

Environmental and Climatic Challenges on the World Heritage Sites

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Abstract

The natural WHSs have prominent global value, where they help to preserve and conserve the value of future and current generations. Thus, IUCN, which represents the body of the Committee of World Heritage seeks to manage the risks that threaten these sites and may be destroyed their values. However, there are a large number of disasters that threaten the cultural heritage around the world. These disasters are obtained from human-made or natural hazards. Several disasters have been occurring within different areas and caused severe damage to the intangible and tangible features of WHSs. Within this paper, the key climatic and environmental risks that face the WHSs have been discussed. This problem has been addressed by showing the volume of damages caused by climatic and environmental risks. Further, three ways have been suggested to manage these risks and to preserve the WHSs from their impact. Finally, a summary and solutions for this problem have been given.

Key Words: WHSs, IUCN, Natural hazards, Human-made hazards, extractive activities, wildfires

1. Introduction

There are a large number of disasters that threaten the cultural heritage around the world.

These disasters are obtained from human-made or natural hazards. Several disasters have been occurring within different areas and caused severe damage to the intangible and tangible features of WHSs. The damage caused by the disasters was extended between cultural landscapes, historic settlements, museums and historic buildings. The Tsunami and Tohoku Earthquake that occurred within Japan in 2011, the civil unrests within Syria, Yemen, Afghanistan, Egypt and Libya, the Christchurch, Chile and Haiti earthquakes that occurred in 2010 and the floods that occurred in Thailand in 2011 are considered as significant examples on the disasters that threaten the WHSs (Jigyasu and Kelley, 2014).

Climate variation is one of the key challenges that expose the WHSs, where its effect is extended between physical, cultural and social aspects (Rits-DMUCH, 2012). Thus, several management responses should be taken at the national and local level to treat the impact of climate variation on the WHSs. Further, there are other threats that face the WHSs like the natural catastrophes (Tsunami incidents) and the human-induced threats (war) should be solved urgently (George, 2012).

On the other hand, the impact of threats and disasters not only limited on the WHS physical features. The impact also extended to involve the native communities that located in a near of the WHSs, the management staff of WHS and the visitor's life.

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Further, the number of population within the surrounding areas of the WHS is larger than any other rural area. Thus, the number of the population that may be impacted by the threats is higher. Also, this situation puts the management authorities of WHS under an excessive pressure in order to overcome and address the disaster risks by concluding into an overall threat-preparedness (Al-Zubaidy, 2014).

1.1 Main Problem

WHSs are available within all countries around the world. WHSs have great values that support the tourism and economic fields of their countries. However, these sites exposed to a large number of environmental and economic risks that destroyed a large number of WHSs around the world. Because these risks are frequently occurring and because they largely increased during the recent years, this paper has been designed to address this problem and to find suitable solutions for this problem. Within this paper, data have been collected from the literature to determine and evaluate the volume of the impact of climatic and environmental risks on WHSs. The data involved determining the key threats that exposed the WHSs, the key areas impacted by these threats, the volume of destructions obtained by these threats. Based on these data, the problem has been managed by benefiting from many plans and strategies. Further, the role of GIS technology in managing the risks and preserving WHSs has been shown.

1.2 Aim of Paper

Due to the increased impact of environmental and climatic challenges on the WHSs, this paper has been designed. The aim of this paper is to address and discuss the key threats that impact the WHSs, determine the volume of threat that exposed the WHSs and find suitable solutions to solve the problem.

1.3 Examples on Threaten WHSs

There is a large number of WHSs around the world and Venice is considered as one of the most significant UNESCO WHSs. Also, it is considered as one of the most attractive historic cities around the world, where the economy of this city is largely based on the tourism sector. Hence, the preservation of historic and cultural assets of the city is significant in order to its economy, development and identity (UNISDR, 2011). The location of Venice is in the "Venice Lagoon" within a set of 118 islands. However, flooding risk is considered as the key risk that threatens this city due to the small altitude of it above the level of the sea. Many measures have been engaged by Venice to preserve the cultural heritage of this city and manage the risk of flood (Trevisan, 2011).

