P-ISSN: 2790-6795	Annals of Human and Social Sciences	October-Dec 2024,Vol. 5, No. 4
O-ISSN:2790-6809	http://doi.org/10.35484/ahss.2024(5-IV)27	[277-292]

Annals of Human and Social Sciences
www.ahss.org.pk

RESEARCH PAPER

Climate Change and its Impact on Disaster Risk Reduction Strategies for Buddhist Heritage in Swat and Mardan, Khyber Pakhtunkhwa

[1]Ar. Mir Wali Shah*, and [2]Prof. Dr. Saima Gulzar

1. PhD Scholar (Architecture), Department of Architecture, University of Management and Technology Lahore, Punjab, Pakistan / Associate Professor Architecture, Hazara University
2. Chairperson, Department of Architecture, University of Management and Technology Lahore, Punjab, Pakistan

Corresponding Author mwshah@gmail.com

ABSTRACT

An alarm for the built heritage such as archaeological ruins under the threats of climate change. This research aims to identify how climate change affecting the measures for protecting the built heritage. Purpose of this research to understand climate risk to Buddhist Built Heritage sites in District Swat and Mardan division, Khyber Pakhtunkhwa-Pakistan, a Land of Gandhara, the prominent in the history of Buddhism. This study looks at how climate change distresses disaster risk reduction measures for Buddhist sites. Methodology adopted, a field surveys, interviews, historical data analysis, to examine state of DRR measures used to assess sites, their effectiveness in the context of shifting climate patterns. The study highlights urgent need for a comprehensive approach to safeguarding this irreplaceable heritage, identifying gaps in strategies, limited integration of climate change. Adoption of novel DRR frameworks, early warning systems, climate-smart infrastructure, collaboration among local communities, government/International organisations were recommended.

Keywords: Buddhist Built Heritage, Climate Change, Hazards, Risk Reduction, Strategies

Introduction

There is a wealth of surviving Buddhist heritage sites in Pakistan's Swat and Mardan regions, each a monument to the area's profound historical and cultural importance. Archaeological treasures from the 1st century BCE provide crucial insight into the spread of Buddhism down the old Silk Road and the growth of Gandhara art and architecture (Zahoor, 2023). Not only does the scattering of Buddhist monasteries, stupas, and rock carvings across the lush valleys of Swat and the plains of Mardan preserve this link to the past, but it also impacts the region's cultural identity. These sites have helped to flourish interfaith dialogue and cultural tourism while significantly adding to the local economy and social fabric.(Figure # 1)

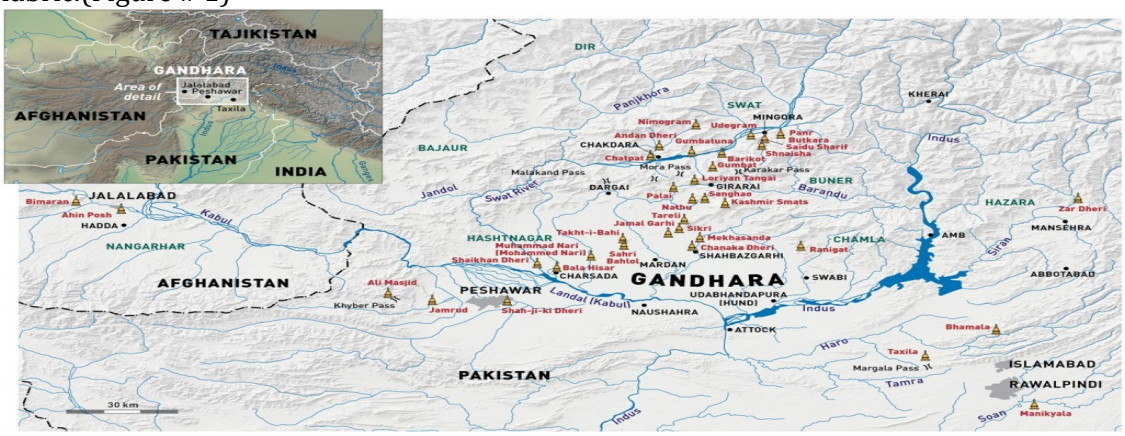

Figure # 1: Map of Gandhara – Buddhist Built Heritage in Khyber Pakhtunkhwa Pakistan

These cultural heritage sites are of paramount importance as both historical assets endogenously and can also afford to provide for the development and social cohesion as exogenous. According to (Kalla, 2022), cultural heritage is a soul form; it is the wellspring of identity and creativity and means respecting cultural diversity and human ingenuity. The conservation of Buddhist heritage sites in Swat and Mardan is critical as a case study because they are vulnerable to natural and human-induced threats. However, as (Sridharan, Sharma, & Ji, 2023) states, these sites need to be protected, as they house their historical legacy through their cultural continuity, and future generations can learn and engage with them as they are.

Table 1
World Heritage Sites impacted by climate change

Region	Number of WH sites impacted	% out of WH sites impacted globally	Natural and mixed heritage sites impacted	Cultural heritage sites impacted
Asia	15	17	7	8
Europe	21	24	4	17
Africa	24	27	7	17

