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Climate Change and its Repercussions on World Heritage Monuments

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Abstract

Climate change has been a serious problem that cannot be ignored. It has become a global issue that requires countries and governments in general, and scientists, experts and researchers in particular, to seek methods that would mitigate the damage that may be caused to cultural heritage monuments and sites as a result of this phenomenon. This research aimed to examine the repercussions of climate change on world heritage monuments. The findings reflected that the debate taking place now is about the extent of the impact of climate change on World Heritage Sites, and given the seriousness of the repercussions resulting from climate change, it was necessary for the international community to establish controls and foundations to reduce and avoid the risks of this phenomenon.

Keywords: *Climate Change, Cultural Heritage Sites, Weather, Intergovernmental Panel on Climate Change.*

1. Introduction

The outcomes of climate summits significantly agree with the international climate forums that the world currently faces the most complex challenges ever and the greatest global threat to humans in the 21st century. In this respect, we live in an era of climate change consequences. This problem has crossed the limits of environmental crises and now poses an imminent threat at all levels. Therefore, it is no longer an exaggeration to describe it as the greatest threat that may face humanity. This issue has become one of the dilemmas that require concerted international efforts to overcome it. Significantly, the international community has become much aware of the need to take action to curb the repercussions of this phenomenon and its negative impact, as the current generation has the means – and also bears the responsibility – to avoid the dire consequences resulting from the exacerbation of climate change.

Although there are still uncertainties in this regard, the risks resulting from climate change are real risks and represent a real and serious threat that can reshape the natural and human geography of the planet once again. Therefore, it puts pressure on all world countries, including the poorest ones. Thus, it is right to argue that the climate is changing and human activities are one of the main reasons behind this. In this context, the IPCC has stressed that the effects of this change are witnessed and have negative and cascading effects. The world's leading scientists in this regard explained that our life is affected by climate change, and the affected sectors include the culture and science sector. Perhaps the most prominent of the

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jurisprudential discussions and the efforts of governmental and non-governmental organizations is climate change and their effects on cultural heritage features, as understanding the current challenges resulting from weather disturbances facing world heritage is important if we want to preserve it and pass it on to future generations, especially since this heritage represents identity of individuals and nations and is directly related to the emergence and advancement of any civilization throughout the ages, and to the extension of human civilization. Therefore, it must be legally protected from all influences that negatively affect it.

1.2. Research Significance

Climate variability is a global issue that poses real risks, the exact extent of which remains unclear. Moreover, scientific uncertainty cannot postpone the international response to this danger if this postponement results in irreparable damage.

Hence, the importance of studying this issue is evident especially in light of the lack of awareness of the importance of recognizing the dangers of this phenomenon and its negative effects, with the continued absence of coordination at the international level to confront the threats of climate variability that may affect sites and monuments of a heritage nature.

1.3. Problem Statement

Climate change is one of the serious threats to World Heritage properties because of its potential effects on their exceptional universal value, including their completeness and authenticity, and their value in economic and social development at the local and international levels. Therefore, this research ventures to examine the repercussions of climate change on cultural heritage monuments.

1.4. Methodology

The nature of the research topic necessitates the use of the descriptive and analytical approaches in studying and analyzing the content. Therefore, the researcher resorted to the descriptive approach whenever necessary to explore the path of changes that occurred in the climate, while adopting the analytical approach to analyze the content of the legal texts related to the research.

2. Climate Change and its Repercussions

2.1. The Concept of Climate Change

Some jurists have defined climate change as a set of legal rules related to addressing the phenomenon of climate change by overcoming, mitigating, or modifying the phenomenon of global warming. Therefore, the phenomenon of climate change is the outcome of the emission of gases called greenhouse gases into the atmosphere (Abdullatif, 2021). In this respect, the Intergovernmental Panel on Climate Change (IPCC, 1988) defined it as “all forms of changes that can be expressed with a statistical description, and which may continue for successive decades, resulting from human activity or from internal interactions of the components of the climate system.” (IPCC, 2007).