In 1966, a strong flood hit the city of Venice, where the level of water within streets was reached to over 190cm. Further, The level of water within the 'Doge's Palace' was reached to 150cm as shown in the figure below. As results of this flood, about 2,000 persons were emigrated their houses and about 1,200 inhabitants were left the city of Venice. Further, a great number of Heritage sites within Venice were destroyed by this flood. According to this flood, UNESCO put Venice into the endangered WHSs list. On the other hand, another flood hit the city of Venice in 2008, where the level of water was reached to 156cm. A huge destruction was obtained from this flood (Foley et al, 2008).



Figure 1: the flood in Venice city (Foley et al, 2008).

Another WHS is Timbuktu, which is situated in the north of Mali near to the desert of Sahara. Timbuktu has been sitting as a WHS in 1988 by UNESCO. Further, Timbuktu involved three main mosques:

Sidi Yahia, Sankore and Djingareyber. Recently, these mosques are threatened via sand invasion and desertification (UNESCO, 2016).

A study within the report of the Center of World Heritage showed the impact of desertification on the Sankore Mosque in Timbuktu. The study showed that the area is exposed to a permanent encroachment of sand, thus the walls of the mosque are constantly raised to preserve the mosque from burring by the sand. According to this threat, the site has been added to the “Danger List” of WHSs. However, a strategy was established to eliminate the sand from the surrounding areas of mosques by enhancing the systems of drainage and building buffer zones. The success of the strategy led to remove the Sankore mosque from the “in Danger List” (Gruber, 2008).

Another study within the report of the Center of World Heritage indicated that the mud buildings within Timbuktu are threatened by the heavy rainfall. The earthen buildings are the most threaten places because they became unbalanced when a heavy water covered their walls and foundations. Thus, large numbers of earthen buildings within Timbuktu were destroyed due to the heavy rains (Gruber, 2008).

Further, the coasts of Egypt are extended along the Sea of Mediterranean and covered about 3,500km. There are many cultural and heritage sites within the coasts of Egypt. However, the variation within climate sometimes impacts on these sites in hidden ways. The paintings on the walls of old temples and tombs are considered as a significant part of the cultural heritage of Egypt. However, the wide variation in air moisture and temperature led to degradation of the stability of these paintings along the time. Further, the variation in climate impacts the cycle of water and the Nile, where this variation may increase the storm surges, groundwater tables and cruising activities, which leads to destroy the heritage sites within the Egyptian Coasts (El Raey, 2010).

The raising in sea level and the global warming made the heritage sites within the Egyptian Coasts always exposed to floods. Hence, a convention was released by UNESCO in 1972 to preserve and identify the heritage sites that have special significance to the humankind heritage. This convention refers to the end of 1950s, when the dam of Assouan has been built by Egypt to preserve the “Nile River”. Further, this convention has taken into account the floods that destroy the Philae and Abu Simbel temples (Cazenave, 2014). The figure below illustrates how the effect of natural disaster in North African (involving Egyptian Coasts) and Middle Eastern Countries is increased with the time.

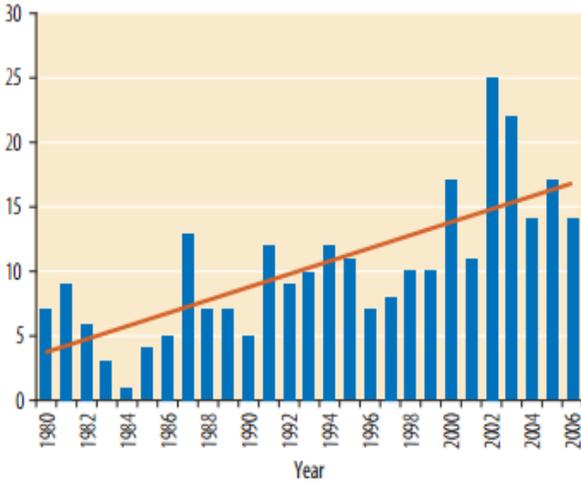


Figure 2: the effect of natural disaster in North African and Middle Eastern Countries, (Caznave, 2014).

Further, the volume of damage obtained from various disasters that occurred within Cairo, Egypt during the period from 1992 to 2006 is illustrated in the figure below, where the damage involved the economic damage volume and the number of killed people.

