear and case study sites have undertaken various measures to enforce both on site. To highlight the links between theory and action, the following section examines the existing literature on the integration of climate action (SDG 13) within each of the remaining 16 SDGs. Where policy matches specific site actions, examples of measures taken by the relevant case study are discussed alongside the associated strategies for World Heritage Sites.

6.3.1. SDG 1 – No Poverty: Developing climate-resilient management frameworks to alleviate poverty in World Heritage Sites

Poverty is among the main causes of environmental damage, particularly in impoverished nations (IUCN 2008, 104; UNESCO 2011, 2). An estimated 10% of the world's population lives in extreme poverty, lacking access to basic services and opportunities, including culture (ICOMOS 2021a, 20; UNESCO 2016, 205). However, culture is a basic service and is integral to alleviating socio-economic poverty and promoting creative industries, jobs, and innovation (Culture 2030 Goal Campaign 2019, 6). As the impact of climate change worsens, it becomes both a direct threat to and a multiplier of poverty, which in turn causes further damage to heritage places and their communities (UNESCO and UNEP 2016, 12; ICOMOS 2021b, 20). The *Sendai Risk Framework* therefore encourages the development of social safety nets for the world's most at risk populations (UN 2015c, 20) in preparation for the risks of climate change.

World Heritage properties offer tremendous potential to alleviate poverty and enhance the livelihoods of their communities, including the marginalised and the poor (WHC 2015, 8). These properties act as storehouses of knowledge that provide basic goods and services, such as security, health, shelter, access to clean air, water, food and other key resources (UNESCO 2016, 254). They can also play a key role in promoting climate-resistant development while promoting fair and scalable adaptation to climate change (ICOMOS 2019, 10; UCLG 2018, 7). Successful implementation of climate action policies through sustainable development can enhance the ability of World Heritage Sites to adapt while maintaining their OUV and eradicating poverty (WHC 2021a, 15).

Pimachiowin Aki has taken specific measures to ensure the livelihood of the First Nation communities on the site. The Management Plan specifies the realisation of periodic domestic needs assessments to ensure that the livelihood of the Anishinaabeg is preserved. Anishinaabe customs rely on a subsistence economy based on the land. With potential changes to biodiversity, the subsistence economy of the Anishinaabeg may become untenable. The Pimachiowin Aki Management Plan therefore proposes to ensure that local communities can safely retain their cultural practices and livelihoods through continual monitoring (Pimachiowin Aki 2016, 57-58).

The city of **Lyon** has taken specific actions aimed at fighting energy poverty. In its Climate Action Plan, the city promises to support energy-poor households by launching an ambitious campaign to change energy-inefficient behaviours and promote efficiency. In doing so, the city aims to not only to help households become financially stable, but also to increase greener energy use across the city (Ville de Lyon 2020, 35).

6.3.2. SDG 2 – No hunger: World Heritage as a haven for resilient food production

Agricultural practices, fishery, forestry, and agrobiodiversity methods are inherently intertwined with complex traditional methods of food production (UNESCO 2012, 94). Future changes in climate will likely cause unpredictability in the availability of food for biodiversity and humans alike (UNESCO 2008, 3; UNESCO and UNEP 2016, 37). More extreme temperatures and precipitation levels will substantially restrict future crop yields and cause greater stress to livestock. Rising seas and stronger storms are also predicted to affect hatcheries. Areas with agricultural systems with higher sensitivity and where a high percentage of the population relies on agriculture will see significant rises in hunger (Koubi 2019, 19). Climate action in agricultural cultural landscapes should involve both reducing carbon-reliant infrastructure and building the resilience of agricultural systems to future disasters. Greenhouse gas levels should be reduced within a timeframe that allows food production and economic development to adapt and proceed in a sustainable manner (IUCN 2008, 104).

The traditional landscapes of some World Heritage Sites support biodiversity, aid climate resilience, and provide basic food security and services to local populations (ICOMOS 2021b, 26; UNESCO 2016, 254; WHC 2021a, 1). These productive cultural landscapes and other conservation areas can act as protected spaces where traditional methods still thrive and where climate actions can be further harnessed. Intangible cultural heritage practices such as the use of heritage grains, which are acclimatised with the local environment and developed through traditional propagation and harvesting techniques can provide locally sourced and resilient food products (Caballero 2021; UCLG 2018, 8). **Machu Picchu** has committed to preserving the agricultural lands within the site while also ensuring that land currently used for agriculture is retained but not expanded to preserve flora and fauna (Morón Alvarez et al. 2015, 13).

In planning for climate change, disaster risk reduction and adaptation should include protecting livelihoods, particularly livestock, working animals, and traditional seeds (UN 2015a, 20). Traditional low-impact irrigation systems and sustainable pastoral nomadism can also reduce the impacts of food production on various ecosystems by allowing natural regeneration of the environment (Caballero 2017).

Pimachiowin Aki is a mixed site resplendent with animal and plant life integral to the hunting, fishing and foraging traditions of the Anishinaabeg and contains various food sources for the local community. Licensed fishing and hunting are managed through provincial regulations and are not under the direct control of Pimachiowin Aki management. However, as the largest protected area in the boreal shield, the site protects countless species, many of which serve as a local food source. Biodiversity may result from climate change and may affect the availability of food and the cultural practices that sustain the communities.

Urban and peri-urban World Heritage Sites are potential areas for food production which may facilitate greater food security for urban areas (UNESCO 2016, 37). Although urbanisation is a significant threat to agriculture and traditional ways of life (UNESCO 2016, 21), green spaces and

undeveloped lands in cities can be hubs of cultural activity and offer a space for food production through urban farming (UNESCO 2016, 21). Traditional settlement patterns in or near productive landscapes can also inspire a new form of urbanism that can be resilient to climate change. There is widespread acceptance of the importance of promoting the sustainable use of public spaces in cities for urban agriculture and increased food security (UN 2016, 32; ICOMOS 2019, 52).

The city of **Lyon** is committed to promoting sustainable and local food sources. As a city that has a large gastronomical culture, it prides itself on many local products. Lyon has committed itself to promoting greater procurement of local and organic food products in municipal buildings. It has increased support to local urban gardens and markets in an effort to increase public awareness of local food production and more economical food consumption (Ville de Lyon 2020, 25).

6.3.3. SDG 3 – Health and well-being: Prioritising health and safety in World Heritage Sites

Climate change will have a direct impact on human health (UNESCO 2007, 23). Climate action therefore involves enhancing the resilience of national health systems and promoting training in disaster medicine and preparedness at the local level (UN 2015c, 3, 19). Disaster risk preparedness is also essential for the well-being of residents to ensure they are safe from future disasters. According to SOC documents, as part of its disaster risk preparedness, the site of **Machu Picchu** moved some of the settlements that were in landslide prone areas. It has now installed a permanent early-warning system for residents to evacuate in case of disasters (Morón Alvarez et al. 2015).

World Heritage Sites play a direct role in human health by providing food, water, and medicinal plants and ensuring that they are protected and equitably accessible (WHC 2015, 6). Some traditional medicines also have important health benefits and are innately tied to the culture of a place. The continued protection and maintenance of World Heritage Sites can therefore contribute to human health and climate action. Any measures taken should be culturally relevant to local customs and include culturally sensitive health and education services, given in the local language with knowledge of the local area and local customs and their role in communal well-being (UCLG 2018, 9; ICCA 2018, 14).

Pimachiowin Aki means ‘land that gives life’ referring the importance of the land in granting ‘hunting success, economic stability, good health into old age, and healthy, happy children’ (Pimachiowin Aki 2016, 4). The importance of protecting the land is therefore inherently linked to the well-being of the community. The land provides food, shelter, water and the means to maintain a happy, healthy life. The practice of Ji-ganawendamang Gidakiiminaan ('keeping the land') is built into the management plan of Pimachiowin Aki and inherently involves preserving the landscape with the involvement of local community for its own benefit (ibid.).

Bringing awareness to air quality and the conservation of historic buildings can promote actions to limit air pollution and its detrimental effects to health (ICOMOS 2019, 49). Highlighting the critical role of building maintenance for reducing carbon-footprints can shine a light on practices

that improve the health of the user (ICOMOS 2019, 50; UNESCO 2016, 21; UN 2016, 13). Both the city of **Lyon** and the **Sydney Opera House** have taken action to improve the wellbeing of building occupants due to air quality. The Sydney Opera Houses building management control system closely monitors air quality (internally and externally) for the benefit of all building occupants (Sydney Opera House 2020, 44), whereas Lyon has promised to improve occupants' awareness of maintenance and good air quality (Ville de Lyon 2020, 63). Both sites are also promoting alternative modes of transport to promote health and wellbeing (Sydney Opera House 2020, 37; Ville de Lyon 2020, 42).

Urban green spaces also serve as inclusive public spaces that are more resilient to climate change by quelling the urban heat island effect, providing better air quality, and promoting a higher urban quality of life and healthier living among residents (UNESCO 2016, 187). This principle has been taken up by **Lyon** in view of the growing threat of heat waves. The city plans to open parks at night to help residents cope with the heat and still be able to enjoy outdoor spaces. Further research into the cooling effects of public fountains during heat waves is also being undertaken along with measures to ensure the wellbeing of staff during such events (Ville de Lyon 2020, 44-45, 63).

6.3.4. SDG 4 – Education: World Heritage as loci of climate learning and adaptation

The scale of the societal transformation that will be required to address climate change will need widespread education that is both grounded in climate science and culturally aware (ICOMOS 2019, iii; ICCA 2018, 14). Early education about climate awareness is key to early adaptation. Cultural heritage can significantly contribute to climate education by allowing people to think creatively and giving them access to sites and experiences they may otherwise not have had. All too often, formal education in many countries continues to erode indigenous culture, language, and knowledge (UNESCO 2012, 66;). Cultural diversity, inclusion and environmental awareness should be integrated into education policies and curricula, the design of which should be led by local stakeholders and should be culturally relevant for a more pluralistic, cohesive, and environmentally conscious world (ICOMOS 2015, 13; ACP 2017 para 21, UCLG 2018, 10; UNESCO 2016, 19; IUCN 2008, 74; Culture 2030 Goal Campaign 2019, 6; Europa Nostra et al. 2019, 2; UCLG 2018, 10).

Machu Picchu and **Pimachiowin Aki** have both agreed to partner with local schools to promote the importance of conserving World Heritage. Machu Picchu encourages local schools to teach about the importance of the historic sanctuary and nature conservation in their curricula (Morón Alvarez et al. 2015, 24). One of the goals of the Pimachiowin Aki Management Plan involves working with local schools to provide experiential learning and the materials to understand Anishinaabe beliefs (Pimachiwoin Aki 2016, 57). Both sites have leveraged their role as cultural institutions to promote their value and the intangible and natural heritage they protect.

World Heritage Sites can also be used to mobilise public and political support for climate adaptation through workshops, media campaigns, exhibitions, and school outreach events (WHC

2006, 5; WHC 2011, 15; WHC 2021a, 13; ICOMOS 2011, 5). **Lyon's** Climate Plan aims to promote greater environmental consciousness among the political class. It also plans to use tree-planting workshops around the city to improve public awareness of the natural environment within the urban fabric. Some of these trees may be planted near schools and involve the participation of local school children (Ville de Lyon 2016, 23-30). The **Sydney Opera House** also aims to develop educational material on environmental sustainability for local schools (Sydney Opera House 2020, 54). It aims to increase community awareness of sustainability through marketing and public media (ibid., 55). These education programs can create a culture of entrepreneurship and innovation, particularly on the micro scale to encourage adaption and resilience in local communities (WHC 2015, 10).

World Heritage Sites are perfectly positioned to promote climate action and sustainability; climate awareness should be included in any associated interpretation and education activities (UNESCO 2008, 5). World Heritage Sites act as a classroom in which to educate visitors, heritage practitioners, and the community about the challenges these places face and how they can adapt (UNESCO and UNEP 2016, 55; IUCN 2008, 29). The **Sydney Opera House** has plans to use performances to promote a greater understanding of sustainability and environmental consciousness (Sydney Opera House 2020, 55). The city of **Lyon** is using public cultural events to promote the importance of climate change and publicise the city's efforts to reduce greenhouse gases (Ville de Lyon 2020, 44, 48).

In terms of intangible cultural heritage, the intergenerational learning of traditional knowledge, rituals, and craftsmanship will be integral not only to the continuity of culture, but also to our understanding of past human adaptation in the face of climate change (ICOMOS 2021a, 38; UNESCO and UNEP 2016, 29; UNESCO 2016, 221). Cultivating relations with previous generations also allows for more intergenerational cohesion and prevents isolation (UNESCO 2016, 223). **Pimachiowin Aki** ensures that land management experts and elders pass on their generational knowledge to ensure that Anishinaabe beliefs continue to be passed down (Pimachiowin Aki 2016, 54). As the climate changes, the teaching of traditional skills will need to be adapted to climate change and will ensure that previous adaptations are handed down.

