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CULTURAL HERITAGE CONSERVATION USING GIS MAPPING: STUDY OF ANCIENT BAUCHI CITY GATES

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Abstract

Cultural heritage conservation plays a vital role in safeguarding a society's identity, history, and legacy, with ancient structures like city gates serving as tangible reflections of past traditions, architectural ingenuity, and socio-political organization. In Bauchi, Nigeria, the ancient city gates constitute an essential element of regional heritage, yet they confront escalating threats from urbanization, environmental degradation, and neglect. Despite geo-information systems (GIS) proving effective in heritage management globally, their application to Bauchi's city gates has remained unexplored. This study therefore employs GIS mapping to document the gates' photographs and precise locations, creating both an educational map and a tourist guide complete with a photo gallery. Adopting a qualitative survey design, the research utilized purposive sampling to interview local custodians of culture and heritage, gathering historical data and firsthand insights. The findings indicate that gates located within the city center are particularly vulnerable to hazards including urban expansion and man-made damage. Notably, many stakeholders despite being aware of protective policies continue activities that risk gate demolition in favor of modern construction. GIS buffer analysis revealed that the western and southern gates lie within 500-meter buffers, and there's rapidly phasing increase in threat from peri-urban encroachment on areas that previously have not been exposed to these threats. Three gates Kofar Tirwun, Kofar Dumi, and Kofar Inkil have already been completely destroyed, while six others remain in a "fair" to moderate state of conservation. To address these challenges, the study recommends that Bauchi State integrate heritage preservation into urban master plans, establish protective buffer zones (especially within 250 meters of high-density areas), and promote heritage-led urban planning to ensure the long-term survival of these culturally significant landmarks.

Keywords:

Heritage, Conservation, GIS Mapping, Urban encroachment, Protective buffers zones, and City Gates ("kofa").

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INTRODUCTION

Sustainable urban development is greatly dependent on culture because it plays a major role in maintaining the cultural heritage, encouraging activities, receiving visitors, and improving quality of life. United Nations Educational, Scientific and Cultural Organization (UNESCO, 2015). The symbolic meaning of the conserved historical artifacts is universal knowledge and the historic built environment conveys values to the sensory experience of any five fundamental qualities of quality communities: response Preservation of cultural heritage is a key factor in the maintenance of cultural identity, historical discourse and heritage of nations. Ancient structures, particularly ex-city gates, are great icons of historical, cultural, and architectural importance; these gates act as a window to the past traditions and accomplishments. Ancient city gates of Bauchi are essential to the cultural heritage of the region which has expressed itself in hundreds of years of innovatory architecture, political organization, and underlying religious intent. Though they are essential to history, these places are threatened by such issues as city expansion, environmental impacts and indifference which necessitates the need for concerted conservation initiatives.
Gate 'Kofa'built and decorated in traditional ways are the history of the gates is entwined in both the history and continued existence of each city. This pattern also applies in Bauchi, which is the capital city for Bauchi State. It is mainly a strengthened entrance that will help in utilizing street networks thus promoting movement in old ancient cities. Such gates are found in various adaptation found in ancient cities, and those existing up to the 18th century in the world. However, many are still standing now as much for their historical and cultural than security reasons. Great number of visitors to cultural heritage places leads to increased traffic highlighting the need for proper preservation efforts through GIS technologies used for sustainable conservation (Gabrovec & Viskovic, 2014).

According to Haung's (2024) perception, GIS integrates geographical information such maps and remote Moreover, GIS has the potential to contribute to the improvement of heritage studies because of its potentials to accurately identify the locations of heritage sites and thus make it easier for the management bodies to protect them. Although GIS has indicated potential in heritage conservation globally, the application of GIS to the ancient Bauchi city gates has not occurred mainly as it is a largely unexplored research area. Such studies are lacking, limiting stakeholders in their planning and conservation of such important cultural sites. This study seeks to fill the gap by using GIS approaches to target locations, assess conditions, record and map the historic gates of Bauchi, provide a framework for conservation planning, stimulate conversation about the use of technology in heritage conservation, and cultivate knowledge of the historical and cultural value of the gates beyond Bauchi. The results will assist us to safeguard Bauchi city gates as well as verify GIS as a tool for heritage sites management.

The applications of Geographic Information Systems (GIS) strongly enhance cultural heritage sites both in their preservation and management. Utilization of GIS in mapping and analysis of the city gates will provide stakeholders with valuable insight into the current state of affairs of these structures, which in turn will make it possible to implement informed conservation measures. Also, GIS will help to digitize heritage collections and document handling while providing key insights from historical geographic data, leading to more understanding of the historical and cultural importance of such places as the interpretation of historical geographical information, thereby enhancing the understanding of the history and cultural context of heritage sites such as the Bauchi City gates.

STATEMENT OF PROBLEM

Sites such as the Bauchi ancient city gates are important resources that protect the cultural, historical, and architectural identity of a people in its preservation. They used to be the relic of any ancient city's heritage and identity but in Bauchi they are merely remembered relics. Notwithstanding the gate as an ornamental and a historical memory of Bauchi Emirate.
These gates once were fundamental in both security and governance but are now of massive cultural value as they are testimonies to the past Bauchi histories. Weakened though they are, they are less appealing today as objects signifying cultural heritage and identity, because the original appearances and names have faded, and they are commonly used for showcasing advertisements and notices. As these buildings become deteriorated, there is an increased risk of the loss of core aspects of Bauchi's cultural history, decreasing connection to the past and course of losing valuable historical information.

OBJECTIVES OF THE STUDY

The objectives of this research are to:

- Identify Bauchi city gates and their locations for heritage sustainability.
- Document the images of Bauchi city gates and their geographical location using GIS Mapping for Education and Learning purposes, (Exhibitions).
- Produce a GIS Map of ancient Bauchi city gates and a photo gallery of the ancient city gates to serve as Tourist's guide.