- Killed People**

Table 1: killed people from disasters in Cairo (Ghoneem and Elewa, 2013).

Disaster	Date	Number of killed people
Storm	1997	18
Extreme temperature	1995	32
Earthquake	1992	552
Mass mov. dry	1993	34
Storm	1997	18
Extreme temperature	1996	22
Epidemic	2006	15

- Economic Damage**

Table 2: Economic damage from disasters in Cairo (Ghoneem and Elewa, 2013).

Disaster	Date	Cost
Flood	1994	140,000
Extreme temperature	2000	0
Earthquake	1992	1,200,000
Flood	1997	1,000
Flood	2002	0
Storm	2004	0

In addition, London contains a large number of heritage sites that impacted by the climate variation. London Tower and Liberty Statue represent two significant heritage sites within London. However, the variation in climate threatens these sites and the

forecasting indicated that if the variation in climate still changes at the same manner, then these sites will be disappeared in the following 2000 years (CBS NEWS, 2014).

1.4 Risks Types and Damages Caused by these Risks

In general, the threat factors relevant to the WHSs stem from different species of natural risks and human-made activity factors. A particular manual has been prepared by the WHC/UNESCO to manage the catastrophe risks. The manual contains seven popular species of risk that are able to cause catastrophe, these species are (Al-Zubaidy, 2014):

- ❖ **Hydrological risks:** This type involves Tsunamis, flash-floods and floods.
- ❖ **Astrophysical risks:** This type involves meteorites.
- ❖ **Meteorological risks:** This type involves fire, heat-waves, hurricanes, lightning and tornadoes.
- ❖ **Biological risks:** This type involves pests and epidemics.
- ❖ **Geological risks:** This type involves mass movement (slumps, slides, and falls), earthquakes and volcanoes.
- ❖ **Climate variation risk:** this type involves floods from the explosion of the glacial lake and increased storm severity and frequency.
- ❖ **Human-induced risks:** this type involves terrorism, infrastructure collapse or failure, armed conflict, civil unrest, pollution and fire.

The table below illustrates these seven types of risks and examples on the influenced properties by these risks (Al-Zubaidy, 2014):

Table 3: Types of risks, (Al-Zubaidy, 2014).

Catastrophe category	Type	The influenced property
Human-made	Armed conflict	Bamiyan Buddhas Site which located in Afghanistan (2001) Tooth Relic Temple, which located in Kandy (1998)
	Natural	Climatic variation
	Fire	Edinburgh Old Town (2003)
	Tornado Sandy	US natural wealth
	Tornado Side cycle	Wildlife within Indian and Bangladesh coasts Mangrove forest
	Earthquake	The Bam Citadel, which located in Iran (2003)
Mix-Impact	Disease outbreak	Destroyed the butterfly population within Mexico.

During the previous few years, huge losses to the properties of World Heritage were obtained from the human-induced and natural catastrophes. There are many examples of the impacts of these catastrophes on various WHSs such as the earthquake that happened in the Cultural Landscape of Bam in 2003. This site represents the Iran Islamic Republic. Further, the Edinburgh Old Town within the “United Kingdom (UK)” was destroyed by the fire that occurred in 2002. In 2001, the vandalism and armed conflict

destroyed the “Bamiyan Buddhas” which is considered as a significant site within Afghanistan. On the other hand, in 2003 the lightning caused five great fires within the “Kootenay National Park (KNP)”, which represents a significant WHS of the “Canadian Rocky Mountain Parks (CRMP)”. These fires burned about 17,000 hectares. The floods that occurred in 2011 destroyed the Ayutthaya WHS, which located in Thailand. Further, the terrorism and civil unrest within Syrian and Mali damaged the cultural heritage and put the properties of World Heritage within Syria on the “in Danger” list of WHS (Bigio et al, 2011).

In 2008, the forest fires that happened within the “Eastern Europe” destroyed the Olympia Archaeological Site. In 2013, the flashfloods that formed from the weighty rains within the State of India’s Uttarakhand damaged several heritage structures within the area. Also, the storms in 2010 submerged several historic centers within Western Europe. In addition, the cities of World Heritage that situated across the rivers and coasts are always exposed to the flood threats (Bigio et al, 2011).