World Heritage Sites can also act as a focus for research and learning on various adaptation methods. World Heritage management has shifted away from training to a more holistic approach of 'knowledge acquisition' (WHC 2011, 2; WHC 2021a, 11). Researchers, local community members, practitioners and stakeholders form part of an international network that can be harnessed to promote interdisciplinary heritage research as part of climate action, mitigation, adaptation, and risk reduction (ICOMOS 2019, 19, 31; UN 2015c, 18). The value of research toward greater climate preparedness is evident in all four case studies. Specific to both **Pimachiowin Aki** and **Machu Picchu**, both have clear aims to increase partnerships with research organisations to better understand the site and its potential resilience (Pimachiowin Aki 2016, 61; Morón Alvarez et al. 205, 26).

Disaster risk reduction is a constant learning process and World Heritage Sites can use this international network to build a culture of disaster prevention where World Heritage communities learn from each other about what adaptations have worked (WHC 2007, 4; IUCN 2008, 79). The **Sydney Opera House** has recognised the importance of its role as a World Heritage Site and has made efforts to be seen as an example of leadership in environmental sustainability. This leadership has the potential to inspire other heritage sites to do the same (Sydney Opera House 2016, 36).

Going forward, World Heritage managers will need to be educated about the climate challenges they face and the importance of contextualising near-term decisions within the longer-term climate perspective. (Koubi 2019, 39; IUCN 2008, 73) More importantly, World Heritage Sites must integrate more training in traditional skills, emergency preparedness, and climate aware conservation practices (UNESCO 2006, 24; UNESCO 2006, 4) in a manner that is culturally aware and involves all members of the community and their expertise.

6.3.5. SDG 5 – Gender equality: World Heritage as an example of gender-responsive capacity building for disaster risk management.

Cultural traditions have historically served to enforce traditional gender roles and gender inequality. Women have historically had less access to resources, fewer rights, and little say in decision-making, which makes them particularly vulnerable to climate hazards (UNESCO 2012, 51, 71). Yet women are also the chief guardians of important local and traditional knowledge (UNESCO 2012, 51, 71). Cultural heritage can help highlight and further the importance women can play in creating a more climate-resilient society.

There is widespread acknowledgment that capacity-building at World Heritage Sites should include women and that they should be involved in the full cycle of the World Heritage process (WHC 2015, 8; UNESCO and UNEP 2016, 24; ICOMOS 2019, 20). Women make up a large part of the labour force in tourism and their full and equal participation in climate action is vital (UNESCO and UNEP 2016, 22-23). Women and men have disparate knowledge sets based on their gender roles and women will have different ideas about disaster risk reduction, climate adaptation and mitigation (UNESCO 2012, 30). Directly involving women in the leadership and roll-out of climate action in World Heritage Sites can serve to promote a more equitable and climate-resilient future.

Pimachiowin Aki has worked to incorporate women into their governance to ensure their voice in management and any relevant decisions regarding climate preparedness. Women were leaders in preparing the nomination for inscription on the World Heritage List, and the management plan supports a Women's Forum which has met a few times since inscription of the site. Many women are also active participants in Annual General Meetings of the Pimachiowin Aki partnership. According to the management plan, 'Women Elders are respected knowledge holders in

Pimachiowin Aki and they continue to provide a voice in decisions as the site moves forward and adapts' (Pimachiowin Aki 2016, 47).

6.3.6. SDG 6 – Clean water and sanitation: Celebrating traditional methods of water management in World Heritage Sites

Over the centuries, humans have created various systems for controlling and accessing water. Some of these historic systems remain today and are recognised as vital to the functioning of communities, their traditions, rituals, and everyday life. These systems can serve as an opportunity to engage local stakeholders and industries to explore ways to adapt water systems to future change (ICOMOS 2021b, 50). Communal fountains and public hygiene areas across the city of **Lyon** are the subject of future research for the city, particularly regarding their potential for harbouring bacteria during the stagnant warm summer months and the city's water system may need to be adapted in the face of future heat waves (Ville de Lyon 2020, 45).

World Heritage Sites with traditional water systems act as strategic areas that protect and maintain healthy, resilient ecosystems that are better suited to weather the impacts of climate change while continuing to provide the clean water their communities rely upon for survival. (WHC 2021a, 1). These systems can promote a governance that is inclusive and effective. Any water management systems that involve indigenous conservation methods should apply local adaptive knowledge and customary laws about access to and use of water (ICCA 2018, 2, 11). As a natural ecosystem protecting rivers and wetlands, water management is integral to maintaining the OUV of **Pimachiowin Aki** and is done in a manner that is culturally relevant and equitable according to Anishinaabe customary laws (Pimachiowin Aki 2016, 54).

Traditional water management systems will come under a lot of stress with future climate conditions and must be not only physically adaptable and resilient, but also culturally relevant and equitable (UNESCO 2016, 269). Such systems and their present and future changes can also be used to raise awareness of water scarcity (UCLG 2018, 14). Reducing water waste is one of the goals of the **Sydney Opera House**. By monitoring water usage throughout the site, it has reduced water waste by over 30% (Sydney Opera House 2016, 23; Bombonato 2021).

World Heritage Sites can also contribute to climate science by acting as the research focus for documenting current and historic traditional water management methods and maintenance systems and their adaptability to historic and future climate changes (WHC 2021a, 36; ICOMOS 2021b, 50). Local water management techniques can then be adapted and improved for disaster risk prevention. Efforts for improved access to water and sanitation in human settlements require innovation and exploring system-wide changes toward more integrated water management. **Machu Picchu** aims to maintain the water usage quota agreed with local authorities while also increasing water access and sanitation among the community (Morón Alvarez et al. 2015, 27).

6.3.7. SDG 7 – Affordable and clean energy: Low-carbon and sensitively energized World Heritage

The rapid changes in weather that accompany climate change will have effects on our energy needs and consumption (IUCN 2008, 96) and will affect our ability to achieve SDG 7. Energy is integral to both climate change mitigation and sustainable development (Caetano et al. 2020, 774) but this energy needs to be a low-carbon option (Caetano et al. 2020, 774). It is important to clarify that such actions should not be to the detriment of the OUV of the site. A total of 16 World Heritage Sites have been affected by renewable energy infrastructure according to the SOC database. The WHCCP has made very clear the need to develop frameworks that promote the co-benefits of climate action while conserving OUV. Such frameworks can be particularly useful when examining renewable energy projects (WHC 2021a, 19). Furthermore, UNESCO encourages property managers to conduct environmental analyses of site operations, services, events and exhibitions to identify energy-saving opportunities. Such actions should be coupled with 'green' procurement (energy, waste and water) strategies and the fostering of green products, services and business models. (WHC 2021a, 32) and should be incorporated into site management and interpretation (ICOMOS 2019, 52). The **Sydney Opera House** has invested annual energy into renewable energy via a power purchase agreement and has been certified carbon neutral since 2018 while also retaining its OUV (Sydney Opera House 2020).

The *Historic Urban Landscape* (UNESCO 2011, 4) recognised that calls for energy efficiency required new approaches and models of urban living that were ecologically sensitive and aimed at improving sustainability and quality of life. Specifically, the urban landscape, its infrastructure, and the design of its buildings are among the greatest drivers of cost and resource efficiencies. **Lyon** aims to create a public information platform to support energy renewal activities. It also plans to investigate the current challenges the city faces in becoming carbon neutral through a better understanding of the financial resources and demographic factors at play. It is also increasing the use of renewable energy in public lighting (Ville de Lyon 2020, 33, 57).

Heritage conservation and the reuse of historic buildings provides several ecological benefits. Firstly, recycling buildings and the reuse of building materials can significantly decrease the energy required for new constructions and reduces associated construction waste (ICOMOS 2015, 11; ICOMOS 2021b, 57). Secondly, the proper maintenance, adaption and management of existing buildings can help reduce energy pressures and lead to greater energy efficiency. 'Indeed, in most cases, maintenance constitutes the simplest, most cost-effective, and readily achievable energy conservation step' (ICOMOS 2019, 16).

Promoting low-carbon energy alternatives is not only relevant to urban areas but is an important decarbonisation strategy for all sites. One of the key ways non-urban sites can promote energy efficiency is through transportation. The tourism industry is heavily reliant on energy intensive

modes of transportation particularly airplanes and automobiles (UNESCO and UNEP 2016, 9). Current trends in tourism are incompatible with the goals of reducing carbon emissions set forth in the Paris Climate Accord (UNESCO and UNEP, 18). Indeed, the **Lyon** Site Manager, agreed that one of the largest challenges the city faced toward climate change mitigation was the arrival of tourists by plane. **Machu Picchu** has identified that one of the key ways of becoming more energy efficient is through the railway that brings tourists to the site. The Management Plan incorporated actions to oversee alternative methods of transport to the park. The site aims to reduce the use of petrol in the buses and trains that lead to the site by 40% by 2035 and be totally carbon neutral by 2050 (Morón Alvarez at al 2015, 21-22).

Understanding the role of heritage and its potential contribution to climate mitigation requires developing and circulating research on strategies and solutions for improving energy efficiency in historic buildings (ICOMOS 2019, 44). Creative actors can be involved in designing educational material and activities to raise awareness and (UCLG 2018, 15) better mobilise citizens to transition toward zero-carbon infrastructure (Europa Nostra et al. 2021, 13). Such actions can be facilitated by proposing an energy efficiency certification (ICOMOS 2019, 44) and increasing financing while promoting training programs tailored to traditional construction methods (Europa Nostra et al. 2021, 13). The **Sydney Opera House** has worked hard to become a five-star rated building for its performance by the Green Building Council of Australia. Five star is equivalent to Australian Excellence in Sustainability. The site is even looking at becoming climate positive. The site's ambitions include reducing energy consumption by 20% by 2023. To enact such measures, it is undertaking energy audits and creating an energy management strategy and user guides to better foster a culture of energy efficiency among staff (Sydney Opera House 2020, 20-21).

6.3.8. SDG 8 – Decent work and economic growth: Promoting circular World Heritage economies and tourist destinations.

Climate change can have devastating economic impacts and can upend whole economies. Storms and floods are known to incur huge economic damage, and drought can have an even greater impact on a country's GDP. Overall economic losses due to climatic events rose 100% from 2015 to 2018 (Koubi 2019, 14). Such economic losses will significantly hamper efforts at sustainable economic development. Despite these challenges, there may be positive effects of disasters on economic growth; physical destruction may trigger greater investment in reconstruction of physical capital. This 'build back better' hypothesis proposes that economic growth may initially dip due to physical and human losses, but the gradual reconstruction and replacement of assets may spur net positive economic effects in the long run (Koubi 2019, 17). Fostering a creative economy while involving local stakeholders and drawing on their perspectives and knowledge, along with their priorities will be integral to any post-disaster rebuilding and subsequent sustainable development (UNESCO and UNEP 2016, 18).

Climate change-driven deterioration of natural and cultural heritage at World Heritage Sites will have negative effects on the tourism sector and lessen the sites' attractiveness, thereby diminishing

economic opportunities for associated communities (UNESCO and UNEP 2016, 10). Climate change threatens the OUV of World Heritage, which in turn threatens the associated tourism economy (UNESCO and UNEP 2016, 16). World Heritage Sites are privileged with the potential to provide some of the best models and innovative examples of sustainable tourism and should be harnessed to their full potential (UNESCO and UNEP 2016, 220).

In its present state, the tourism industry is incompatible with current decarbonisation goals (UNESCO and UNEP 2016, 18). Adapting to climate change may mean difficult choices for the tourist economy, yet adaptation must be adopted into socio-economic and environmental policies (ICOMOS 2019, 40, 42; IUCN 2008, 99). The role of heritage sites in fostering a more adaptive and resilient economy should not be overlooked. A cultural lens on economic development can facilitate the creation of a circular economy, which emphasises sustainable production, efficient consumption, and reuse. A circular economy is seen as one of the key ways of adapting to and mitigating climate change (Europa Nostra et al. 2021, 16). The **Sydney Opera House** has incorporated a focus on fostering a circular economy in its procurement strategy (Sydney Opera House 2020, 10). **Lyon** has also looked at promoting a circular economy. The city plans to work with the commercial sector to promote an awareness of waste reduction by working with project managers and planners to include energy efficient methods in their plans and raise awareness within the sector. In so doing, the city also plans to promote a 'global cost' perspective with regards to procurement and development (Ville de Lyon 2020, 37-38, 51).

Disaster risk management will also need to be integrated into the economy and throughout the tourism industry (UN 2015c, 20) ensuring that the existing workforce is trained in disaster response measures and logistical capacities to ensure the continuity of operations and greater economic recovery (UN 2015c, 21). **Machu Picchu** has made clear goals to integrate the local population into the tourism economy and in disaster risk planning by valuing local feedback in decision-making (Morón Alvarez 2015, 21).

World Heritage is an important asset for economic development; it attracts investments and safeguards green, locally based, stable, and decent jobs, only a portion of which are dedicated to tourism (UNESCO 2016, 254). World Heritage Listing can bring significant benefits to a country and local communities through infrastructure development and greater economic opportunity (UNESCO and UNEP 2016, 20). Sustainable tourism in World Heritage Sites remains one of the greatest challenges these sites face and must be done in an environmentally conscious and participatory way (WHC 2011, 2). **Pimachiowin Aki**'s management ensures the involvement of local communities in the development of a tourist economy on the site. Tourism is partially managed by the Anishinaabeg who are working to incorporate customary laws and traditions into the site's interpretation (Pimachiowin Aki 2016, 54). The management plan specifies promoting economic growth where appropriate including the potential development of eco-tourism on the land as a way of continually monitoring and promoting the site's conservation as a resilient carbon sink and resource for climate change adaptation. Any economic development would have to conform to community guidelines and respect the OUV of the site (ibid., 58-59).

