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Contributions to Architectural and Urban Resilience Through Vulnerability Assessment: The Case of Mozambique Island's World Heritage

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Abstract: Mozambique Island, a UNESCO World Heritage property, faces significant challenges due to climate change and extreme weather events. This study proposes a comprehensive framework for assessing morphological vulnerabilities and enhancing urban resilience in this unique historical urban landscape. The research methodology involves a thorough analysis of historical cartography, urban evolution, topography, and vernacular architecture, combined with recent conservation assessments and case studies from other climate-vulnerable regions. This study reveals the island's dual urban structure, comprising the Stone and Lime town and the Macuti town, each with distinct morphological characteristics and vulnerabilities. Historical maps and topographical analysis demonstrate how the island's geography has shaped its urban development, with the Stone and Lime town built on higher ground and the Macuti town situated at or below sea level, increasing its flood risk. The research highlights the importance of integrating traditional knowledge with resilience strategies while respecting the authenticity and integrity of the World Heritage property. Key findings include the need for a GIS-based management tool for continuous conservation assessment, and the crucial role of community engagement in implementing resilience mechanisms. This study contributes to the broader discourse on cultural heritage as a contributor to architectural and urban resilience, offering valuable insights for other World Heritage properties facing similar climate challenges. The proposed framework emphasizes the importance of balancing heritage preservation with adaptive strategies, while enhancing the island's resilience facing climate-related threats.

Keywords: UNESCO World Heritage; vulnerability; architectural resilience; urban resilience; vernacular architecture; morphological analysis; Mozambique Island

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1. Introduction

The Island of Mozambique (Figure 1) is a fortified island located on a calcareous coral reef, in the north of Mozambique, province of Nampula. The island played an important role in the history of the Indian Ocean due to its key intercontinental trading links between Europe, Africa, and the Indian subcontinent. For almost four centuries, the island of Mozambique was the first capital of Mozambique.

Figure 1. Panoramic photo of Mozambique island. Reproduced with permission from Mariana Correia, author archive, 2018.

Due to its outstanding architecture and urbanism, and the continuous use, throughout five centuries, of the same traditional building techniques and materials, in 1991, the World Heritage Committee listed the fortified city as a World Heritage property [1]. The island is known for its remarkable architectural unity expressed by two types of architecture and urban systems: Macuti town and Stone and Lime town. Macuti town was named after the local palm leaves that were used to roof the traditional African houses, built on the south side of the island. It is located on a lower level, as it was used for centuries, as with the stone quarry for the Stone and Lime town, including its stone monuments. The Stone and Lime town, located in the north part of the island, reveals the cultural diversity of the Swahili, Arab, and European influences, just like the island communities, which represent the multicultural history of navigation that crossed the island.

Presently, the island of Mozambique faces a series of challenges related to its preservation and vulnerability due to extreme weather events associated with climate change. Implementing measures to reduce the negative impacts of climate change can be an opportunity for proactive planning, particularly in high-risk areas like Mozambique Island, located on the southeastern coast of Africa, an area prone to cyclones [1].

1.1. Cultural Heritage and Morphology Vulnerability Assessment

Morphology vulnerability assessment allow to evaluate the susceptibility of physical features to changes or damage caused by several factors, including climate change and human activities, specifically in this case of cultural heritage site preservation. By understanding the vulnerability of morphological features, it is possible to develop more effective strategies for land use, conservation, and adaptation to environmental changes.

In the context of cultural heritage, the concept of vulnerability has evolved to address the specific challenges faced by cultural heritage sites and structures. While the general idea of vulnerability remains consistent across disciplines, its application in the heritage field has some unique characteristics. Vulnerability, in the context of UNESCO's World Heritage sites, is a multifaceted concept that encompasses the susceptibility of cultural and natural heritage properties to various hazards and threats. UNESCO defines vulnerability as the inherent weakness of a heritage property due to its location or specific characteristics, which makes it susceptible to potential damage or loss when exposed to hazards. This definition emphasizes that vulnerability is not just about the external threats, but also about the intrinsic qualities of the heritage site itself [2].

UNESCO emphasizes the importance of integrating disaster risk reduction into the management of World Heritage properties through a comprehensive approach. This involves developing strategies to reduce risks from disasters, which are tailored to the unique characteristics of each heritage site [3]. The organization also recognizes the value of incorporating traditional knowledge and community-based management practices, acknowledging that local communities often possess invaluable insights and time-tested methods for mitigating risks [4].

The evolution of vulnerability definitions and frameworks in cultural heritage contexts reflects a growing understanding of the complex challenges faced by heritage sites (Table 1). Initially focused on climate change susceptibility, definitions have expanded to encompass physical, social, and economic vulnerabilities. ICOMOS documents show a progression from general risk assessments to more specialized approaches tailored to cultural heritage.

Table 1. Evolution of vulnerability concepts in cultural heritage from the documents published by ICOMOS in a chronological table.

	Vulnerability Definition	Proposed Framework
2007 Heritage at Risk Report [5]	Presented as a key component of risk assessment for cultural heritage sites. It is understood as the susceptibility of heritage assets to damage or loss.	Risk assessment framework for cultural heritage sites
2010 New Zealand Charter [6]	Defined as susceptibility to damage or destruction. This includes both natural and human-induced threats to cultural heritage.	Conservation and protection framework for cultural heritage
2011 The Paris Declaration on Heritage as a Driver of Development [7]	Described in relation to natural and human-made disasters. It emphasizes the need to consider heritage sites' susceptibility to various hazards in development contexts.	Framework for integrating heritage protection in development planning
2014 Florence Declaration on Heritage and Landscape as Human Values [8]	Specifically linked to climate change and natural disasters. It highlights the increasing risks posed to cultural landscapes and heritage sites by environmental factors.	Framework for assessing climate change impacts on cultural landscapes
2017 Action Plan: Cultural Heritage and Localizing the SDGs [9]	Presented as a crucial aspect of disaster risk reduction for cultural heritage. It emphasizes the need to assess and address vulnerabilities in the context of sustainable development goals.	Framework for integrating cultural heritage in SDG implementation
2019 The Future of Our Pasts: Engaging Cultural Heritage in Climate Action [10]	Defined as the susceptibility to harm and lack of capacity to cope with adverse effects, particularly in the context of climate change impacts on cultural heritage.	Climate change adaptation framework for cultural heritage
2021 Heritage and Climate Change Outline Report [11]	Described as a function of sensitivity and adaptive capacity. It emphasizes that vulnerability assessment should consider both the inherent susceptibility of heritage assets and their ability to adapt to changing conditions.	Vulnerability = Sensitivity/Adaptive Capacity
2022 Charter on Cultural Heritage and Climate Action [12]	Defined as the susceptibility to adverse effects of climate change. It emphasizes the need to assess both physical and social vulnerabilities of heritage sites in the face of climate-related hazards.	Climate action framework for cultural heritage
2024 Guidance on Heritage Impact Assessments for Cultural World Heritage Properties [13]	Presented as the susceptibility to change that may diminish significance. It focuses on the potential impacts of development or changes on the Outstanding Universal Value of World Heritage sites.	Heritage Impact Assessment framework for World Heritage sites