Furthermore, the United Nations Framework Convention on Climate Change, which is the first legal reference for everything related to climate protection at the international level and is also a common international framework for addressing the causes and consequences of climate

change viewed climate change as "...a change in the climate that is attributable to direct or indirect human activity that leads to a change in the composition of the global atmosphere, which is observed in addition to natural climate change, over similar time periods" (United Nations Framework Convention on Climate Change, 1992). Accordingly, it distinguishes between natural change and change due to human factors (Zakiah, 2019).

Thus, a comprehensive definition for the phenomenon of climate change can be the one that views it as "any influential and long-term change or disturbance that can occur in the average weather condition, and it can include the average temperature, the rainfall rate, and the state of the winds, and it occurs for a specific area, regardless of the reasons for this change".

It should be noted that the problem of climate change is referred to as "the creeping catastrophe." This description was given by Dr. Conn Summerhays (Ali, 2017). In this respect, the concept of temperature change is closely linked to climate change, as temperature change is one of the forms of climate change. This was enough to increase the interest of climate scientists in the subject of temperature change, provoking them to make serious attempts to determine the nature of these changes and find out their causes (Al-Mustauf, 2006).

2. Causes and Repercussions of Climate Change

2.2.1. Causes of Climate Change

Signs of climate change began to appear in the wake of the Industrial Revolution, when scientists started warning of the imbalance in the planet's climate equation, due to the increase in the proportion of greenhouse gases and their high concentration in the atmosphere in quantities exceeding what the atmosphere needs to maintain the Earth's temperature. This occurred as a result of human dependence on fossil fuels as the main source of energy for an estimated rate of about 78% of the energy used in the world, the combustion of which results in the emission of huge quantities of these gases, the most important of which is carbon dioxide, which is directly responsible for the phenomenon of global warming (Askar, 2013). Therefore, the causes of climate change can be classified into two main groups:

1- **Natural Causes:** These causes are as follows:

- a) Volcanic eruptions which emit greenhouse gases in huge quantities.
- b) The phenomenon of sunspots: It occurs approximately every 11 years as a result of a disturbance in the sun's magnetic field, which increases the thermal energy of the radiation emanating from it (Sayyed, 2019).
- c) Dust storms in dry and semi-arid regions that suffer from deteriorating vegetation cover and lack of agriculture and rain.
- d) Tectonic processes (continental shift theory).
- e) Cosmic rays resulting from the explosion of some stars, as they strike the Earth's upper atmosphere and lead to the formation of radioactive carbon.
- f) Astronomical changes (change in the shape of the Earth's orbit, the angle of inclination of the Earth's axis, the direction of inclination of the Earth's axis) (AbdulZaher, 2015).

2- **Human Causes:** Although climate change may occur as a result of natural factors, as it was mentioned previously, human activity plays the largest role in this regard. This type of human causes can be summarized as follows:

- a) Gases emitted from various industries, such as oil refining, electric power production, battery factories, cement production plants, car exhausts, and electric generators.

- b) Deforestation and tree removal operations: They are the largest source of absorption of greenhouse gases, especially carbon dioxide.
- c) Gases emitted from wastewater, especially methane, which is ten times more dangerous than carbon dioxide.
- d) Outputs of agricultural activities such as fertilizers and fodder (Mustafa, 2019).

2.2.2 Repercussions of Climate Change

The problem of climate change has become a realistic and scientifically proven fact that is unambiguous and indisputable. Although it is not easy to definitively predict the devastating effects of this phenomenon in terms of the timing or scope of its occurrence, there are great risks awaiting the planet as a result of climate change, including the risks we have already seen, such as an increase in the frequency of extreme heat waves, a decrease in cold waves, and the melting of ice sheets in the Arctic and West Antarctica (Jaafar, 2022), in addition to changing rainfall patterns and rising sea and ocean surface levels, which actually began to rise at a level of (0.1-0.2) meters during the last century (Askar, 2013). This increases the possibility of some areas of heritage nature being submerged and drowned, in addition to the possibility of the disappearance or drying up of many coastal countries and regions.

