



African Journal of Climate Change and Resource Sustainability

ajccrs.eanso.org

Volume 4, Issue 1, 2025

Print ISSN: 790-962X | Online ISSN: 790-9638

Title DOI: <https://doi.org/10.37284/2790-9638>



EAST AFRICAN
NATURE &
SCIENCE
ORGANIZATION

Original Article

Effects of Climate Change on Fort Patiko Historical Site in Northern Uganda

Patrick Kabwijamu¹*, Agatha Alidri¹, Expedito Nuwategeka¹, Omara John Christopher¹ & Patrick Ochen¹

¹ Gulu University, P. O. Box 166, Gulu, Uganda.

* Author for Correspondence Email: kabwijamupatrick@gmail.com

Article DOI: <https://doi.org/10.37284/ajccrs.4.1.2613>

Date Published: **ABSTRACT**

15 January 2025

Keywords:

*Fort Patiko,
Climate Change,
Historical Sites,
Conservation,
Environmental
History.*

This study investigated the effect of climate change on Fort Patiko in Gulu District, in Northern Uganda from 1972 to 2023. Archaeological and historic sites are under threat of climate change, characterised by global warming, heavy rains and flooding, drought and extreme weather events. Fort Patiko may not be an exception. The study established that Fort Patiko's originality and physical appearance have been impacted by climate change. Due to rain and heat waves, the rock's colour and structures have changed over time. Wind, rain, and humidity agents of erosion are weakening the rock structures. There are fewer studies which have tried to explore the effect of climate change on Fort Patiko, therefore, this study will fill the gap. Qualitative and quantitative research methods were employed for this study to understand the diversity and intensity of the effect of climate change on the Fort Patiko historical site. The ethnohistorical research design was used to extract historical narratives and events pointing to the effects of climate change on Fort Patiko. Data was collected through, a review of documents and reports on climate change in the region; direct observation, and interviews with local community members to explore the nature and effects of climate change on Fort Patiko. A total of 55 participants were interviewed. Thematic analysis was used to identify key characteristics and effects of climate change on the Fort Patiko historical site.

APA CITATION

Kabwijamu, P., Alidri, A., Nuwategeka, E., Christopher, O. J. & Ochen, P. (2025). Effects of Climate Change on Fort Patiko Historical Site in Northern Uganda. *African Journal of Climate Change and Resource Sustainability*, 4(1), 12-31. <https://doi.org/10.37284/ajccrs.4.1.2613>.

CHICAGO CITATION

Kabwijamu, Patrick, Agatha Alidri, Expedito Nuwategeka, Omara John Christopher and Patrick Ochen. 2025. "Effects of Climate Change on Fort Patiko Historical Site in Northern Uganda", *African Journal of Climate Change and Resource Sustainability* 4 (1), 12-31. <https://doi.org/10.37284/ajccrs.4.1.2613>.

HARVARD CITATION

Kabwijamu, P., Alidri, A., Nuwategeka, E., Christopher, O. J. & Ochen, P. (2025) "Effects of Climate Change on Fort Patiko Historical Site in Northern Uganda", *African Journal of Climate Change and Resource Sustainability*, 4(1), pp. 12-31. Doi: [10.37284/ajccrs.4.1.2613](https://doi.org/10.37284/ajccrs.4.1.2613).

IEEE CITATION

P. Kabwijamu, A. Alidri, E. Nuwategeka, O. J. Christopher & P. Ochen "Effects of Climate Change on Fort Patiko Historical Site in Northern Uganda", *AJCCRS*, vol. 4, no. 1, pp. 12-31, Jan.

MLA CITATION

Kabwijamu, Patrick, Agatha Alidri, Expedito Nuwategeka, Omara John Christopher & Patrick Ochen. "Effects of Climate Change on Fort Patiko Historical Site in Northern Uganda". *African Journal of Climate Change and Resource Sustainability*, Vol. 4, no. 1, Jan. 2025, pp. 12-31, doi:10.37284/ajccrs.4.1.2613.

INTRODUCTION

This study investigated the effect of climate change on Fort Patiko in Gulu District, in Northern Uganda from 1972 to 2023. It adopted a historical perspective in the context of environmental history, exploring the relationship between society, human activities and the environment. Globally, historical sites face enormous effects of climate change and human activities, affecting their existence and quality. Yet, historical sites are important cultural and national heritage. Similarly, Fort Patiko has over the years exhibited degradation due to both climate change and human activities. This exposes the site to the risk of being destroyed and losing its historical significance. This study aims to assess the actual and potential effects of climate change on Fort Patiko in Northern Uganda.

Statement of Problem

Archaeological and historic sites are under threat due to climate change, especially in underdeveloped countries. The adverse impacts of climate change, such as rising temperatures, and extreme weather events, pose serious risks to the preservation and conservation of these valuable cultural heritage sites. In the American context, the Historic American Buildings Survey (HABS) did a documentation of the historic buildings that had a significant history of the Americans (Burns, 2004). The degradation progress, which depends on external agents of decay, exposure, the intrinsic properties of the material to be studied, and object construction vulnerability, is nowadays exacerbated by both anthropic factors and the impact of climate change. Due to more frequent and severe weather events, greater exposure, ageing of materials, and the existence of previous conservative interventions, the need for adapting cultural heritage to anthropic and climate change-related effects is becoming more urgent (Bertolin, 2019, p.1).

As reported, there is climate change in Northern Uganda, that has hampered the ecosystem (USGS, & USAID, 2012). Climate change has been known not to spare historical sites, around the world like Edinburgh Castle, Kilchurn Castle, in Scotland, Hagar Qim temple in Malta, Wadi Kenta in the Western Sahara and the ruins of Kaole in Tanzania, Wadlei in Uganda (Brooks et al., 2020, p.302; Sesana et al., 2021, p.3). It is therefore most likely that Fort Patiko may not be an exception. There are fewer studies which have tried to explore the effect of climate change on Fort Patiko, therefore, this study will fill the gap.