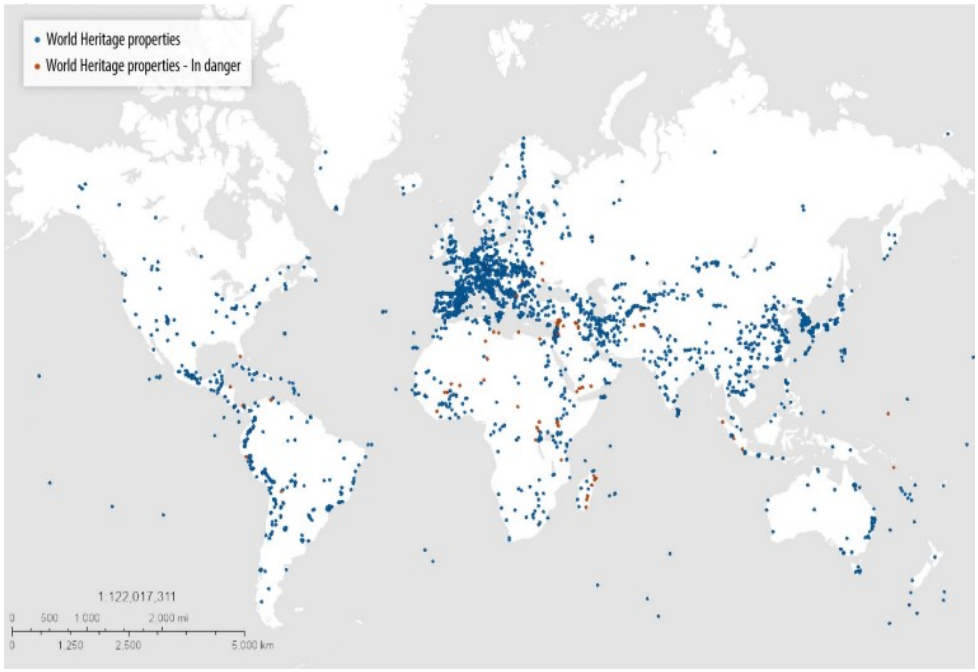

Figure # 2: Map of World Heritage Sites – Source UNSECO
Regions where World Heritage Sites are most impacted by climate change: Source ICOMOS/ICSM/CHC 2022

Literature Review

In recent years, (Table #1), the global perspective of the impact of climate change on cultural heritage has become increasingly popular as global warming processes are accelerating and, therefore, present a novel challenge to preserving historical sites worldwide. As noted by Stephen et al., cultural heritage sites are susceptible to the effects of weather extremes, alterations in temperature and precipitation patterns, and sea-level rise (Axon, Chapman, & Light, 2024). Further, this sensitivity amplifies the vulnerability of the sites at hand. The activities of these environmental stressors can result in physical damage, erosion, and complete loss of irreplaceable cultural assets. (Figure # 2) Climate change is a particularly acute threat to the Buddhist heritage sites in Swat and Mardan. Due to its peculiar geographical location, the region is exposed to multiple climate-induced

hazards, resulting from its vicinity with Hindu Kush mountains and semi-arid climate. Several Buddhist monuments in the area are already being damaged by the increased frequency and intensity of "extreme weather events" like flash floods and landslides. Changing temperatures and increases in relative humidity are also seriously speeding the rate at which aiguillette stones and murals are deteriorating and will erase centuries of artistic and cultural heritage(Cacciotti, Sardella, Drdácký, & Bonazza, 2024).(Figure # 3). Past studies on heritage conservation in climate-vulnerable areas call for comprehensive and adaptive management strategies. Accordingly, (Engel & Librelotto, 2024) presents a multi-disciplinary approach with climate science, heritage conservation, and community engagement to develop resilient preservation approaches. However, researchers such as (Tokan & Kurniati, 2024), in the case of Swat and Mardan, have pointed towards the significance of considering traditional knowledge and local adaptive practices towards conservation efforts since long there has been an intimate relationship between the communities in their cultural heritage.

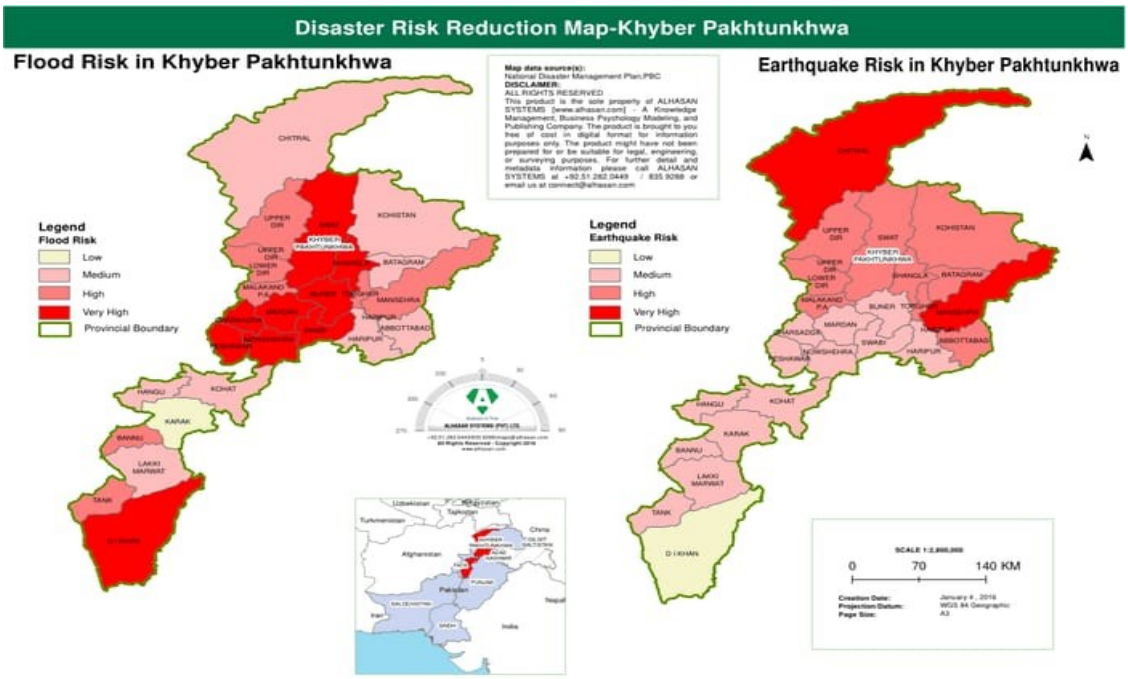

Figure # 3: Maps of Hazards i.e. Earthquake and Flood (Source: PDMA)

In Swat and Mardan, cultural heritage sites such as this become more important as the global community tackles the problems of climate change. They are also tremendous repositories of historic and cultural resources and significant signals of how climate change impacts our shared human inheritance. If these vulnerable sites are studied and protected, our lessons will help us understand how cultural heritages can tackle environmental change and develop strategies to conserve heritage worldwide.