Recent frameworks, such as those in the 2021 Heritage and Climate Change Outline Report and the 2022 ICOMOS Charter, emphasize the importance of adaptive capacity and the need to assess both physical and social vulnerabilities. The most significant change is the shift from viewing vulnerability as a static concept to understanding it as a dynamic interplay between sensitivity and adaptive capacity. Current frameworks, like the 2024 ICOMOS Guidance, now consider the potential impacts on the Outstanding Universal Value of World Heritage sites, demonstrating a more nuanced and comprehensive approach to vulnerability assessment in cultural heritage contexts.

This evolution in both definitions and frameworks reflects a deepening understanding of the complexities involved in protecting cultural heritage in the face of multiple threats, particularly climate change. It also underscores the importance of interdisciplinary approaches and the integration of cultural heritage concerns into broader environmental and development agendas.

1.2. Mozambique Island Exposure to Climate Change and Risk Hazard

Mozambique is part of the South-West Indian Ocean (SWIO) region which is regularly affected by Tropical Cyclone (TC) activity that primarily happens from November to April [14]. The influence of climate change on Mozambique's weather patterns is particularly evident in the increasing intensity and frequency of tropical cyclones. These cyclones, classified as Category 3 or higher on the Saffir–Simpson scale, are characterized by sustained winds exceeding 178 km/h [14]. The country has experienced a notable increase in the occurrence of such intense cyclones. These events have caused widespread destruction, displacing thousands of people, and severely damaging infrastructure along the coast. The eventual increase in sea surface temperatures due to climate change is likely to fuel even more powerful cyclones in the future, exacerbating the risks faced by coastal communities and heritage sites [14].

According to the 2021 Global Climate Risk Index, Mozambique was the country in Africa that was the most affected by climate change [15]. With 2700 km of coastline, Mozambique is highly vulnerable to climate change impacts. The country has experienced a significant increase in average temperatures, affecting Mozambique's ecosystems and local livelihoods, particularly in coastal areas like Mozambique Island. Also, it is expected to experience increased variability in precipitation, with some regions facing more frequent droughts while others may see an increase in flooding events [16]. The country is particularly susceptible to tropical cyclones, flooding, and sea-level rise. These extreme weather events pose significant risks to infrastructure, historic architecture, and urban fabric, especially in UNESCO World Heritage sites, as is the case of Mozambique Island [16].

On 11 March 2022, Cyclone Gombe severely impacted Mozambique Island and the surrounding region. According to district authorities, approximately 7000 people on the island were affected by the cyclone, with over 5500 houses sustaining damage. [17]. The cyclone's effects on Mozambique Island were part of a broader pattern of destruction across Nampula province. Gombe brought winds up to 190 km/h and precipitation levels reaching 200 mm in 24 h, resulting in widespread flooding, displacement, and damage to both public infrastructure and private residences. This extreme weather event was particularly significant as it was the strongest storm to hit Mozambique since the devastating Cyclones Idai and Kenneth in 2019, underscoring the region's vulnerability to climate-related disasters [17].

Cyclone Gombe's impact on Mozambique Island follows a series of extreme weather events that affected Mozambique in 2022. It followed Tropical Storm Ana in January and Tropical Depression Dumako in February of the same year. Across the affected regions of Nampula and Zambezia provinces, Gombe impacted a total of 400,175 people, resulting in 20 fatalities and 82 injuries [18].

The impact of the cyclone also affected the public health on the Island. It created environmental conditions that were conducive to the proliferation of various diseases. Stagnant floodwaters and inadequate sanitation facilities in crowded shelters increased the risk of waterborne disease outbreaks. Furthermore, the post-cyclone environment provided favorable conditions for mosquito breeding, potentially leading to an increase in vector-borne diseases such as malaria [19]. This issue is particularly important since it accentuates the importance of addressing the sanitation and health infrastructure needs on the Island, as already addressed in the 2018 report from the UNESCO mission [20].

Regarding the built heritage, Gombe left a trail of destruction behind, which also impacted the World Heritage property. According to UNESCO [21] (p. 2) *Cyclone Gombe has a direct impact on maintaining the authenticity and integrity of the Island, as the Attributes that have been protected despite numerous difficulties are now extremely vulnerable*. Gombe cyclone impacted all the island fabric, particularly in four monuments: Palácio de São Paulo (now Museu da Ilha de Moçambique), São Domingos Convent (Court), Nossa Senhora de Baluarte Chapel, and the Hospital and Municipal Market [21].

To respond to the increasing Climate Change challenges, a Local Adaptation Plan (LAP) for Mozambique Island was developed in 2019, to align with recommendations from international forums, such as the 2015 Paris Protocol and Mozambique's National Strategy for Adaptation and Mitigation of Climate Change, approved in 2012 [22]. The LAP for Mozambique Island is a comprehensive strategy aimed at addressing climate-related challenges and promoting resilient development. Developed through a participatory process involving various social groups and stakeholders, the plan emphasizes community engagement and local knowledge. The implementation structure was designed to be led by the Municipality President, supported by a Municipal Technical team, a Climate Resilient Development Advisory Committee, and the Municipal Assembly. A final assessment is planned for 2028 [22].

2. Materials and Methods

This study adopts a multifaceted approach to analyse Mozambique Island's morphological vulnerabilities in the context of extreme climate events. The methodology is designed to provide a thorough understanding of the island's historical development, physical characteristics, and current vulnerabilities that contribute to climate adaptation and heritage preservation.