LITERATURE REVIEW

Preservation of the cultural heritage is now a global issue as communities strive to save their intangible and tangible heritage. Older buildings such as the city gateways, walls, and monuments not only symbolize the past architectural achievements but also the chronologies of culture and socio-political histories of the period. They also suffer the impact of urbanization, climate change, abandonment, and destruction and need new approaches in their documentation, analysis, and preservation. Geographic Information Systems (GIS) application has been the hallmark technology of cultural heritage preservation, wherein GIS offers new landscapes of investigating, displaying, and sustaining spatial data.

History of Bauchi City Gates

Bauchi city gates are one of Nigeria's cultural heritage sites. They were constructed in the city's early history and utilized as defense gates to control entry and exit points of individuals coming into and exiting the city, and to express the city's socio-political order. However, though historic, they are not yet explored in-depth by scholars and face extinction by encroachment and abandonment as well. Few accounts, like Maina's (2017), advocate for the historical importance of the gates but fail to provide rigorous documentation as well as conservation strategies.

Role of GIS in Cultural Heritage Conservation

Currently, GIS is an essential tool for preservation of cultural heritage because of the ability to combine spatial and attribute data. The use of Geographic Information Systems (GIS) in the mapping and spatial analysis of heritage sites - and thus visualization - enables better tracking of changes, risk evaluation, and preparedness for conservation actions. According to Campana and Remondino (2008), GIS technology allows preparing digital inventories giving holistic approach to the analysis and management of heritage sites. In their work, Azevedo

and Cândido (2020) describe the usage of GIS to produce visualizations and to analyze historic monuments to aid in defining priority conservation zones and interventions. These GIS are particularly helpful in under-developed countries that have conservation resource constraints. For example, Yusuf et al (2020) showed how GIS could preserve and research heritage successfully in northern Nigeria and how this could be valuable among regions with simple conservation controls. These ISS (issues) explain GIS's capability to fill knowledge gaps to encourage evidence-driven decisions in heritage management. Despite the wide use of the GIS technology in the international heritage management – the application in Nigeria is meager. In developing mapping of historic sites in the northern Nigeria, the study by Abdulrahman et al. (2022) demonstrates how GIS has been able to contribute baseline information for conservation planning. Aluko et al. (2021) proved that GIS can track the impact of urbanization on ancient monuments, revealing its contribution to the solution of the present-day problems in heritage management.

Cultural Heritage Conservation and Challenges

The preservation of cultural heritage is keeping up cultural resources in favor of their succeeding generation but not at the cost of the historic integrity they possess. Conservation, according to Jokilehto (1999) and Mason (2002), is not the mere preservation of buildings but conservation of their significance and meaning of culture. But the issue of such a poor documentation, lack of finance, and the demands of modern development always work against conservation, particularly in the Third World such as Nigeria. Oladumiye and Adeyemi (2019) research expose the specific issues in Nigeria, where most of its heritage sites are threatened by urbanization, climate change, and bad policies.

THEORETICAL FRAMEWORK

The Fatorić & Seekamp (2017) integrated conservation approach asserts that the siting of cultural heritage, along with geospatial analysis, forms an integrated framework for the conservation of the heritage item in its wider socio-spatial context. The Theory emphasizes conservation of cultural heritage not as typically individual monuments but as included as a component of the entire social, spatial and environmental portfolio. It considers cultural heritage management a process that is comprehensive in nature and includes consideration of the people, urbanization and growth and existing needs. It is most suitable for GIS mapping because it favors utilizing new spatial technology in monitoring, planning and documentation of heritage. This theory favors the application of GIS as a spatial analysis tool of, mapping and documenting the relationship between heritage buildings (e.g., historic gates) and the city. It promotes sustainable conservation through inter-disciplinary engagement.

Use of GIS in cultural heritage preservation has been up to the mark worldwide but, unfortunately, for preserving Nigeria's heritage, particularly the old city gates of Bauchi, its use is yet to be accomplished. This paper draws on the available literature to further attest to the application of GIS as an important tool in preservation of historic buildings and conservation of cultural heritage for future generations.

METHODOLOGY

This is the scientific and methodical manner of documenting and researching the historic city gates of Bauchi, and also using GIS to further promote their conservation and cultural value. Literature review of the available literature on conservation of historic buildings was conducted. Besides, reconnaissance survey of the historic city gates was conducted, where gates' details were collected, gate condition observation made and digital photographs also taken. The research employed non-probability sampling technique (purposeful sampling

technique) and conducted interviews over a sample of the people in charge of culture and heritage in Bauchi, among which historical information of gates was also collected to analyze.

Study Area: Fieldwork was conducted in Bauchi metropolis in Bauchi State. Situated in the North-East geopolitical zone in Nigeria. The State has a population of about 4,653,066 (2006 est.) and is located at coordinates 10.3103 [decimal degrees latitude], 9.84388 [decimal degrees longitude] at elevation/altitude meters (Bauchi State Government, 2014). The research involves the edges of the historical city of Bauchi, Nigeria especially regarding the older gates of this old city and those known to many as kofa, important cultural historical places defining city limits historically. Data Collection

Field Surveying:

Conduct survey to reveal which are existing today city entrance with their locus.

Photographic survey and document observed changes from its originality of these doors.

•Spatial Data: Latitude and longitude of all the gates of the city were provided. They were utilized for mapping.

Source of Data: Gate Coordinates Available in UTM coordinates and;

•Urban Features

Up-to-date Buildings: Urban centre near administrative and commercial areas.

Road Network: It is probably a radial network from the city centre.