6.3.9. SDG 9 – Infrastructure and Innovation: Unobtrusive green infrastructure and innovations for World Heritage

Climate change should be a routine consideration in all resource management and infrastructure planning in World Heritage since it is both a direct threat and a threat multiplier that will exacerbate current issues in heritage infrastructure, thereby increasing site vulnerabilities (IUCN 2008, 86; UNESCO and UNEP 201, 12). Site managers and stakeholders need to 'use knowledge, innovation, and education to build a culture of disaster planning, safety, and resilience at World Heritage properties' (UNESCO 2007, 38). Otherwise, a lack of coordination on temporary or reconstructive measures can create further damage to heritage following climate disasters (UNESCO 2016, 83). The **Sydney Opera House** has already performed an initial disaster risk assessment to determine the impact of a changing climate on the building, operations and visitor experience. The **Machu Picchu** management plan incorporates the creation of 15 control posts to monitor the conditions of the park. It has also taken action to canalise the rivers, strengthen the roads and set up an early-warning system for populations at risk of floods or landslides (Morón Alvarez et al. 2015, 13, 22).

World Heritage Sites are perfect laboratories for testing out innovative and adaptive solutions (UNESCO 2008, 5). Engaging with scientists, local communities, and others who care about or depend on World Heritage Sites can promote the development of innovative ideas and opportunities and bring communities together to face climate change (IUCN 2008, 28, 32). World Heritage properties often include constructions based on local materials many of which include climate-adaptable construction methods. These low-energy architectural models can be used to improve resilience to climate hazards and can promote traditional knowledge and socio-economic diversity (UNESCO 2016, 243). The **Sydney Opera House** plans to integrate sustainable development principles into building contracts by implementing procurement tools that incorporate positive social, environmental and economic impacts into building and construction contracts (Sydney Opera House 2020, 27). **Machu Picchu** has included a provision in its management plan to ensure that buildings conform to local ecological standards and are in concert with the character of the landscape (Morón Alvarez et al. 2015, 27).

World Heritage Sites can also be used to promote alternative forms of transport. Historic city centres are often compact and pedestrian, favouring non-motorised mobility or public transportation due to often narrow road networks and limited parking (Bigio et al, 2014, viii). **Lyon** has implemented methods of improving the carbon footprint of city employees by increasing remote working and incentivising public and alternative methods of transport (electric bikes, bikes, walking). The city is also increasing the number of lanes for alternative vehicles and enforcing other measures that promote alternative transportation technologies (Ville de Lyon 2020, 42, 57). The **Sydney Opera House** has taken similar measures with a clear objective to promote green transport infrastructure on site and among staff (Sydney Opera House 2020, 38).

World Heritage Cities can serve as incubators of innovation and green infrastructure (UNESCO 2016, 20-21). The historic buildings that make up these urban centres have generally been designed

with passive heating and cooling systems that are highly adapted to local climate conditions and have a low carbon footprint (Bigio et al, 2014, viii). According to the **Lyon** Site Manager, city authorities in Lyon recognise the inherent thermal retention capacity of historic buildings and the historic quarter. The sinuous streets of the old quarter provide greater ventilation whereas air circulation is more limited in modern dwellings. Naturally sourced materials also have a lower carbon footprint, which authorities are investigating as a model for future architecture. The need to find alternate means of cooling other than individual air conditioning units is imperative and Lyon aims to promote awareness among residents of the importance of maintenance and energy efficiency.

Retaining and renovating historic buildings can not only help reduce a city's environmental footprint but can increase resilience to climate risks while providing unity, strengthening social cohesion, and promoting cultural activities (UNESCO 2016, 138, 176, 179). Through regular maintenance, heritage buildings can optimise their energy efficiency (ICOMOS 2019, 16) and act as a valuable carbon sink that can help achieve climate mitigation in World Heritage Sites (UNESCO 2006, 9; WHC 2021, 12). **Lyon** hopes to inspire residents to undertake renovation projects that include thermal upgrading and maintenance. Within its own buildings, it will incorporate renewable energy and thermal efficiency into building works. The objective is to incorporate adaptability into all future renovations (Ville de Lyon 2020, 33-34).

Climate change has exacerbated many urban problems such as flash floods, hurricanes, and heatwaves (UNESCO 2016, 178). Furthermore, millions of citizens in the world's urban areas are facing increasing vulnerability to rising sea levels and other climate hazards. These hazards comprise only some of the many challenges that city governments and planning authorities face and will need to address (UNESCO 2016, 222). Culture-based methodologies can enhance the resilience of cities to climate hazards, not only in creating more adaptable infrastructure but in post-disaster recovery (UNESCO 2016, 21). Historic urban green spaces and water systems increase the resilience of city infrastructure to climate change and make the city more liveable while also improving wellbeing (UNESCO 2016, 189). According to UNESCO (2016, 181), 'resilience is linked to sustainability through the integration of heritage and traditional knowledge in innovative and culture-based solutions to environmental concerns. Urban resilience is provided through the multi- and mixed uses of the city.'

6.3.10. SDG 10 – Reduced Inequalities: Fostering climate justice in World Heritage

Climate change will likely increase inequality across countries making equity and climate justice fundamental to addressing the challenges of climate change (Koubi 2019,18; ICOMOS 2021, 12). Climate adaptation, mitigation and disaster risk reduction will therefore need to involve engaging with the whole of society and gaining a holistic understanding of the issues at hand (UN 2015c, 13). In preparing for disasters, states should encourage the participation of children and youth as agents of change, persons with disabilities in implementing universal design, older generations for their wisdom and experience, indigenous groups through their knowledge and local perspective,

and migrants for the resilience and adaptive capacity they bring to communities (UN 2015c, 23). **Machu Picchu** has pledged to explore the origins, traditions and perspectives of the rural populations and involve the local community in implementing its disaster risk management plan and in advising the site (Morón Alvarez et al. 2015, 28).

Heritage can be used to facilitate equitable climate action policies. A more dynamic-relationship between heritage and its context can lead to greater reciprocity between stakeholders and decision-makers, in essence creating a more inclusive approach (UNESCO 2011, 3). It is imperative that populations on the frontline of climate change and marginalised communities, or those in the global south, have access to the resources and knowledge to prepare for climate change (ICOMOS 2019, 20). Above all there is a need for greater equity among populations to build solidarity in this imminent threat (ICOMOS 2019, 19).

Equitable climate action includes involving indigenous populations. Indigenous populations are more at risk from climate change due to small population sizes, isolation, and often the absence of recognised rights over their territories (UNESCO 2012, 38). Inclusive conservation and climate action should therefore involve respecting local, traditional knowledge, protecting it from misuse, and using it in partnership with other forms of knowledge to reduce inequities (ICCA 2018, 12). One of the principal ways of respecting indigenous populations is by creating a constructive dialogue between indigenous peoples and climate scientists to ensure that decision-makers have the best available knowledge for climate action (UNESCO 2012, 37). For example, 'traditional communities may not know how to respond to a major fire, but they may have a specific organization for collective action in responding to a disaster' (UNESCO 2010, 12). **Pimachiowin Aki** encourages efforts to co-produce Anishinaabe and western knowledge. The local communities are inherently involved in monitoring the site and are involved in any adaptive measures taken. (Pimachiowin Aki 2015, 47, 54, 64).

Indigenous and other marginalised or isolated communities are particularly vulnerable to climate change and some will likely face displacement. Research suggests that climate change will have an increasing impact on migration due mainly to its effects on agriculture (Koubi 2019, 24) and will likely cause mass population displacement, particularly in low-income countries (Koubi 2019, 28). The ability to move depends largely on an individual's wealth. Poor, uneducated, and socially isolated people are more likely to be trapped by the effects of climate change. Therefore, climate risk reduction and adaptation can build the resilience of individuals and communities and help them prepare for or prevent displacement due to climatic events (Koubi 2019, 23). Addressing migration, refuge and internal displacement can be facilitated by policies and programmes that encourage active participation in cultural life and intercultural dialogue (UCLG 2018, 20). ˜

The world's cities will receive the brunt of climate-induced migration, a phenomenon that will further exacerbate their inherent inequality. Promoting sustainable and resilient cities that can accommodate migrants includes fostering policies that promote the use of communal spaces that can be used by everybody in a culture of inclusivity (UNESCO 2016, 152). These public spaces are closely tied to communal notions of heritage and can help negotiate issues of inequality

particularly through public open spaces and can play a crucial role in social cohesion and inclusivity while also connecting people with their environment (UNESCO 2016, 22). The **Sydney Opera House** has separate Reconciliation and Accessibility Action Plans aimed at increasing the inclusivity of the site. In terms of environmental action, the Opera House also plans to develop a monitoring tool that evaluates the procurement framework's social impacts and whether it aligns with positive social and economic principles (Sydney Opera House 2020, 27).

Climate change will also exacerbate inequality among nations and will affect everyone; the costs therefore need to be shared equitably (IUCN 2008, 103). The UN Framework Convention on Climate Change stipulated that developed countries should help developing countries in adapting to climate change (UNESCO 2007, 5). In this same vein, the 2019 Climate Action Summit confirmed that the transition to a net-zero economy should leave no-one behind and ensure that no one is disadvantaged from necessary climate actions. This summit also committed to providing concrete support for and financial assistance to Small Island Developing States (UN Secretary General 2019, 7). Moreover, 'North-South cooperation, complemented by South-South and triangular cooperation, has proven to be key to reducing disaster risk and there is a need to further strengthen cooperation in both areas' (UN 2015c, 25).

The inequality inherent in bearing the brunt of climate change and in the ability to address it is also evident in World Heritage. Much of the World Heritage at risk is found in the cities of global-south (UNESCO 2016, 152). Yet in terms of heritage significance, there is no distinction in importance between north or south, wealthy or poor countries (UNESCO 2016, 229). The World Heritage Centre has given priority under the World Heritage Convention toward climate change related activities in Africa and Small Island Developing States (SIDS) (UNESCO and UNEP 2008, 4). In such countries, promoting the 'role of World Heritage in climate-resilient development pathways [can] strengthen sustainable development (including efforts to eradicate poverty and reduce inequalities) and promote mitigation of and adaptation to a changing climate' (WHC 2021a, 19). Climate resilient development and disaster risk reduction must include a diverse range of voices in relation to age, vulnerable groups, and gender diversity (WHC 2007, 3).

6.3.11. SDG 11 – Sustainable cities and communities: Creating climate-resilient World Heritage communities

Target 11.4 specifically mentions the safeguarding of the world's cultural and natural heritage. To do so, States Parties need to 'reduce the vulnerability of World Heritage properties and their settings as well as promote the social and economic resilience of local and associated communities to disaster and climate change' (WHC 2015, 5). The autonomous adaptive capacity of World Heritage Sites is not sufficient to protect against the loss of OUV. As such, there is an urgent need to better understand the climate exposure and sensitivity of OUV in all World Heritage Sites and incorporate measures to protect the OUV in its context in management plans that incorporate tailored risk-preparedness measures (UNESCO 2006, 3; UNESCO and UNEP 2016, 31). Many of

the actions site managers have taken toward promoting adaptation and mitigation on their sites have been visited in other SDGs and do not need to be repeated.

Climatic effects on World Heritage cannot be understood in isolation but should rather be examined in a global context (UNESCO 2006, 31). World Heritage properties have an important role to play as 'host sites' where pilot projects of adaptation and mitigation strategies are developed and implemented. They can then act as "seed sites" for promoting and sharing their climate actions with local communities and the greater World Heritage community (ICOMOS 2019, 3). In the words of the **Sydney Opera House** Environmental Sustainability Manager, 'the community pay attention to what's happening in the Opera House, and so that gives us the opportunity and responsibility to provide guidance and support, to inspire positive change through good leadership.'

The *Sendai Disaster Risk Framework* emphasises the importance of protecting cultural institutions and other sites of cultural, historical, or religious interest (UN 2015, 19) since these sites play a key role in the vibrancy of communities. Heritage promotes a sense of identity and solidarity, which can be harnessed to appropriate climate action through a 'sense of belonging' (ICOMOS 2019, iii). This sense of belonging can rapidly be shattered following disasters. Cultural programmes and the rehabilitation of cultural heritage and institutions can help reinstate the feeling of normalcy, self-esteem, sense of place, and confidence in the future that is intrinsic to resilient communities (UNESCO 2013, 5; ICOMOS 2021, 12). For example, the management framework of **Pimachiowin Aki** fully accommodates Anishinaabe customary knowledge, practices, and protocols (Pimachiowin Aki 2016, 54) which are intrinsic to the sense of place of communities and will be integral in any rebuilding from disaster.

Communities also play a role in promoting appropriate climate action. For example, climate science can warn of what effects climate change will have but will not be able to advise on what adaptation strategies are most suited for a certain social, economic, and environmental system (ICOMOS 2019, 14). The **Pimachiowin Aki** management plan also includes provisions for further research into the Anishinaabe practice of Ji-ganawendamang Gidakiiminaan (keeping of the land) to ensure its preservation and integration into any future adaptation policies (Pimachiowin Aki 2016, 60).