2.1. Morphological Vulnerability Through Cartographical Analysis

This analysis involves examining historical maps, cartography, and topographical data to identify urban growth patterns and assess how natural features have influenced street layouts and building orientations. An analysis of the evolution of urban form concerning topography aiming to contribute to the understanding of problems associated with extreme weather conditions namely flooding and cyclones was performed.

The investigation will then focus on the morpho-typological characteristics of buildings and public spaces in relation to tectonics. This component will examine house typologies, neighborhood layouts, and public space, with particular attention to their vulnerability to extreme weather. By studying these elements, the research aims to identify the main occurrences of building pathologies and anomalies, considering common structural issues, recurring problems in public spaces during extreme weather events, and the relationship between building materials and local climate conditions. Also, a comprehensive assessment of the general state of conservation of buildings and public spaces will provide an evaluation of their condition before the cyclone. This component will be critical in identifying effective design strategies and areas for improvement in urban resilience.

2.1.1. Historical Urban Evolution

Mozambique Island is a dual urban structure divided into (i) the Macuti town: an area with traditional buildings made of macuti (palm leaf) roofs, and wattle and daub structures, and more recently with traditional brick masonry and informal concrete houses; and (ii) the Stone and Lime town: the historical colonial area built of stone masonry buildings and lime plaster originated from the island (Figure 2).

Figure 2. Cartography of Mozambique Island and its geographical location. Red circles mark the buildings and areas most affected by Cyclone Gombe. Produced by the authors, 2024.

The Stone and Lime town stands out for its stone masonry buildings and stone national monuments, such as the fortress of São Sebastião, and several defensive and religious buildings. It was in the Stone and Lime town that started in 1507, the first seat of the Portuguese colonial government in Eastern Africa [1]. This urban area reflects the European influence on the island, with buildings that incorporate construction techniques and architectural styles adapted to the local context. In contrast, the town of Macuti has a markedly different character, characterized by traditional dwellings with distinctive macuti roofs [23]. These structures, which use intertwined palm leaves as a roof, represent the persistence of African building techniques. The coexistence of these two areas on Mozambique Island illustrates the cultural and architectural duality that defines its unique urban landscape.

The urban development of Mozambique Island was shaped by various historical, economic, and social factors [23]. The Portuguese colonial period in particular had a profound impact on the spatial organization and architecture of the island, introducing new elements and construction techniques that merged with local traditions (Figure 3).

Figure 3. Cartography of 1802 with a red circle of the stone quarry. Document provided by Portugal, *Arquivo Histórico Ultramarino* [24].

The island's urban evolution did not follow a linear process, being characterized by periods of growth, stagnation, and transformation [23]. The strategic importance of the island as a commercial and military depot directly influenced its urban development, resulting in the construction of fortifications, administrative buildings, and port infrastructures [23]. These structures, together with housing and public spaces, formed the complex urban fabric that characterizes the island today.

2.1.2. Topography Analyses

A morphological analysis reveals significant contrasts in the spatial organization of Mozambique Island's neighbourhoods. According to Almeida [23] (p. 22), there is *a dualistic reading of the social space of Mozambique Island, based on a dichotomy established by the settlement regime and sustained by ways of life and representation in different contexts, such as colonial, national and international*.

The Stone and Lime town displays a formal urban structure, characterized by regular streets and well-defined blocks, revealing European influence in its planning. On the other hand, Macuti town has a more organic configuration, with winding streets and informal public spaces, reflecting African building traditions and a more spontaneous adaptation to the landscape and local needs [23] (Figure 2). When examining Macuti house typology, materials, and building techniques, they all reveal specific building culture traditions. For instance, the Macuti roofs highlight a distinctive and functional architectural element. Also, the internal layout of the houses and the interaction between private and public spaces demonstrate how these architectural features are a direct reflection of the ways of life and cultural traditions of the local population [23].

The historical and morphological evolution of Mozambique Island reveals a complex interaction between diverse cultural and architectural influences, as well as changes in urban and conservation policies over time. Initially, stone and lime buildings took center stage, defining an urban structure of narrow streets. Until 1750, macuti huts coexisted with masonry houses [21]. The charter of 1841 established standardized dimensions for the plots, and on the coast, the houses had courtyards and elongated blocks [25]. The influence of Swahili architecture, derived from Arabic, gradually replaced the indigenous typologies, with traditional cylindrical buildings giving way to rectangular structures with courtyards. Between 1855 and 1867, efforts were made to remove thatch from the Stone and Lime town [25]. In the 19th century, attempts at gentrification and removal of the native population took place, resulting in different urban characteristics between the two areas of the island [25].

On the other hand, the island is not flat. The soil profile of Mozambique Island and the sea level have influenced the current urban morphology and building construction, from the first settlements to the present day.

The representation and Topographical Map of the Island of Mozambique visually highlight the current elevations and depressions in the profiles of the island. As early as the 17th century, a depression on the island is documented which, when flooded, became a channel and divided the island into two parts. In the later cartography in 1802 (Figure 3), a quarry is observed in the area where is located the current Macuti twon. In the 1835 cartography, the main road to Macuti is already revealed, located in the quarry area.

The recurring cause stems from the point of greatest maritime aggression. The floods in the interior of the island and the area of the Macuti town were already reflected in the 1754 cartography. The island would be divided in two by the floods, with an area on the shore—the eastern zone—that is more exposed to currents of the monsoons, and to cyclones (Figure 4).

In the 20th century, the neighborhood to the south increased, as did the Main Street (*Avenida 25 de junho*). The land was parceled out after the stone was removed, and the successive subdivisions made the neighborhood more *compact and labyrinthic* [26] (p. 20). The town grew to the north and near the factories along the coast, towards the fort. In 1966, the construction of the bridge to the south established a link with the mainland.

The Stone and Lime town is built on higher ground above the maximum tide level, while the Macuti town lies at or below sea level [26]. This topographical difference continues to cause flooding and drainage issues during heavy rains, posing ongoing public health and sanitation challenges (Figure 4).