Urban Growth Areas: Peri urban boundaries reflect recent growth, satellite imagery, and urban master plans, which are assumed to be buffer areas.

Data Management and GIS Tools

The following software and computer programs were used throughout the research:

• ArcGIS Desktop (ArcMap): Creating maps, manipulating data, georeferencing imagery and spatial analysis.

• Google Earth Pro: For extracting satellite imagery and overlaying recent and historical imagery.

• Shapefiles: For storing and managing geospatial data (gates' locations, historical, etc.).

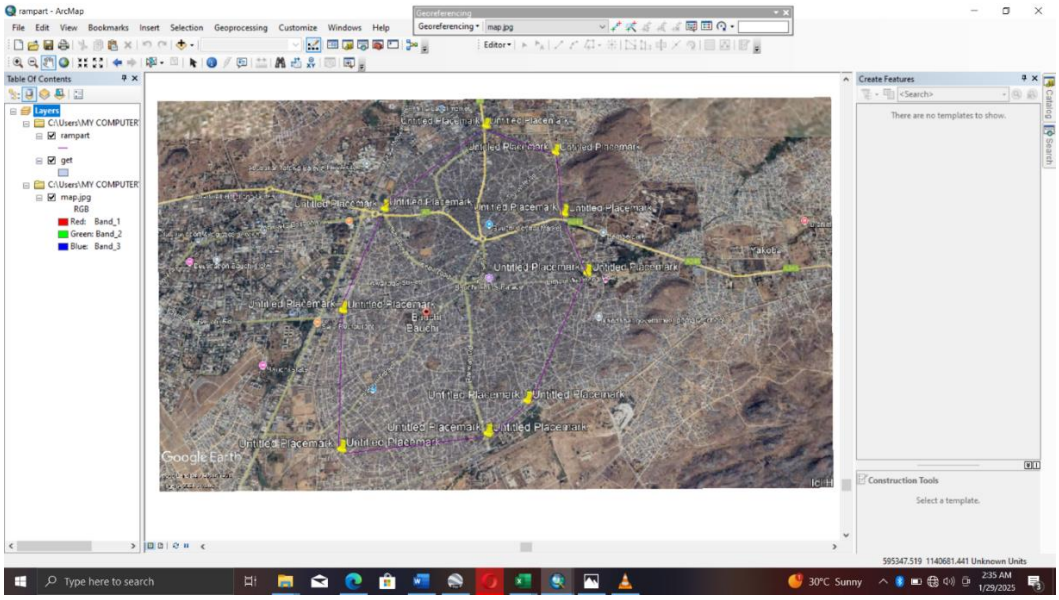
• Digitizing Tools: For digitizing physical features (city gates) into digital GIS data for analysis.

GIS Data Preparation

The following GIS data sets were prepared in order to map Bauchi city gates and conduct spatial analysis:

Image Data: These are aerial or satellite photographs, used for visual determination of the location and status of the city gates. Georeferenced to the known reference points are the provided images so that they align perfectly with existing map data of Bauchi City.

Figure 1: Georeferencing Image Data



Shapefile Creation: Shapefile was used to store the coordinates of each gate and its associated attributes. The gates were digitized using ArcGIS, the precise locations of the gates were digitized as point features. Each gate was represented by a point in the shapefile, with associated attribute data such as, historical significance and current physical condition, as observed by the study.