Throughout history, cities have been melting pots of diversity bringing together experiences and knowledge from a wide range of populations, thereby facilitating dialogue, innovation, and creativity, and enshrining in the built fabric precious traditional knowledge that helped prevent disaster risks and communal tensions (UNESCO 2016, 155). In recent history, the impacts of climate change have already led many cities to adopt greener measures including the reintroduction of forests, wetlands, peatlands and green urban spaces as mitigation and adaptation strategies for climate change (UNESCO 2016, 182). Reconnecting the city with its natural and agricultural environment not only increases climate resiliency but fosters the protection and reappropriation of heritage sites (UNESCO 2016, 34). To increase climate resilience, **Lyon** is making significant efforts towards greening the city by planting urban gardens and trees including on terraces and

roofs. It is also increasing financial support for shared gardens and training local volunteers in gardening in order to increase the sustainability of these shared green spaces (Ville de Lyon 2020, 31). Lyon has also created a separate fund for community-led projects toward climate action as a way of incentivising community participation in the city's ecological transition (Ibid.).

6.3.12. SDG 12 – Responsible consumption and production: Sustainable resource management in World Heritage Sites.

World Heritage is threatened through overconsumption. Climate change poses a significant threat to the sustainable use of biodiversity that is in no way helped by the illegal harvesting of natural resources and oil and gas development (UNESCO and UNEP 2016, 27). Non-climatic pressures such as urbanism and uncontrolled tourism will also greatly be exacerbated by climate change (WHC 2021a, 20). When properly managed, World Heritage Sites represent locally developed strategies for the sustainable use of resources. World Heritage Sites can be used to highlight climate resilient strategies that promote the sustainable use of natural resources along with sustainable tourism practices that engage the local population and their needs (ibid.).

Heritage sites represent several sustainable consumption and production practices through the use and reuse of natural resources and a natural reliance on local material. Many heritage practices respect the regenerative capacity of the natural environment and use it in an equitable and sustainable manner. These practices can inspire more culturally appropriate and sustainable development programs that can help safeguard against climate change. By the very act of adaptively reusing, restoring and rehabilitating buildings, heritage professionals promote sustainable consumption and production and promote zero-waste consumption patterns. Such actions are promoted by the **Sydney Opera House** which aims to emphasise reuse of building material in management and rehabilitation (Sydney Opera House 2020, 32). On the other hand, some practices may become less relevant in the future, as the raw material becomes rarer or less efficient to produce, or when traditional cultural practices are incompatible with ethical production standards (ICOMOS 2021b, 82). **Machu Picchu** has emphasised a need to move away from local livestock production toward native camelids due to the environmental impacts of cattle. The site also encourages a change in land use to promote the use of higher yield lands instead of the expansion of agricultural activity (Morón Alvarez et al. 2015, 22).

Traditional customs may also inspire the behavioural changes required to promote more sustainable consumption practices (ICOMOS 2021b, 82). Heritage and culture can act as guidelines for the production and consumption of local products and can be harnessed in various programs to preserve and spread local knowledge and practices that contribute to the sustainable use of resources (UCLG 2015, 25; UCLG 2018, 24).) The site of **Pimachiowin Aki** allows licensed recreational/sport hunting and any adjacent forestry harvest 'mirror[s] the abundance and diversity of the boreal forest'. (Pimachiowin Aki 2016, 57). The site management recognises the potential to capitalise on non-forestry products and commits to performing market research to

examine this potential, bearing in mind that it must be done in an ecologically sustainable way (ibid., 59).

Culture can also be used to stress geographically localised economies where each part of production, consumption, and reuse is localised, thereby reducing miles travelled and putting greater value into local skills and networks (Europa Nostra 2021 et al., 17). Gastronomy based on local production and the use of green spaces for sustainable gardening practices can be also useful for highlighting local economies (UCLG 2018, 24). The city of **Lyon** has a thriving gastronomical culture and promotes local food production through the 'Made in Lyon' label. It also hopes to inspire more innovative delivery methods that reduce waste from production to mobilisation. Such measures include promoting the importance of green procurement among businesses and increased efforts to reduce the city's waste through regulating portion sizes and food, while improving the collection of green waste (Ville de Lyon 2020, 38, 49, 72).

Culture is integral to prevalent forms of production, consumption, social organisation, and lifestyles that either increase greenhouse gas emissions, or provide a model for traditional, low carbon adaptive technologies and lifestyles (ICOMOS 2019, 28). There is a need to identify and document, traditional low-waste and energy efficient means of production and consumption as templates for contemporary living for which cultural heritage is an important resource (ICOMOS 2019, 48). This idea was affirmed by the New Urban Agenda, which recognised that 'culture should be taken into account in the promotion and implementation of new sustainable consumption and production patterns that contribute to the responsible use of resources and address the adverse impact of climate change' (UN 2016, 4). As an important cultural institution, the **Sydney Opera House** hopes to foster a culture of waste reduction on the site. To do so, the Opera House will implement efforts to become a single-use plastic free site and reduce office paper use by 50% while ensuring that paper procured is 100% recycled or certified as sustainable. Furthermore, it plans to donate reusable items to the community or non-profit organisations (Sydney Opera House 2020, 28, 32).

6.3.13. SDG 14 – Life under water: Preserving underwater World Heritage and marine ecosystems holistically

Climate change will have significant effects on efforts to preserve marine and underwater environments. The increased ocean temperatures and associated acidification pose a threat to marine biodiversity and underwater cultural sites. Some World Heritage Sites are already facing an increase in the occurrence of bleaching events which can lead to the extinction of coral reefs on a massive scale (UNESCO 2007, 10).

The WHSDP encourages State Parties to understand the close relationship between biological diversity and the local cultures that rely on them (WHC 2015, 3). Marine life are inextricable from the cultural life of communities and often provide an important food source and opportunities for economic development. (UNESCO 2012, 58). Underwater ecosystems within settlements also

provide heat screens and reduce sun or wind load. They are also a vital source of food (ICOMOS 2019, 51). Sustainably managing the waterways and preserving the biodiversity of the rivers and wetlands is integral to the management of **Pimachiowin Aki**, partly for fishing for the local communities and to preserve the biodiversity intrinsic to the site's OUV. Management of the waterways is performed in keeping with Anishinaabe traditions in an inclusive manner ensuring their voices are heard (Pimachiowin Aki 2016, 36, 53).

The protection of marine biodiversity plays an important role in the fight against climate change (UN 2015, 2). Maintaining it is essential for sustaining the adaptive capacity and resilience of large-scale ecosystems in a changing climate (UNESCO and UNEP 2016, 28). The same is true for urban water systems (wetlands and storm water management systems) which can yield ecosystems that increase climate change resilience (UNESCO 2016, 189). Specific to urban areas, public spaces are often located along waterfronts, and as such, can be used simultaneously as a means of raising awareness and managing habitat-rich, stable shorelines that can help treat urban waste (UNESCO 2016, 186)

Located on the edge of Sydney Harbour, and surrounded on three sides by water, the marine environment is a key part of the **Sydney Opera House**'s setting and inspired its iconic architecture. The site has installed an artificial reef to help boost biodiversity and has pledged to 'investigate opportunities for further funding or partnerships to support projects which directly support Goal 14 as the primary focus' (Sydney Opera House 2020, 8).

6.3.14. SDG 15 – Life on Land: Protecting ecosystems and promoting urban forestry in World Heritage

The effects of climate change on terrestrial biodiversity are already being felt. Increases in atmospheric temperatures are leading to increased melting of glaciers and causing unalterable changes to mountainous and polar environments. The shifting temperatures may also affect the timing of biological cycles, shifts in habitat ranges, a greater frequency and severity of wildfires and the migration of pests and invasive species (UNESCO 2007, 10). Environmental degradation is one of the major threats to achieving sustainable development (UNESCO 2016, 81). One of the major factors that will exacerbate the impacts of climate change is the fractured state of some environments. These areas will require new and innovative management strategies (UNESCO and UNEP 2016, 13).

Maintaining biodiversity is important for increasing the resilience of ecosystems to climate change (UNESCO and UNEP 2016, 28; UN 2015, 2). Many World Heritage Sites include complex habitats and ecosystems that serve as natural buffers against the effects of climate change and associated disasters. The management strategies of these sites should therefore include their inherent adaptive capacity and innate potential to reduce disaster risk (UNESCO and UNEP 2016, 32). Strategies such as maintaining genetic and species diversity in fields and herds provide a low-risk buffer in uncertain environments (UNESCO 2012, 38). Such diversity at the species level is

complemented by greater resilience from biodiversity in the landscape (UNESCO 2012, 46). Protecting biodiversity is one of the main goals of **Machu Picchu**'s Management Plan which has included several targets for protecting key species such as the Andean bear, native bird and orchid populations and minimising human impacts on the various ecosystems within the site. More importantly, the site plans to research the retreat of the Incachiriasca glacier due to climate change in an attempt to better understand its ramifications on the property's biodiversity (Morón Alvarez 2015, 15-18).

To best understand how to protect environments from climate change, World Heritage Sites need to focus research on the resilience of their respective environments. Research should focus on species responses in habitat range expansion and contraction and to changes in temperature and moisture and the migration of invasive species (UNESCO 2008, 10). Furthermore, research should also involve investigations into the carbon sink potential of existing heritage sites (ICOMOS 2019, 17), which has been identified as one of the main contributions of World Heritage to climate change mitigation (WHC 2021b, 25). One of main identified contributions that **Pimachiowin Aki** can make to climate change mitigation is its potential as a carbon sink. Preserving the biodiversity of the site is integral to protecting its OUV and the livelihood of the community that depends on it. One of the key actions the site takes to prevent some of the worse effects of climate change is through fire management (Pimachiowin Aki 2016, 55).

Climate change mitigation involves the 'enhancement of forest carbon stocks through restoration of ecological functioning of degraded forest landscapes' (ICOMOS 2019, 53).' At the 2019 UN climate summit, 20 countries committed to such actions of ecological conservation and restoration through the planting of over 17 billion trees (UN Secretary General 2019, 6). Tree planting is also an important form of climate adaptation in urban areas. The impact of climate change is already leading many cities to realise the mitigating possibilities and adaptive potential of forests, wetlands and greenspaces. The use of native and endemic plants along streets, in front gardens and parks reinforces local identity, provides habitats for wildlife, and yields ecosystems that increase climate change resilience (UNESCO 2016, 189). These vegetated areas can also help reduce extreme heat and wind (ICOMOS 2019, 51). As previously mentioned, **Lyon** has made significant efforts to improve green space around the city including the implementation of its Nature Plan, which aims to increase biodiversity around the city in the face of climate change (Ville de Lyon 2020, 30).

6.3.15. SDG 16 – Peace, Justice, and Strong Institutions: Preserving peaceful and plentiful World Heritage communities

Climate change will exacerbate current efforts toward peace, justice and strong institutions. Climate-induced shifts in resource distribution can threaten the well-being of states, thereby increasing the possibility of armed conflict and illegal mining of natural resources (Koubi 2019, 32). Moreover, political instability following disasters is the main cause for decline in economic growth (Koubi 2019, 17). The increased likelihood of economic downturns, environmental disasters, and war and conflict will increase incidences of migration, especially in underdeveloped

countries, which will further exacerbate the likelihood of conflict and the ability of those nations to absorb an influx of migrants. The successful management of migrations, conflicts, and disasters will greatly depend on political institutions and government capacity to address these challenges in a peaceful manner (Koubi 2019, 31) and will impact efforts to conserve World Heritage Sites. However, the adaptive capacity of nations and governments is also determined by society's ability to act collectively (UNESCO 2012, 49). The World Heritage Climate Change Policy calls for strengthening support within global, regional, and national frameworks and local institutions for the greater protection of World Heritage properties in the face of climate change (WHC 2007, 4).

The substantial reduction in potential loss of life and livelihood from disasters can only be achieved through the strong commitment of political leadership in every country and at all levels. To do so, it is critical for local governments to foster active public and democratic debate and decision-making, where community members can lead the present and decide on the future with solutions that are culturally appropriate and transparent (UNESCO 2016, 210; ICOMOS 2019, 20). Communities need to be involved in the overall planning, management, implementation and monitoring of climate strategies (UNESCO 2006, 25). Genuine public-participation also adds legitimacy to actions taken for climate adaptation (ICOMOS 2019, 18) and helps foster a culture of disaster risk planning and prevention. Resiliency is increased through scenario planning, which should incorporate a range of plausible conditions and involve the local community. Such participatory planning increases the buy-in from the communities who create them. The results can then be used as an entry-point for further conversations and increase cohesion and understanding among the community (IUCN 2008, 61). To promote public buy-in for climate change policies, the city of **Lyon** plans to create an online forum for discussion to increase public participation in decision making and in city improvement projects. It also plans to increase financial support for green policies and actions and has pledged to ensure that policy-makers are well-versed in climate considerations (Ville de Lyon 2020, 22-23, 55).