Buddhist Heritage sites in the Swat and Mardan regions of Khyber Pakhtunkhwa, Pakistan, constitute an exceptional concentration of sites that attest to their central role in the diffusion and evolution of Buddhism. This rich archaeological landscape, (Figure – 4) sometimes called 'the cradle of Buddhist civilization' (Filigenzi, Olivieri, Terrasi, Marzaioli, & Capano, 2016), comprises an impressive range of structures such as monasteries, stupas, rock carvings, and pre-historic urban settlements from the 3rd century BCE to the 8th century CE. The region's strategic position between the ancient Silk Road ensured great cultural interchange, leading to the development of the Gandharan art style, which took the influence of Hellenistic, Persian, and Indian and added Buddhist iconography.

Figure # 4: Aba Sahib Cheena Buddhist Heritage Site at Swat (Source: Author)

Figure # 5: Butkara – I Rain water inside the Site

Butkara I, (Figure – 5) an essential site in the Swat valley, is a monumental staircase complex built over several centuries to form a Unesco World Heritage Site; the rock carvings of Jahan Abad include one of the giant Buddha images in the region. The well-preserved Gandharan monastery complex in Mardan in the Takhti-Bahi complex attracts scholars and pilgrims (Faccenna, 2007). In combination with many other sites spread across the valleys and plains of the region, these sites provide invaluable information on the religious, artistic, and social aspects of ancient Buddhist societies in the area.

The preservation state of these heritage sites is complex at the current time. Some monuments, most notably Takht-i-Baih, (Figure – 6) have been fortunate to have ongoing conservation efforts and generally stable conditions, whereas others are beset with enormous challenges. Domenico suggest that poor funding for conservation, urbanization, and expanded agriculture have contributed to the decline of many sites (Faccenna, 2006). Climate patterns such as increased rainfall and temperature variability have increased these

challenges, with a concomitant acceleration of the damage to exposed structures and peril to the archaeological remains that are potentially fragile (Sardar, 2012).

Figure # 6: That-e-Bhai – Impacts of Weather on WHS (Source Author)

The disaster risk reduction (DRR) framework has come to support the protection of cultural heritage in a world of increasing environmental threats. The United Nations adopted the Sendai Framework for Disaster Risk Reduction 2015-2030, which stresses the integration of preservation methods for cultural heritage into general strategies for disaster risk management. DRR within the context of heritage conservation can be defined as different proactive pre-disaster measures related to identifying, assessing, and mitigating cultural assets at risk.

Risk assessment, (Figure – 7) preparedness, and resilience building are critical concepts within the DRR framework to address potential disasters at heritage sites. This framework involves systematic analysis of hazards and vulnerabilities in heritage sites, developing emergency response plans in places, and developing local capabilities to resist and recover from disaster (Ferrari, 2024). These concepts are partly applied to conserve cultural heritage by a multidisciplinary approach using the knowledge and expertise of archaeology, conservation science, climate studies, and disaster management.

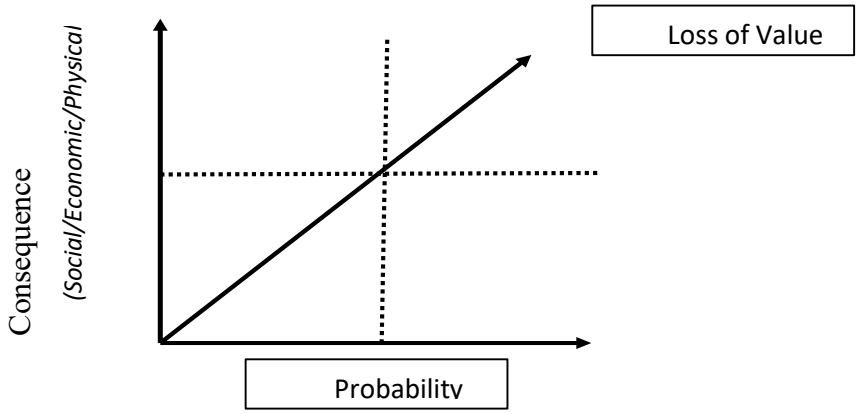

Figure # 7: Risk Assessment

These concepts are partly applied to conserve cultural heritage by a multidisciplinary approach using the knowledge and expertise of archaeology, conservation science, climate studies, and disaster management.

Different case studies show the effectiveness of DRR strategies in protecting cultural heritage. For example, seismic retrofitting and advanced fire prevention systems at wooden temples and shrines in Japan drastically decreased the vulnerability to earthquakes and fires (Detwiler & Huda, 2024). Using integrated risk maps for cultural heritage sites in Italy has made it possible to focus conservation efforts more selectively. It is also helpful in mapping appropriate emergency response plans (Ferrari, 2024). The examples show the possibility of adapting and applying DRR principles to Buddhist heritage sites in Swat and Mardan.

While the literature on cultural heritage preservation and climate change adaptation is growing, knowledge still has gaps in their intersection—for example, about Disaster Risk Reduction and Buddhist heritage in Khyber Pakhtunkhwa. Despite previous studies focusing on various aspects of heritage conservation in the region, such as archaeological documentation(Bhatia & Shukla, 2024) and tourism development, the overall analysis of the proposed DRR framework, climate change projections, and site-specific conservation needs for heritage sites in the region has been hitherto lacking.

Considering Swat and Mardan's environmental, cultural, and socio-economic context, this research gap is significant. Specifics of the heritage of Buddhist sites in the region have specific implications for reducing risks and adapting to climate change. According to (Tokan & Kurniati, 2024); (Ferrari, 2024), there is an urgent need for interdisciplinary studies to bridge the gap between climate science, heritage conservation, and local knowledge systems to develop effective and context-based strategies for conserving these vital cultural assets.

Furthermore, community-based disaster risk reduction has begun to gain ground in other contexts. Still, the application of this idea to heritage conservation in Khyber Pakhtunkhwa has yet to be widely explored. Whether traditional or innovative, research needs to be done on how local communities can effectively protect Buddhist heritage sites through climate resilience(Faccenna, 2007).

Addressing these research gaps is necessary to preserve Swat and Mardan’s Buddhist heritage and contribute to broader theoretical questions about the challenges of cultural heritage conservation in such climate-vulnerable regions. Future research can focus on this intersection of climate change, DRR, and Buddhist heritage to expand holistic and sustainable ways to protect the world’s cultural heritage from environmental change.