Figure 2: Shapefile creation

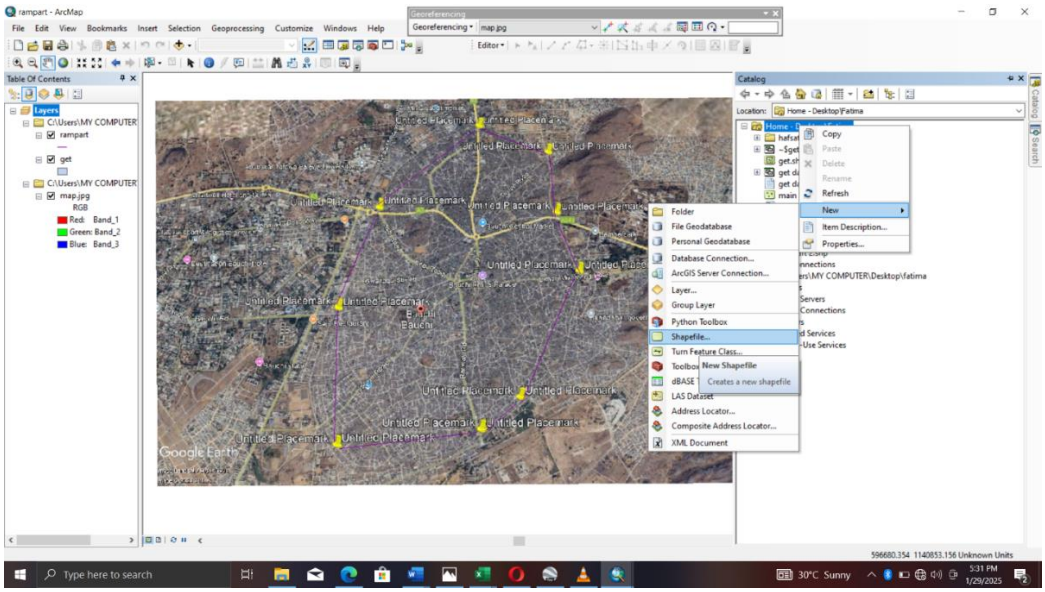


Figure 3: Shapefile

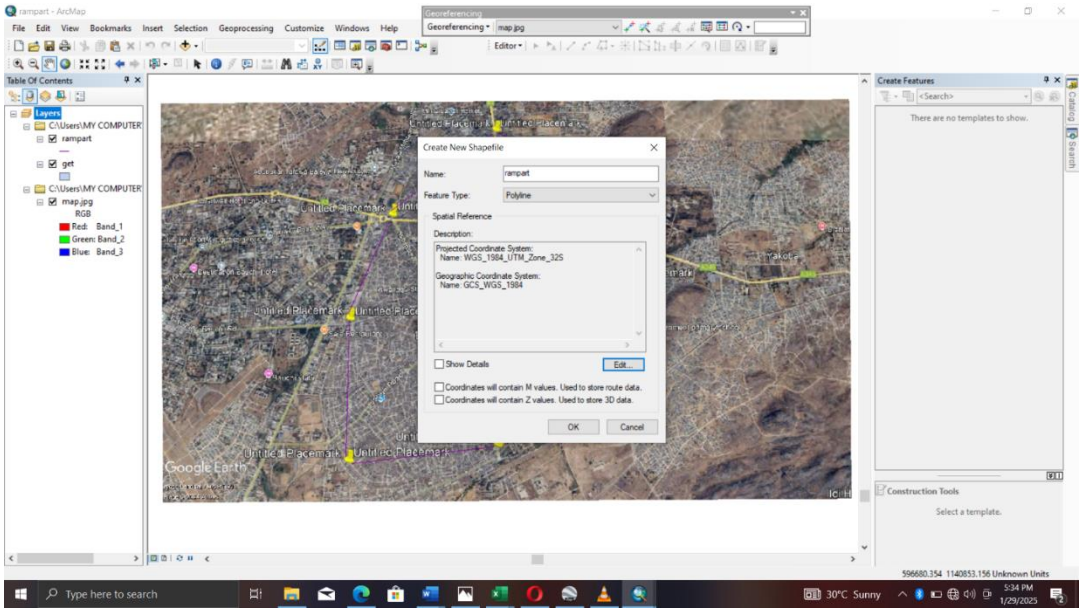


Table 1: Shapefile (list of coordinates, historical significance and physical condition of the gates)

S/N	NAME OF GATES	EASTING	NORTHING	HISTORICAL SIGNIFICANCE	CURRENT CONDITION	DESCRIPTION OF CONDITION
1	**Kofar Wase** (Built by Mal. Yakubu between 1807 and 1812)	593606 593606	1140552 1140569	For protection, the gate was a war strategy to prevent city from being easily invaded.	Moderately preserved	The encroachment on the gate is average
2	**Kofar Jahun**(Built after Bauchi was further expanded)	593524 593843	1141383 1139811	Provides administrative records of every movement of people passing through the gate, along with foreign record affairs for self-defense.	fairly preserved	The encroachment on the gate is below average
3	**Kofar Nasarawo** (Built after Bauchi was further expanded)	592662 593128	1141764 1138353	Provides administrative records of every movement of people passing through the gate, along with foreign record affairs for self-defense.	Moderately preserved	The encroachment on the gate is average
4	**Kofar Wunti** (Built by Mal. Yakubu between 1807 and 1812)	593843 593530	1139804 1141372	For protection, the gate was a war strategy to prevent city from being easily invaded.	Moderately preserved	The encroachment on the gate is average

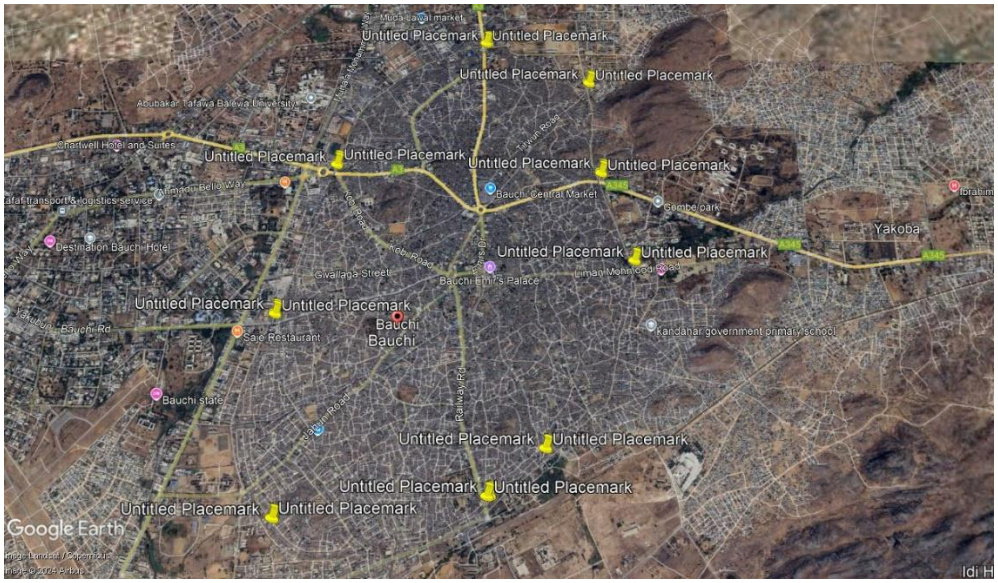
5	**Kofar Ran** (Built after Bauchi was further expanded)	593122 592678	1138350 1141766	Provides administrative records of every movement of people passing through the gate, along with foreign record affairs for self-defense.	Moderately preserved	The encroachment on the gate is average
6	**Kofar Tirwun** (Built by Mal. Yakubu between 1807 and 1812)	591456 591451	1140641 1140625	For protection, the gate was a war strategy to prevent city from being easily invaded.	Destroyed	The whole part of the gate has been encroached upon
7	**Kofar Wambai** (Built after Bauchi was further expanded)	591049 591050	1139380 1139366	Provides administrative records of every movement of people passing through the gate, along with foreign record affairs for self-defense.	Moderately preserved	The encroachment on the gate is average
8	**Kofar Inkil** (Built by Mal. Yakubu between 1807 and 1812)	591150 591155	1137858 1137852	For protection, the gate was a war strategy to prevent city from being easily invaded.	Destroyed	The whole part of the gate has been encroached upon
9	**Kofar Dumi** (Built after Bauchi was further expanded)	592694 592711	1138008 1138014	Provides administrative records of every movement of people passing through the gate, along with foreign record affairs for self-defense.	Destroyed	The whole part of the gate has been encroached upon

Source: field survey, 2025

The conditions of the gates were observed and judged according to the degree of encroachment as at the time of this research.