In the face of the unknowns of climate change, constructive dialogue between scientists and indigenous populations is key to decision making-based on the best available knowledge of the environment and governance (UNESCO 2012, 38). A crucial factor that contributes to the successful conservation of nature is the capacity of indigenous peoples and local communities to manage the conservation of their territories (ICCA 2018, 2). 'In managing territory and resources, indigenous peoples use social mechanisms and customary governance structures to ensure equitable access to resources, and thus build the social fabric of resilience in the face of environmental change' (UNESCO 2012, 49). Reverting the focus of research and governance on communities can invert top-down institution capacity-building and sustainable development models and improve climate governance by placing communities at the centre of the decision-making process (ICOMOS 2019, 12).

Pimachiowin Aki is comprised of the ancestral lands of four First Nations along with two provincial parks and is split between the provinces of Manitoba and Ontario. Decisions are taken by the board which is represented by a democratically elected official from each First Nation along

with representatives from both provincial governments (Pimachiowin Aki 2016, 47). This governance structure is supported by the Guardians who serve as custodians of the lands and waters and are monitoring the conservation of the site and serve as 'sentinels of a changing climate.' These Guardians are members of the local communities and provide information on the ground for any adaptive changes (Pimachiowin Aki 2016).

Going forward, policies and frameworks that protect World Heritage Sites will need to have the flexibility to adapt to climate change. It may no longer be feasible to maintain the state of conservation as was originally established with past benchmarks that may no longer be pertinent (IUCN 2008, 65). World Heritage Sites need to implement adaptive management strategies and risk planning in order to increase their potential resilience to climate change (UNESCO and UNEP, 22). Risk planning for various scenarios helps communities and World Heritage Sites deal with a range of future conditions. Disaster risk management was a clear goal of **Machu Picchu**'s management plan and involved a multidisciplinary team of experts from across the various governmental organisations involved in managing the site in consultation with the local community. There is a clear inclusion of the need to educate the community in the importance of disaster risk management and climate change (Morón Alvarez et al. 2015, 58).

6.3.16. SDG 17 – Partnership for the goals – Partnering to prepare World Heritage for climate change

In addressing the global challenge of climate change, relevant stakeholders and rights holders at all levels should collaborate in global partnership, with a spirit of inclusion and solidarity (WHC 2021a, 5). Partnerships allow the 'decarbonization imperative reflected in the Paris Agreement [to be] accomplished in tandem with achievement of the global aspiration for sustainable development embodied in the 2030 Agenda' (ICOMOS 2019, 10). In a similar vein, The World Heritage Committee has committed to enhancing collaboration and partnerships with other organisations at the international and national level (WHC 2021a, 17). This spirit of partnership includes developed countries helping developing countries prepare for climate change (UNESCO 2007, 5).

The Sendai Framework promotes international cooperation for disaster risk reduction (UN 2015, 24) through the mutual learning and exchanging of good practice among the scientific and technological community, private partners, and government institutions (ibid., 16). Such cooperation also relies on a clear articulation of responsibilities across partners to ensure mutual outreach, complementarity, and accountability (UN 2015b, 13).

Partnership for climate change is not limited to the international level but must include a network of regional and local actors. Climate change mitigation and adaptation should take an intersectoral approach by identifying relevant sectors and collaborating to reach a shared understanding (ICOMOS 2019, 40). One of the principal ways of reducing risks at World Heritage Sites is through public-private partnerships, specifically through incentives for guaranteeing mechanisms and the amelioration of relations between potential investors at local and regional levels (UNESCO

16, 244). The **Sydney Opera House** has outlined clear goals to further partnerships for funding and support for greater climate action, renewable energy adaptation and promoting green transport (Sydney Opera House 2020, 38). The site also plans to use partnerships to develop its climate action and sustainability strategy (ibid., 51)

At the local level, a network of partners is required for the successful conservation of World Heritage Sites (WHC 2011, 13). The World Heritage Capacity Building strategy also encourages the creation of a network of World Heritage Sites at the national level (WHC 2011, 14). Protected areas provide key opportunities for partnerships in risk reduction, provisioning and mitigation. After all, those conservation organisations that are most resilient to the effects of climate change are those that routinely work on projects with a variety of partners using different working relationships (IUCN 2008, 26). By using a layered approach and a wide pool of talent from multiple partners, World Heritage Sites can improve 'short- and long-term planning and strengthen monitoring and protection efforts. (UNESCO and UNEP 2016, 30).' By drawing on such public-private partnership, sites can ensure benefit sharing in and around World Heritage Sites through economic incentives and investment cooperation (UNESCO 2016, 235).

Some of the goals iterated in the Climate Action Plan of the city of **Lyon** rely heavily on the involvement of partners. The city's goal to renovate buildings to be more energy efficient and more thermally resilient involves the creation of a Pre-renovation Orientation Committee with the participation of local governing bodies and experts in renovation to ensure that any construction plans confirm to energy and architectural standards along with historic character. Any renovations for thermal upgrading in private accommodations would be partially supported by the city in partnership with other public partners. The city also plans to work with various partners to disseminate information about efficient energy use (Ville de Lyon 2020, 33-35).

Another opportunity World Heritage Sites present for partnerships is through collaboration with relevant organisations and institutions who can research the effects of climate change and can advise on mitigation and adaptation strategies, methodologies and tools (UNESCO 2008, 4). Many scientists, partners and conservation groups can help site managers gain a better understanding of climate change and its specific impacts on a given site. One of the targets put forward by **Machu Picchu** was to sign at least three more agreements with academic institutions or NGOs to further research on the site (Morón Alvarez et al. 2015, 26). Through such partnerships, World Heritage Sites can incorporate 'young people's knowledge, skills, enthusiasm, and perspectives into management solutions, while helping students build connections to the places they are learning about' (IUCN 2008, 33). **Pimachiowin Aki** promotes research partnerships with academic institutions throughout its management plan. The results of such research are to be integrated 'into educational and outreach partnership efforts to engage students and the public in learning about and caring for Pimachiowin Aki' (Pimachiowin Aki 2016, 60).

7. CONCLUSION

The Sustainable Development Goals and climate action are both holistic in nature and involve a continual and global effort. Climate change is a result of decades of unsustainability and requires implementing sustainable development to reverse it. The sustainable development goals and climate action are therefore intrinsically linked and should be tackled together. Climate change will have an impact on all the SDGs and should be addressed within the targets and actions of each SDG. World Heritage Sites can serve as important seed sites for developing such actions. As is clear from the case studies, World Heritage Sites can contribute to implementing climate action and the SDGs in tandem. The wide variety of actions in case study management plans that addressed both climate change and sustainable development shows the concrete steps World Heritage Sites are taking towards achieving both agendas.

As a baseline, the SOC reports indicate that the OUV of many World Heritage Sites are threatened by climate change. Although some threats were resolved through simple interventions, many faced progressive issues, some of which could only be resolved through global action toward climate change. The visibility and vulnerability of these sites allows them to shine the spotlight on the issues they face and contribute to a global conversation on mitigation and adaptation.

The most salient point highlighted during most expert and site manager interviews was the importance of leadership in climate action. The integral role of governance in delivering the Sustainable Development Goals and climate action could not be understated as it was described as the most important enabling factor toward concrete action. Good governance in World Heritage Sites can provide the leadership to other cities, sites, protected areas and their communities in highlighting the importance of climate action and sustainability. Acting within a global World Heritage community can extend the effectiveness of climate action and inspire others toward sustainable change.

The draft WHCCP makes it clear that it should be integrated into the WHSDP. After all, climate action is one of the SDGs and it should be incorporated into that framework. However, one of the points brought up by some of the interviewees is that of the immediacy and imperative of climate action. Whereas the SDGs have key targets and a defined timeframe, climate change is an emergency with no set deadline. Instead, it is an imperative that demands global immediate action as its primary goal. In this way, climate action should be considered as a priority. Rather than using the WHSDP as a framework for climate action, the relationship should be inverted; Climate action can serve as an enabler of future sustainable development and should be used as a framework for future actions.

8. RECOMMENDATIONS FOR FUTURE RESEARCH

This research is just one study that showed the potential for research into the integration of sustainable development and climate action. The urgency of the climate crisis dictates that a greater

understanding of best practice in integrating climate action and sustainable development could benefit future initiatives toward its implementation. Below are several recommendations to take forward the goals of future research by the SDGWG or other researchers interested in this topic.

8.1. Scope

The survey size of case studies and expert interviews in this research was very limited in this study and based on the restriction of the researcher's network given the narrow timeframe of study. Furthermore, no natural World Heritage Sites were included in the study for the reasons given above and would have contributed considerably to the depth of the research. A greater array of heritage practitioners from the global north and south and from a range of professions would also have contributed a wider perspective on current issues regarding climate action and sustainable development.

8.2. Methodology

The methodology used to map management plans to the *Future of our Pasts* was imperfect. The *Future of our Pasts* is largely focused on built heritage and on the global community of heritage practitioners. Many of the actions described in the management plans were only tangentially discussed in the *Future of our Pasts* or were lumped under the broadest and most generic actions described in the document. Management plans offered an often-more holistic view of climate actions, such as addressing consumption, water management, food production and protecting biodiversity, all aspects of climate action that were not expanded upon in the *Future of our Pasts.* Future investigations should use a more holistic framework to map management plans.

This research could build upon previous research frameworks such as the one developed by Our World Heritage to investigate sustainable development practices at World Heritage Sites across the globe. The use of a similar framework and the wider sample size could be used to gain a far deeper understanding of site actions and practitioner perspectives.

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APPENDIX A

State of Conservation climate change threats

Table A1 explores all the World Heritage Sites threatened by climate change. The various threats are numbered 1-12 across the x-axis. The total number of threats detected is found in the right-most column. Those sites with more 3 or more threats were examined further for individual actions in the SOC reports and are included in Table 3.3.3 in the literature review. This table was compiled at the time of research in summer 2021 and may not be fully up to date.

Table A1. List of all World Heritage Sites affected by climate change and the various threats based on the year they were detected.

1. Changes to oceanic waters 2. Desertification 3. Drought			4. Flooding 5. Storms 6. Temperature change						7. Temperature 8. Avalanche/ landslide 9. Water (rain/water table)			10. Wildfires 11. Wind 12. Other climate change impacts				
Name	Type	Country	1	2	3	4	5	6	7	8	9	10	11	12	Total
Abu Mena	C	Egypt									2001				1
Agra Fort	C	India									2003				1
Aksum	C	Ethiopia									2012				1
Ancient Building Complex in the Wudang Mountains	C	China										2004			1
Ancient City of Nessebar	C	Bulgaria											2010		1
Ancient Ksour of Ouadane, Chinguetti, Tichitt and Oualata	C	Mauritania		2001			2002							2009	3
Ancient Thebes with its Necropolis	C	Egypt				2006					2006				2
Antigua Guatemala	C	Guatemala					1999								1
Archaeological Areas of Pompei, Herculaneum and Torre Annunziata	C	Italy					2012				2011				2
Archaeological Park and Ruins of Quirigua	C	Guatemala					1999				1994		1994		3

1. Changes to oceanic waters	4. Flooding	7. Temperature
2. Desertification	5. Storms	8. Avalanche/ landslide
3. Drought	6. Temperature change	9. Water (rain/water table)
		10. Wildfires
		11. Wind
		12. Other climate change impacts

Name	Type	Country	1	2	3	4	5	6	7	8	9	10	11	12	Total
Archaeological Ruins at Moenjodaro	C	Pakistan				1991					1991				2
Archaeological Site of Cyrene	C	Libya				2006			2004		2004	2019			4
Archaeological Site of Leptis Magna	C	Libya		2019		1990									2
Asante Traditional Buildings	C	Ghana									1996				1
Ashur (Qal'at Sherqat)	C	Iraq				2006									1
Baalbek	C	Lebanon									1996				1
Baroque Churches of the Philippines	C	Philippines									1998				1
Bialowieza Forest	N	Belarus/ Poland						2004			2004				2
Birthplace of Jesus: Church of the Nativity and the Pilgrimage Route, Bethlehem	C	Palestine									2013				1
Blue and John Crow Mountains	M	Jamaica										2017			1
Cape Floral Region Protected Areas	N	South Africa										2006		2018	2
Cathedral of Notre Dame, Former Abbey of Saint-Rémi and Palace of Tau, Reims	C	France					2000								1
Cerrado Protected Areas: Chapada dos Veadeiros and Emas National Parks	N	Brazil										2013			1
Chan Chan Archaeological Zone	C	Peru					2003				2003				2
Chartres Cathedral	C	France					2000								1
Chavin (Archaeological Site)	C	Peru							2006		2004		2006	1998	4
Churches of Chiloé	C	Chile					2004				2004		2002		3
Churches of Moldavia	C	Romania									2011				1
City of Cuzco	C	Peru									2004				1

1. Changes to oceanic waters 2. Desertification 3. Drought	4. Flooding 5. Storms 6. Temperature change	7. Temperature 8. Avalanche/ landslide 9. Water (rain/water table)	10. Wildfires 11. Wind 12. Other climate change impacts