The disasters within Bhutan destroyed the heritage sites and the old social and communal traditions. The heritage sites within Bhutan became deteriorated due to the events that occurred during the previous 20 years. The first event was in 1994, where a flood that caused by an explosion of glacial lake covered the “Punakha Dzong” site and destroyed it. The events have remained until 2011, where large number heritage sites and rural dwellings were destroyed by several earthquakes (The World Bank, 2014).

1.5 Impact of Wildfires on WHSs

Generally, cultural heritage can be considered as one of the most significant ingredients of human identity and history. However, the impact of natural threats has been greatly increased during the few past years, where most of these threats are regarding to the variation in climate which involves many excessive weather events like windstorms, floods and wildfires. Recently, wildfires became a serious risk to WHSs. Further, the excessive weather events are forecast to be more destructive and frequent within the basin of the Mediterranean (Hewitson, 2014).

In 2007, the wildfire exposed the Ancient Olympia, which represents one of the most popular properties of World Heritage that relevant to the UNESCO. The majority of the location was damaged by the wildfire, which arrive to the historic hilltop that covered by pine trees. In addition, other heritage properties that relevant to UNESCO have been threatened by the events of wildfire involving Laurisilva (Portugal), Monastery of Nea Moni (Greece) and the National Park of Garajonay (Spain). On the other hand, the wildfire threatened the Athos Holy Mount in 2012 (UNESCO World Heritage Center, 2014).

Further, there are many studies that performed to manage and address the threats obtained from wildfires. The study of Mallinis et al (2016) is one of these studies where it aimed to utilize the application of GIS and remote sensing via the satellite to manage the fire risks that expose the cultural heritage. Also, the study aimed to implement and enhance optimal plans for fire management. The study was performed on the “Holy Mount Athos (Mt. Athos)” within Greece. The findings of the study recommended developing a detailed model for the location of certain fuel is very optimal for the forecasting of fire behavior. Further, create a detailed map for the type of fuel beside to a

map for fire exposure and risk. The figure below illustrates the satellite images that utilized within the study, where these images were utilized to extract the cover of the fuel within Mt. Athos.



Figure 3: Satellite images for Mt. Athos, (Mallinis et al, 2016).

Four key actions were suggested by Calkin et al (2014) to minimize the structures loss threat that obtained from the events of wildfires. The suggested actions recommended for minimizing the intensity and size of wildfire, minimizing the occurrence of wildfire, raising the resistance of buildings to the ignition and minimizing the development of the human within the regions that vulnerable to fire. Thus, the findings of the present study can be linked to the monasteries standards of ignition resistance and the data of fire occurrence in order to develop an integrated management concept for the Wildland-structural fire.

1.6 Impact of Extractive Activities on WHSs

Several locations overall the world like the Okavango Delta, GBR and Grand Canyon are exposed to different extractive activities. About 31% of WHSs are now under the risks obtained from these activities. The source of these risks refers to the gas, oil and commercial mining exploration companies, where these companies get privileges to start in their activities around and within these heritage sites. Further, persistent and important environmental destruction is obtained from the activities of extractive sector (Munro and Toit, 2015). The environmental destruction that obtained from the various extractive activities involved deranged processes of ecosystem, pollution and invasive species introduction, reduced biodiversity and habitat fragmentation and loss (Butt et al, 2013; Edwards et al, 2015). Moreover, a large number of indirect effects that related to the weal infrastructure can be obtained from the extractive activities (UNEP-WCMC, 2014; Butt et al, 2013). Also, the effects of extractive activities within developing countries caused water pollution, illegal hunting, deforestation, soil erosion, artisanal mining and agricultural expansion (Osti et al, 2011; Butt et al, 2013). Based on these effects, the IUCN (IUCN, 2010) and the Committee of World Heritage (UNESCO, 2013) stated that there is no compatibility between the status of WHSs and the extractive activities (IUCN, 2013).

On the other hand, a global evaluation has been performed in 2015 by WWF-UK for the whole 229 WHSs against the activities of extraction (WWF, 2015). The results of the evaluation research indicated that about 38% of WHSs involved mining concessions activities, while 5% of WHSs involved mining activities. Further, 22% of WHSs involved gas and oil concessions. Hence, about 30.56% of WHSs have form or more of extractive operations in their limits. The tables below illustrate these results.