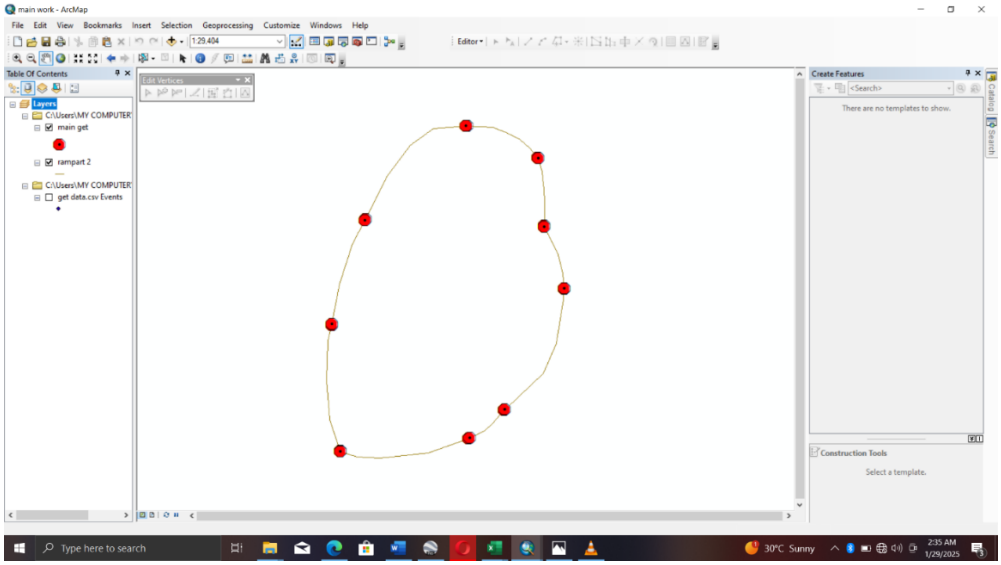
Coordinates and Map Integration: The provided coordinates (Easting and Northing) were inputted into ArcGIS to create a GIS layer representing the gates' locations. This data wasthen integrated into the overall map of the ancient Bauchi City, providing spatial context to each gate’s location.

Figure 4: Coordinates and Map Integration



Digitizing: is the process ofconverting spatial information from a non-digital format (like paper maps or aerial photos) into a digital format, typically for use in mapping or spatial analysis.

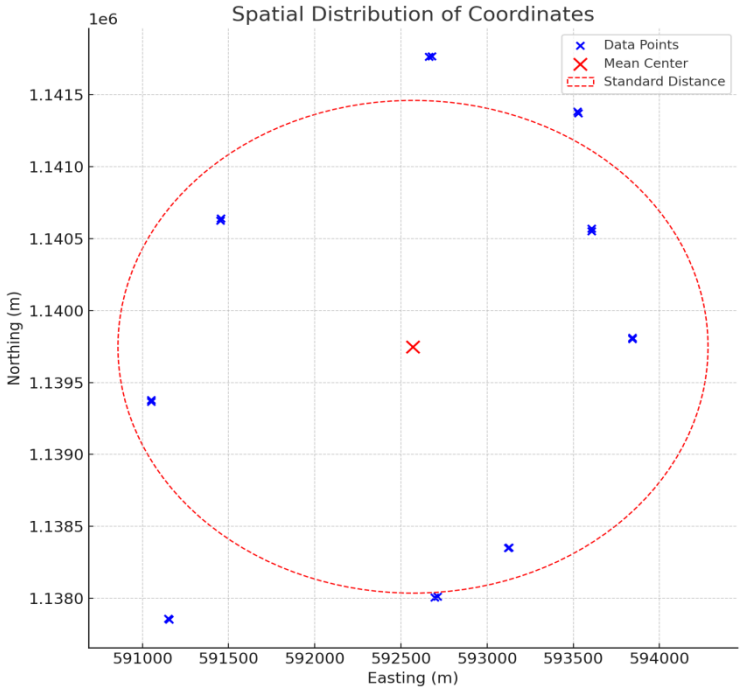
Figure 5: Converting Map into Digital format



Geospatial Analysis: With the spatial data of the city gates in place, the following analysis was conducted.

Spatial Distribution Analysis: A spatial analysis was performed to assess the geographical distribution of the city gates across Bauchi. This will help identify concentrations or clusters of gates and any trends in their historical placement relative to the city's development.

Figure 6: Spatial Distribution Analysis of the Coordinates



Spatial Distribution Analysis based on provided coordinates

Map Interpretation

The scatter plot:

- Shows the individual locations in **blue**.
- Highlights the **mean center** in **red**.
- Displays a **dashed red circle** representing the standard distance.
- The distribution shows a clear **central clustering pattern**.

Mean Center (Centroid)

The **mean center** represents the average location of all the points:

- **Easting:** 592,569.89 m
- **Northing:** 1,139,748.22 m

This point marks the geographic center of the distribution and is visualized as a red "×" on the plot.

Spatial Range

The range gives an idea of the spatial extent:

- **Easting Range:** 2,794 meters
- **Northing Range:** 3,914 meters

This shows the data spans a broader range in the north–south direction than east–west.

