

Response to: what implications do climate change and the 2015 Paris Agreement have for cultural heritage principles?

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Abstract: Climate change poses significant threats to global cultural heritage, with rising temperatures, increased precipitation, and more frequent extreme weather events accelerating the decay of historic sites and natural landscapes. This paper examines the multifaceted impacts of climate change on cultural heritage, highlighting the urgent need for effective mitigation strategies as outlined in the 2015 Paris Agreement. Through case studies of Hurst Castle in England and Venice in Italy, the study illustrates how these changes have already led to significant damage to heritage sites. It underscores the role of international cooperation and the integration of climate action into heritage preservation efforts. Furthermore, the paper discusses the importance of sustainable development and cultural heritage protection, calling for global action to ensure the preservation of human history in the face of climate change. The findings stress the need for comprehensive climate risk assessments and strategic planning to safeguard cultural heritage for future generations.

Keywords: Paris Agreement; Cultural Heritage; Climate Change

1. Global Climate Background

Climate science has shown that our planet is gradually warming, and greenhouse gases, urbanization, and deforestation- a series of threats are destroying the ecological environment that supports human beings. Biodiversity is also being destroyed like never before. In the face of these emergencies, are we ready? The earth is still warming, and humans are still releasing greenhouse gases. Every 1.5 degrees Celsius increase in global warming will seriously threaten human health and natural and cultural heritage (2022). From 1901 to 2010, the average international sea level rose by 0.19 meters. Since the industrial age, manufactured greenhouse gas emissions have increased the concentration of carbon dioxide, methane, and nitrous oxide in the atmosphere. These are the main reasons for climate warming. Climate change also causes rising sea levels, less snow and ice, and higher ocean temperatures, increasing extreme weather such as storms, extreme precipitation, floods, landslides, and droughts (Massey, 2020). Humans can change past trajectories with practical actions to prevent catastrophic climate changes (Massey, 2020). By understanding the causes and impacts of climate change, it is significant to find countermeasures, prioritize urban greening and reduce energy consumption.

The social response to global climate change is expressed and regulated by culture. Culture is rooted in all aspects of society and exists in production, consumption, and social lifestyle. The identification and response to climate risks are all regulated by culture. Culture is central to human understanding of the causes and impacts of climate change (Massey, 2020). Human culture, social value, and natural value are inseparable. Culture and place are closely linked, the site carries culture, local heritage, architecture, landscape, design, and natural environment, which shape the spatial structure of the place, and people live in this structure (Massey, 2020). Culture is rooted in the site, and protecting culture is to protect the historical heritage and culture of the place. At present, climate change has become one of the significant threats to natural and cultural heritage. To save human cultural heritage, people need to act and actively respond to climate change (2022).

2. The Concept of Cultural Heritage

Cultural heritage expresses society, art, and lifestyle that people pass down from generation to generation, including customs, architecture, objects, and art forms, and embodies people's values. Cultural heritage is divided into intangible and tangible cultural heritage, and it used to be a part of human survival activities, a manifestation of human beliefs, traditions, and lifestyles, and a trace of human activities from ancient times to modern times. It is an essential part of human culture. There are three types of cultural heritage:

- ① built environment: urban architecture and archaeological remains.
- ② Natural environment: including agricultural landscape and coastline.

③ Books and pictures.

Cultural heritage usually refers to movable and immovable cultural relics, ruins, cultural items, and other things worthy of people's protection (Brumann, 2015). It represents the thought and spirit of an era and is an indispensable and essential part of human history and culture. The research and protection of cultural heritage is the responsibility of human beings.