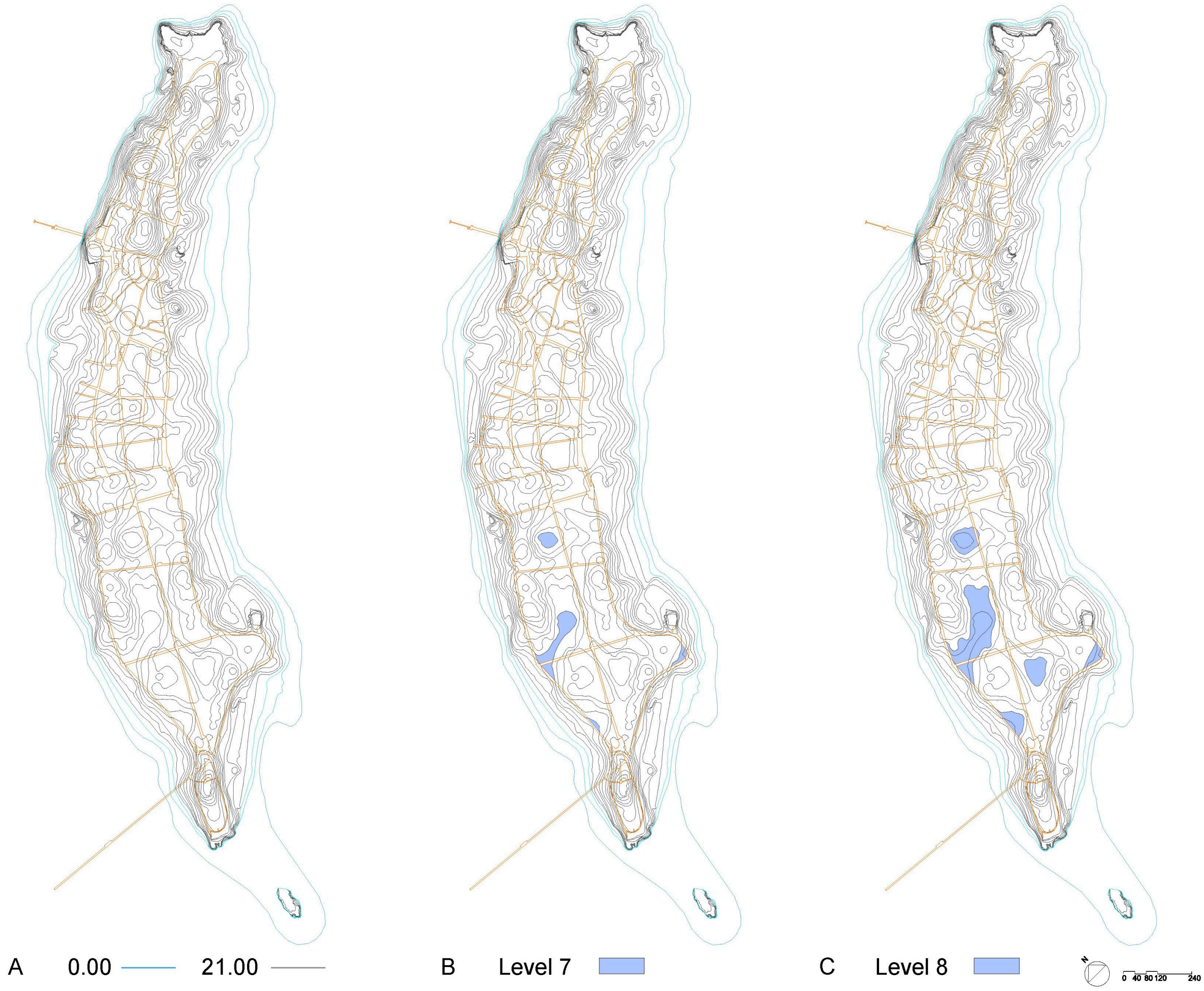

Figure 4. Topographic cartography with public-space street layer: from sea level to flooding zones. Reproduced by the authors.

2.2. Cultural Heritage Process of Mozambique Island

The heritage process of Mozambique Island during the 20th century and leading up to its UNESCO World Heritage nomination was characterized by a complex interplay of historical, cultural, and administrative factors. In the early 20th century, the island's rich architectural heritage, stemming from its role as a Portuguese trading post since the 16th century, began to receive increased attention. The island's cultural significance was further recognized in 1943 when the former colonial Commission for Monuments and Historic Relics in Mozambique began classifying historical monuments [1].

Following Mozambique's independence in 1975, efforts to preserve the island's heritage intensified, with the establishment of the National Service of Museums and Antiquities in 1975, and the Brigade for the Conservation and Restoration of Ilha de Moçambique in 1977. These initiatives culminated in the passing of the Law for the Protection of the Cultural Heritage of Mozambique (Law No. 10/88). This statute designates the entire old town as a protected urban complex, recognizing its collective historical and cultural significance. This law made an automatic classification as a national cultural heritage of all structures predating 1920, mandating their inclusion in the National Register for Cultural Heritage, overseen by the Ministry of Culture [1].

This legislative framework, combined with the island's exceptional architectural unity and historical significance, paved the way for its inscription as a UNESCO World Heritage Site in 1991, recognizing its outstanding universal value as a witness to the exchange of European, Arab, Indian, and African cultural influences [1]. Following its UNESCO World Heritage Site listing, the island has undergone a continuous process of conservation and management efforts.

It is important to highlight the Regulation for the Classification and Management of the Built and Landscape Heritage of the Island of Mozambique, approved by Decree 54/2016, of November 2016. The document lists 510 stone and lime buildings on Mozambique Island, establishing general criteria for interventions in built heritage, which include authenticity, integrity, legibility, reversibility, and cultural and environmental identity. This Regulation structures heritage, according to its relative value in classes A+, A, B, C, and D (Table 2). The built heritage classification system establishes a hierarchy that reflects the buildings' historical, architectural, and cultural value. The highest class, Class A, encompasses monuments and buildings of exceptional historical and architectural importance, followed by Class B, which includes buildings of high heritage value. Class C covers structures of significant historical and architectural interest, although less than the previous classes. Finally, Class D, the lowest, comprises buildings with less individual heritage value, but which contribute to the overall character of the urban ensemble. This classification serves as the basis for determining the level of protection and the interventions allowed in each building, guaranteeing the adequate preservation of the island's heritage. The Regulation establishes specific intervention guidelines for each class of cultural property. It also establishes local management committees to involve communities in the protection of their heritage, recognizing them as the legitimate guardians and beneficiaries of these cultural assets.

Table 2. Comparative analysis of the regulation on the classification and management of the built and landscape heritage of the Island of Mozambique based on the colors of the map of classified buildings [20].