Table 4: number of WHSs that impacted by extractive activities, (WWF, 2015).

Area	No. of WHS	WHS no. that exposed to extractive activities
Arab States	6	1 (17%)
The Caribbean and Latin America	41	13 (31%)
Africa	41	25 (61%)
North America and Europe	71	7 (10%)
The Pacific and Asia	70	24 (34%)
Total	299	70 (31%)

Table 5: number of WHSs that involved mining, oil and gas concessions, (WWF, 2015).

Area	WHS involved mining activities	WHS involved mining concessions	WHS involved gas and oil concessions
Arab States	0	0	1
The Caribbean and Latin America	1	10	3
Africa	3	11	17
North America and Europe	3	2	3
The Pacific and Asia	5	15	16
Total	12	38	40

As mentioned, there are many areas around the world are affected by the various extraction activities and “Selous Game Reserve (SGR)” is considered as one of these areas. SGR is located in Tanzania and it became as one of the WHSs in 1982 (IUCN, 2014a). However, the extractive privileges became licensed within SGR, thus the extractive activities within this area has increased (IUCN, 2014b). A survey has been conducted on this area to determine the volume of extractive activities and the results indicated that there are more than 50 mining concessions, 6 gas and oil concessions and 5 active mines. Based on these results, SGR became one of the areas that exposed to threats and it added to “Danger List” of World Heritage in 2014 (Osipova et al, 2014). The figure below illustrates the volume of extractive operations within SGR area.

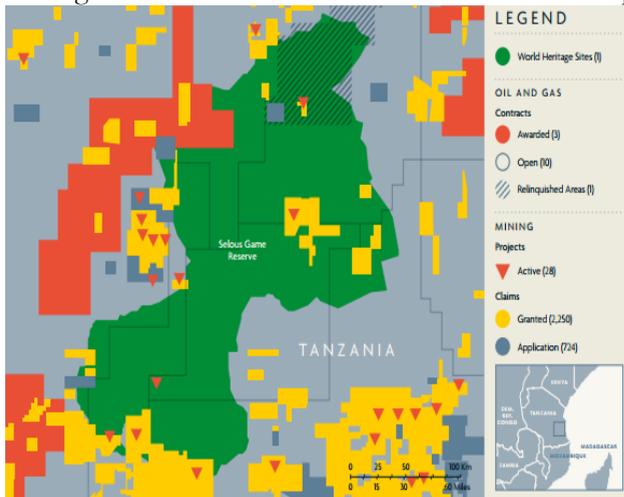


Figure 4: the volume of extractive operations within SGR, (IUCN and UNEP-WCMC, 2015)

Hence, to preserve the WHSs from the effects of the growing of extractive sector, four main topics should be treated (Munro and Toit, 2015):

- ❖ State Parties readiness to punish the responsible about the extractive activities in their WHSs.

- ❖ Inadequate funding to allow the Committee of World Heritage from confirming the WHSs integrity.
- ❖ Weak due diligence and poor knowledge of the companies of the extractive sector pay them to purchase privileges or work around or within the WHSs.
- ❖ Shortage in information in the financial organizations leads to indirect or direct projects financing that effect on the WHSs.

1.7 Managing Climatic and Environmental Risks

Within this section, three ways have been suggested to manage the risks exposed the WHSs. The first way aims to summarize the key efforts and surveys performed by large organizations to determine the volume of threat exposed the WHSs in order to manage these risks. Within the second way, the role of GIS technology in managing the risks exposed WHSs has been shown and discussed. The third way aims to review many plans and projects in order to determine the key actions that should performed to manage the risks and to preserve the WHSs.

6.1 Surveys and Efforts Conducted by Large Organizations on WHSs.

There are many efforts that performed to minimize the heritage exposure into disasters. One of these efforts is the report that arranged by the Center of World Heritage in 2006. This report was prepared based on the “World Heritage Committee (WHC)” request. According to the report, there are no recognized processes, plans and policies to manage the disaster threats within the majority of the properties of World Heritage, especially within the world developing countries (Jigyasu, 2015).