3. Threats of Climate Crisis to Cultural Heritage

Local cultural heritage and historical buildings give local people a sense of place, belonging, and identity. These heritages have been interacting with the surrounding environment, thereby changing, and climate change has exacerbated the aging of cultural heritage (2022). Climate change can lead to physical degradation and chemical mechanisms by affecting the structure and composition of materials (Sesana et al., 2021). The increase in temperature will increase the frequency of freeze-thaw cycles, eventually destroying brick and ceramic structures. The thermal brittleness of materials is caused by temperature changes and the expansion and contraction of particles on the surface of materials (Sesana et al., 2021). The primary corrosion factor in the historical building environment is water. The increase in precipitation caused by climate change can lead to natural disasters such as soil saturation, rising water levels, and floods, which can increase the corrosion of building materials (Sesana et al., 2021). Air pollution, often associated with surface contamination of stone buildings, can lower the pH of rainwater, leading to acid rain. Increased humidity can accelerate the biological degradation of cultural heritage, causing damage to wooden structures through fungi, algae, and molds. Experimental evidence proves that the growth of algal plants can lead to the weathering of sandstone buildings and that fungi are one of the main reasons for the destruction of wooden structures (Sesana et al., 2021). Storms can severely damage cultural sites and buildings. Wind can transport pollutants, such as sand and salt, that can wear away building materials and rock art surfaces and cause fading of building surfaces (Sesana et al., 2021). Increases in temperature, precipitation, changes in humidity, air pollution, and storm intensity have all been recognized by UNESCO as threats to cultural heritage, and these threats have prompted an increasing number of exploratory studies (Sesana et al., 2021).

4. The 2015 Paris Agreement

The Paris Agreement is an international treaty adopted at the United Nations Climate Change Conference (COP 21) held in Paris, France on December 12, 2015. It is composed of 196 contracting parties and is legally binding. A cycle lasts for five years. This international treaty entered into force on November 4, 2016. The goal of the Paris Agreement is to limit the change in global average temperature to 1.5°C by the end of this century. According to the United Nations Climate Commission, an increase in average temperature of more than 1.5°C will cause severe climate change and natural disasters, including drought, flood and rainfall.

The Paris Agreement is the first binding agreement on global joint response to climate deterioration, which agrees to reduce greenhouse gas emissions by 43% before 2030, its implementation requires the cooperation of various countries. Since 2020, various countries have been actively taking action to formulate nationally determined contribution goals (National Climate Action Plans-NDC), in order to achieve the 2030 target of the Paris Agreement, the long-term strategic goal of reducing emissions is established, and the national development plan is built on the nationally determined contribution target. The Paris Agreement calls on developed countries to provide economic and technical assistance to resource-poor developing countries. Mitigation of greenhouse gas emissions requires advanced technology and large-scale investment. The agreement establishes a technical framework for reducing greenhouse gas emissions and provides guidance to help countries in need of technology, and countries have established an Enhanced Transparency Framework (ETF). Starting in 2024, Each country will follow international procedures to report to the United Nations the actions and progress of mitigation.

Since the enactment of the Paris Agreement, new markets have been opened up for low-carbon solutions. The key to future corporate competitiveness lies in zero-carbon solutions and new material technologies. However, the Paris Agreement has certain flexibility and national discretion. Different national conditions may affect the realization of the goal in 2030. Now all countries must cooperate with government policies to quickly take actions to reduce emissions, otherwise the goals of the Paris Agreement by 2030 are unlikely to be met (Preston, 2019).

5. Response on the question ‘What impact do climate change and the 2015 Paris Agreement have on

cultural heritage principles?’

Heritage resources include all cultural and natural heritages in the world. The existence of culture and nature has a great impact on human beings and future generations. World heritage is considered as a ‘cultural landscape’, which can attract many international tourists to generate some value effects and promote local economic development (Shirvani Dastgerdi et al., 2020). The protection of heritage is closely related to the sustainability of cultural heritage. The sustainable development of cultural heritage depends on a stable and good climate environment. However, the deterioration of the global climate has threatened the sustainable development of cultural heritage resources. Climate deterioration can produce many extreme weathers affect the ordinary value of many cultural heritages (Shirvani Dastgerdi et al., 2020), such as: sea level rise and storms pose a major threat to three world heritage sites in London, England, including the Tower of London, the Palace of Westminster and Maritime Greenwich (Shirvani Dastgerdi et al., 2020).

Climate change accelerates the decay process of cultural heritage. Climate affects and destroys cultural heritage from several aspects such as temperature, precipitation, humidity and wind. Water is one of the main factors leading to material degradation (Sesana et al., 2021). Increased water and precipitation can lead to the decomposition and decay of materials, sand, salt and air pollution in the wind increases surface wear and structural collapse of the building, different temperature and humidity can affect the internal chemical and biological decay of the building, the same reasons can also lead to chemical degradation of silk and paper, and extreme weather will put pressure on the protection of cultural heritage exposed to the outdoors (Sesana et al., 2021). The world heritage is already in the unprecedented global climate deterioration, global biodiversity is also disappearing, climate change has destroyed the ecological environment on which human beings depend, and the world natural heritage is the representative of the world’s natural ecosystem (2021). They contribute to the healthy and resilient development of ecosystems. World cultural heritage represented by cultural landscapes, historical buildings and rural buildings are closely related to surrounding areas, communities and ecosystems. Local development strategies address climate change through the use of sustainable local resources. Climate change can also affect the cultural heritage, cultural landscape and customs of local communities (2021).