LITERATURE REVIEW

Changes in preservation conditions due to climate-related decay processes are unavoidable phenomena for both movable and immovable cultural heritage (Bertolin, 2019, p.1). Climate change has directly impacted the cultural landscapes and historic environment, having a direct effect of degrading culture. Managing the risks associated with climate change can preserve archaeological embodiments, and secure the culture and future ethics of the incoming generation (Melnick, 2015).

UNESCO's World Heritage Centre is committed to working closely with all stakeholders including the States Parties to the 1972 Convention, other international conventions and organizations, civil society and the scientific community to address the multiple challenges posed by climate change to the precious and fragile cultural and natural heritage of the world (UNESCO Report, 2007, p.4), but not much has been achieved in the protection of historical sites such as Fort Patiko.

Recent studies have indicated that there has been a general increase in land precipitation. Globally it was reported that land precipitation has increased by 2% on the eve of the 20th Century. However globally, this is not spatially and temporarily uniformly distributed (Dore, 2005). According to Mwale et al. (2004), in East Africa, precipitation

is based on regional location and seasons, topography, lakes like Lake Victoria and alteration of the inter-tropical convergency zone (ITCZ). Mwale et al. (2004, p. 1510-1523) found that East Africa experienced a repetitive decrease in the September –October –November rainfall from 1962 to 1997, leading to 12 droughts between 1965 and 1997.

Therefore, climate change affects both the socio-economic and ecosystem aspects of the globe, historical landscapes and historical sites such as Fort Patiko in Uganda. These sites may include ancient caves which may be flooded due to increased rainfall, urban monuments disfigured due to acid rains, limestone landscapes eroded, and rock paintings and other related infrastructures affected by exfoliation. In Uganda, previous studies acknowledge the role of Fort Patiko in the ethnic construction and cultural identities of the people of Acholi (Amone, 2015, pp.6-7). The Fort was perceived as a centre of marginalization, peace and reconciliation during the later days of Sir Samuel Baker, thus acting as a rescue point for the slaves, and stores for millet, sim-sim and military war in Northern Uganda. (Linden et al., n.d., p.17).

Theoretical Framework

Historical climatology and historical climate impact studies ('longue durée') are adopted in this study. The primary way that historians have engaged with climate adaptation since the 1970s is through climate impact studies. The interdisciplinary approach advanced by Lucien Febvre in the journal *Annales d'histoire économique et sociale*, which he founded in 1929 is today the pillar of the "Annales School" of history (Burke, 1990). This school developed the historical subdiscipline known as 'historical climatology' (Febvre, & Bataillon, 1922). The inception of historical climatology is traced to Fernand Braudel's concept of historical time, divided into *longue durée* (geographical and environmental change), *moyenne durée* (economic cycles and social movements) and *histoire événementielle* (the fast-paced time of political history) (Braudel, 1987). The idea was to

look at historical processes over the long term (i.e. several centuries) as a precondition to studying climate and climatic changes historically. The second phase was a quantitative approach to history, also called "the quantitative revolution". It is the collection of masses of historical data, for example, information on grain prices, birth-, death- and marriage dates, or, in the case of climate history, grape harvest dates, which could be transformed into statistics (Burke, 1990).

The pioneer of historical climatology, Emmanuel Le Roy Ladurie, third generation *Annales* historian, devised a reading of history 'without human beings' (Le Roy Ladurie, 1967; Adamson, et al., 2017), whereby written sources were used to create a history of the climate with humans viewed only as observers. He concluded that "in the long term the human consequences of climate seem to be slight, perhaps negligible, and certainly difficult to detect" which influenced the field of historical climatology for several decades (Adamson, et al., 2017). However, with time this theory remains to be challenged. British climatologists, Gordon Manley and Hubert Lamb, who wrote climate histories came with a divergent opinion to Ladurie that appreciated the influence of climate on human cultures (Lamb, 1990; 1995; Manley, 1972), but remained critical of the generalizations and lack of evidence displayed in previous deterministic writings. Lamb's work was built upon by climate researchers leading to the development of historical climatology into a discipline that addressed 'climate reconstruction; the identification and measurement of impact; adaptation and perception' (Wigley et al., 1985). This has been adapted in this study to explore the effect of climate change on cultural and historical sites in the 21st century.

Conceptualizing Climate Change

Climate change refers to global and regional changes in the severity of weather aspects over time such as temperature, humidity, rainfall, cloudiness and wind patterns (Mahdjoubi et al., 2017, p.12; Schaller, 1900; Treut et al., 2007, p.103); predicting and detecting weather changes over a specific period gives us a picture of climate

change. Nsubuga, & Rautenbach (2018, p.759); and Fawzy et al. (2020, p.2071) define Climate change as a systematic alteration of the atmosphere over decades or much longer time scales; this can be an alteration of a region's rainfall per annum, a fluctuation in city temperatures for a specific period, this can also be generalized on a global scale (Mahdjoubi et al., 2017). The study defined climate change as an alteration of weather systems in a place over 30 years.

The balance of climate is achieved when the sun's rays are reflected into the atmosphere by ice and clouds, any inconvenience in the atmosphere brings about an imbalance responsible for climate change. Some of the sun's rays are absorbed by the atmosphere and the rest by the earth's surface. The Green House Gases (GHGs) in the atmosphere are responsible for re-emitting the temperatures in all directions to keep a balance. An increase of the GHGs in the atmosphere beyond normal scale makes it warmer thus altering the climate (Treat et al., 2007, p.103-105). Anthropogenic factors like changes in land use also alter climate, and the affluent into the atmosphere that absorbs different high energy levels (Wolf et al., 2021, p.7).