2.2.2.1 Repercussions of Climate Change on World Heritage Monuments

The Earth's climate is changing. It has always been volatile. But the issues raised by climate change today are of growing concern. This made it top the agenda of all international and regional summits. Thus, climate action became one of the direct sustainable development goals, represented by Goal Thirteen. It indirectly affects the rest of the sustainable development goals. According to published scientific reports, climate change threatens agricultural crop production. Thus, it threatens global food security, which may challenge the achievement of the second goal of the United Nations Sustainable Development Goals to eradicate hunger. Therefore, any fluctuation in climate would lead to destabilization of the social and environmental conditions in the entire world. Climate change will therefore negatively impact the integrity of World Cultural and Natural Heritage properties, which is already happening. It is known that heritage, as a resource of life, is indispensable and cannot be replaced if it is damaged or destroyed. It is the legacy of humanity, the present in which we live, and the property that we must hand over to future generations (UNESCO, 1972). This was emphasized by most heritage and archaeologists, saying, "Heritage builds identity and destroying heritage destroys identity. Therefore, people and communities are responsible for the sustainable protection of their heritage. Since the destruction of heritage is multidimensional, people and communities must bear responsibility towards their heritage" (Albert, et al., 2022).

First: The Impact of Climate Change on Archaeological Monuments

Ban Ki-moon, former Secretary-General of the United Nations, says: "Climate change does not consider borders, nor does it take into account the social condition of humanity, rich or poor, young or old. This is what we call (global challenges), which require the solidarity of the entire world." In this respect, the constant fluctuation of the planet's climate has made climate change issues a source of concern as a result of the magnitude of the unprecedented changes occurring in the world. Recently, climate change at the international level has become a direct threat to world cultural heritage monuments (Rudolff, 2006).

It will also have a direct impact on the geographical, economic and social fabric and other aspects of human life, as the international community has come to widely acknowledge that climate change will constitute one of the most prominent challenges it will face in the 21st century. This requires concerted international efforts to implement an integrated approach to issues related to the protection and preservation of the environment and sustainable development. In this respect climate change poses an additional threat because it exacerbates expected rates of decay or contributes to the emergence of new decay phenomena. This is because climate change may exacerbate the physical, chemical, and biological mechanisms that cause deterioration by affecting the structure of archaeological monuments. It may also affect the frequency and intensity of hazardous events such as droughts, floods and landslides, which have unavoidable wide-ranging impacts on World Heritage sites (Sabbioni, 2008), as the melting of the world's glaciers has direct repercussions on the features of sites inscribed on the Heritage List. Climate fluctuations may also have a severe impact on human life, as floods caused by the sudden melting of glacial lakes threaten human habitations (Mohammed, 2023). The matter does not differ much when there are changes in the amounts of rainfall, as water is considered one of the most important factors of decay for all buildings, especially historical buildings, as an increase in rainfall in light of climate change can lead to soil saturation and increased load on gutters and sewage pipes, thus increasing risk of moisture penetration into historical materials including building walls. In other words, increased rainfall rates may lead to soil swelling, which means “change in volume as a result of changes in moisture content,” as the soil can absorb large amounts of water after rainfall, causing it to swell. Conversely, the soil can become very hard when it dries, leading to the ground shrinking and cracking (Morilla, et al., 2022; Sesana, et al., 2021). There are also other threats looming over sites classified as historical monuments due to sea level rise in response to global warming caused by human activities, as climate models predict that by the year 2100 a large percentage (about 75%) of the world’s coasts will suffer from sea level rise, which results in devastating negative effects on the population and archaeological monuments. Climate models also confirmed that if the temperature rises between (2-3 degrees), a large number of cultural sites will be damaged or even completely submerged during the coming periods (Cazenave, 2014).

Significantly, intangible cultural heritage was also not immune to the damage caused by climate change. In this regard, the decline and disappearance of vegetation, animal and plant species will lead to a change in important cultural and traditional practices, and thus lead to a change in the food system, traditional cooking skills, medicinal herbs and associated traditions. Therefore, climate change can lead to local communities abandoning their environment and related customs and practices that affect the way they live, work, worship, and socialize. Given the spiritual connection between indigenous peoples and their lands and nature, they are greatly affected by climate change. The damage and loss caused by climate change also changes people's relationships with each other and with the land and places that shape their identity and culture. This loss is transmitted from generation to generation, as indigenous practices and customs disappear when local communities are forced to leave their homes and traditional ways of life (Higgins, 2022), causing developments and changes in the meaning of identity and values, and the loss of heritage stories, rituals and traditions that will no longer have a foothold in the country.