At present, more and more cases have confirmed that climate change has a major impact on cultural heritage. All countries should take action to slow down the rise in global temperatures and ensure the realization of the goals of the 2015 Paris Agreement. Countries’ actions on climate change must comply with the Paris Agreement (2021), the Paris Agreement states that the integrity of the ecosystem should be protected when addressing climate change, and the agreement provides guidance for countries to mitigate climate change.

Mitigation of climate change is to reduce natural disasters, which is conducive to the protection and sustainable development of cultural heritage. Therefore, in order to protect cultural heritage, countries must take climate action. In order to cooperate with the Paris Agreement. The World Heritage Committee provides countries with a climate action policy framework for World Heritage, which can conduct research on climate adaptation, mitigation and innovation, and cooperate with the World Heritage Convention to formulate the principles and objectives of cultural heritage protection in each country, with the priority of protecting cultural heritage and mitigating climate change. Update national cultural heritage management tools and action plans, regularly monitor implementation, and establish climate models for world heritage to predict climate risks of cultural heritage, and incorporate sustainable development into the World Heritage Convention (2021).

The goal in the United Nations’ 2030 Agenda for Sustainable Development is to take action to deal with climate change, and to protect and restore the sustainability of ecosystems (2023). Act now, otherwise it will lead to heat waves, droughts, floods and rising sea levels, endangering the lives of 3 billion people, and urgent climate action to meet the Paris Agreement commitments (2023). The realization of the United Nations’ 2030 Agenda for Sustainable Development and the Paris Agreement depends on maintaining the air, water, land and ecosystems related to the environment, climate change, biodiversity and the good development of ecosystems means that the goal of sustainable development can be carried out smoothly. The 2030 Agenda for Sustainable Development and the Paris Agreement contribute to the protection and sustainable development of world cultural heritage. 2030 Agenda for Sustainable Development refers to the Paris Agreement and provides the world’s development with a framework to jointly address climate issues. The protection of world cultural heritage can promote

sustainable local development. Sustainable development is premised on the protection of world cultural heritage.

6. Case Study Analysis

6.1 Case 1: Hurst Castle in England, United Kingdom

Hurst Castle in England was built by Henry VIII from 1541 to 1544. The purpose of the construction was to prevent French invasion. In 1649, King Charles I was imprisoned here (Yandell, 2022). Currently, the owner of Historic Hurst Castle is English Heritage. The castle is one of the famous scenic spots in the UK. Hurst was once identified as one of the most vulnerable castles in the UK. In February 2021, a part of the castle was submerged by sea water. Coastal erosion and ocean storms constituted the greatest threat to Hurst Castle (Yandell, 2022), and this Castle becomes one of the most difficult heritage sites in the UK to protect (Yandell, 2021). A section of the 38-meter wall of the building broke and fell into the sea, exposing the interior of the building. The storm damage accelerated the decay of Hurst Castle, and many potential problems arise (Yandell, 2021). Conservation agencies began to investigate the geology and foundations of the Castle. They consolidated the coast with 22,000 tons of pebbles and rocks to cushion the impact of the waves, and the restoration work also included strengthening a wall from 1850 (Yandell, 2022).

The occurrence of extreme weather indicates that the impact of climate change on the UK is already very significant. The climate assessment of the UK ten years ago showed that the number of climate risks has increased. It is the seawater erosion, sea level rise and storm increase caused by climate change that caused Hurst Castle to be damaged. Britain has become one of the first countries in the world to implement the Paris Agreement (2022). The UK incorporates climate planning into its long-term strategy and formulates a third National Adaptation Plan (NAP3) to fully support climate change mitigation in order to reduce the impact and damage of extreme weather on cultural heritage sites and promote the improvement of the cultural heritage protection work system under the influence of climate change (2022).