The major aspects that climate scientists look at to measure climate change are the elements of climate that affect archaeological sites such as wind, which is the horizontal fluctuation of the atmosphere or the movement of air masses from a region of higher pressure to a lower pressure; solar radiation and temperature, which is the energy generated from the sun, this determines air temperature that brings about heating of the earth surface. Humidity is defined as the amount of water available in the atmosphere at a particular time and space, this causes the hotness of the day and entirely affects the ecosystem and precipitation, which is the water that falls on the earth's surface in the form of hail, snow sleet, drizzle, fog, mist and rain (Balasubramanian, 2017, p.14). All of the above depends on pollution, a negative outcome that alters our environment affecting ecological processes. Pollution is a process that induces harmful substances or energy

in excess concentrations that alter ecological processes (Bhargava, 2016).

Historical sites harbor the culture of a specific group of people they are found in (Azaryahu, & Foote, 2008, p.179), and they are associated with a past event, person, or activity, where the location itself holds historical, cultural, or archaeological importance (O'Donnell, & Patricia, 1999). Historical sites can take various forms, such as ancient ruins, castles, palaces, temples, archaeological sites, museums, and memorials (Benedikter, 2004, p.369). Each site has its unique story, shedding light on different periods of history and the civilizations that once thrived there (Li, 2018, p.86). Historical sites among other places and events contribute both to the Gross Domestic Product (GDP) of the country and the preservation of people's culture (Alexandrakis et al., 2019, p.279-283; Cassar, 2005, p.20).

RESEARCH METHODOLOGY

Qualitative and quantitative research methods were employed for this study to understand the diversity and intensity of the effect of climate change on the Fort Patiko historical site. The historical research design was used to extract historical narratives and events pointing to the effects of climate change on Fort Patiko. Data was collected through, a review of documents and reports on climate change in the region; direct observation, and interviews with local community members, elders, and the Fort caretakers were done to explore the nature and effects of climate change on Fort Patiko. Ethnography was used when the researcher spent two months at Fort Patiko studying the community and how they interacted with the environment within and around them. A total of 55 participants were interviewed. Thematic analysis was used to identify key characteristics and effects of climate change on the Fort Patiko historical site.

The study was conducted in the villages of Kal, Omoti, Patalira and Anyadwee, in Gulu District, Northern Uganda, because of their location near Fort Patiko. Fort Patiko is culturally, economically, and historically an important heritage and tourism site in Gulu District.

FINDINGS AND DISCUSSION

This section presents findings and a discussion on the effect of climate change on Fort Patiko. The analysis is based on the responses from the participants and observation of some of the points of reference made by the study participants. It should be noted that respondents confirmed the negative effects of climate change on the Fort evidenced by changes in the physical structure and the cultural narratives on Fort Patiko.

The Effect of Climate Change on Fort Patiko

The findings indicated the following effects of climate change on Fort Patiko:

The Widening of the Trenches

It was noted that the structure of the trench constructed by the Arabs to prevent the escape of slaves had been denatured by running water resulting from the heavy downpour of rain and surface water runoff from the hilltop. Sections of the trenches were widened, deepened and shallow as they were filled with soil deposits. According to the measurements and observations made during the survey, the space between the trench had changed significantly from 10 to 22 feet wide, compared to the measurements in the archival records. The depth of the trenches was observed to be shallow due to the piles of sand and soil deposits in the trenches. Measurements taken from one part of the trench show a decrease in width from 10 to 8 feet in some sections and 7 feet in others. This indicates that the rocks have been worn off or shifted position.

It was noted that the area to the left of the "Gate of no Return" measured 12 feet because running

water passes through the illegal access route from Ajulu Hill to the centre. Therefore, it is anticipated that this will become more profound as the rains increasingly wash away the trench bed. However, the structure of the trenches at the Fort is irregular. This discloses that the illegal pathways from Ajulu Hill allow water to flow directly into the trench, exacerbating erosion and altering the trench's dimensions. Moreover, the natural topography of the area, combined with irregular trench structures, makes the site more susceptible to erosion, particularly during heavy rains.

The researcher observed that continuous erosion could undermine the foundation of the "Gate of No Return" and other structures within the Fort, leading to potential collapse or significant structural damage. This causes the historical features and artefacts around the Fort to be eroded or buried by sediments, hence the loss of valuable cultural heritage.

The visual impact of erosion detracts from the historical ambience of the site, making it less attractive to tourists and researchers. According to studies, humidity is a crucial factor in the degradation of rocks, particularly limestone, which crumbles when its humidity levels rise and mix with rainwater that contains a weak carbonic acid that breaks down the rocks (Angin et al., 2019; Leuta, 2009; Rushin, 1973; Webb et al., 2003). This does not exclude a structure like the trench around the Fort. Variations in humidity and rainfall also cause changes in vegetation zones, which may impact archaeological sites due to the roots' effect on the rocks as seen in the photo below.

Field Photograph 1: A Widened and Shallow Trench in the Sides



Source: *Field photograph by the researcher*

Effects on the Rocks

From observations of the rocks, climate change effects were visible at Fort Patiko. A total of 5 (1%) study respondents submitted that high temperatures and heavy rains affected the colour and texture of the rock. Temperature measurements were taken, and results showed that the rock temperature was at 38 degrees, with wind speed at 10km/h. The colour of the rock changed from white and shiny to dark, reddish brown due to high temperature and heat. This was attributed to the long dry seasons and droughts that had become frequent in recent years (Interview with Fort Patiko caretaker). It is predicted that the rock may turn dark brown. The prolonged exposure to higher temperatures causes physical and chemical changes in rocks. The heat can lead to oxidation processes that alter the mineral composition and colour of the rock. Changes in environmental conditions, such as increased humidity and temperature, can promote microbial growth on the rock surface. Certain microorganisms produce pigments that contribute to colour change.

The change from a white and shiny appearance to a dark reddish-brown significantly alters the visual appeal of the Fort. This detracts from the site's historical authenticity and attractiveness to visitors and alteration of the cultural narrative and heritage associated with Fort Patiko. Changes in the rock's colour and composition can make it more susceptible to erosion and weathering, accelerating the deterioration of the rock and the overall structure. Continuous exposure to adverse climatic conditions can compromise the structural integrity of the rock, posing risks to the stability of the Fort. The observation that the rock at Fort Patiko has changed colour from white and shiny to dark reddish-brown due to excessive heat underscores the impact of climate change on cultural heritage sites. This discolouration not only affects the visual and historical appeal of the site but also serves as an indicator of broader environmental changes.