Further, the Center of World Heritage performed another new research on the geological threats. The collected data from the research showed that about 76% of the properties of World Heritage are possibly exposed to those five geological threats: severe erosion, volcanic eruption, landslide, tsunami and earthquake. Moreover, the data from two key reporting systems that prepared by the Convention of World Heritage have been investigated and analyzed to evaluate the awareness level of risks in order to optimally deal with these risks. Based on the reports, the results show that about 51 percent of the location managers say that their locations were exposed to the geological threats (UNESCO, 2015).

In 2005, the Center of World Heritage released a survey to evaluate the nature and extent of the climate varying effects on the properties of World Heritage. Further, the survey aimed to determine the activities that should be achieved to treat with these effects. The survey was conducted on 83 States Parties, where 110 responses were gathered from the survey. About 72% approved that the variation in climate had a great effect on the cultural and natural heritage. Further, about 125 WHSs were classified as threatened sites by the variation of climate. A universal report was released in 2007 based on the current survey and other considerable case studies. The report was released by the WHC to show how the variation in climate effects on the World Heritage (Colette, 2007).

A survey that conducted by the Convention of World Heritage indicated that the Convention of World Heritage involved about 229 WHSs that are distributed over 97 different countries. Further, these distributed locations provide the global, national and local communities with various benefits like water and food provision, climate variation

reduction and flood avoidance. Moreover, they support the spiritual values, safeguard cultural and local economies (Stolton et al, 2015). The “International Union for Conservation of Nature (IUCN)” indicated that the WHSs (Osipova et al, 2014):

- ❖ 93% of WHSs supply tourism and recreation benefits.
- ❖ 84% of WHSs participated in education.
- ❖ 91% of WHSs delivered employment.

2. Applying GIS Technology to Manage Risks and Preserve WHSs.

The GIS technology is considered as one of the most significant and modern technologies that applied to preserve the WHSs. The GIS technology has been utilized within various projects to manage the risks and to preserve the heritage sites. “Disaster Management (DISMA)” is one of the key projects that applied the technology of GIS to preserve the cultural heritage and to manage the risk within these sites in Eastern Attica area. The key aims of this project are (CANAH, 2016):

- Preserve cultural heritage in face on forest and flood hazards.
- Encourage the cooperation among local governance structures and scientific communities.

Further, the technologies of GIS and remote sensing had been utilized by Ghoneem and Elewa (2015) to manage the risk and disaster that threaten the cultural heritage within Cairo. The aim of this study was to prepare a preliminary plan of risk management utilizing the map of environmental risk for Cairo. The generated map illustrated the locations of the most threatened risks within Cairo based on various information sources and field evidence (Ghoneem and Elewa, 2013).

The technology of GIS has been also utilized within the project established by the “Indian Space Research Organization (ISRO)” and the “Ministry of Cultural (MOC)”. The goal of this project is to monitor and identify the heritage sites within India. Also, the project helps to manage and preserve a great number of monuments and heritage sites within the country. GIS has been utilized to generate a map for the significant heritage sites within India, where three zones of management have been identified around the target sites using GIS. The figure below illustrates the zones delineated by GIS (ISRO, 2016).



Figure 5: the zones delineated by GIS (ISRO, 2016).

2.1 Projects and Plans to Preserve the WHSs

Large number of plans and projects have been established to preserve WHSs by determining the actions that should be achieved to manage and reduce the threats face the WHSs. Within this section, the

most popular and significant plans are discussed and reviewed.

The “Future of the World Heritage Convention” is one of the key strategies that released to preserve the WHSs. The strategic plan was agreed in 2011, where it involves all implementations and activities of the Convention of World Heritage during the period from 2012 to 2022. The strategy raises the estimation for natural and cultural heritage, strengthens the contact among the local stakeholders and civil community as well as enhancing the historical understanding. Further, the strategy provided many measures that increase the efficiency of the public management and provided the people with more chances to effect on the WHSs activities (Viitanen and Grahn-Laasonen, 2015).

The “Capacity Building in Tourism Planning and Management” project has been designed to construct an optimal capacity for the heritage sites within the world. The project focused on the planning and management of tourist. A program to manage the tourism was released on two main heritage locations: the “Ohrid Site” and the “Durmitor National Park” (World Heritage Convention, 2010a).