Moreover, it is expected that the effects of climate change will lead to increased human migration and movements globally. Therefore, it is likely that a large number of people will be forced to leave their homelands due to beach erosion, coastal flooding, cultural and agricultural disruption, and other forms of climate-related disturbance (Bedi, 2022). In this regard, countries whose populations are approaching such displacement point out that the impact of

climate change is related to their survival and security, and that “the cultural identity of the entire nation is threatened by this change.” In this regard, the Intergovernmental Panel on Climate Change indicated that between 50 and 200 million people will move by the middle of the twenty-first century as a result of sea level rise, floods, and drought, whether within their countries or across borders on a permanent or temporary basis (Hee-Eun, 2011).

Here, it is necessary to pay attention to the effects of climate change on marine sites of world cultural heritage, such as coral reef clusters on the seabed around the world, which will be affected by environmental transformations associated with rising temperatures and increasing ocean acidification, as the noticeable effects on coral reefs are represented by increased rate of coral bleaching and decreased rate of calcification, in addition to a host of other subtle but fundamentally important changes in physiological and environmental processes (Ove, 2011). There is little evidence to suggest that coral reefs will be able to adapt to these changes, leading to the conclusion that coral reef ecosystems will become globally rare by the middle of this century, with some expected to be gone by 2100, as coral reefs and some of them dying due to rising sea temperatures (Melanie, 2017).

It was shown that these fluctuations will have harmful effects on archaeological sites of World Heritage. Therefore, there is no doubt that sudden changes to the cycle of rainfall, droughts, groundwater levels, and humidity will have negative effects on attempts to preserve cultural heritage. Furthermore, the rise in temperatures and the phenomenon of permafrost thawing that accompanies it in the Arctic region, in addition to the rise in sea levels, are factors that have serious consequences for this heritage. Rising sea levels and floods resulting from climate change may have serious effects on buildings, the social fabric of cities, and historical settlement movements (UNESCO, 2017). In addition, the high level of ground humidity due to floods may result in the growth of salt crystals on the roof of buildings, which causes great damage to decorated buildings in particular. Increased humidity may also cause an increase or decrease in the soil level.

Second: Applied Models Regarding the Impact of Climate Change on World Heritage Monuments

UNESCO expressed that one in three natural sites and one in six cultural heritage sites are currently under threat due to noticeable climate change, adding that in recent months and years, we have seen cultural and natural heritage sites, including many UNESCO World Heritage Site, threatened by the dangers of climate fluctuations. Good examples are the following:

1- **Venice (Italy):** In May 2016, UNESCO prepared a report on the increasing “risks of climate change on cultural and natural heritage sites.” The report indicated that approximately 31 natural and cultural sites inscribed on the World Heritage List in 29 different countries may be exposed to the danger of melting ice, rising water levels, extreme temperatures, worsening droughts, and increasing forest fires, as well as floods and other severe weather conditions. The Italian city of Venice was one of the most prominent World Heritage sites at risk from climate change, as the Intergovernmental Panel on Climate Change (IPCC) of the United Nations reported that the floods witnessed by the city of Venice are likely to increase in the coming years due to a rise in water levels in the Adriatic Sea by a few percent millimeters every year. This leads to the expectation that severe floods will occur once every six years by 2050, and every five months by 2100, after these floods occurred approximately once every 100 years (skynewsarabia.com). This makes this landmark in danger of disappearing.