	Class A	Class B	Class C	Class D
Criteria	Strict guarantee of authenticity, integrity, cultural and environmental identity		Guarantee of authenticity, integrity, cultural and environmental identity	
Respecting the original	Original design, spatiality, volumetry and image	Original structure, spatiality, volumetry and image		Facade and, if possible, structure, spatiality, volumetry and image
Techniques and materials	Strict respect for traditional techniques and original materials		Respect for traditional techniques and original materials	
Modern equipment	Exceptional possibilities, with restrictions	Possibility of incorporation		*
Typological and façade alterations	*	Minor alterations allowed	Changes allowed without changing exterior-interior relations	Possibility of rebuilding the original façade and structure
Modern materials	*	Allowed if needed for durability and comfort		*

* Without information.

A joint initiative between Lúrio University and the UNESCO Chair in Intercultural Dialogue on Heritage of Portuguese Influence at the University of Coimbra was held in 2017. According to the report [27], Mozambique faced several challenges in preserving its built heritage. These included the need for training and capacity building in conservation practices, the strengthening of institutions responsible for studying, regulating, and monitoring heritage, and the involvement of a wide range of economic and social agents. In addition, it is crucial to obtain adequate funding for the study, safeguarding, and maintenance of heritage, as well as promoting public awareness of its importance.

The regulated decentralization of activities and the promotion of a sense of belonging and sustainability are also key aspects. To tackle these challenges effectively, an integrated and collaborative approach is needed to ensure the sustainable preservation of Mozambique's rich built heritage.

The follow-up report [25] included a survey and systematization of the buildings from Macuti town and Stone and Lime town. The survey was conducted in January 2022, before the Gombe cyclone (which happened in March 2022). The survey of 72 buildings addressed the architectural characterization of the island (Figure 5a), while the overlay of topographic cartography with the public-space street network (Figure 5b) highlights the urban morphology of the island. This comprehensive approach provides a holistic view of the island's-built environment, combining detailed architectural analysis with broader urban patterns. Together, these figures provide a comprehensive understanding of the island's-built environment, from individual buildings to the overall urban structure.

(**a**) (**b**)

Figure 5. (**a**) Building cartography with red circles marking survey locations (January 2022), based on information from [25] (**b**) Topographic cartography with the public-space street layer in black and green. Produced by the authors.

This study contained images and references regarding the implantation, design, and organization, the percentage of openings on the main façade, the type of front balcony, the exterior balcony cover, the metal railing on the balcony, the openings and the frames, and the categories of windows and doors, the geometry of the roof, as well as the constructive characterization and the state of conservation of the urban fabric. The study on the island of Mozambique was distributed between the Macuti town (40 buildings) and the Stone and Lime town (32 buildings). In the case of Stone and Lime town, eight unique buildings were included, which received a particular analysis.

The methodology adopted for the categorization and sub-classification of building typologies followed the same principle used in the 2011 report entitled "Island of Mozambique—Architectural Survey and Study on Local Vernacular Architecture" [25], namely:

(a) Traditional construction with a natural fiber roof, which is considered the "original" vernacular construction.
(b) Traditional construction covered with an industrial roof.
(c) Conventional construction covered with industrial tiles, as well as three versions involving coral stone construction and a concrete slab roof (Figure 6).

Figure 6. Panoramic view of Macuti town. Reproduced with permission from Mariana Correia, author archive, 2018.

In the analysis for the survey of Stone and Lime town, the work of Alexandre Lobato (1945) was used as a basis, adopting a categorization and subdivision based on the morphology and typology of popular residences and storage structures.

Building upon this historical foundation, recent conservation efforts have been documented in a comprehensive report by the Conservation Office (GACIM), which provides an overview of the challenges and initiatives undertaken on Mozambique Island from 2019 to 2022 [21].

This report, focusing particularly on the aftermath of Cyclone Gombe in March 2022, highlights several critical aspects of the island's preservation. It emphasizes the importance of expanding the buffer zone following the Technical Guidelines for the Application of the World Heritage Convention, a measure deemed crucial for enhancing the protection of the site's Outstanding Universal Value. Additionally, the report stresses the need for approval of an Urban Structure Plan for the Island of Mozambique District, which would provide a framework for sustainable development and conservation of the heritage site. The document also outlines the development of "Specific Rules for the Conservation of the Built Heritage of the Macuti Town" and addresses the pressing need to improve living conditions in this area. Acknowledging the challenges posed by demographic pressure, the report details several initiatives aimed at preserving the unique architectural heritage while enhancing residents' quality of life, including the acquisition of a house to serve as "Casa dos Contos" and efforts to mobilize funds for sustainable development [21].

2.3. Constructive Techniques and Vernacular Architecture in Mozambique Island

When the town was built of stone and mortar, the town ordinances (1850–1899) required regular annual maintenance, between June and August. The quarrying of limestone had regulations stating that it could not come close to the road and that the ground had to be re-laid and levelled. The huts were initially restricted and could only be outside the town limits, where there were also lime kilns, a slaughterhouse, and deposits of firewood and coal. Roofs covered in straw or macuti had to be temporary until they were replaced with tiles or schist [26] and buildings had to be 2.5 m apart.

The traditional housing typology in Mozambique Island is characterized by a plan organized around a central courtyard. Rooms are typically arranged in a "U" or "L" shape surrounding this patio, with main rooms facing the street and bedrooms along the sides. Access to the house is through a corridor connecting the street to the patio. Service areas like kitchens and bathrooms are usually located at the rear of the plot. Stairs to upper floors are commonly found in the patio area, and verandas or galleries often surround the patio on upper levels. This architectural configuration allows for good ventilation and natural lighting of interior spaces while providing a private outdoor area at the center of the residence. The layout reflects a design that is well-adapted to the local climate and social customs of the island.

The architecture exhibits homogeneity in its use of materials and construction techniques, which is particularly evident in Stone and Lime town (Figure 7). Buildings in this area share common architectural elements and construction methods, characterized by the widespread use of coral stone and lime mortar. The structures typically feature thick load-bearing walls made of coral limestone blocks, with lime-based plaster and whitewash finishes on both exterior and interior surfaces.

Figure 7. Two examples of street view façades from Stone and Lime town. Reproduced with permission from Mariana Correia, author archive, 2018.

Wooden floor and roof structures, often with local hardwoods, are prevalent throughout the buildings. Clay tile roofing is common, usually with slight slopes to facilitate rainwater drainage. Doors and windows are consistently made of wood, frequently sharing similar designs and proportions across different structures. Interior spaces are typically organized around central courtyards, which provide natural ventilation and light.