Further, the “Exhibition during COP 16 in Cancun on the Effects of Climate Change on World Heritage Sites” project was established to increase the awareness about climate variation damaging impacts on the UNESCO WHSs. Satellite images have been utilized to observe these locations and to draw these variations. The key variations that displayed within the satellite images are: flooding, disappearing permafrost, melting glaciers, desertification and coral bleaching (World Heritage Convention, 2010b).

Further, the project of Noah’s Ark is another example of researches that performed to evaluate the climate variation effect on the constructed heritage during the following 100 years. A key publication was created by this project: the “Atlas of Climate Change Impact on European Cultural Heritage”. This publication involves management strategies and scientific analysis that involves maps for the threaten heritage sites (Sabbioni et al, 2010).

A management plan was released by Edinburgh Council City, Historic Scotland and World Heritage of Edinburgh to design a management framework for WHS of Edinburgh New and Old Towns. The purpose of the designed framework was to keep the site outstanding global value, which allows the stakeholders and the users from recognizing why Edinburgh became one of the WHSs. The UNESCO added the Edinburgh New and Old Town to the list of World Heritage in the year of 1995. The stakeholders were included within the plan to benefit from their experiments and visions and this added a great contribution to the objectives and vision of the plan. The designed framework provides management to the WHSs until the year of 2016 (Hyslop et al, 2011).

Another management plan is that released by UNESCO in 2014 to preserve and manage the “Derwent Valley Mills World Heritage Site (DVMWHS)”, which was added to the list of World Heritage in 2001 by UNESCO. The plan was developed by the public and many stakeholders in order to analyze the recent opportunities and challenges that exposed the Property of DVMWHS and to develop an action and implementation plan to overcome on these challenges (Hyslop et al, 2011). Further, the plan aims to achieve the following aspirations:

- ❖ Improve, conserve and preserve the DVMWHS Outstanding Global Value.
- ❖ Encourage the access to and the awareness of DVMWHS.

- ❖ Encourage the sustainable tourism in DVMWHS.
- ❖ Improve the social and economic wellbeing of DVMWHS societies.
- ❖ Encourage the informal and formal learning within DVMWHS.
- ❖ Encourage the partners to implement their projects and getting better funding in DVMWHS.
- ❖ Manage the relationship with the partners in a sustainable and efficient way.

1.8 Data Analysis

As shown from the sections above, large number of WHSs within various countries around the world has been impacted by the various climatic and environmental risks. A large number of these sites has been destroyed by these risks, which also extended to involve the near areas, native population and visitors. Thus, this paper based on the literature to address this problem. The paper suggested three ways to manage the risks exposed the WHSs. The first way aims to summarize the key surveys that performed by various organizations on WHSs, these surveys aim to determine the volume of threat the exposed the WHSs and which sites should be added to the danger list. Based on this way, the governments within all countries can benefit from this way to conduct surveys on their WHSs. The second way aims to utilize the GIS technology to manage the risks exposed the WHSs. Thus, this technology can be utilized to generate maps involved the significant WHSs and which of these sites are in danger. Further, the third way aims to establish plans and projects to preserve the WHSs from risks. The plans aim to determine the key actions that should be performed to manage the risks exposed the WHSs.

1.9 Results and Solutions

As a summary, the WHSs around the world are impacted by increasing climatic and environmental risks. The impact of these threats involves the heritage sites, the surrounding areas, the near communities and the visitors. Further, a huge number of WHSs within various areas have been destroyed by these risks. Because these risks are frequently occurring and they referred to natural reasons, there is no certain solution can be suggested to solve the problem of these risks. Thus, many recommendations have been provided to preserve the WHSs and to reduce the impact of environmental and climatic risks:

- ❖ Increase the awareness among people about WHSs.
- ❖ Promoting support within related local, global, regional and national initiatives to minimize risks at the properties of World Heritage.
- ❖ Utilizing education, innovation and knowledge to construct a culture to prevent the disasters within the properties of WHSs.
- ❖ Preparing plans to manage the risks that threaten the WHSs.
- ❖ Applying GIS technology to manage the risks and preserve the WHSs.

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