Furthermore, 20 (40%) respondents acknowledged the effect of climate change on the rocks and noted that the rocks were also breaking

into boulders due to high temperatures. The observations revealed that some of the broken pieces were from bigger rocks, and this may continue to break evidenced by the cracks and many lines of weaknesses on the rocks¹. The study deduces that rocks expand when heated and contract when cooled. Repeated cycles of expansion and contraction, driven by daily and seasonal temperature fluctuations, can create stress within the rock. This stress can exploit existing lines of weakness, leading to fractures and eventual breakage. High temperatures can accelerate weathering processes, particularly in rocks with existing vulnerabilities. The fragmentation of larger rocks and boulders into smaller pieces can destabilize the rock formations, posing risks to the fort's structural stability. This can lead to collapses or significant damage to historical features, continued breaking of rocks weakens the foundation of the fort and its

surrounding structures, compromising their long-term preservation thus visually diminishing Fort Patiko as the once solid and imposing rock formations break. This degradation can impact the site's attractiveness to tourists and researchers.

Furthermore, the physical alteration of the rock formations affects the cultural and historical narrative associated with Fort Patiko. The site's authenticity and historical context may be compromised. This finding agrees with the argument that a slight distinction in temperature alters porous building stones (Grossi et al., 2007). Angin et al. (2019) and Leuta (2009), claim that temperature changes have a major impact on the stones, causing weathering and the breakdown of the rocks into small particles. Therefore, these factors, along with atmospheric effects and living things, are responsible for the destruction of limestone and sandstone.

Field Photograph 2: Darkened Rocks Due to Exposure to the Sun's Heat



Source: *Field photograph by the researcher*

¹ Mr. Ronald, the caretaker of Fort Patiko, highlighted two significant issues affecting the stone lining at the execution centre. Firstly, the lining of the rock separating the execution center is gradually collapsing due to expansion and contraction caused by environmental factors. Secondly, the rock arrangement was disrupted by the actions of the Lord's Resistance Army (LRA) soldiers. Additionally, community members have been removing stones from the site for quarrying purposes. Stones used in construction expand and

contract in response to temperature fluctuations and quarrying disturbances. Over time, this movement can weaken the mortar holding them together, leading to structural instability and eventual collapse. Exposure to rain, wind, and other weather conditions gradually erodes the mortar and weakens the bond between stones.

Field Photograph 3: Lines of Weaknesses on the Rock



Source: Field photograph by the researcher

Effect on Agriculture

While examining the effect of climate change on agriculture, 48 (96%) of the respondents argued that climate change has greatly influenced agricultural activities around the Fort. While the surrounding communities suffer the effect of long drought which affects agriculture, the area around the historical site is characterised by high soil water retention capacity and vegetative cover. Due to the fertile soils and high soil water content around the Fort, the community has encroached on the land for agricultural purposes, especially in the dry season. However, climate change has also greatly affected agriculture around this area as the yields from the harvest are poor. We can therefore extrapolate that climate change has altered traditional rainfall patterns, leading to increased occurrences of droughts, heavy rains (El-Nino) and floods. Erratic rainfall adversely affects crop growth and water availability for agriculture, posing challenges to food security. Changes in precipitation patterns result in water stress for crops, particularly during critical growth stages. Insufficient water availability limits crop yields and agricultural sustainability.

Effect on the Vegetation and Ecosystem

The vegetation is also gradually vanishing, with some parts turning brown and drying up. As observed in excessive sunlight and seasonal changes, trees that once served as hiding places for animals like elephants are no longer there, endangering animal habitats. An example is the tortoise stream or the water shade on top of the rock. The water level in this stream has remarkably reduced. The findings reveal that higher temperatures associated with climate change accelerate evapotranspiration, leading to the drying and browning of vegetation. Prolonged exposure to excessive sunlight further stresses plants, affecting their health and survival. Erratic rainfall patterns and altered seasons disrupt the natural growth cycles of vegetation. Inadequate water availability during critical periods exacerbates vegetation stress and contributes to drying. This results in declining tree cover habitat connectivity for wildlife species, limiting their movement and access to essential resources such as food and shelter. Trees that once provided shelter and food sources for animals like elephants have disappeared, endangering local biodiversity and ecosystem resilience.

A total of 6% of the respondents observed that there was a possibility the tortoise stream would dry out at one point due to extreme climate effects. Similarly, 28 (56%) respondents acknowledged an increase in atmospheric temperature impacting livelihood. Lobell and Field (2007) argue that the world's food and nutritional security are at risk due to climate change. The greenhouse effect causes the temperature to rise. The average global temperature is expected to increase by 2 °C by 2100, causing significant global economic losses (Lobell and Field, 2007). The average global temperature is rising steadily because of increased photosynthesis, and the concentration of CO₂ a greenhouse gas in large portions. This increase in CO₂ is causing the Earth's atmosphere to retain

more heat, which leads to the rising temperature. This is known as the greenhouse effect, a major contributor to global warming with consequences, including rising sea levels, melting glaciers, and extreme weather events. It is essential to take action to reduce emissions and combat the effects of global warming. However, this increase in temperature counteracts the benefits of increased photosynthesis by increasing crop respiration rate and evapotranspiration, increasing pest infestation, changing the flora of weeds, and shortening crop duration, leading to a decrease in crop yields and harm to food security. The effects of climate change on agriculture can also harm biodiversity.