Climate change has increasingly become a significant threat to heritage sites, especially in vulnerable regions, conservationists, archaeologists, and policymakers have been wondering about. Cultural heritage sites, particularly those in the archaeological, geological, or geomorphological senses, are threatened in new and unprecedented ways by rising global temperatures and less predictable weather patterns. This problem is acute in the context of the Buddhist heritage sites in Khyber Pakhtunkhwa, Pakistan. In addition, due to its geographical and climatological particularities, the region is particularly prone to the harmful effect of climate change, speeding up the deterioration of irreplaceable historical and cultural heritage (Sladić, 2024).

Recently, it has been shown that natural disasters are increasing in Khyber Pakhtunkhwa, including floods, earthquakes, and landslides, which greatly endanger Buddhist heritage sites. According to (Ferrari, 2024), extreme weather events in the region have become more frequent and intense in recent decades, and proponents predict this trend will continue. In addition to altering how these climatic shifts impact the physical structures of heritage sites, these climatic shifts change environmental conditions that have contributed to preserving these heritages over the centuries. Climate change impacts and increased risk of natural disasters combined to produce a complex challenge for heritage conservation in the region (Bosi, 2024).

The DoAM identified the 12 Sites (Table # 2) that were damaged by the recent flood 2022 during the monsoon rainfall.

Table 2
Sites damaged by flood 2022

Name of the Monument/Place	Description and Extent of Damage
Shinasha Stupa, Swat	During heavy rainfall main stupa damaged due to which stones from drums of stupa collapsed. Furthermore, due to rain serious dampness caused to structure which is dangerous & can be collapsed any time if not repair on time and partially damaged.
Amulkdara Stupa, Swat	As amulkdara stupa is adjacent to Elam River the site is very badly affected by rainfall & flood due to which serious erosion occurred from sloping side. Moreover, due to dampness the corner of 2nd Major stupa has collapsed & cracks been developed in every structure which will collapse in near future if not repair on time and partially damaged.
Aba Sahib Chena Stupa, Swat	Due to rainfall & adjacent water main the retaining wall erected to protect the sites from erosion has collapsed at three different points due to which the site is tilted at some location. due to settlement of surrounding soil the main structure of abashaib is in danger & proper conservation work is required to avoid any further damaged to the site and partially damaged.
Shinghardar Stupa, Swat.	Due to heavy rainfall & hailstorm the stones block from the main stupa is detached & fallen. the foundation of stupa is in bad condition due to recent heavy rainfall & urgent repair/conservation work is required to avoid any further damaged & collapse to site and partially damaged.
Barikot, Bazira Site, Swat	Due to rainfall the sewerage system of the site is blocked which is causing dampness in surrounding structure. Urgent repair/conservation required to avoid further damage to the said site and partially damaged.
Butkara-1 Site Swat.	Butkara site is located on the edge of Jambil River due to flood the retaining wall for protection of site is detoriated. Moreover, rainfall caused horizontal & vertical cracks in votive stupa & other structures. As the site is located on bank of jambil river if it is not conserved or protected it may not only be flooded but washed away. Retaining wall on bank of river need to be erected on priority basis to avoid any further loss to this heritage site.
Gumbatona Site, Swat.	The site is located on bank of canal due to rainfall the flood damaged the retaining wall & erosion of soil has been observed on left side of Gumbatona site. Furthermore, the Stupas/ Votive stupa is damage because of heavy rainfall. Urgent conservation/ protective work is required to avoid any further damage to the site and partially damaged.
Thokar Dara Stupa, Swat	Due to heavy rainfall the walls of the main hall is collapsed, cracks are developed in various walls. Moreover, stones from corner of some stupas are falling due to dampness in structures which need urgent conservation work to avoid any further damages to the site in future and partially damaged.
Swat Museum and Store	Due to rainfall the swat museum was affected and dampness & minor cracks developed in several wall & slabs. Moreover cracks & dampness were also observed in reserved building which is dangerous & need to be rectified to avoid further damaged to said building. Furthermore, due to voltage fluctuation UPS system & batteries were also damaged and partially damaged.
Jamal Ghari Site, Mardan	Due to heavy rainfall the outside wall of Jamal Ghari courtyard site is pushed out in bulging position due to rainy water pressure & soon it can fall so urgent repair work is required to avoid collapse of walls and partially damaged.
Tharelli Swal Dher Site, Mardan	Tharelli site is prone to flash flood in every monsoon but due to recent heavy rainfall & flash flood it was hit badly & caused damages to retaining wall & votive stupa court. the approach road to site was washed away by heavy flash flood. The site needs urgent conservation/protection work to avoid any further damage to the site. The approach road to site is completely damaged.

Many of the Buddhist sites in Sway and Mardan are situated in zones prone to flooding and landslides, and thus, they are more vulnerable to climate-induced disasters. Loss or severe damage to these sites, which are a vital part of the cultural heritage of the local communities dependent on these sites for their cultural identity and economic survival in increasingly essential ways via tourism, would not only be an irreplaceable loss of cultural heritage but serve as a blow to local communities. In addition, the delicate stone carvings and mural paintings at these sites are particularly sensitive to environmental stressors exacerbated by climate change (Faccenna, 2006).

The two primary objectives of this study are to address the complex challenges facing Buddhist heritage sites in Khyber Pakhtunkhwa. This approach, then, attempts to investigate how climate change amplifies disaster risks for these sites through the historical climate, current trends, and future projections to identify the most critical climate risk factors. The second part of the study seeks to investigate and assess disaster risk reduction (DRR) strategies that are specifically adapted to the unique environment of these Buddhist heritage sites, and traditional conservation methods as well as potentially innovative strategies to apply the lessons of resilience on climate adaptation under the circumstances of the limits of local resources and capacities.