2- Huascarán National Park (Peru): Huascarán National Park is located in the highest tropical mountain range in the world. It was included in the World Heritage List in 1985 due to its picturesque nature, characterized by deep valleys, glacial lakes, and diverse vegetation, with a rare group of wild animals such as “spectacled” bears and the Andean eagle. According to monitoring and studying a number of the effects of climate change in Huascarán Park, it was found that the most prominent pictures of the climate change that this site has been exposed to are represented by the melting of glaciers, which resulted in a significant change in the quantity and quality of water, as it decreased by 22% compared to what it was in the 1960s. The melting and disintegration of glaciers poses a serious threat to the cultural values in the reserve and the regions. Besides, some archaeological sites, such as the Wilcahuin archaeological site, are located in the path of possible landslides resulting from unstable soil and waste that is exposed after the ice is removed from it. This indicates the complete disappearance of these monuments. In addition, a very serious threat to the park is the diversity of rainfall patterns (Augustin, 2007). If it continues, scientists expect that there will not be any ice masses in this heritage landmark in less than 50 years, and there will be a scarcity of water (Adrian, et al., 2017).

3. Cape Floristic Region (South Africa): This site, which was included on the World Heritage List in 2004, is located in the southwestern region of South Africa, and it is one of the most important regions in the world in terms of wild biodiversity. This site includes national parks, nature reserves, areas of picturesque nature, national forests, and mountain watersheds. These elements add to the site a large number of endemic plant species related to the fynbos plant, which has a strong and flexible leaf, and it grows in the Mediterranean climate and is resistant to frequent fires at the same time, and is a plant unique to the Cape Flower Reserve. For this reason, this reserve was considered one of the six flower kingdoms in the world, given the exceptional aesthetic nature of the flowers it contains (Bastian & Guy, 2005).

According to observations, supporting evidence, and model experiments, climate change could be the most important threat facing this reserve over the next fifty to one hundred years, as changes in soil moisture levels and the amount of winter precipitation lead to a change in the distribution of unique species. Warming and drought will also exacerbate the water stress experienced by the reserve. In this regard, some forecasts indicate that by the year 2050, the Flower Reserve will face warmer and drier conditions, with the average annual temperature increasing by about 1.8 degrees Celsius, thus harming biodiversity, which is considered a direct reason for the reserve being considered a World Heritage Site (Rutherford, 1999).

4. Antiquities of Babylon (Iraq): The repercussions of the phenomenon of climate change affect almost everything. In light of the extreme climate that the world is witnessing today, especially the Middle East region, archaeological and cultural sites have become vulnerable to destruction and collapse. It was not far from the city of Babylon, which was included in the UNESCO Cultural Heritage List in 2019, as the city began to suffer collapse and erosion due to the combination of climate change phenomena. In this regard, the high salinity of the ground resulting from long droughts led to the erosion of the mud bricks that make up the walls of the Babylonian monuments. The increasing rise in temperature rates that Iraq witnessed in previous years (Iraqi Ministry of Environment & United Nations Development Programme, 2022), in addition to the water scarcity that Iraq has suffered from since 2004, played a prominent role in the change and erosion of most of the features of the ancient city of Babylon. It is also worth noting that the dust and dust storms whose occurrence rates have increased in recent years have contributed to the obliteration of some of the city’s landmarks by carrying seeds of large plants that grow in the cracks of ancient structures, causing parts of them to

collapse. Furthermore, sand dunes can cover the surfaces of some archaeological sites, which results in difficulty reaching the site for an unlimited period (Federico, 2019).

5. The Pyramids of Giza (Egypt): Climate forecasts indicate that Egypt will suffer from the effects of climate change in the future, which is represented by a rise in sea level as a result of the melting of snow in the polar regions, water scarcity, as well as an increase in the frequency and intensity of extreme climate phenomena such as heat waves, heavy rains, dust and sand storms (Islam, 2021). This had a negative impact on some World Heritage sites, the most important of which are the Pyramids of Giza, which were included in the UNESCO World Heritage List in 1979, as the extreme rise in temperature and humidity rates resulted in a change in the color of the stones in the pyramid structures (UNESCO, 1972). Climate fluctuations due to pollution and high carbon emissions can also have harmful effects on the features of the pyramids built of limestone, as the more pollution increases, the greater the possibility of disintegration of the stones that make up the pyramid. This became clear in the Cleopatra Obelisk, from which hieroglyphic writing disappeared (www.almasryalyoum.com).