Name	Type	Country	1	2	3	4	5	6	7	8	9	10	11	12	Total
Cliff of Bandiagara (Land if the Dogons)	M	Mali			2003										1
Colonial City of Santo Domingo	C	Dominic Republic					1998								1
Comoé National Park	N	Côte d'Ivoire										2006			1
Complex of Hué Monuments	C	Viet Nam				2000	1997								2
Coro and its Port	C	Venezuela				2012					2003				2
Cultural Landscape of Sintra	C	Portugal						2005				2005			2
Curonian Spit	C	Lithuania/ Russian Federation					2004								1
Delos	C	Greece											1994		1
Djoudj National Bird Sanctuary	N	Senegal									1982				1
Doñana National Park	N	Spain									2011				1
East Rennell	N	Solomon Islands	2013				2013								2
Everglades National Park	N	United States of America					1992								1
Fatehpur Sikri	C	India									2003				1
Fort and Shalamar Gardens in Lahore	C	Pakistan									2004				1
Fortifications on the Caribbean Side of Panama: Portobelo-San Lorenzo	C	Panama				2012	2011			2003					3
Forts and Castles, Volta, Greater Accra, Central and Western Regions	C	Ghana									1996		1996		2
Fossil Hominid Sites of South Africa	C	South Africa									2017			2019	2

1. Changes to oceanic waters 2. Desertification 3. Drought	4. Flooding 5. Storms 6. Temperature change	7. Temperature 8. Avalanche/ landslide 9. Water (rain/water table)	10. Wildfires 11. Wind 12. Other climate change impacts

Name	Type	Country	1	2	3	4	5	6	7	8	9	10	11	12	Total
Garden Kingdom of Dessau-Wörlitz	C	Germany				2003									1
Gebel Barkal and the Sites of the Napatan Region	C	Sudan		2016		2010							2010		3
Gelati Monastery	C	Georgia									2004		2004		2
Great Barrier Reef	N	Australia	2011				2011	2011						2011	4
Hal Saflieni Hypogeum	C	Malta							1990		1990				2
Hatra	C	Iraq									2001				1
Historic Cairo	C	Egypt									1993				1
Historic Centre of Shakhrisyabz	C	Uzbekistan									2003				1
Historic Centre of the Town of Goiás	C	Brazil				2002					2004				2
Historic Centre of the Town of Olinda	C	Brazil								1987					1
Historic City of Ayutthaya	C	Thailand				2015									1
Historic City of Meknes	C	Morocco									2000				1
Historic Ensemble of the Potala Palace	C	China									2001				1
Historic Sanctuary of Machu Picchu	M	Peru				2011				2003		1987			3
Historic Town of Grand-Bassam	C	Côte d'Ivoire					2013				2013				2
Historic Town of Ouro Preto	C	Brazil								1990					1
Historical Centre of the City of Arequipa	C	Peru				2005									1
Historical Monuments of Makli, Thatta	C	Pakistan							2007		2006		2006	2012	4
Humberstone and Santa Laura Saltpeter Works	C	Chile											2006		1
Ichkeul National Park	N	Tunisia									1985				1
Ilulissat Icefjord	N	Denmark						2009							1

1. Changes to oceanic waters 2. Desertification 3. Drought	4. Flooding 5. Storms 6. Temperature change	7. Temperature 8. Avalanche/ landslide 9. Water (rain/water table)	10. Wildfires 11. Wind 12. Other climate change impacts

Name	Type	Country	1	2	3	4	5	6	7	8	9	10	11	12	Total
Island of Mozambique	C	Mozambique					1994								1
Island of Saint-Louis	C	Senegal				2005					2005				2
Jelling Mounds, Runic Stones and Church	C	Denmark							2009		2009		2009		3
Joya de Cerén Archaeological Site	C	El Salvador				1998	1998								2
Kathmandu Valley	C	Nepal								1990					1
Kaziranga National Park	N	India				1997									1
Keoladeo National Park	N	India			2005										1
Komodo National Park	N	Indonesia										1996			1
Koutammakou, the Land of the Batammariba	C	Togo									2019				1
Ksar of Ait-Ben-Haddou	C	Morocco				2017				2004					2
Lagoons of New Caledonia: Reef Diversity and Associated	N	France												2011	1
Lake Baikal	N	Russian Federation										2017			1
Lorentz National Park	N	Indonesia												2017	1
Lumbini, the Birthplace of Lord Buddha	C	Nepal									2001				1
M'Zab Valley	C	Algeria				2006									1
Madara Rider	C	Bulgaria							1991				1991		2
Maya Site of Copan	C	Honduras					1998								1
Medina of Essaouira (formerly Mogador)	C	Morocco									2004		2004		2
Megalithic Temples of Malta	C	Malta					1994								1
Minaret and Archaeological Remains of Jam	C	Afghanistan				2003									1
Monarch Butterfly Biosphere Reserve	N	Mexico										2010			1

1. Changes to oceanic waters 2. Desertification 3. Drought	4. Flooding 5. Storms 6. Temperature change	7. Temperature 8. Avalanche/ landslide 9. Water (rain/water table)	10. Wildfires 11. Wind 12. Other climate change impacts

Name	Type	Country	1	2	3	4	5	6	7	8	9	10	11	12	Total
Monastery of Batalha	C	Portugal					1990				1990				2
Monastery of Hieronymites and Tower of Belém in Lisbon	C	Portugal					1990				1990				2
Mont-Saint-Michel and its Bay	C	France					2000								1
Mosi-oa-Tunya/Victoria Falls	N	Zambia/ Zimbabwe			2006										1
Mount Athos	M	Greece										1992			1
Mount Kenya National Park/Natural Forest	N	Kenya								2000		2000			2
National History Park – Citadel, Sans Souci, Ramiers	C	Haiti				1991	1991				1991				3
Ngorongoro Conservation Area	M	United Republic of Tanzania									2004				1
Niokolo-Koba National Park	N	Senegal			2011										1
Old City of Jerusalem	C	Jerusalem (Site proposed by Jordan)						2004							1
Old City of Sana'a	C	Yemen		2019											1
Old Havana and its Fortification System	C	Cuba					1993								1
Old Walled City of Shibam	C	Yemen				1991					2017				2
Osun-Osogbo Sacred Grove	C	Nigeria										2014			1
Palace and Park of Versailles	C	France					2000								1
Paris, Banks of the Seine	C	France					2000								1
Petra	C	Jordan				1997									1
Pitons, cirque and remparts of Reunion Island	N	France										2013			1

1. Changes to oceanic waters	4. Flooding	7. Temperature
2. Desertification	5. Storms	8. Avalanche/ landslide
3. Drought	6. Temperature change	9. Water (rain/water table)

10. Wildfires		
11. Wind		
12. Other climate change impacts		

Name	Type	Country	1	2	3	4	5	6	7	8	9	10	11	12	Total
Portovenere, Cinque Terre, and the Islands (Palmaria, Tino and Tinetto)	C	Italy				2012				2012					2
Quseir Amra	C	Jordan									1994				1
Rainforests of the Atsinanana	N	Madagascar										2009			1
Rangiri Dambulla Cave Temple	C	Sri Lanka									2018				1
Rice Terraces of the Philippine Cordilleras	C	Philippines								2003					1
Río Plátano Biosphere Reserve	N	Honduras					1998								1
Rock-Hewn Churches, Lalibela	C	Ethiopia									1996				1
Roman Monument, Cathedral of St Peter and Church of Our Lady in Trier	C	Germany									2001				1
Royal Hill of Ambohimanga	C	Madagascar					2003								1
Royal Palaces of Abomey	C	Benin					1985				2012				2
Ruins of the Buddhist Vihara at Paharpur	C	Bangladesh									2007				1
Rwenzori Mountains National Park	N	Uganda										2018		2009	2
Sagarmatha National Park	N	Nepal						2006						2012	2
Shiretoko	N	Japan												2019	1
Simien National Park	N	Ethiopia												2018	1
Site of Palmyra	C	Syrian Arab Republic							1994		1994				2
Socotra Archipelago	N	Yemen					2019								1
Stone Town of Zanzibar	C	Tanzania	2011												1
Strasbourg, Grande-Ile and Neustadt	C	France					2000								1
Sun Temple, Konârak	C	India					1997								1
Susa	C	Iran									2017				1

1. Changes to oceanic waters 2. Desertification 3. Drought	4. Flooding 5. Storms 6. Temperature change	7. Temperature 8. Avalanche/ landslide 9. Water (rain/water table)	10. Wildfires 11. Wind 12. Other climate change impacts

Name	Type	Country	1	2	3	4	5	6	7	8	9	10	11	12	Total
Taj Mahal	C	India									2003				1
Tchogha Zanbil	C	Iran									1995				1
The Loire Valley between Sully-sur-Loire and Chalonnes	C	France					2000								1
The Sundarbans	N	Bangladesh	2019				2008								2
Thungyai-Huai Kha Khaeng Wildlife Sanctuaries	N	Thailand										1998			1
Tikal National Park	M	Guatemala					1998								1
Timbuktu	C	Mali		1990		2004					1990		1990		4
Tipasa	C	Algeria											2005		1
Town of Luang Prabang	C	Lao People's Democratic Republic				2007									1
Venice and its Lagoon	C	Italy												2019	1
Volcanoes of Kamchatka	N	Russian Federation										2004			1
Waterton Glacier International Peace Park	N	Canada/ United States						2009						2009	2
Wet Tropics of Queensland	N	Australia												2000	1
Wieliczka and Bochnia Royal Salt Mines	C	Poland									1984				1
Wood Buffalo National Park	N	Canada												2017	1
Wulingyuan Scenic and Historic Interest Area	N	China				1998									1
Xanthos-Letoon	C	Turkey				1994					1991				2

APPENDIX B

Practitioner Interview results

The following table shows a summary of the main responses given for each question according to each theme of inquiry. The themes are included in the left column.

Table B1. Expert interviews

Themes of Inquiry	Interviewee 1 – Jordi Pascual, Coordinator of UCLG Committee of Culture
1 – Enabling factors	World Heritage cities can connect to other SDGs through 11.4. However, this connection is not happening as widely and in-depth as it could.
2 – Are some SDGs more implemented	11.4 but is the weakest target of most SDGS and uses the vaguest language but is usually used as an entry point for cities to consider culture.
3 -SDGs in management plans	Voluntary National Reviews, and more specifically, Voluntary Local Reviews which have more cultural considerations, do not distinguish among economic, social, environment, and cultural impacts, because the narrative of the Agenda 2030 is still based on the triangle of sustainable development, that is, only social, economic and environmental considerations. Culture is still missing as an explicit dimension. Rather all SDGs are transversal (or should be implemented as transversal and include cultural considerations in their implementation. However, reviews are not making explicit mention of the SDGs or actively reporting on them.
4 – Climate action	There are three main ways that cities can act toward climate: 1) resources and energy expenditure, 2) tourism and allowing local communities to be involved. 3) raising awareness
5 – Mitigation	Not discussed
6 -Adaptation	Not discussed
7 – Paris Accord	It is important to emphasise the connection between science and policy. The action of citizens in cultural activities has a clear impact on social cohesion and wellbeing.
8 – Risk and loss	Not discussed
Other points	It is imperative that we trust in science. The role of gender in World Heritage needs to be very seriously considered. Colonialism should also be addressed in World Heritage cities. Colonialism is not mentioned in SDGs, but any efforts to decarbonise need a feminist and a decolonial approach that empowers people living in real places, not in abstract spaces.

	Interviewee 2 – Anonymous
1 – Enabling factors	Depends on what SDGs are relevant to the site and are already being addressed by managers.
2 – Are some SDGs more implemented	Obviously SDG11 is integral. All SDGs with a social dimension (16). Cultural landscapes often involve SDG 2. But on the whole, it is very site specific. Requires an intentional approach to harness potential of SDGs.
3 -SDGs in management plans	There is very little integration of SDGs into management. plans. There is often no methodological framework or clear approach. The WHSDP has been helpful to give clearer guidelines. But sustainable development is really only established on a case-by-case basis. There is tracking toward the WHSDP policy, but we are currently only onto third cycle of periodic reporting and SDGs were included in second.
4 – Climate action	Climate action is primarily discussed in the WHCCP. World Heritage properties can contribute to the NDCs from their environment and ecosystem and benefit environmental conservation.
5 – Mitigation	Mitigation is mentioned in WHCCP. However, it is important to note the difference between mitigation in heritage and climate change sectors. In climate change it means to cut emissions, i.e. address the root cause of the problem. In heritage it means to avoid or reduce as much as possible the worst effects of the problem (which in CC terms would be "adaptation"). World Heritage can showcase and promote heritage-based and more sustainable approaches which contribute to mitigating CC, and which could become models for the environment at large.
6 -Adaptation	Need to first understand the risks. Periodic reporting includes effects of climate change and what managers are doing to mitigate and adapt. Traditional ways of knowing can be mapped to further contribute to adaptation.
7 – Paris Accord	It is important that site managers coordinate with scientists to understand the changes in environmental conditions caused by climate change that will probably happen at their site in the mid to long term.
8 – Risk and loss	Intangible heritage needs to be considered in disaster risk and damage, not just tangible heritage. Importance of science and reaching out to scientists to understand the effects of climate change. Obsession with authenticity is a defensive behaviour – faced by the consequences of climate change, we may have to, at some point, adopt a more flexible approach which embraces change and focuses on adaptation within cultural continuity. Cultural resilience is not just the physical recovery and reconstruction of what has been affected by a disaster, but also the ability to move on and culturally adapt to a changing environment, thereby creating the heritage of the future.
Other points	Contributing to SDGs is an intentional approach and is not intrinsic to World Heritage management. There is often a conflict between sustainable development and the protection of World Heritage properties but, in the long term, sustainability principles should take priority.
	Interviewee 3 – Deirdre McDermott, Representative of ICOMOS Ireland to the SDGWG and CCHWG
1 – Enabling factors	The benefit of the SDGs is that they provide a holistic approach.
2 – Are some SDGs more implemented	All SDGs contribute to the discussion of climate action. 11.4, 7, 9 in particular, but they are all transversal.