This research is significant because it bridges critical gaps in our knowledge about how climate change, disaster risk reduction, and cultural heritage preservation intersect within Khyber Pakhtunkhwa's Buddhist sites. The study seeks to advance theoretical understanding and practical uses in various critical areas by addressing these complex and interrelated issues. It will first provide helpful knowledge regarding the exact mechanisms of how climate change affects Buddhist heritage sites in the region so that the climate vulnerability of cultural landscapes can be better understood. This knowledge is essential for establishing targeted conservation strategies and providing information for policy decisions about heritage management in the context of environmental change (Sladić, 2024). The study will further the growing literature on climate change impacts on cultural heritage by examining the unique challenges of these sites. The second contribution of the study is that it will explore and evaluate DRR strategies for Buddhist heritage sites, adding to the growing literature on adapting cultural heritage to climate. Since climate change poses distinct challenges in different geographical and cultural settings, as (Bosi, 2024) argued, there is a real need for context-appropriate heritage conservation approaches. This research will fill this gap by providing empirical evidence and practical recommendations for including DRR principles in heritage management practices in Khyber Pakhtunkhwa.

In addition, the study's emphasis on the intersections of climate change, DRR, and Buddhist heritage in this region has the potential to inform similar research in other culturally significant, climate-exposed areas worldwide. By showing that interdisciplinary work on heritage conservation is essential, the research can encourage and guide future work on the complicated issues of heritage conservation in the face of global environmental change.

Finally, the findings of this research have important practical implications for policymakers, conservation professionals, and local communities dealing with managing and protecting Buddhist heritage sites in Khyber Pakhtunkhwa. The study can provide direct evidence-based recommendations for DRR strategies that can direct conservation planning and resource allocation to make these valuable cultural assets more resilient to climate-related threats. In a region where resources for heritage conservation can be scarce but where focused, appropriate interventions can greatly influence preserving cultural heritage for future generations, this practical application of research results is imperative.

Material and Methods

This study uses a qualitative research methodology to examine the impact of climate change on Buddhist sites of heritage in Swat and Mardan and assess disaster risk reduction (DRR) strategies. This study is appropriate for qualitative research because of its ability to delve into complex, context-specific issues, and qualitative research is ideal for heritage preservation in the presence of climate-induced risks. Instead, it focuses on elucidating the detailed problems these heritage sites face in dealing with climate change and the measures adopted to address these risks. The research is based on a systematic literature review and synthesizing existing knowledge about climate change, DRR, and heritage preservation. Such an approach is grounded in a broad scope of academic, government agencies, and

organizational sources. In addition to the literature review, I examine case studies of similar heritage sites impacted by climate change to parallel and highlight best practices.

Drawing on thematic analysis, the study analyzes the patterns within DRR strategies to identify some recurring themes contributing to cultural heritage protection. Thematic analysis is a method of choice for identifying, analyzing, and reporting patterns within qualitative data. This helps to study the usefulness of the current DRR measures, like those indicated in the Sendai Framework for Disaster Risk Reduction. The uniqueness of the Buddhist heritage sites of Khyber Pakhtunkhwa can be addressed by filling up the gaps present in already existing strategies, and the thematic analysis framework thus provides a path to improve the strategy in the way best suited for the conditions of Khyber Pakhtunkhwa's Buddhist heritage sites.

This research includes reports, documents, and literature from government agencies, nongovernmental organizations (NGOs), international bodies, and heritage conservation and disaster risk management experts. Because purposive sampling is a form of non-probability sampling method that permits the researcher to select those cases that are particularly relevant to the research questions, sampling is used. The technique is appropriate for considering targeted DRR strategies and focusing on selected heritage sites. Reports from organizations, including UNESCO, the National Disaster Management Authority (NDMA) of Pakistan, and NGOs involved in heritage conservation in Pakistan, are included as the sample. Interviews with experts in heritage preservation, who are both researchers and have field experience dealing with heritage in disaster-prone areas, are also conducted to better understand the challenges and strategies at play in the case of Buddhist sites in Swat and Mardan.

This study gathers data for reporting through a comprehensive review of the reports published by government bodies, NGOs, and international organizations. These reports are crucial to understanding the state and status of heritage sites, the environmental risk they are exposed to, and the DRR strategies being carried out to protect [them]. UNESCO and the NDMA reports are studied to learn what these organizations have done to preserve heritage in disaster-prone areas. In addition to document review, heritage conservation and disaster management experts are interviewed semi-structurally. Qualitative data on the effectiveness of existing DRR strategies and the possibility for improvement can be collected through these interviews. The semi-structured format is flexible in its framing yet focused on its goal. It enables experts to share their experiences and suggest how climate resilience can be more fully integrated into heritage conservation.

The data collected was analyzed using recurring themes. It is suggested that thematic analysis is well suited to identifying patterns in DRR strategies and evaluating the effectiveness of strategies to safeguard Buddhist heritage sites. Key themes include climate change adaptation, community involvement in heritage preservation, and the incorporation of local and international DRR frameworks.

In particular, the Sendai Framework for Disaster Risk Reduction is a global framework agreed to by the United Nations to reduce disaster risk and build resilience. The Sendai Framework makes a strong case for the need-to-know disaster risk, enhances disaster risk governance, and supports the implementation of DRR strategies to protect cultural assets. This study applies the Sendai Framework to evaluate how current DRR efforts comply with and the chances for improving the protection of Buddhist heritage in Swat and Mardan. Finally, this research methodology aims to create a deep understanding of the interplay between climate change, disaster risk, and heritage preservation to contribute to academic and policy development literature.

Results and Discussions

Theme 1: Climate Change Trends and Disaster Vulnerability in Khyber Pakhtunkhwa

Climate change is exacerbating the already vulnerable region of Khyber Pakhtunkhwa (KP). A rise in temperatures, a general increase in precipitation, and a shift in weather patterns are among the vital climatic trends that signal rising disaster risks (Fatorić & Daly, 2023). Research has shown that the average temperature in KP is increasing drastically, causing extreme weather events like severe flooding and landslides in the Swat and Mardan districts (Aktürk & Hauser, 2024). Understanding these trends benefits effective disaster risk management (DRM) as it helps policymakers respond to the changing climate conditions (Hyslop, 2023).

Geographical features such as steep slopes and river valleys are mapped to disaster-prone areas in KP. These socio-economic vulnerabilities and geographical factors significantly determine local communities and cultural heritage sites (Zafar et al., 2024). Additionally, research suggests that rural populations are especially vulnerable because they have fewer resources for adaptation and recovery (Rizwan Ullah, Mao, & Nasrullah, 2024).