3. Towards an Effective System to Reduce the Risks of Climate Change Affecting World Heritage Monuments

Establishing an effective system to ward off the risks of climate change to which cultural heritage monuments may be exposed must include several stages:

1- **Preparation Stage:** This stage aims to comprehensively improve the conditions surrounding the cultural and natural landmark. This is done by monitoring, reporting and mitigating the effects of climate change. Examples of this include using sources to extinguish fires that may result from high temperatures, including the use of fire-proofing materials, developing an automatic system that sprays water to extinguish fires if they occur, using predictive devices that sense temperature rises early, and establishing monitoring stations in coastal cultural heritage sites by developing secure, small-scale systems to measure sea level rise and using communication systems capable of providing early warning about the arrival of expected floods and their severity (Herb, 2007), in addition to establishing dams and terraces covered with earth, as these terraces help retain water from the slopes, thus alleviating floods as well as reducing the impact on infrastructure and the accumulation of silt in water tanks. The edge of the terrace reduces the speed of surface runoff, while the plants on the terrace improve the soil structure and increase the capacity of water infiltration (Bedeaux, 2018). It is also necessary to work on installing warning devices that give early indications before earthquakes occur, in addition to strengthening and fortifying archaeological buildings in all their parts and contents with structural reinforcement to reduce the devastating effects resulting from earthquakes and other repercussions of climate change.

2- **The Repair Stage:** Efforts in this stage are based on reducing the negative impacts resulting from climate change and removing them as much as possible, such as removing flood waters if they occur, and rebuilding damaged cultural landmarks (Augustin, 2007), as well as creating physical man-made structures, such as the project that included establishing submerged mobile barriers at the entrances to the lagoon in the city of Venice, in addition to expanding coastal wetland ecosystems to help control water levels and remove damaged materials from the site and transport them to safe stores or provide facilities for their preservation. Relocation may be a last resort for World Heritage sites in great danger. In 1999, North Carolina beach erosion forced the National Park Service to move the Cape Hatteras

Lighthouse half a mile inland. These methods may be effective, but they are expensive, as moving the Cape Hatteras Lighthouse cost about 11.8 million US dollars. In addition, a detailed assessment of the situation in damaged or at-risk cultural heritage sites must be conducted, and the necessary techniques must be used to examine invisible damage (Herb, 2007). Here it is worth noting that these repair plans must be prepared in advance, but their implementation cannot take place except after full consultation with heritage preservation experts who have the ability to assess the risks to which world heritage monuments may be exposed, including the risks of climate change and its consequences. This risk assessment is an essential part of any adaptation plan to climate change.

4.. Conclusion

It has become obvious that climate change is one of the most serious threats to World Heritage properties, which may negatively affect their exceptional universal value, including their integrity, authenticity, and ability to achieve economic and social development at the local and international levels. In this respect, climate change has significant impacts on world cultural and natural heritage features, as rising temperatures, rising sea levels, and other forms of climate variability lead to damage to world heritage.

Furthermore, climate change does not only affect the cultural heritage features included in the definition of cultural heritage. Rather, the consequences of climate change affect the relationship between humans with these monuments and their relationship with each other. Therefore, the issue of climate change is international in nature, and therefore any efforts to protect world heritage monuments within the country's territory will remain limited in effectiveness. In this respect, the process of protecting cultural heritage from the risks of climate variability requires international efforts in addition to national efforts, which are an integral part of it.

These conclusions make it necessary to provide the following recommendations:

- 1- There is a need to increase environmental awareness of the dangers of climate change.
- 2- It is necessary to carry out research and studies at all levels related to climate change, especially with regard to world heritage.
- 3- Site managers and other stakeholders should join and support the Climate Heritage Network, provide a means for sharing information and experiences, and develop a platform from which learning can take place regarding responding to climate change risks.
- 4- The risk assessment and adaptation plan must be reviewed regularly, at least every five years, to ensure that it takes into account the latest scientific knowledge summarized by the Intergovernmental Panel on Climate Change in its assessment reports and draws on the experience to date in implementing the adaptation plan and from expertise relevant to other World Heritage sites facing similar risks from climate change.
- 5- It is urging to hold seminars and conferences in order to explain the risks resulting from climate change, as well as contributing to charting the way for developing solutions to reduce these risks.

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