Standard Distance

The **standard distance** measures the average dispersion from the mean center:

- **Standard Distance:**= 1,711.90 meters

This indicates that the points are moderately spread out around the center. A circle with this radius was plotted to represent the spread.

Nearest Neighbor Analysis

This helps assess the spatial pattern:

- **Mean Nearest Neighbor Distance:**= 12.89 meters

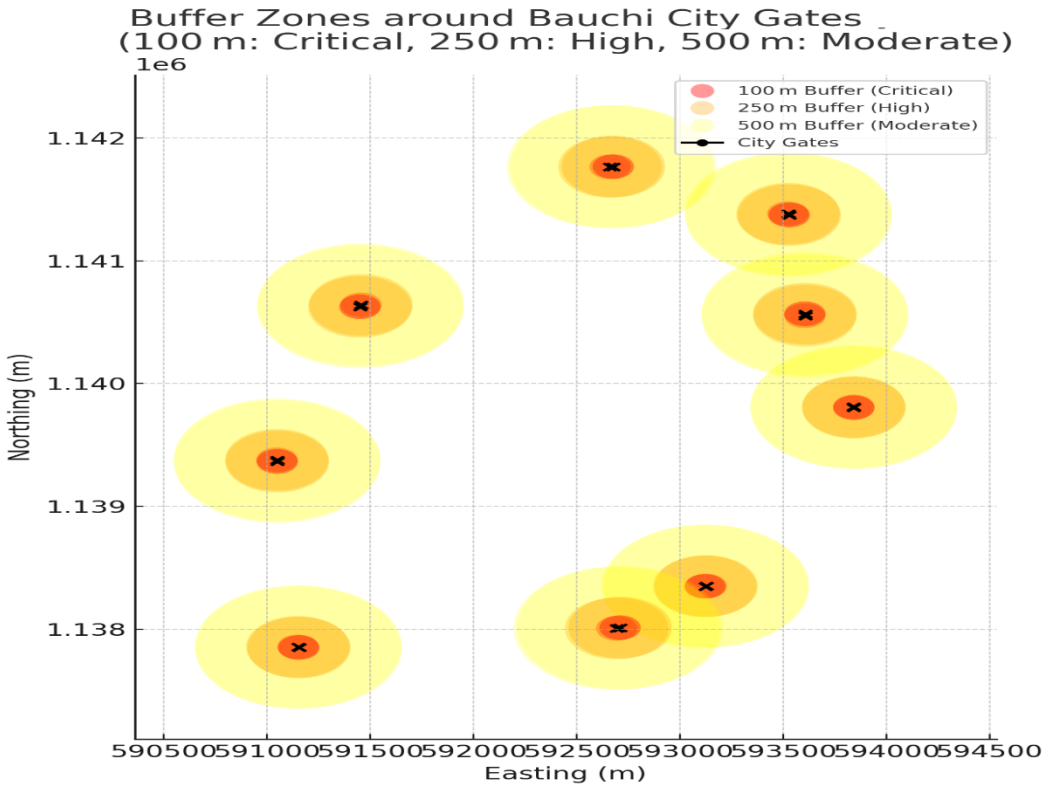
This very small average nearest distance suggests that the points are clustered rather than randomly or evenly spaced, which could indicate some spatial grouping or attraction phenomena.

Proximity Analysis: Conducted proximity analysis to determine the relationship between the gates and key urban features like, modern buildings, roads and urban growth areas. This analysis evaluates the spatial proximity of ancient city gates in Bauchi to key urban features, with the goal of assessing how modern development has encroached upon or influenced the conservation of these heritage structures and highlights the areas where urbanization has impacted or threatens the preservation of the gates.

Buffer Zones

Created concentric buffers at 100 m, 250 m, and 500 m around each gate to represent critical, high,

Below is a GISstyle buffer map illustrating proximity risk zones around each Bauchi City Gate.



Theproximity analysis using 100 m (critical), 250 m (high), and 500 m (moderate) buffer zones reveals that:

- Most gates lie within highpressure (250 m) and critical (100 m) zones, indicating significant risk of encroachment by modern buildings and infrastructure.
- Overlapping buffers in the urban core highlight clusters of gates facing compounded threats from roads, construction, and urban sprawl.
- Peripheral gates near the southern and western fringes remain in moderate-pressure zones but fall just inside the 500 m buffer, signaling emerging urban growth pressures.

Coordinates of 9 Bauchi City Gates (UTM Zone coordinates) were plotted as point features.

Figure 7: shows the spatial distribution of buffer zones: Critical (red), High (orange), and Moderate (yellow) risk buffers around Bauchi City Gates based on 100 m, 250 m, and 500 m proximities.