3 -SDGs in management plans	It is up to the reader or the site manager to integrate the policies. Their use is very much site and context specific.
4 – Climate action	SDGs are more high level. The Future of our Pasts is more based on local actions so it is difficult to discuss how they integrate.
5 – Mitigation	Practitioners can aid climate action through the creation of guidelines to promote practitioner's objectives and contribute their more holistic understanding of a site.
6 -Adaptation	The greenest building is one already built. We should encourage more work toward the retrofitting of buildings.
7 – High Ambition	The political importance of World Heritage Sites is not to be discounted. They have a lot of clout and political power.
8 – Risk and loss	
Other points	World Heritage has become too commodified and politicised. It's what countries aspire to, to get them in the consumption loop. It is important to consider the local perspective. We need to incorporate international discussions and build capacity at the local level.
	Interviewee 4 – Lucia Pesci, Vice-President of FLACAM (Foro Latinoamericano de Ciencias Ambientales), Argentina (Interviewed in Spanish)
1 – Enabling factors	Governance is the greatest challenge for sustainable development, without it, the other SDGs cannot be implemented. This includes participatory governance involving local communities, the joining of the public and private sector, and the extension of best practices beyond only the sphere of the government. Poverty and inequity imply the most profound unsustainability. In such cases it is impossible to speak of environmental sustainability.
2 – Are some SDGs more implemented	SDG 17 is the most important but also the most innovative and imperative.
3 -SDGs in management plans	There are currently many efforts to implement new modalities of governance that are more inclusive.
4 – Climate action	Climate change is a result of unsustainable practices. World Heritage can promote awareness to its value and that of the environment. We need to think globally in our local actions and need to extrapolate the lessons learned from World Heritage to our daily landscapes and heritage. It is essential that we understand heritage within its environment, as a landscape that incorporates both natural and cultural elements. The management of such a landscape can have a significant role to play in promoting climate action. Economic diversification is also key, to reduce monoculture and pressures on the environment. The same can be said for urban sprawl, which in turn reduces the necessity of a car. The management of World Heritage sites is really just a drop in the bucket and will only have a small impact on climate mitigation. Climate mitigation is more related to cultural landscapes than individual sites. World Heritage can be used as laboratories for innovation and promoting credibility and visibility
5 – Mitigation	Climate action (both mitigation and adaptation) is not specifically addressed on most World Heritage Sites. SDG 7 is more related to urban and landscape planning more than the management of World Heritage –there is not a direct association with World Heritage. It has more to do with cities and diversification of the economy in general.
6 -Adaptation	Proper planning and understanding of the risks is key

7 – High Ambition	Climate action is still not a very prescient topic and is not addressed by most World Heritage Sites. It is not in the forefront of actions. It is too recent of a discussion and the implementation is focused on other SDGs. Most important is that heritage be understood within its context. We need greater capacity building among local professionals as they often don't even know where to start. In this way local communities can be very helpful in providing support in terms of traditional knowledge and an understanding of the local context.
8 – Risk and loss	Reality is different than theories and the context and impacts often vary and mitigate any possible efforts toward climate action.
Other points	Sustainability is a goal that will always remain as such, not because it is not achievable, rather because there is always more to be done. Site managers and policy makers have a particular responsibility to enforce climate friendly actions. Currently, climate action is a citizen movement, and we are still far from reaching climate sustainability. There is a global movement of recognition of climate change. We need greater communication among World Heritage sites or among heritage preservationists.
	Interviewee 5 – Pamela Duran, Scientific Researcher at the Technical University of Munich, Germany
1 – Enabling factors	Governance is one of the main enabling factors. If the social, economic, or natural environment is unbalanced it will disable any work toward SDGs.
2 – Are some SDGs more implemented	Environment SDGs are often more addressed than social ones. As long as there is profit and governance the other SDGs can be addressed. Once sites are listed, they get the go-ahead to exploit the site for tourism. Once they get the economic engine then they can address capacity building but that is not always the case.
3 -SDGs in management plans	She is not sure if SDGs are in management plans, but some aspects of the SDGs are being addressed, perhaps not tracked, but addressed
4 – Climate action	Most sites have taken measures to address climate change but is uncertain if actually incorporated into management plans.
5 – Mitigation	Mitigation is often seen more related to natural sites in terms of the carbon sink.
6 -Adaptation	Adaptation is very site dependent – some sites will want to restrict visitors (Venice). Others need them to get funding (Cliffs of Bandiagara).
7 – High Ambition	Traditional knowledge can be harnessed to improve adaptation strategies. Future mitigation strategies may become World Heritage sites later.
8 – Risk and loss	There is little discussion of preparing for loss. There is only so much site managers can do and much depends on State Party governments, even neighbouring governments.
Other points	The SDGs and climate action do complement each other, but largely depend on governance. So long as there is a strong good governance, than there is an ability to enact policies toward climate change. If there is no governance, the whole system could collapse. The more sites you protect, the more climate resilient is the ecosystem. World Heritage listing gives green card to exploit the site for tourism
	Interviewee 6 – Witiya Pittungnapoo, Associate Professor at the Faculty of Architecture, Naresuan University, Thailand
1 – Enabling factors	Hard to make people see the holistic approach. To really enable SDGs, we need to first understand the concept and it doesn't always translate so we have to make sure it is culturally relevant.

2 – Are some SDGs more implemented	Currently, authorities are largely focused on SDG 4 to teach the local communities about importance of conservation. The aim of the local authority (Sukhothai Historical Park under the Fine Arts Department, Ministry of Culture) is focused on SDG 4 much more than 11.4. There is currently limited discussion of a more holistic view of SDGs and heritage conservation.
3 -SDGs in management plans	SDGs are not in Management plans but since UNESCO has bestowed the Creative City Network, it has allowed some sustainable development. Authorities are currently focussing on SDG11 but hoping to sort out some other SDGs along the way. There is more of an effort to involve local communities, particularly in the creative, cultural industries.
4 – Climate action	In Thailand, people have learned to live with flooding based on their local wisdom. Stilt houses are good examples of vernacular architecture which reduce flood risk during the rainy season. However, this indigenous knowledge seems unable to cope with unpredictable flooding due to climate change; therefore, affordable technology should be applied to address the climate challenge. Climate change is not clearly connected in the big picture of the mind of locals and site managers with current weather patterns.
5 – Mitigation	Sukhothai and Si Satchanalai including Ayutthaya WHSs have introduced electric trams, electric cars, bicycles to enter sites to reduce CO2 emission. Sites are also trying to plant more trees, use more renewable energy (e.g. solar lights), and have made a particular effort toward reducing chemical usage in Ayutthaya WHS.
6 -Adaptation	A current reformation of urban planning constitution (implemented since 2021) is a major force for progress in climate change. It tries to protect the green spaces, open spaces, and water courses. More importantly, this reformation has been more concerned with climate change and disaster risk (e.g. flooding, landslides). More trees are planted to reduce urban heat island in and around the World Heritage Sites
7 – High Ambition	There is currently not enough funding and support to really investigate climate change; especially, in the World Heritage Sties in Thailand. Actions are largely reactive actions and do not look at the long term. There is more focus on poverty rather than climate change which is not considered urgent due to its long-term impacts. But WH sites do play a role in promoting climate change indirectly.
8 – Risk and loss	No real discussion for loss. There has been no strong scientific evidence in Thailand for damage of heritage monuments in associated with climate change. Reactive monitoring.
Other points	Climate change adaptation has been constant through time based on local wisdom and affordable technology. Local communities have noticed certain change in heritage buildings and landscapes; however, there is not much supporting evidence to link climate change effects on Sukhothai heritage sites. Some communities still don't understand the relationship with climate change and conservation (e.g. knocked down temporary flood barriers that was protecting Ayutthaya WHS during the big 2011 flooding was a lesson learned.)

Table B2. Case study interviews

	Antoine Limouzin – Chargé de mission transition écologique, Ville de Lyon, France (Interviewed in French)
1 – Enabling factors	There are a lot of civil society groups that promote quality of life in the city, and it is a subject that is well accepted among the population. The agricultural areas around the city allow for the flourishing of local agricultural and food products in the green belt. Also, the mayor, the arrondissement heads, and the metropolitan area government are mostly led by ecologists.
2 – Are some SDGs more implemented	
3 -SDGs in management plans	The site produces a report every year on the state of sustainable development within the city and for the first time this year they will be mapped to the relevant SDGs. Currently developing indicators for the 17 SDGs. The city plan was not created around the SDGs or to be followed with indicators, so they have to take current actions and slot them in, which is difficult.
4 – Climate action	There is a priority given to the climate action in sustainable development. Rather than three intersecting pillars, they are three concentric circles, each relying on the other. It is impossible to change the environment and ecological footprint of the city without addressing the social and economic spheres of the problem. It is a problem that is more important that the others and affects all the others.
5 – Mitigation	World Heritage can be used to promote awareness to the preservation of what has been done previously, and that modernity does not necessarily mean tearing down everything. Increasing public transport and alternative ways of travel (bikes instead of cars). The city has a set pile of money for community projects toward climate action and the ecological transition
6 -Adaptation	Historic quarters are more resilient and adapted for major heat events, which is one of the main threats facing Lyon. The sinuous streets of the old quarter provide greater ventilation whereas air circulation is more limited in modern dwellings. Locally sourced materials also have a lower carbon footprint, and they are investigating as a model for future architecture. Lyon is one of the cities that is heating up the most in France and they are looking at increasing the vegetation around the city, particularly in schools. They are increasing efforts toward gardening in the city and awareness of the importance of finding other solutions than just individual AC units. They are asking building contractors to incorporate green trends in buildings
7 – High Ambition	They are moving away from talking about sustainable development and more toward an ecological transition to make people aware of the importance of these measures.
8 – Risk and loss	Not discussed
Other points	Sees the value of World Heritage as a building block for the future that enables continuity for the city and its residents.

	Has a holistic view of sustainability with environment as the largest circle World Heritage is more of a conflict for mitigation – attracts lots of tourist coming in planes. Even if the historic centre contributes to tourism and the artisan economy, it is still a significant expense.
	Emma Bombonato – Manager for Environmental Sustainability at the Sydney Opera House, Australia
1 – Enabling factors	The effective governance of the site is based on a team that works across different projects and it gives more opportunity for staff and community engagement. They have staff representing each portfolio to enable a more collaborative and holistic approach.
2 – Are some SDGs more implemented	They have formally commited to 9 SDGs although do generally think that all 17 are important. Additional SDGs will be incorporated with new strategic plans, including most recently the Diversity Inclusion and Belonging Strategy.
3 -SDGs in management plans	They have specific person in charge of making sure the heritage policy is addressed. SDGs are being tracked through KPIs (as seen on mgmt. plan)
4 – Climate action	Climate action will exacerbate all other issues related to sustainability. The three main pillars are inequality, ending poverty and climate action. Can't solve one without the other, they have to be unison – it's not just an environmental issue but has to be a balance.
5 – Mitigation	The site has been carbon neutral since 2018 and pulls its energy either from wind or solar projects through a renewable Power Purchase Agreement. They are also five-star certified with the Green Building Council Australia (GBCA) which is a certification for building performance and looking at receive six-star certification and even becoming climate positive.
6 -Adaptation	They already currently working on the development of an Adaptation plan. They have management strategies and safety protocols in place for extreme weather events as an example but are looking at what future frequency of such events will be and are planning events with less likelihood of climatic extremes (spring and autumn)
7 – High Ambition	The site can inspire other World Heritage sites for setting a good example. A lot of people pay attention to what is happening in the Opera House. The Opera House's vision is to inspire and strengthen the community. They have been able to help other heritage sites promote sustainability.
8 – Risk and loss	They have done an initial risk assessment and noted that whether it be the building itself, the visitor experience or operations, supply chain, extreme weather is definitely going to create some disruption. They are only in the initial phases of investigation.