Local climatic trends must be factored into disaster preparedness and response strategies to be influential. Global best practices suggest that climate projections are integrated into local risk assessment and planning processes (Hussain, Meng, Shah, & Hussain, 2024). The resilience of communities and preservation of cultural heritage from the impact of climate change can be supported by this comprehensive approach (Saad, Mahsud, & Mian, 2024). However, ensuring that climate change challenges (such as flooding, habitat loss and destruction, and sea level rise) are mitigated through KP calls for a complicated, multifaceted strategy, combining local knowledge and scientific research to create a community and cultural heritage that is protected.

Theme 2: Assessing Vulnerabilities of Buddhist Heritage Sites

Multiple socio-economic and climatic changes face Buddhist heritage sites in Khyber Pakhtunkhwa. In an in-depth assessment, it is found that the Butkara Stupa and the ruins of the ancient Gandhara civilization are highly vulnerable to climate-induced disasters (Umar, 2024). The age and materials of these sites carry structural vulnerabilities due to increased precipitation and temperature fluctuations (Abbas et al., 2024).

However, these cultural assets have been linked to environmental factors, including landslides, soil erosion, and flooding (Hina et al., 2024). It has been shown that mountainous areas such as Swat and Mardan are especially vulnerable to extreme weather events. Furthermore, deficient funding and limited local capacity to implement conservation strategies further increase these vulnerabilities, placing sites at risk of natural disasters (Alam, Ullah, & Ali).

There is a great need for comprehensive vulnerability assessments. Such assessments should consider more than the structural integrity of heritage sites; they should also consider the socio-economic dynamics that dictate whether they are priceless (AFROZ, 2024). Preservation efforts can be more effective if integrated with local community knowledge in these assessments by making strategies culturally relevant and sustainable (Assen et al., 2024).

Additionally, heritage conservation can be integrated into broader disaster risk reduction frameworks to perform the holistic approach to vulnerability management of these sites (Naz, 2023). However, given the increasing magnitude of the threat posed by climate change on cultural heritage, adaptive strategies to protect these invaluable resources are essential, including working to address environmental and structural vulnerabilities.

Theme 3: Historical Context and Impact of Past Disasters on Heritage Sites

The historical context of natural disasters in Khyber Pakhtunkhwa mirrored the significant impacts on Buddhist heritage sites. The descent of the calamitous 2010 floods provides monumental learnings for how climate-driven disasters have previously afflicted cultural assets (Khan, Zaina, Muhammad, & Tapete, 2023). Moreover, the floods caused immediate damage to the physical structures and disrupted the social fabric of communities residing around these heritage sites (Dogar, Shah, & Al Faisal, 2024).

Past disaster assessments of damage reports show the magnitude of loss incurred on sites such as the Butkara Stupa, which was eroded and flooded(Nazir, Caldeira, & Seabra, 2023). The results demonstrated in such case studies highlight the need for impacts to be documented to inform future disaster risk reduction strategies. In addition, recovery efforts following past disasters demonstrate that communities balance immediate needs with the long-term preservation of cultural heritage.

The study of the interplay patterns between past disasters and the preservation of heritage sites reveals a repeated cycle of high loss from the lack of preparedness (Nazeer & Bork, 2021). An apparent reason for better risk assessment methodologies is to ensure that cultural heritage aspects are considered in decision-making processes for disaster preparation and remediation strategy (Nazeer & Bork, 2021). As in the case of heritage conservation, lessons learned from past events can guide the better allocation of heritage resources and policymaking and community engagement.

Finally, effective disaster risk management based on knowledge of the historical context of disasters, particularly their impact on the Buddhist heritage of Khyber Pakhtunkhwa, is crucial. By recognizing the lessons from past events, these invaluable cultural sites will be provided with the means to protect themselves against future climate-induced challenges.

Theme 4: Evaluation of Current Disaster Risk Reduction Strategies

To determine the effect of effective heritage conservation on climate change challenges, an evaluation of current disaster risk reduction (DRR) strategies in Khyber Pakhtunkhwa is essential. For this purpose, National and provincial policies, such as the National Disaster Management Plan and provincial policies, have been implemented to tackle the disaster risks (Nazeer & Bork, 2019). Nevertheless, studies have concluded that ESRP provides little or no protection for cultural heritage, especially Buddhist sites (Shah et al., 2018).

A review highlights that while it is shown that DRR policies do exist, they generally need more emphasis on cultural heritage preservation (Tamagnone, Caporali, & Sidoti, 2022). Difficulty implementing heritage conservation in DRR plans effectively stems from the need for specific guidelines for integrating heritage conservation in DRR plans (Aktürk & Hauser, 2024). Additionally, impediments to progress include inadequate funding, limited community engagement, and insufficiently trained local authorities.

International organizations such as UNESCO and other heritage preservation bodies are essential in strengthening localized DRR (Naz, 2023). They assist these organizations with technical assistance and funds to integrate heritage conservation into national disaster management strategies (Nazeer & Bork, 2019). Nevertheless, coordination and communication with stakeholders may only sometimes be harmonized, resulting in overlapping activities and inefficiency.

These challenges require a community-level approach that involves fundraising, awareness-raising campaigns, and capacity building of different stakeholders. To improve

the direct relevance and effectiveness of DRR frameworks, they can also be facilitated by incorporating local knowledge and practices.

Discussions

This study finds that Buddhist heritage sites in Khyber Pakhtunkhwa are very vulnerable to the impacts of climate change. Studies like (Aktürk & Hauser, 2024; Assen et al., 2024) have shown that these sites are more prone to being aggravated by key climate trends such as rising temperature and increased precipitation. This is consistent with the existing literature on the increased frequency and intensity of climate-related disasters that affect cultural heritage around the globe. Moreover, reviewing past disasters, particularly the 2010 floods, reinforces the necessity to frame disaster risk reduction (DRR) strategies for heritage conservation in a more contemporary manner (Alam et al.).

Moreover, the study underlines the gaps in implementing national and local DRR frameworks. This finding is consistent with prevalent literature on the need for specialized guidelines regarding how heritage elements should be integrated into disaster management (Nazeer & Bork, 2021). International organizations such as UNESCO not only provide support and technical assistance, as documented earlier (Dogar et al., 2024; Fatorić & Daly, 2023) but have also played a central role in identifying the practices to promote safety in heritage buildings surviving the Gulf monsoons. Overall, the findings support the need for a multi-pronged approach that places cultural heritage protection as a high priority in the face of the increasing threats brought on by climate change.