Field Photograph 4: Tortoise Stream Drying off



Source: Field photograph by the researcher

Field Photograph 5: Photo of a Garden Encroached on the Fort Premises



Source: *Field photograph by the researcher*

A respondent mentioned the effect of climate change on the 'Gate of no Return' which according to the measurements, stands six (6) feet on the left side and four (4) feet on the right side. Mr Ronald the historical site caretaker attributed the heights to the rain that penetrates the weak rocks joined together with soil and cement on the outside coverings that weakens the rock and the mud soil thus leading to the breaking of the rock to attain irregular heights. The researcher observed that the rock crumbles down due to increased temperatures in the day which leads to expansion and reduction in temperatures at night leads to contraction thus breaking the rock into smaller particles and gradually leading to the breaking of the joined rock structures in a process called exfoliation. The 'Gate of no return' is most likely to crumble wholly if no action is taken because the left outside part has already developed cracks on the rocks, and plants are growing with the structure.

The 'Gate of No Return' at Fort Patiko, according to Mr Ronald and the researcher, is experiencing significant structural changes due to climatic factors. The irregularity in height is primarily

attributed to rainfall, temperature fluctuations, and biological growth that weaken the rocks and soil cement covering the structure. The study further deduces that rainwater penetrates through weak points in the rock and the outer soil-cement layer covering the gate. Over time, this permeation weakens the bond between rocks and soil cement, leading to instability and potential collapse. Continuous exposure to rainwater causes erosion and weathering of the rock, particularly where the structure is inadequately protected or where cracks and fissures develop.

Diurnal temperature fluctuations, with high daytime temperatures and cooler nights, induce expansion and contraction of the rocks. This phenomenon, known as exfoliation, weakens the structural compactness of the gate over time. The cyclic stress caused by daily temperature changes exacerbates the fracturing and crumbling of the rock structure, contributing to its gradual deterioration. More so, vegetation such as plants growing within cracks and crevices of the gate's structure further accelerates its degradation. Plant roots can penetrate the rocks, widening existing cracks and weakening the structure. As plants

grow, their roots exert pressure on the surrounding rocks and cement, exacerbating the structural weaknesses and contributing to the breakdown of the gate.

Visible cracks on the rocks and uneven height indicate ongoing structural instability. If left unaddressed, these cracks may propagate, leading to partial or complete collapse of the gate. The gate is particularly vulnerable to further fragmentation due to the combined effects of rainfall, temperature variations, and biological growth.

Without intervention, the integrity and historical significance of the gate could be lost. It is important to ascertain that the 'Gate of No Return' holds significant historical and cultural symbolism, representing a poignant aspect of Fort Patiko's history. Its deterioration impacts the physical structure and diminishes its symbolic value and educational potential for visitors and future generations. Conservation of such historical structures is crucial for maintaining cultural heritage and promoting tourism, contributing to the local economy and community identity.

Filed Photograph 6: The 'Gate of No Return' Devasted Due to Rain and Temperature Fluctuations

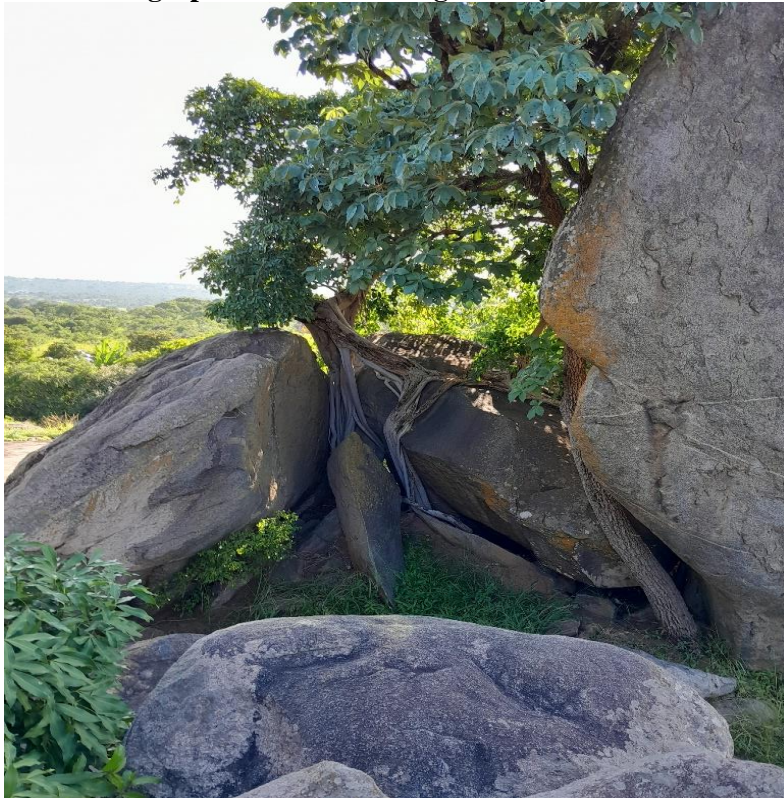


Source: *Field photograph by the researcher*

A rock near Baker's lip has already crumbled and it is attributed to temperature fluctuations. Next to the lip is a watch tower that has already shown signs of weakness and will probably split at any time due to temperature fluctuations and the root effect, which is demonstrated by the growing trees in the watch tower's rock patterns at the base; the same watch tower has darker areas that are exposed to heat and sunlight more than the hidden areas, which still have signs of brightness and lustre. Additionally, it was noted that the exquisitely intertwined rock piles have tree plants

growing among them due to rainwater that encourages germination. These trees put pressure on the rocks through their root system, causing the intertwined rocks to break away. Additionally, the rocks are most likely to fall apart following another phase of climate change. Therefore, it is worth noting that the effect of climatic factors, such as high temperature, heavy rainfall and strong winds, attributed to the crumbling of the "Gate of no Return can be preempted on climate change and human activities to some extent.