This architectural cohesion stems from the limited availability of local building materials and the endurance of traditional construction techniques over centuries [26]. However, nowadays concrete and other new materials have started to have a significant presence.

The masonry of buildings in Mozambique Island is characterized by the use of coral limestone blocks bonded together with lime mortar. Wall thicknesses typically range from 60 cm to 100 cm. Openings for doors and windows are spanned by stone or wooden lintels, with corners and openings often reinforced using cut stone blocks. Both interior and exterior wall surfaces are generally plastered and whitewashed, with the plaster made from lime mixed with fine coral sand. Some buildings feature decorative stonework around openings and at corners. This masonry technique, built with local coral limestone and lime mortar, is well-adapted to the tropical climate and has contributed to the durability and distinctive appearance of the island's architecture over centuries. The thick walls provide thermal insulation, while the lime-based materials allow the buildings to "breathe" and resist moisture damage. Doors, roofs, and windows are described and well-documented. Providing an important archive of built heritage, it is important to highlight that at that time, measurement surveys were made of 10 buildings, including construction details [26].

The Macuti town features a dense urban fabric with narrow, winding streets and alleys. The architecture is predominantly traditional, with houses built using local materials like wood, earth mixture, and palm leaves (macuti) (Figure 8). The Macuti town is divided into distinct quarters, each with unique characteristics. The oldest quarter is in the northern part, closest to the stone town, with a more regular street pattern and some stone buildings mixed with traditional houses. The central area is the most densely populated, with a maze-like network of narrow paths between closely packed houses. The southern part is less densely built, with more open spaces and larger plots. The western edge faces the mainland and has a more linear structure along the shore, while the eastern side borders the ocean and includes some flood-prone areas. Each quarter has its own social dynamics and community structures, often centered around small squares or open spaces. The architecture throughout Macuti town reflects the cultural heritage and traditional building techniques of the local population, adapted to the tropical climate and available resources [26].

(a) (b)

Figure 8. (**a**) Photo of Macuti buildings. Reproduced from [28]. (**b**) Photo of Macuti buildings and the drainage channel. Reproduced with permission from Mariana Correia, author archive, 2018.

The built form of the Macuti town on Mozambique Island is characterized by its organic and dense layout, reflecting the traditional African urban pattern. Houses are typically rectangular in shape, measuring about 3 × 6 m, and are arranged in compact clusters [26]. These clusters often form small courtyards or open spaces shared by multiple dwellings, fostering a sense of community and providing areas for social interaction. The houses are generally single-story structures, with walls made of wattle and daub or mud bricks. Roofs are traditionally covered with macuti although corrugated iron sheets are becoming increasingly common.

The Macuti houses in Mozambique Island are characterized by their traditional construction methods and materials. The walls of these houses are typically built using one of two techniques:

- Wattle and daub (*tabique* or *pau a pique*): This method involves creating a framework of wooden poles or bamboo, which are then filled with an earth mixture, straw, and sometimes animal dung. This creates a sturdy wall structure that is well-suited to the local climate (Figure 9).

- Adobe (sun-dried blocks): Some Macuti houses have walls made of adobe masonry. These adobes are made from local soil mixed with straw or other plant fibres for reinforcement.

Figure 9. Photo of Macuti buildings with the wattle-and-daub structure. Reproduced from [28].

The roofing structure consists of wooden rafters covered with palm leaves, providing excellent insulation against the tropical heat and allowing for natural ventilation. However, this traditional roofing material requires regular maintenance and replacement.

Inside the houses, usually, there are no ceilings, leaving the underside of the roof structure exposed. This open ceiling design helps with air circulation and cooling. In some cases, a partial ceiling may be created using woven mats or other light materials to provide some separation between the living space and the roof. The combination of the macuti roof and the open or partially covered ceilings contributes to the overall climate adaptation of these traditional houses, helping to keep the interior spaces cooler in the hot and humid environment of Mozambique Island [26].

Concrete buildings have become increasingly common in the Macuti town. These structures represent a shift from traditional building methods towards more modern construction techniques. These structures typically feature rectangular floor plans larger than traditional macuti houses, with walls made of concrete blocks or bricks. They often have corrugated iron or fiber cement roofing instead of palm leaves, and windows and doors made of metal or wood. To protect against flooding, these buildings are constructed with raised foundations. Some concrete buildings are also built with multiple stories, further distinguishing them from traditional single-story macuti houses [26].

The survey of buildings in the 1980s report describes that measurement surveys were conducted for 10 selected buildings, including construction details. This comprehensive survey provided an important archive of the built heritage on the island. The documentation likely included floor plans, elevations, cross-sections, and detailed drawings of architectural elements and construction techniques [26].

Also in the 1980s, the report on Mozambique Island highlighted the importance of local resources for construction and restoration efforts. The island's traditional architecture relies heavily on materials sourced from the surrounding environment:

- Coral stone, extracted from nearby reefs, serves as the primary building material for walls and foundations.
- Lime, produced by burning coral in kilns, is used as mortar and for plastering.
- Mangrove poles and coconut palm wood are used for roof structures and flooring.

- Clay, found on the mainland, is employed for making roof tiles and bricks.
- Earth mixture is used as the base for the wattle and daub walls, and the adobe masonry walls.
- Macuti, found on the mainland, is used for roofing in the Macuti town.
- The sea provides sand for construction purposes.

These locally available resources have shaped the unique architectural character of Mozambique Island for centuries [26].

However, some of these traditional materials, particularly coral stone and macuti, are becoming scarce due to overexploitation. As a result, there is a need for careful management and consideration of alternative materials when addressing future conservation.