6.2 Case 2: Venice City in Italy

The city of Venice, Italy, was founded around AD 450. Venice was built on 100,000 palafities that were driven into the mud, located on the Venetian lagoon. The palafities were supported by wooden beams driven into the mud, and the trunks planted in the lagoon are very hard, and they become the underwater foundation of the Venetian architecture. Venice is composed of 118 islands. The Grand Canal passes through Venice in an S shape (Benve, 2022). From 1994 to 2016, Venice sank by 1.9 mm per year, but the latest data show that the speed of Venice's sinking accelerated from 2010 to 2015. After a study in 2017, it was predicted that by 2100, the entire Venice will be completely submerged because the water level of the Mediterranean Sea is rising (Benve, 2022). In November 2019, Venice reached an all-time high water level of 1.87 meters, all of which are serious consequences of climate change.

Today Venice is facing many challenges, such as: the salt water of the ocean is eroding the brick walls of the building; the waves caused by the ships are exacerbating the corrosion of the walls and structures; rising tides seep more water into buildings; global climate worsens, glaciers melt and sea levels rise; industrial and agricultural waste in canals cause urban pollution; floods strike (Benve, 2022). Climate change makes floods always threaten the historical buildings of Venice. In 2019, Venice was hit by severe floods (Barry, 2021). The floods invaded St. Mark's Basilica, and the fate of Venice being submerged has attracted international attention. Venice is a product of human ingenuity and ingenuity, the city needs to be saved. St. Mark's Basilica is the lowest place in Venice. This place can be used to monitor the rising sea level. Venice's city defense Moses system has been activated, but it is still in the testing stage. The government is actively maintaining and intervening (Barry, 2021). To reduce disasters caused by climate, it is very important to carry out work such as daily monitoring, inspection and danger warning in Venice.

Through the analysis of two cases, it is clearly to see that the natural disasters caused by climate change have seriously damaged the cultural heritage of mankind, and the places bearing the glorious history of mankind have been severely eroded. It reminds people to pay attention to the impact of climate change. Climate change has threatened the living environment of human beings. Countries need to accelerate climate action, strive to achieve the goals of the Paris Agreement, and contribute to the sustainability of cultural heritage and world development.

7. Discussion and Result

Due to the occurrence of extreme weather caused by climate change, climate change will exacerbate the decay of world cultural heritage. Although the research on this type of impact is mostly dominated by European research institutes, with European countries as the research objects, current research has also included and focused on climate research in North America, Australia and New Zealand, there are few studies in other regions, so this study has certain limitations. But the above studies also outline the impact of climate change on world cultural heritage, without taking into account the uncertainty of climate change predictions (Sesana et al., 2021), and the uncertainty of how the climate will evolve. This paper examines the gradual changes in climate variables such as temperature, precipitation, temperature and wind caused by climate change, how they affect the decay process of cultural heritage in the outdoor environment, and there is also a synergy between the various variables, which leads to direct and indirect effects on various building materials and buildings (Sesana et al., 2021).

Prediction and research on climate change can inform climate risks in advance, assess the vulnerability of cultural heritage to protect cultural heritage in advance, and improve the ability to deal with climate change. The research on climate change is still lacking in scope, and the main research focuses on developed countries, regions of Asia, Africa and Central America lack complete climate data, there are many uncertainties about the impact of climate change on cultural heritage, and there is a lack of best practice information and climate tools to manage climate change (Sesana et al., 2021). The protection of cultural heritage lacks scientific management. International organizations should advance research on climate change in developing countries.

8. Conclusion

Since 2007, people's understanding of the impact of climate change has greatly increased. As the global temperature gradually rises, with the support of the World Heritage Convention, the world heritage will usher in 'transformative changes', so that the world's cultural heritage can maintain carbon neutral and resilient development, and adapt to the changing climate. The universal value of cultural heritage is protected. World cultural heritage, as a model and the most direct beneficiary of climate action, can promote changes in policy, economic, environmental and social sectors to benefit future generations (2021).

In 2015, the World Heritage Committee injected the content of sustainable development into the World Heritage Convention to ensure sustainable development goals and strengthen the protection of cultural heritage (2021). The protection of world cultural heritage is consistent with local sustainable development goals, and jointly address the challenges of climate governance and create conditions for cultural heritage to implement changes that can contribute to the promotion of sustainable development goals (2021). Considering that climate change threatens the serious consequences of cultural heritage and is irreversible, stakeholders of world cultural heritage and State parties should take timely measures to conduct climate risk assessment and cultural heritage vulnerability assessment, so that decision makers can understand climate risk and cultural heritage in advance. Developing strategic goals for long-term response to and reducing the impact of climate change on cultural heritage can better protect human wealth.

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