Field Photograph 7: Rocks Disintegrated by Root Pressure



Source: Field photograph by the researcher

Field Photograph 8: Plants Growing in the Joined Rocks



Source: Field photograph by the researcher

Observations made on top of the rock revealed the effect of climate change on the armoury, millet and the simsim store in that, they have shown evidence of crumbling down. On all three structures, there are cracks observed developing on the wall both internally and outside. This has been attributed to the rainwater that enters the joined rock walls with mud plastered with cement and sand; these three structures were grass thatched offering fresh air to the Arab soldiers and Sir Samuel Bakers soldiers, this no longer exists as it was given in to rainfall that penetrated the grass thus rotting leaving the three structures open. The square building further has shown evidence of growing tree plants with the roots protruding through the wall leaving behind cracks on the walls, it is also projected that the roots will eventually dissect the rocks leading to the crumbling of the rocks and the entire building. Water collects on the floor of the stores which will eventually weaken the wall thus breaking away. Furthermore, apart from the pit latrine built by Amin's government crumbling down, the reception centre has also shown signs of breaking down on the verandas that have been eaten up by running water. The research findings highlight

significant structural deterioration at Fort Patiko, exacerbated by water damage and environmental factors. Specifically, water infiltration and erosion are weakening the walls of storage facilities and other structures like the reception centre, posing risks of collapse and further degradation. Water collects on the floors of the storage rooms, potentially leading to moisture infiltration into the walls. Over time, this moisture weakens the structural set-up of the walls, causing them to deteriorate and potentially collapse. Persistent moisture within the walls promotes mould growth and deterioration of building materials and compromises the structural stability of the facilities.

The reception centre verandas have shown signs of erosion caused by running water. This erosion exposes underlying materials to moisture, accelerating deterioration and compromising the structural stability of the verandas. Continuous erosion weakens the foundation of the reception centre, posing risks of structural failure and necessitating immediate intervention to prevent further damage.

Field Photograph 9: A Pit Latrine Deteriorating.



Source: *Field photograph by the researcher*

Field Photograph 9: The Armoury Store Affected by Root Pressure



Source: Field photograph by the researcher

Field Photograph 10: The millet Store Devasted



Source: Field photograph by the researcher

The evidence of claimed spilled blood stains and the axe-marks left behind as a result of chopping off slaves' heads are gradually disappearing as running water washes it away daily as well as the sun that darkens and exfoliates the rocks. Fort Patiko holds significant historical value, particularly as a site associated with the tragic history of the slave trade. Evidence of this dark past, such as blood stains and axe marks from the beheading of slaves is crucial for understanding and preserving the site's historical narrative. However, this study highlights that these physical remnants are gradually disappearing due to environmental factors, which threaten the preservation of this tangible heritage. The study attributes this to exposure to running water which erodes the surfaces of the rocks where blood stains and axe marks are present. Over time, the continuous flow of water washes away these historical marks, reducing their visibility and eventually causing them to disappear entirely. The mechanical action of water, especially during heavy rains, can wear down the rock surface, smoothing out the indentations and removing traces of stains and marks. Furthermore, prolonged exposure to sunlight causes the rock surfaces to darken over time. This natural weathering process can obscure the visibility of blood stains and axe marks, making them harder to discern. Lastly, Temperature variations between day and night cause the rocks to expand and contract, a process known as exfoliation. This results in the peeling away of the outer layers of rock, which can gradually erase the surface evidence of historical events. The blood stains and axe marks serve as powerful physical reminders of the brutal history of slavery associated with Fort Patiko. Their disappearance diminishes the site's ability to convey its historical significance and the emotional impact of its past. These physical pieces of evidence are crucial for educating visitors about the history of the slave trade. Their loss would weaken the narrative and reduce the site's effectiveness as an educational resource.

Additionally, Baker's cross and the moon inscribed by Baker and Arabs respectively are

disappearing due to the high temperature that darkens and tears off the rocks.

From this observation, the study deduces that Fort Patiko is a site of immense historical significance, with various inscriptions and markings that tell the stories of its past. Among these are Baker's Cross and the moon inscription made by Samuel Baker and the Arabs, respectively. These markings are historical artefacts and cultural symbols that provide insights into the activities and presence of different groups at the Fort. However, the study findings indicate that these inscriptions are gradually disappearing due to environmental factors, particularly the effects of sun exposure. The darkening can obscure the visibility of the inscriptions, making them less discernible. The intense ultraviolet rays and sun heat accelerate the weathering process of the rocks, causing their deterioration. The daily heating and cooling cause the rocks to expand during the day and contract at night. This thermal stress leads to the formation of cracks and fissures in the rock surface, a process known as exfoliation. Over time, this can cause the outer layers of the rock to peel away, erasing the inscriptions. Their disappearance represents a loss of tangible cultural heritage that connects the present to the past. These inscriptions are important educational tools for visitors and researchers. They help convey the historical narratives associated with the site and illustrate the presence and influence of different historical figures and groups.

Near the cooking place is a tree called *Lucooro* which broke due to strong winds blowing across the Fort, breaking the branches. The wind breaks the trees, and the shaking of the trees weakens the rocks which eventually break down. Lightning and thunder also weaken the rocks. As a result of cutting down trees which would have acted as windbreakers, the rocks and soils are exposed to the wind as an agent of erosion.

This finding reveals that Fort Patiko faces multiple environmental challenges threatening its structural originality and historical value. The study findings highlight the adverse effects of strong winds, lightning, and tree loss on the Fort's ecosystem and

infrastructure. Specifically, the falling of the *Lucooro* tree, and the impact of winds, and lightning have contributed to the weakening of rocks and soil erosion, which pose significant risks to the site's preservation. To deduce this more, the findings point out that strong winds have the power to break trees and their branches. This physical damage is not limited to vegetation; the shaking and movement caused by strong winds can also impact nearby rocks, leading to their eventual weakening and breakdown. Trees serve as natural windbreakers, protecting the soil and rocks from the direct impact of strong winds. Cutting down trees reduces protective barriers, leaving rocks and soil exposed to wind erosion. The absence of trees exacerbates the vulnerability of rocks to environmental stressors. Lightning strikes can cause immediate and severe damage to rocks creating fractures and fissures. Repeated exposure to lightning can progressively weaken rock structures, making them more susceptible to breaking down under environmental stress. The

damage from lightning can also accelerate the process of erosion. Cracks and weakened surfaces created by lightning are more easily worn away by wind and water, leading to a faster rate of deterioration.