The findings from this research are consistent with the broader discourse on the intersection of climate change and cultural heritage compared to existing studies. (Nazir et al., 2023) considered heritage sites in disaster-prone areas as essential themes. Although many studies address the effects of climate change on physical cultural heritage, this research deals with the vulnerability of the Buddhist heritage sites in Khyber Pakhtunkhwa.

Additionally, although such a role of community engagement has been documented in DRR strategy literature (Dogar et al., 2024), this study extends this by illustrating how local knowledge can make DRR frameworks focused on cultural heritage more effective. Across the board, the results help to fill in existing knowledge of the interconnections between climate change, disaster risk, and heritage conservation in a region that has only just begun to be studied extensively.

Proposed Improvements to DRR Strategies.

To tackle climate change's difficulties, heritage conservation must become adaptive. Some of these include incorporating climate resilience measures in restoration projects, opting for sustainability, and incorporating green practices in heritage sites. In addition, improving adaptive management plans that encompass climate projections will assist in ranking interventions prioritized by vulnerability assessments. These strategies then embrace such possibilities, enabling heritage preservation to be more robust to climate change's ongoing and future impacts and render cultural sites less susceptible to make up for the lost time as time progresses.

Heritage protection efforts are only successful when they engage local communities. Participatory workshops and inclusive decision-making processes will help foster community involvement in participating in disaster risk reduction (DRR) strategies and ensure that local knowledge and perspectives are integrated into DRR strategies. Besides, education and training programs targeted to increase preparedness and response in case of disasters will enable community members to take part in safeguarding cultural heritage. Assisting sovereign states in raising awareness of the importance of these sites, including the risks they could face if not properly managed, can foster the development of the

communities' sense of pride and responsibility for these DRR initiatives for community resilience building.

Cultural heritage in Khyber Pakhtunkhwa must develop and strengthen the integration of climate resilience in DRR policies to protect cultural heritage. Therefore, heritage conservation in disaster management plans should be carefully designed into comprehensive frameworks, including specific guidelines. Government and international organizations can collaborate to improve resources and provide technical assistance and capacity building to local authorities. Moreover, the stakeholders within DRR, such as local communities, NGOs, and academic institutions, can work in partnership to foster knowledge sharing and implement DRR strategies.

Conclusion

This study then shows the grave risks to Buddhist heritage sites in Khyber Pakhtunkhwa due to climate change and evaluates the efficiency of current disaster risk reduction (DRR) strategies. The results suggest that DRR frameworks need to incorporate cultural considerations better to address vulnerabilities in heritage preservation in the context of climate change. Although current policies have laid a disaster management foundation, the elements that need to be added are specific measures addressing heritage conservation, which warrants further targeted improvement.

This research further contributes to this diverse heritage preservation investigation by highlighting the strong interrelations between climate change, disaster risk, and cultural heritage. The study focuses on the uniquely vulnerable situation of Buddhist sites in Khyber Pakhtunkhwa and provides a resource for regional and international work in heritage conservation facing climatic threats. The findings present a valuable contribution by providing a foundation for developing adaptive strategies aimed at the resilience of cultural heritage in the face of ongoing environmental challenges.

Other vulnerable regions must be further explored at the intersection of climate change, heritage conservation, and DRR strategies. Comparisons among these cultural contexts could yield information about the best practices and what has been learned. Moreover, since holistic approaches to heritage preservation will require an interdisciplinary approach supported primarily by a social, economic, and environmental perspective, it is essential to ensure that such perspectives are studied multi- and cross-disciplinary. Possible impacts of emerging technology, such as remote sensing and data analytics, on disaster preparedness and response for cultural heritage is a promising future direction of investigation.

References

Abbas, M., Khan, F., Liou, Y.-A., Ullah, H., Javed, B., & Ali, S. (2024). Assessment of the impacts of climate change on the construction of homogeneous climatic regions and ensemble climate projections using CMIP6 data over Pakistan. *Atmospheric Research*, *304*, 107359.

AFROZ, D. (2024). Vulnerability Of Heritage Sites To Climatic Extreme Events: Khalifatabaad Ancient Mosque. *International Journal of Conservation Science*, *15*(3), 1371.

Aktürk, G., & Hauser, S. J. (2024). Integrated understanding of climate change and disaster risk for building resilience of cultural heritage sites. *Natural Hazards*, 1-26.

Alam, M., Ullah, T., & Ali, D. Adapting to Change: The Impact of Climatic Shifts on Tourism Destinations and Tourist Mobility in Northern Pakistan. *Journal of Policy Research*, *10*(3), 96-101.

Assen, Y. M., Kura, A. L., Dube, E. E., Mensuro, G. K., Debelo, A. R., & Gure, L. B. (2024). Climate Change Threats to UNESCO-Designated World Heritage Sites: Empirical Evidence from Konso Cultural Landscape, Ethiopia. *Sustainability*, *16*(19), 8442.

Axon, S., Chapman, A., & Light, D. (2024). Climate Impacts on Tangible Coastal Cultural Heritage in the United States: Towards Sustainable and Adaptive Coastal Heritage Management. *Sustainability*, *16*(16), 6800.

Bhatia, S., & Shukla, N. (2024). Integrating traditional knowledge and cultural heritage with climate adaptation and disaster risk reduction: the role of training and tools. *Journal of Cultural Heritage Management and Sustainable Development*, *14*(5), 773-776.

Bosi, E. (2024). Through damage analysis and historical learning: a workflow for multi-hazard vulnerability assessment in cultural heritage preservation. *EGU General Assembly 2024*

Cacciotti, R., Sardella, A., Drdácký, M., & Bonazza, A. (2024). A Methodology for Vulnerability Assessment of Cultural Heritage in Extreme Climate Changes. *International Journal of Disaster Risk Science*, *15*(3), 404-420. https://doi.org/10.1007/s13753-024-00564-8

Detwiler, S., & Huda, M. B. (2024). Museum Emergency Management and Disaster Risk Reduction Strategies. In *Handbook of Climate Change Impacts on River Basin Management* (pp. 185-198). CRC Press.