Analysis of Buffer zones

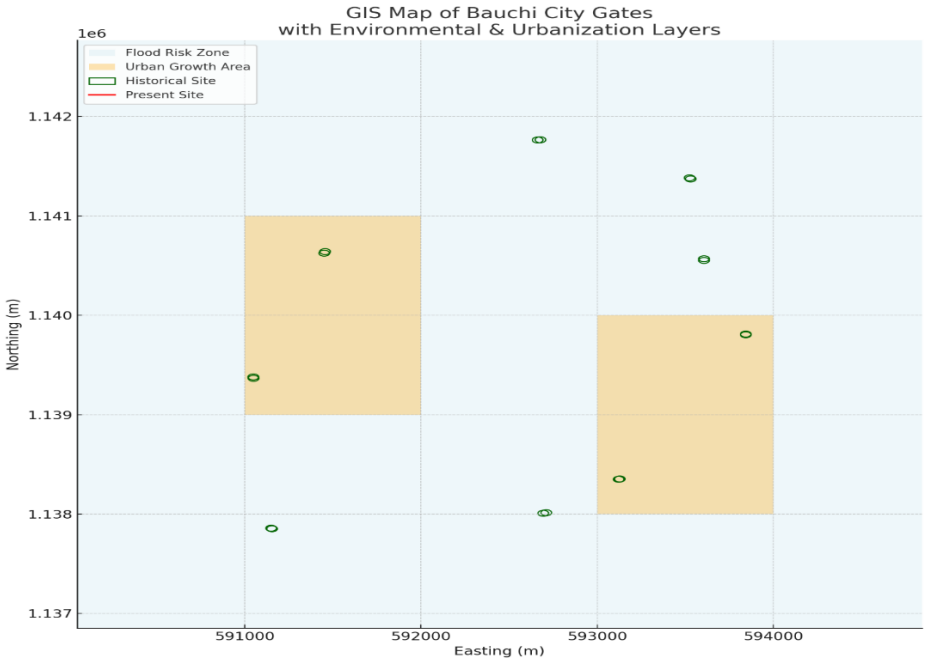
Urban Core Encroachment: Gates located near the modern city center (upper right quadrant of Figure7) have buffers almost entirely overlapped by the 100 m and 250 m zones, indicating immediate threats from building expansion and heavy traffic.

Clustered Risk Areas: Overlapping buffers suggest that multiple gates share the same high-impact zones, compounding preservation challenges and necessitating area-wide conservation strategies.

Emerging Growth Fronts: Southern-western gates, while currently in moderate-pressure zones, lie just inside 500 m buffers, signaling likely future encroachment as the city expands.

Feature Intersection: Buildings (within 100m = high threat zone), Roads (within 100-250m = potential risk) and Urban Growth Areas (within 500m = moderate pressure)

Figure 8: GIS Mapping of Ancient Bauchi city gates



Above is a GIS Map of Bauchi City Gates incorporating;

- **Heritage Sites Layer:**

Historical State: Green circles mark the original footprint of each gate.

Present State: Red crosses denote their current surveyed locations.

- **Environmental Factors**

Flood Risk Zone: The lightblue shaded background represents areas susceptible to urban flooding, based on modeled flood data for Bauchi

- **Urban Growth Areas**

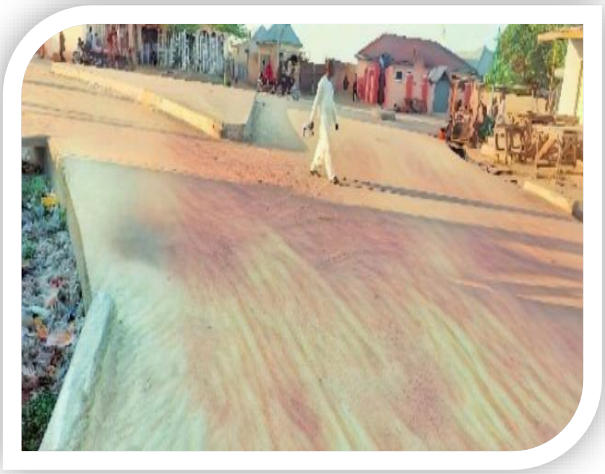
HighGrowth Polygons (orange): Simulated zones reflecting rapid expansion identified from spatial growth studies (1976–2015)

Documentation and Presentation: Below is a table of photo gallery showcasing the nine (9) Bauchi City Gates, each paired with a current photograph, all geo-referenced to their corresponding geographic locations for users to explore the history, current condition and other relevant attributes of the gates.

Table 2: Photo Gallery of Bauchi city Gates

S/N	NAME OF GATES	EASTING	NORTHING	CURRENT PHOTO OF THE GATES
1	**Kofar Wase**	593606	1140552	
		593606	1140569	
2	**Kofar Jahun**	593524	1141383	
		593843	1139811	
3	**Kofar Nasarawo**	592662	1141764	

		593128	1138353	
4	**Kofar Wunti**	593843	1139804	
		593530	1141372	
5	**Kofar Ran**	593122	1138350	
		592678	1141766	
6	**Kofar Tirwun**	591456	1140641	
		591451	1140625	
7	**Kofar Wambai**	591049	1139380	

		591050	1139366	
8	**Kofar Inkil**	591150	1137858	
		591155	1137852	
9	**Kofar Dumi**	592694	1138008	
		592711	1138014	

Source: field survey, 2025

SUMMARY OF FINDINGS

Nine gates of the ancient city identified as "Kofa" were also marked, and the locations were stored as a GIS shape-file, and represented as individual points on the map, every point reporting its history status and current state. The locus of the gates showed distinct concentration of the gates around the central point (mean center at 592,569.89 m E, 1,139,748.22 m N) and the mean distance was 1, Most gates were found to be less than 100 using analysis with buffers and nearest neighbor analysis. The worst part is that people who know the protective policies of these gates and walls continue performing activities that may result in the demolition of such in places to give way for modern construction. Western and the southern city gates are within the 500-meter buffers, and there's rapidly phasing increase in threat from peri-urban encroachment on areas that previously have not been exposed to these threats. Kofar Tirwun, Kofar Dumi, and Kofar Inkil were totally destroyed from encroachment, while six have been saved in a conservation status that is "fairly" to moderately complete.

When superimposed on flood hazard modelled and high urban expansion areas, certain gates especially those in the city center are vulnerable to all forms of hazards both man-made disasters and urban expansion. Field survey, UTM coordinate mapping, digitizing, spatial statistical analysis (mean center, standard distance, nearest neighbor) and buffer mapping coupled together is a robust, reproducible tool for documentation of heritage in contexts of high urban expansion. Gates within 100 m buffers should be given immediate legal protection and enforced buffer zones, gates within 250 m zones should be given suitable area-wide conservation measures, and gateways at the edge of 500 m zones should be monitored to be taken back in the future. There is evidence favoring the integration of such protected areas that demand, at least, a minimum of 30metres buffer between gates and any buildings: according to International Union for Conservation of Nature (IUCN, 2010) into Bauchi urban master plan in order to come up with protective zoning, heritage corridors and GIS-based monitoring systems on a yearly basis.