The combination of strong winds and the lack of vegetative cover significantly increases soil and rock erosion. Wind acts as a powerful erosion agent, especially in exposed areas, gradually wearing away at the rocks and soil. Exposure to environmental elements, particularly wind and sunlight, alters the physical and chemical properties of the rock. This exposure creates a negative feedback loop where increased erosion leads to more rapid degradation of the site's features. Without intervention, the ongoing environmental impacts can lead to irreversible damage. The combination of wind, lightning, and erosion poses long-term risks to the conservation of Fort Patiko.

Field Photograph 11: Bakers Cross on the Rock



Source: *Field photograph by the researcher*

Field Photograph 12: The Execution Slab with the Axe Marks and Possible Dried Blood Stains



Source: *Field photograph by the researcher*

Therefore, human activities such as games and sports, bush burning, and agriculture have played a crucial role in creating avenues for the effect of climate change on Fort Patiko as discussed in the Anthropogenic Global Warming (AGW). Besides, the role of climate change through its extreme weather elements such as high temperatures, humidity, increased precipitation, wind and sunshine has critically changed the physical outlook of Fort Patiko as intricately displayed by the Human Forces (Cassar, 2009).

CONCLUSION

Fort Patiko's originality and physical appearance have been impacted by climate change. The Gate of No Return, Apim Rock, the watch tower, the millet, simsim, and armoury store, and the model

granaries collapsing due to rain and heat waves, have all had their rock colour and structures changed by temperature and sunlight. Wind, rain, and humidity are agents of erosion, weakening the joined rocks of the store structures, which then crumble down to form soil, a factor responsible for vegetation growth, leaving the rock exposed to the root effect of the trees, and causing them to disintegrate. Furthermore, the shifting weather patterns and rich soils have drawn agricultural activity, which has resulted in an encroachment on the Fort Patiko Gazzated territory.

Recommendations

The study findings pointed out that there is encroachment of the Fort by the community members. There should be a strengthening of the

legal frameworks guiding the Fort by employing security persons to enforce the rules and regulations.

Climate change has presented itself as a challenge towards destroying and crumbling down historical sites in Uganda. There should be policy briefs aimed at conducting an assessment of vulnerabilities, collaborative partnerships, funding and resources to protect Fort Patiko from the effects of climate change.

There should be a timely impact assessment of climate change and forecasting changes that may, directly and indirectly, affect Fort Patiko.

There should be mobilisation and lobbying for financial resources and the required expertise through writing projects and proposals to improve the infrastructure of Fort Patiko to adapt to the effects of climate change, however, this should be done without changing the originality of the place.

Community engagement and participation should be looked at by incorporating indigenous knowledge systems and environmental justice frameworks drawn with support from the community. This agrees with Bradbury (2008) who encourages collaborative inquiry, where researchers and community members work together to identify issues, develop interventions, and enact change. By empowering communities to co-create knowledge and solutions.

There should be an improvement in technology through introducing remote sensing useful for detecting, understanding and monitoring the effects of climate change.

The study findings stipulate the fact that lack of awareness has contributed to the neglect of historical sites. Therefore, community awareness and sensitization through organising market days and cultural days where the community is taught about the importance of historical sites to the Acholi community and Uganda at large; through this awareness, the community would be subjected to solicit adaptation strategies pinned to indigenous approaches and systems of preservation and protection.

Acknowledgement

This publication was sponsored by the Carnegie-Makerere University Consolidating Early Career Academic Programme (CECAP), 2022 to 2024.

Conflict of Interest

The authors declare that there is no conflict of interest.

REFERENCES

- Adamson, G.C.D, Hannaford, M. J., & Rohland, E. J. (2017). Re-thinking the present: The role of a historical focus in climate change adaptation research In *Global Environmental Change*. <https://doi.org/10.1016/j.gloenvcha.2017.12.003>
- Alexandrakis, G., Manasakis, C., & Kampanis, N. A. (2019). Economic and societal impacts on cultural heritage sites, resulting from natural effects and climate change. *Heritage*, 2(1), 279– 305. <https://doi.org/10.3390/heritage2010019>
- Amone, C. (2015). Constructivism, instrumentalism and the rise of Acholi ethnic identity in northern Uganda. *African Identities*, 13(2), 129– 143. <https://doi.org/10.1080/14725843.2015.1023255>
- Angın, M., Çubukçuoğlu, B., & Gökçekuş, H. (2019). Case studies on the impacts of climate change on historical buildings in Northern Cyprus. *International Journal of Built Environment and Sustainability*, 7(1), 57–65. <https://doi.org/10.11113/ijbes.v7.n1.432>
- Azaryahu, M., & Foote, K. E. (2008). Historical space as narrative medium: On the configuration of spatial narratives of time at historical sites. *GeoJournal*, 73(3), 179–194. <https://doi.org/10.1007/s10708-008-9202-4>
- Balasubramanian, A. (2017). Digital Elevation Model (Dem) In Gis by Prof. A. Balasubramanian Centre for Advanced Studies in Earth Science, University of Mysore, Mysore. *ResearchGate*, September. <https://doi.org/10.13140/RG.2.2.30133.58085>