Dogar, A. A., Shah, I., & Al Faisal, A. (2024). Cultural Heritage Under Attack: Motives for Deliberate Destruction of Cultural Property in Armed Conflict in Swat. *Heritage & Society*, *17*(2), 258-277.

Engel, E. R. M., & Librelotto, L. I. (2024). Cultural Heritage And The Climate Crisis: A Literature Review: Patrimônio Cultural E Crise Climática: Revisão Da Literatura. *MIX Sustentável*, *10*(4), 127-142.

Faccenna, D. (2006). reconstruction of a Sculptural Complex in the Buddhist Sacred area of Butkara I. *East and West*, *56*(1/3), 177-194.

Faccenna, D. (2007). Chapter Seven. The artistic center of Butkara I and Saidu Sharif I in the pre-Kusana period. In *On the Cusp of an Era* (pp. 165-199). Brill.

Fatorić, S., & Daly, C. (2023). Towards a climate-smart cultural heritage management. *Wiley Interdisciplinary Reviews: Climate Change*, *14*(6), e855.

Ferrari, L. (2024). Emergency Response for Architectural Heritage in Seismic Areas: An Integrated Approach to Safety and Conservation. *Heritage*, *7*(9), 4678-4696.

Filigenzi, A., Olivieri, L., Terrasi, F., Marzaioli, F., & Capano, M. (2016). Buddhist settlements and proto-historic graveyards: New chronometric and archaeological data from Saidu Sharif I (Swat, Pakistan). *Newsletter di Archeologia CISA*, *7*, 23-33.

Hina, S., Saleem, F., Hina, A., Ullah, I., Bibi, T., & Mahmood, T. (2024). Exploring trends and variability of climate change indices in the agro-ecological zones of Pakistan and their driving mechanisms. *International Journal of Climatology*, *44*(10), 3589-3612.

Hussain, M. F., Meng, X., Shah, S. F., & Hussain, M. A. (2024). Integrating spatiotemporal analysis of land transformation and urban growth in Peshawar Valley and its implications on temperature in response to climate change. *ISPRS International Journal of Geo-Information*, *13*(7), 239.

Hyslop, E. (2023). Interdisciplinarity in Heritage Conservation: intersections with climate change and sustainability. In *Evolving heritage conservation practice in the 21st century* (pp. 173-187). Springer.

Kalla, R. (2022). The need for conservation of archeological heritage, current challenges and forthcoming approaches. *ECS Transactions*, *107*(1), 5647.

Khan, M. Y., Zaina, F., Muhammad, S., & Tapete, D. (2023). Integrating Copernicus Satellite Products and Ground-Truthing for Documenting and Monitoring the Impact of the 2022 Extreme Floods in Pakistan on Cultural Heritage. *Remote Sensing*, *15*(10), 2518.

Naz, F. (2023). *Buddhist art of Gandhāra: a catalogue of newly documented sites in Malakand District* (P. S. Wannaporn Rienjang, Ed.). Archaeopress Publishing Ltd, .

Nazeer, M., & Bork, H.-R. (2019). Flood vulnerability assessment through different methodological approaches in the context of North-West Khyber Pakhtunkhwa, Pakistan. *Sustainability*, *11*(23), 6695.

Nazeer, M., & Bork, H.-R. (2021). A local scale flood vulnerability assessment in the flood-prone area of Khyber Pakhtunkhwa, Pakistan. *Natural Hazards*, *105*, 755-781.

Nazir, F., Caldeira, A. M., & Seabra, C. (2023). Heritage tourism and terrorism: media coverage of the destruction and rebuilding of Jahanabad Seated Buddha in Pakistan. *Journal of Heritage Tourism*, *18*(4), 504-530.

Rizwan Ullah, M., Mao, J., & Nasrullah, M. (2024). Climate change awareness and adoption measurements of respondents toward food security in Khyber Pakhtunkhwa, Pakistan. *Journal of Water and Climate Change*, *15*(9), 4699-4712.

Saad, S., Mahsud, M. I., & Mian, G. (2024). Climate change impacts: exploring the rising climate-security nexus in Pakistan. *Liberal Arts and Social Sciences International Journal (LASSIJ)*, *8*(1), 177-190.

Sardar, B. (2012). Rock art in the Swat Valley, Pakistan. *Ancient Asia*, *3*, 66-78.

Shah, A. A., Khan, N. A., Nabi, N., Pervez, A. K., Koivogui, S. K., & Ado, A. M. (2018). Flooding in Khyber Pakhtunkhwa: Gathering lessons learned and perceptions at the community level of the NGOs extended shelter intervention program. *International NGO Journal*, *13*(2), 7-16.

Sladić, M. (2024). Strategy for Protection of Cultural Heritage Exposed to the Natural and Man-Made Activity Disasters in Serbia. *Journal of Civil Engineering and Architecture*, *18*, 223-235.

Sridharan, K., Sharma, A., & Ji, S. (2023). Cultural Heritage Conservation Through the Framework of UNSDG. International Conference on Research into Design,

Tamagnone, P., Caporali, E., & Sidoti, A. (2022). Safeguarding heritage sites from hydrometeorological extremes: the Santa Croce district in Florence. EGU General Assembly Conference Abstracts,

Tokan, C. K. L., & Kurniati, R. (2024). Sustainability conservation strategy of Kotagede Heritage Area on the effects of climate change. IOP Conference Series: Earth and Environmental Science,

Umar, M. (2024*). Climate Change Adjustment Factor on rainfall depths in river basins of Khyber Pakhtunkhwa, Pakistan*.

Zafar, U., Anjum, M. N., Hussain, S., Sultan, M., Rasool, G., Riaz, M. Z. B., Shoaib, M., & Asif, M. (2024). Analyzing the Spatiotemporal Changes in Climatic Extremes in Cold and Mountainous Environment: Insights from the Himalayan Mountains of Pakistan. *Atmosphere*, *15*(10), 1221.

Zahoor, M. (2023). Reconstructing The Buddhist's Monastic Society In Hazara From The 3 Rd Century Bc To 5 Th Century Ce: An Archaeological And Historical Approach. *Central Asia (1729-9802)*(93).