Other points	The management really wanted to really promote the Opera House's leadership going forward and the SDGs were part of that conversation. The Environmental Action Plan is one of three plans (reconciliation, accessibility, environment). These were the jumping off points for alignment with the SDGs
	Machu Picchu - Anonymous (Interviewed in Spanish)
1 – Enabling factors	Putting the conservation of cultural and natural above economic and tourism development
2 – Are some SDGs more implemented	
3 -SDGs in management plans	Sustainable development is in the management plan.
4 – Climate action	Local populations don't realise the extent of climate change. Climate change and sustainable development can only be realised incrementally with no precipitous developments (such as too many tourists) and both are an exercise in progressive caution and protection of the site's cultural and natural aspects with the input of all. Current actions toward preparing are largely based on monitoring.
5 – Mitigation	Working toward having fully electric transport by 2050.
6 -Adaptation	In terms of disaster risk reduction, largely involves canalising the rivers, preventing forest fires, and reinforcing the roads to avoid landslides.
7 – High Ambition	The main role of world heritage is monitoring for better understanding.,
8 – Risk and loss	Early warning alarm system.
Other points	Biggest issue is removing waste – only access in is via railroad so requires loading waste out in trains Tourism has accelerated too quickly and unsustainably at the site Next management plan will be much more concrete with more realisable targets.
	Pimachiowin Aki - Anonymous
1 – Enabling factors	The conservation of the site is based on five building blocks: governance, learning, equality, environment, partnership

2 – Are some SDGs more implemented	It is difficult to extract SDGs as the site's holistic approach does not compartmentalise them. Sustainable development is understood as keeping the land, a concept that is both cultural and natural and holistic in nature. Sustainable development is not something in the local language so is hard to relate. The site is managed through complementary, long-term, legislative, regulatory, institutional and traditional stewardship measures
3 -SDGs in management plans	The SDGs are represented in the management plan through the 5 building blocks and the management plans of each area. Management is based on an inclusive partnership among community members and local government staff. There is no required reporting on SDGs. Reporting is done through periodic management plan evaluations.
4 – Climate action	Climate action is based on reactive monitoring. The site is currently building an information management system and monitoring framework based on measurements over time. This system involves data collection, habitat mapping, and satellite and drone imagery.
5 – Mitigation	As a carbon-dense environment, the site itself offers mitigation potential against climate change.
6 -Adaptation	The large north-south extent of the site which spans a large range of the temperature gradient facilitates ecological resilience in a changing climate. Because the site is so large, local residents are key players in the state of conservation.
7 – High Ambition	Site staff is currently helping a lot of other sites with conservation goals (not specific to climate action but conservation more generally). The site is very active in the co-production of knowledge and building partnerships with other sites and researchers
8 – Risk and loss	There are some community-driven efforts to mitigate negative impacts of wildfires, such as clearing brush around houses and in other areas.
Other points	The site is really managed from a grass-roots perspective. It was begun by First Nations

APPENDIX C

Case study management plan results

Each of the tables below matches management plan actions against each of the 17 SDGs (columns). Each of the relevant *Future of our Pasts* priorities are then mapped as they relate to both. The actions in the *Future of our Pasts* are split into various sections: H is used to designate the High-Ambition targets of the Paris Accord, A– adaptation measures, M- mitigation measures, and L- Loss and Damage.

Table C1. City of Lyon Management Plan Mapping

Ville de Lyon – Plan Climat, Air, Energie (Plan written in French)																	
SDGs	1	2	3	4		6	7	8	9	10	11	12	13	14	15	16	17
1.1 Strengthen citizen participation				M3.6.7.2							H1.1.7, A6.2.3					H1.1.7	
1.2 Sustainable and local food system		M3.3 .4.2									M3.3.4.2						
2.1 Develop and deploy Tree Plan				H1.3.5							M3.3.4.2				M3.6.6		
2.2 Finalise and deploy the Nature Plan				H1.3.5									A13.2.3		A6.2.3		
2.3 Putting gardens at the heart of the city				A5.3.1							A1.2, A10.2				A6.2.3	A10.2	
3.1 Further residential renovation							M3.2.3.1 M3.2.3.5 M3.5.1	M3.2.3.5	M3.2.3.1 M3.2.3.5 M3.5.1								
3.2 Combating energy poverty	A14 .2											M3.1, M3.2.4.3					A12. 6
3.3 Encourage commerce for climate, air, and energy								A12.8, M3.3.4.6	M3.3.4.6			M3.1					
3.4 Strengthen awareness of the				M1.3.1, A1.2							M1.3.1, A1.2						

Ville de Lyon – Plan Climat, Air, Energie (Plan written in French)																	
SDGs	1	2	3	4		6	7	8	9	10	11	12	13	14	15	16	17
climate issue in public buildings																	
3.5 Reinforce active and efficient mobility									M3.3.4.6 M3.6.4								
4.1 Adapting to heat waves			A6. 2.4	A10.2.1							A6.2.4		A7.4				
4.2 Prepare for drought			A6. 2.4			A6.2.4					M3.2.4.3						
5.1 Promote the climate, air and energy policy				M3.7.1.4 A5.3.1									M3.7.1.2 M3.7.1.4				
5.2 Increase sustainable purchasing				A5.3.1								A5.3.1, M3.1					
5.3 Integrate climate, air, and energy criteria purchasing policy				A5.3.1				12.8	M3.2.1.1			A8.1, 12.8					
5.4 Strengthen the culture of sustainable administration				A5.3.1					M3.6.7.1							A9.1.2	
5.5 Strengthen financial management of policy																M3.2.3.5	
5.6 Sustain effective public lighting actions							M3.5.4		M3.5.4								
5.7 Improve efficient economical energy in asset management									M3.2.1, M3.2.5.11								
5.8 Strengthen the inclusion of climate,							M3.5.1-3.5.4.3		M3.2.5, M3.2.5.1		A7.1		A7.1, A13.2.3		A13.2.3		

Ville de Lyon – Plan Climat, Air, Energie (Plan written in French)																	
SDGs	1	2	3	4		6	7	8	9	10	11	12	13	14	15	16	17
air, energy objectives in investment strategy																	
5.9 Strengthen the awareness of building occupants regarding climate issues			M3.2.3.7	M3.2.5.3 A9.3													
5.10 Improve agent mobility																	
5.11 Formalise environmental and energy management in planning operations																M3.2.5.6	
5.12 Take better account of climate air energy components in town planning rules																	
5.13 Managing waste sustainably												M3.2.4.3 M3.6.4					

Table C2. Sydney Opera House Management Plan Mapping

Sydney Opera House - Environmental Action Plan																	
SDGs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1.1 Maximise operational savings through energy efficiency							M3.2.1.3, M3.2.5.1,										
1.2 Embed energy efficiency into systems and processes							M3.2.5.4										
1.3 Raise awareness of energy efficient practices to increase staff engagement							H1.3.4, M3.2.1, 9.3										
2.1 Understand water use to enhance water management capability																	
2.2 Monitor and report performance to identify areas to improve efficiency																	
2.3 Embed water efficiency across all operations																	
3.1 Work within procurement frameworks for better financial, environmental, social outcomes				H1.3.2, A5.3.1, A3.3.3, A8.1				A12.8	M3.1, M3.4.2	10.1, M3.1		M3.7.1.4, 12.8					
3.2 Implement strategies to reduce paper use and increase use of recycled office content															M3.7.1.4		
3.3 Embed sustainability criteria into commercial F&B contract requirements																	
4.1. Maintain best practice operational waste management						A5.3.1											

Sydney Opera House - Environmental Action Plan																	
SDGs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
4.2 Maintain best practice waste management for renewal, capital works and maintenance												M3.2.4.3, M3.2.4.4					
4.3 Maintain compliance with regulations for chemical and hazardous substances disposal																	
5.1 Maintain carbon-neutral organisation status													A7.5.3, M3.2.5, M3.7.5, M3.7.1.2				
5.2 Implement a Plan to achieve Climate Positive 2023				M3.7.3.5			M3.6.8						M3.7.1.5				M3.7.3.2, H1.4.2
5.3 Increase preparedness and resilience to climate change				L5.2, A7.6									L3.1, L3.5				L5.1
5.4 Share experience with heritage sites and lead by example in trialing initiatives				M3.7.3.6, A5.1									A11.2				A5.1
6.1 Support and encourage sustainable transport options through active travel									M3.3.4.7, M3.6.4								
7.1. Executive team are accountable for sustainability performance																A7.5.3, A9.1.2	
7.2 Integrate the UN Global Goals across all relevant plans																A7.5.3	
7.3 Provide tools and resources to increase awareness and enable workplace sustainability				M3.1.2, A5.2													

Sydney Opera House - Environmental Action Plan																	
SDGs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
7.4 Increase awareness of sustainability and foster culture of leadership in sustainability				M3.1.2, A5.3													
7.5 Improve indoor environment quality to enhance the wellbeing of our audience and people																	
7.6 Increase engagement via cross portfolio and program collaboration																	
11.1 Demonstrate Leadership in building management operations and performance									M3.2.3.3, 3.2.5.4								
8.1 Embed an Environmental Risk Management Framework with Opera House processes													L3.1, L3.5				
9.1 Manage and minimise the impact of our operation on the local environment														A6.2.3	A.5.3		
9.2. Inspire our community to connect with nature through Commitment to biodiversity																	
10.1 Work in partnership with on-site partners to improve environmental performance															A5.3		A5.3, A15.7
10.2 Enhance outcomes through greater resourcing via strategic partnerships				H1.4.2													H1.4.2

Sydney Opera House - Environmental Action Plan																	
SDGs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
10.3 Continue leadership by fostering strong partnerships to share our successes																	
11.2 Demonstrate commitment to leadership in sustainable event management				M3.6.7.2													
11.3 Use performance, productions, and experience to engage our audience with sustainability				M3.6.7.2													
11.4 Support and promote educational opportunities for students				H1.3.5													
11.5 Increase community awareness of sustainability in marketing and communication				M3.6.7.2													

Table C3. Machu Picchu Management Plan Mapping

Plan Maestro de Machupicchu (Plan written in Spanish)																	
SDGs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Carry out archaeological and interdisciplinary research																	A7.2.1
Conserve and maintain the Llaqta of Machupicchu, the archaeological monuments and the lnka network				H1.3.2, L1.3.3					L1.3.3, A3.1.2.								
Recover the archaeological monuments of the SHM - PANM																	
Maintain the conservation status of ecosystems biological diversity				A2.3, A3.1											A2.3, A3.1		A3.1
Strengthen the development of tourism																	

Organise and regulate the West access																	
Improve involvement of the local population in tourism.																	
Organise the means of transport in order to reduce their impacts							M3.5.1, M3.7.3.2										
Organise the productive activities that occur within the site		M3.3.5.2					A15.7					A2.1.2, A15.7					
Strengthen the identity of the inhabitants of the site and buffer zone in relation to the values cultural and natural areas				H1.3.5, H1.2.3						A1.1.5							
Promote interdisciplinary research.				H1.4.2													H1.4.2
Increase stakeholder participation.																	
Improve solid waste management																	
Harmonise rural housing design with the landscape									M3.2.3.1		M3.2.3.1						
Strengthen Andean Amazonian territorial connections with adjoining districts																	
Promote participatory and intersectoral management of disaster risk management											A9.2.3		A6.2.4, 7.4			A6.2.4, 7.4	

Table C4. Pimachiowin Aki Management Plan Mapping

Pimachiowin Aki Management Actions																	
SDGs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
3.1.1 Cultural Values				H1.1.5, H1.2.3				H1.1.5			H1.1.5					H1.1.6, H1.3.3, A1.1.3	
3.1.2 Waterways				H1.2.3		M3.3.3, M3.3.4.3 A6.2.3				A13.5				1,4,3, 6.2.3		H1.4.4, A13.5, A1.1.3	
3.1.3 Fish and wildlife												A1.2.2 M3.1			M3.4.1, M3.7.3.4		A5.1
3.1.4 Fire				H1.2.3, 4.3, 10.1									M3.6				M3.1

Pimachiowin Aki Management Actions																	
SDGs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
3.1.5 Hydro-electric transmission lines							M3.5.1									M3.7.1.1	
3.1.6 Access roads									A15.7							A15.7	
3.1.7 Commercial forestry												M3.1			4.3	A12.4	
3.1.8 Mineral exploration and mining												M3.1			M3.1	A12.4	
3.1.9 Performance measures				A7.5.2							A6.2.3		A3.2			A3.3.2	A8.1
3.2.1 Experiential opportunities				H1.2.3, H1.3.5, H1.3.6, A10.2.2						H1.3.6	A1.2					A1.2	
3.2.2 Domestic needs assessment	A2.2.2 A2.3.3 A2.5	A1.2, M3.3 .4.2															
3.2.3 Tourism and visitor use								A15.7			A15.7	A15.7				A12.4	
3.2.4 Local economic growth and diversification								A12.8			12.4	12.4		M3.1	M3.1		
3.3.1 Protocols				M3.1, H1.2.3, H1.1.5, A10.2.1				H1.1.5, M3.6.1 M3.7.3. 4			H1.2.3 H1.3.3 1.1.7		M3.5. 3			H1.1.7	
3.3.2 Promotion and fundraising				M3.7.3.5 H1.3.5													
3.3.3 Education and outreach				H.1.3.5, A5.3.1, A10.2.1													
3.4.1 Research and research partnerships	A1.2.2			H1.2.3, H1.4.2,				A1.2.2					H1.2.6 A2.3,	A1.1,	A1.1	A1.1, A11.3	H1.4.2 H1.1.6 A4.4,

Pimachiowin Aki Management Actions																	
SDGs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
				A5.2, A5.3.1													A5.2, A7.2.1
3.4.2 Data management													A3.1, 2.1, 2.3				A2.1, A2.3, A3.3.2
3.4.3 Monitoring		A1.2	A10 .2	7.5.2, A10.1		M3.3.3, M3.3.4.3 A6.2.3				A1.4, A3.4, A10.1	A1.2, A12.4, A10.2	A1.2.2 A12.4	A3.1, A4.3, A7.5.2 A13.2. 4	A3.1, A4.3	A3.1, A4.3	A1.2, A1.4, A12.4	A3.4, A10.1