- Benedikter, R. (2004). Privatisation of Italian cultural heritage. *International Journal of Heritage Studies*, 10(4), 369–389. <https://doi.org/10.1080/1352725042000257393>
- Bertolin, C. (2019). Adapting cultural heritage to climate change-related effects. *Geosciences*, 9(6), 1–15. <https://doi.org/10.3390/geosciences9060250>
- Bhargava, R. (2016). *Environmental pollution: Sources, causes, effect and effect and control control*.
- Braudel, F., 1987. Histoire et sciences sociales. La longue durée. *Réseaux* 5, 7–37.
- Brooks, N., Clarke, J., Ngaruiya, G. W., & Wangui, E. E. (2020). African heritage in a changing climate. *Azania*, 297–328. <https://doi.org/10.1080/0067270X.2020.1792177>
- Burke, P., (1990). *The French Historical Revolution: The Annales School, 1929-89*. Stanford University Press.
- Burns, J. A. (2004). *Recording historic structures*. John Wiley & Sons.
- Cassar, M. (2005). *Climate Change and the Historic*. Centre for Sustainable Heritage, University College London.
- Dore, M. H. I. (2005). Climate change and changes in global precipitation patterns: What do we know? *Environment International*, 31(8), 1167–1181. <https://doi.org/10.1016/j.envint.2005.03.004>
- Fawzy, S., Osman, A. I., Doran, J., & Rooney, D. W. (2020). Strategies for mitigation of climate change: a review Intergovernmental Panel on Climate Change. *Environmental Chemistry Letters*, 18(6), 2069–2094. <https://doi.org/10.1007/s10311-020-01059-w>
- Febvre, L., & Bataillon, L. (1922). *Earth and human evolution: A geographical introduction to history* (Vol. 4). Renaissance du Livre.
- Grossi, C. M., Brimblecombe, P., & Harris, I. (2007). Predicting long term freeze-thaw risks on Europe built heritage and archaeological sites in a changing climate. *Science of the Total Environment*, 377(2–3), 273–281. <https://doi.org/10.1016/j.scitotenv.2007.02.014>
- Hamilton, C. (2012). *Australian Journal of Political Science Theories of Climate Change Review Essay Theories of Climate Change. September 2013*, 37–41. <https://doi.org/10.1080/10361146.2012.732213>
- Lamb, H.H., (1990). *Climate: Past, Present and Future*, 1 ed. Routledge, London.
- Lamb, H.H., (1995). *Climate, History and the Modern World*, 2 ed. Routledge, London; New York.
- Le Roy Ladurie, E., (1967). *Histoire du climat depuis l'an mil*, Nouvelle bibliothèque scientifique. Flammarion Paris.
- Leuta, Tšepang. (July 2009). Evaluating The Rate Of Rock Art Deterioration In The Ukhahlamba, Drakensberg Park, Kwazulu Natal presented at University of Pretoria
- Li, Y. (2018). *Characteristics and protection experience of historical buildings in Macao*. 193(Ssme), 84–88. <https://doi.org/10.2991/ssme-18.2018.15>
- van der Linden, J., Rodrigues-Vasse, A., Kopp, M., Dier, F., & Abraham, B. (2020). *Youth, education and work in (post-) conflict areas*. Globalisation Studies Groningen.
- Mahdjoubi, L., Hawas, S., Fitton, R., Dewidar, K., Nagy, G., & ... (2017). *A guide for monitoring the effects of climate change on heritage building materials and elements*. <https://uwe-repository.worktribe.com/output/882571>
- Manley, G., 1972. *Climate and the British Scene*, 5th impression ed. HarperCollins Distribution services
- Melnick, R. Z. (2015). Climate change and landscape preservation. *Change Over Time*,

- 5(2), 174– 179. <https://doi.org/10.1353/cot.2015.0013>
- Mwale, D., Gan, T. Y., & Shen, S. S. P. (2004). A new analysis of variability and predictability of seasonal rainfall of central southern Africa for 1950-94. *International Journal of Climatology*, 24(12), 1509–1530. <https://doi.org/10.1002/joc.1062>
- Nsubuga, F. W., & Rautenbach, H. (2018). Climate change and variability: a review of what is known and ought to be known for Uganda. *International Journal of Climate Change Strategies and Management*, 10(5), 752–771. <https://doi.org/10.1108/IJCCSM-04-2017-0090>
- O'Donnell, & Patricia, M. (1999). *General Guidelines for Identifying and Evaluating Historic Landscapes*. February, 27. <http://www.caltrans.ca.gov/ser/downloads/cultural/language.pdf>
- Rushin, C. J. (1973). Interpretive and paleontologic values of Natural Trap Cave Bighorn Mountains Wyoming (Doctoral dissertation). Retrieved from <https://scholarworks.umt.edu/etd/4673>
- Schaller. (1900). *Introduction to Climate Change - citizens' assembly briefing, around 1.5k words*. 1, 0–3.
- Sesana, E., Gagnon, A. S., Ciantelli, C., Cassar, J. A., & Hughes, J. J. (2021). Climate change impacts on cultural heritage: A literature review. *Wiley Interdisciplinary Reviews: Climate Change*, 12(4), 1–29. <https://doi.org/10.1002/wcc.710>
- Treut, L., Somerville, R., Cubasch, U., Ding, Y., Mauritzen, C., Mokssit, a, Peterson, T., Prather, M., Qin, D., Manning, M., Chen, Z., Marquis, M., Averyt, K. B., & Tignor, M. (2007). Historical Overview of Climate Change Science. *Earth, Chapter 1*(October), 93– 127. <https://doi.org/10.1016/j.soilbio.2010.04.001>
- UNESCO World Heritage Report (2007). Climate Change and World Heritage Report on predicting and managing the impacts of climate change on World Heritage and Strategy to assist States Parties to implement appropriate management response. Publication based on Document WHC-06/30.COM/7.1 presented to the World Heritage Committee at its 30th session, Vilnius, Lithuania, 8-16 July 2006
- USGS, & USAID. (2012). A Climate Trend Analysis of Ethiopia. *Famine Early Warning Systems Network—Informing Climate Change Adaptation Series*, October, 1–4. <http://pubs.usgs.gov/fs/2012/3123/>
- Webb, J., Grimes, K., & Osborne, A. (2003). Black holes: Caves in the Australian landscape. *Karstologia Mémoires*, 14(3), 1–52.
- Wigley, T.M.L., Ingram, M.J., Farmer, G. (Eds.), 1985. *Climate and History: Studies in Past Climates and Their Impact on Man*. Cambridge University Press (Revised ed. edition. ed.).
- Wolf, E., Inez, F., Brian, H., & F.B., M. J. (2021). Climate change and global warming: Impacts on crop production. *Genetically Modified Plants*, 283– 296. <https://doi.org/10.1016/b978-0-12-818564-3.09991-1>
- Cassar, M. (2009). *Climate change and the historic environment*. University College London.