2.4. Conservation Assessment of Mozambique Island

Before the Gombe cyclone, as previously mentioned, a state of conservation assessment was performed by the local conservation office (GACIM). In this report [25], it is possible to identify both commonalities and distinct differences in the degradation phenomena affecting the Macuti, and the Stone and Lime built heritage (Figure 10). In both neighborhoods, flooring issues such as cracks, wear, and aging of materials are prevalent. However, the Stone and Lime buildings also face a lack of adhesion, which is not mentioned in the Macuti ones. This additional problem suggests a more severe deterioration of flooring materials in the Stone and Lime area. When examining the façade and masonry, both built heritage experience paint degradation. The Macuti buildings are particularly affected by major localized cracking, while the Stone and Lime buildings reveal significant signs of humidity and general aging of materials. These differences indicate that while both areas suffer from surface-level degradation, the Stone and Lime town might be dealing with more profound structural issues due to moisture. The wooden frames in both neighborhoods exhibit paint degradation, and wood degradation. However, the Macuti houses also report degraded or non-existent hardware (metallic elements of the frames) and broken glass, suggesting a more advanced stage of neglect or damage. For window frames, both cases experience mild or scattered cracking and chromatic changes. The Macuti town buildings additionally faces major localized cracking, indicating more severe structural stress. Finally, the roof conditions differ significantly. The Macuti buildings suffer mainly from major deformation and poor drainage, while the Stone and Lime roofing is described as non-existent, ruined, or pre-ruined. This last level of degradation is also described in 40% of the Macuti houses characterized as having natural fibers as roofing, underlining the major degradation phenomena associated with the traditional roof structure of the Macuti town. Nevertheless, this highlights a critical degradation in the vernacular roofing in both neighborhoods.

Overall, while both towns share several common degradation phenomena, the Stone and Lime town appears to be in a more advanced state of deterioration, particularly in terms of flooring adhesion, façade humidity, and roof conditions.

After the cyclone, a new report on the state of conservation of Mozambique Island was prepared by the Island of Mozambique Conservation Office (GACIM) [21]. In this document, the damages reported in the aftermath of the cyclone reveal the intensity and the level of destruction that the built heritage suffered. As previously mentioned, four important monuments were severely damaged by the cyclone—Palácio de São Paulo; São Domingos Convent; Nossa Senhora de Baluarte Chapel; Hospital and Municipal Market. These buildings experienced significant physical degradation and loss of material mostly on the roof structure and main façades. On the other hand, the report indicates that in seven Macuti houses, GACIM implemented reinforcement techniques on the traditional fiber roofs during a project entitled "Heritage Education and Participatory Construction in Macuti Town". In these seven houses, the cyclone did not cause any damage emphasizing the importance of using resilient reinforcement techniques and doing it through community engagement strategies.

It is important to highlight that when addressing conservation efforts and actions, they should be tailored to the specific challenges faced by each town. Both Macuti and Stone and Lime built heritage present different materials and building techniques that need to be preserved in specific ways. This is even more relevant when facing extreme climate events that require the implementation of resilient measurements that should not compromise the integrity and the authenticity of the property.

Figure 10. Some examples of the degradation phenomena (cracks, humidity areas, paint degradation, and weathering) observed in the Stone and Lime buildings. Reproduced with permission from Mariana Correia, author archive, 2018.

2.5. Case Studies Analysis—Bangladesh and Fiji

To provide concrete examples and in-depth analysis, the methodology incorporates two comparative case studies. These will focus on representative examples of buildings and public spaces, conducting detailed assessments of their performance during extreme weather events. The analysis of case studies are valuable lessons that contribute to identifying comprehensive principles from vernacular practices. Examining diverse traditional architectural examples from other geographical regions provides essential insights for sustainable heritage conservation practices.

2.5.1. Sandwip Island, in Bangladesh

In the coastal island of Sandwip, in Bangladesh, vernacular construction practices were used to enhance cyclone resilience [29]. Through structured questionnaires, video recording, and detailed documentation of vernacular architecture and planning strategies, the study identifies resilient design and construction principles integrated into local Sandwip Island building practices.

Recommendations for bolstering local resilience include integrated strategic and spatial planning at the settlement level and organized planting. For infrastructure and services, a long-term strategy suggests replacing landfills, constructing roads with permanent materials, limiting motorized vehicles, and enhancing connections to surrounding areas with electrical energy support for industrial activities and neighborhood-wide solar panels. Regarding land use, comprehensive zoning is recommended, with designated areas for coastal forestry, small agricultural-based industries, commercial activities, and fishing support. Residential land use densification is also advised. For housing, research should investigate local materials and construction techniques to propose sustainable solutions. Building compact, multi-story houses on stilts can serve as warehouses, especially for emergency shelters during natural climate disasters.

Local practice techniques were analyzed in the pre-disaster period, to understand their potential to resist the effects of cyclones (Table 3). The study highlights coastal communities' reliance on Indigenous wisdom throughout the disaster cycle. However, this valuable knowledge system has not been fully recognized in policy-making or modern disaster management paradigms. Integrating traditional and scientific knowledge is crucial for effective resilience strategies.

Table 3. Local practices used in Sandwip Island to enhance vernacular architecture.

Urban/Territorial Level Practices	Household Level Practices	Architectural and Structural Details
- Physical Planning: Houses are strategically positioned with surrounding vegetation to absorb wind forces, and tree types are selected based on wind direction. - Tree Distance: Houses are placed safely from trees to avoid damage from falling during intense winds, with distance based on tree height. - Rainwater Harvesting: Cyclone damage to water sources is mitigated by creating ponds to store rainwater, and elevated latrines are constructed for sanitation.	- Orientation: Houses are designed with a rectangular layout, positioning the shorter side toward the wind to prevent toppling. - House Typology: Homes feature a central space protected by a surrounding area with a lower section, with hip roofs, minimal overhangs, and separate roof structures for added safety. - Openings: Top-hung windows are preferred for cyclone safety, while corner openings are avoided. Symmetrical openings on the windward side are recommended.	- Foundation: Homes are built on raised mounds for flood protection, with height based on local flood experience. - Vertical Post System: Vertical posts are separated above ground from foundation posts for durability and easy replacement. - Walls are reinforced with diagonal bracing to withstand wind pressure. - Roof: Properly secured roofs with strong purlins reduce cyclone damage. - Materials: Stronger materials like nylon ropes are used to reinforce structures against cyclones.

2.5.2. Navala Traditional Houses, in Fiji

Another interesting case study is the traditional houses in Navala, Fiji that were affected by Cyclone Winston [30]. Despite Fiji's housing stock suffering extensive damage during the annual cyclone season, leading to excessive costs in repairing and rebuilding damaged properties, the study's key findings reveal that traditional houses, especially those with central poles, performed well during the cyclone and meet the internationally recommended cyclone-resistant structural characteristics.