DISCUSSION

Information on nine Bauchi city gates was mapped and labeled as point data within a GIS database with useful notes on past and present state of the gates. This is consistent with the position of Campana and Remondino (2008) who hold that GIS-based digital inventories make systematic conservation easier through spatial location and attribute data association, according to which a reliable and reproducible inventory of heritage assets was generated for Bauchi's mean center analysis (59 With the use of nearest neighbor and clustering methodology, Lin et al. (2021) examined a number of agricultural cultural heritages in China confirming the efficiency of said procedures for the purposes of remaining distinguishable from agglomerations to the boundary regions. Most lodgings of gates are in the 100 m-250 m buffer and are thus prone to hazards from modern developments and transportation networks. GIS buffer analysis done by Aluko et al (2021) showed that Lagos monuments are directly at the mercy of urban sprawl having, therefore, supported the claim that buffer mapping can easily indicate at-risk areas. Five-hundred-meter buffers mark potential weaknesses where gates bordering the Bauchi city in the south and west are included. Studies conducted by Yusuf et al. (2020) show that opportunities for urban sprawl are increasing around peri-urban heritage sites in northern Nigerian towns, as confirmed by their GIS proximity tests. Three gates are in ruins, the Kofar Tirwun, Dumi and Inkil, while six are partly standing.

Such conditions reflect Oladumiye and Adeyemi's (2019) analysis of Nigerian heritage sites, indicating that such inconsistency in conservation success can be attributed to variation in legal protection and community involvement. In integrating flood risk data to and urban growth data, it was evident the core area gates are under the joint pressure of two hazards. Following a review of the topic in 2017, Fatorić and Seekamp highlight the need for incorporating geospatial monitoring into conservation strategies in face of the climate changes and urban expansion. A synthesis of field surveys, UTM mapping, digitization, and spatial-statistical analysis is what Fatorić and Seekamp (2017) and Azevedo and Cândido (2020) show as a multiagency conservation way, indicating GIS's capacity to promote complete and data

Application of IUCN's minimum 30 m buffer (IUCN, 2010) to all gates and with buffer zones of 100 m-250 m is fully supported by heritage-buffer theory (Wang et al., 2022), which argues that graded buffer zones allow conservation responses to be modulated based on site-specific threats. Incorporating such buffer prescriptions into master planning at the local level in Bauchi fulfills Jokilehto's (1999) demand that buffer zones and heritage corridors are made central to statutory planning, thereby routinizing development control usage and routine GIS

monitoring Community-based buffer management, lastly, resonates with Mason's (2002) demand for participatory conservation frameworks whereby protective measures are co-designed by local interest groups, a modality easily facilitated by GIS platforms through collaborative mapping routines

CONCLUSION

Through the application of GIS technology, this study has developed a comprehensive course of action for documenting and researching the ancient city gates of Bauchi by combining field surveys, precise UTM coordinates, spatial knowledge to explore their history trajectories and contemporary preservation obstacles. Using a systematic recording of the position of gates and application of analytical tools such as mean center, range, standard distance and nearest neighbor analysis, the study has discovered a strong clustering of these historic structures and quantified their spatial distribution in the urban area. Upon using 100 m, 250 m and 500 m buffers, it was evident that contemporary developments, major routes and expansion of urban boundaries have been increasingly challenging the gates with the densest urban sectors of Bauchi getting the worst affected.

The research identifies priority zones for heritage preservation through buffer maps and overlay maps showing flood susceptibility and urban expansion based on mapping spatial data using GIS. The gates marked by high pressure (250 m) and critical (100 m) buffers are at imminent risk, and those on the fringes of urban area are likely to be under continued pressure from the rate of development in future. Such findings emphasize the value of statutory protective buffers and heritage-sensitive zoning while emphasizing the need for constant spatial monitoring, stakeholder's involvement, and incorporating of heritage corridors in urban planning.

As such, this methodology thereby determines a systematic data-informed process to conserve heritage in rapidly changing urban landscapes. The next steps include enhancing these assessments with sophisticated land-use information, explicit infrastructure outlines, and dynamical urban growth scenarios to inform the changing conservation efforts. With the focus on the ancient entrances of Bauchi, this investigation presents a GIS-based technique to aid the preservation of cultural heritage as local cities develop sustainably.

RECOMMENDATIONS

Based on the findings from the GIS analysis, this study proposed recommendations for preserving and conserving the ancient gates of Bauchi as follows:

• The National, States and Local governments should encourage the conservation of historic buildings and structures with necessary incentives and supporting mechanisms.

• Additional effort had to go into strengthening the mass media campaigns that would emphasize the benefits of conservation of the historic built environment: Such endeavors are critical to identify, share, and uphold the acknowledged worthiness of places, and instructing people on how to cleanse up and shout out any attachment to the historic built environment.

• Emirate councils should use their power to enable community activities that would increase local awareness of the significance of protecting historic spaces: acting as guardians of traditional culture and heritage, and contributors to the maintenance of the historic built environment.

- Government should incorporate gate preservation in city masterplans and establish buffering protective zone around all gates, and particularly those within 250 m of high-density urban areas to prevent further development encroachment.

- Overlapping Risk Zones: The location of some gates within flood prone land indicates the need for better flood defenses and drainage solutions and calls for active community involvement in identifying buffer zone management strategies.

- Cultural heritage programs should use GIS maps and photo galleries to inform the public about how important it was and how important it is to maintain these gates' significant history.

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