In this case, some unique characteristics of the traditional bure, from the time it takes for the house to collapse to the collapse pattern itself. The damage pattern is primarily on the outside of the house, which would protect inhabitants from being hit by the falling roof structure. Unique cyclone resistance features were highlighted that could be recommended for regional implementation in future houses. Standard square or rectangular plans are best for cyclone resistance, with short walls having a maximum height of 1.85 m above the foundation level. These houses have no windows, only three wooden doors with wooden frames placed on three sides. The houses were well-insulated compared to contemporary houses with corrugated iron roofs, making windows unnecessary for ventilation. The breathable wall mats or weaves prevented temperature build-up, inside the house [30]. In climate events with intense winds, the absence of windows protects the roof from blowing off and the leeward side walls from collapsing, as the pressure build-up inside the house becomes negligible.

All houses were built on a raised rock foundation, a recommended practice in flood-prone areas, as intense rain associated with cyclones results in strong surface water flow that could wash away the house. In the two main models of traditional Navala houses, the main difference, besides the size and roof slope, was the use of straight posts. The straight pillar, carved from hardwood timber, was placed in the middle of the house, deeply embedded in the rock foundation up to about 1.5 m. Foundations of traditional Navala houses can reach 1 m in height. The wooden posts are deeply embedded in the foundation, with hole depths ranging from 1.5 m for corner and wall posts to 3 m for center posts. This feature anchors the structure to the foundation and prevents it from being pushed by intense winds.

Observations addressed in Navala revealed that the large model with a 55° roof slope was less damaged, following Tropical Cyclone Winston. Further research is needed to examine the behavior of roofs with slopes between 46° and 60° in high wind conditions. The eaves had minimal width and did not exceed the thickness of the roof's thatches. To make the buildings even stronger, the roof culms were tied to a truss made of bamboo cane. The truss acts as a shock absorber in high wind conditions, allowing the roof to move slightly rather than breaking the roof structure. The hipped roof resists strong wind better than gabled roofs. The roof beams are mainly made of bamboo cane or straight branches. The roof's structural connections are tied with natural ropes made from flattened bamboo canes. All connections in the house are secured with ropes made from natural sennit (*magimagi*), allowing a slight movement of the house's structural connections during high wind conditions. Tied connections are highly recommended for cyclone-resistant housing. The contemporary version of these connections consists of metal cords, in addition to the use of nails [30].

The findings from both case studies have significant potential to enhance local resilience and serve as a valuable resource for future research aimed at promoting disaster resilience through Indigenous knowledge and practices. It is worth noting that the solutions mentioned have demonstrated their effectiveness, as their performance has been validated through successful practical experiences rooted in local knowledge accumulated from the communities' daily activities. However, implementing these solutions in different geographical or social contexts requires a thorough analysis of numerous factors, including the type of predominant climatic phenomena, the intensity of these events, and their potential interaction with other risks or hazards.

3. Results and Discussion

The methodology used in this analysis of Mozambique Island through urban evolution, historical cartography, topography, morphology, and construction techniques provides valuable insights into the island's vulnerabilities and resilience challenges, as evidenced by the following:

(a) Urban Evolution (historical) and Topography—Morphological Analysis

- The island's dual urban structure, consisting of the Stone and Lime town and the Macuti town, reflects its complex cultural and architectural heritage.
- Historical maps reveal that the island's topography has significantly influenced its urban development, with the Stone and Lime town built on higher ground and the Macuti town situated at or below sea level.
- The quarry area, documented in 1802 cartography (see Figure 3), later became the site of Macuti town, highlighting how resource extraction shaped urban development.
- The Stone and Lime town exhibits a formal urban structure with regular streets, while the Macuti town has a more organic configuration with winding streets.

- The 20th century saw increased urbanization in the southern part of the island, with Macuti town becoming more compact and labyrinthine due to successive land subdivisions.

(b) Construction Techniques and Vernacular Architecture

- Traditional Macuti houses use distinctive roofing techniques and materials that reflect local building culture and adaptation to climate.
- The Stone and Lime town's buildings, constructed with stone masonry and lime plaster, represent a different approach to climate adaptation.

(c) Cultural Heritage Classification and Conservation

- The Heritage Classification system (Classes A+, A, B, C, and D) established by Decree 54/2016 provides a framework to address preservation efforts, especially in the case of national monuments (Class A+).
- However, the Heritage Classification system introduces potential risks, especially in the case of Categories B, C, & D, as it gives more flexibility for change, even opening the possibility for façadism in the World Heritage property (as seen in [20]).
- The 2022 buildings survey provides a baseline for understanding the architectural characteristics and state of conservation before Cyclone Gombe.

(d) Vulnerabilities to Climate Change

- The island's exposure to cyclones, as evidenced by the impact of Cyclone Gombe in 2022, underscores its climate vulnerability.
- The low-lying areas, particularly in the Macuti town, are at higher risk of flooding and sea-level rise impacts.
- The different construction techniques and materials used in the two towns result in varying levels of resilience to extreme weather events.
- The need to balance authentic preservation with modern resilience measures presents a significant challenge, especially in the face of increasing climate-related risks.

(e) Comparative analyses—case studies

The study cases of Fiji and Bangladesh, when considered in the context of Mozambique Island, reveal several key points that can enhance our understanding of urban resilience strategies for UNESCO World Heritage sites facing climate change challenges. Lessons from Fiji and Bangladesh highlight the importance of integrating urban-level practices, household-level practices, and architectural and structural details, focusing on the following:

(a) Vulnerability Assessments: Bangladesh's approach to assessing the vulnerability of essential infrastructure could be applied more rigorously to Mozambique Island, particularly in evaluating the resilience of historic structures in both Stone and Lime town and Macuti town.
(b) Informal Settlement Focus: Fiji's attention to informal settlements is particularly relevant for Mozambique Island's Macuti town, where addressing infrastructure and housing vulnerabilities is crucial for overall urban resilience.
(c) Awareness Raising and Capacity Building: Both Fiji and Bangladesh emphasize the importance of awareness and capacity building through community engagement:

- Training and Education: Mozambique Island could benefit from implementing more comprehensive training programs, like those in Fiji, focusing on disaster preparedness and conservation techniques specific to its unique architectural heritage.

- Integration of Disaster Risk Management: Following Bangladesh's example, Mozambique Island should consider further integrating disaster risk management into its urban planning and heritage conservation practices.

These findings contribute significantly to understanding the island's vulnerabilities and can inform targeted resilience strategies. This comprehensive understanding is crucial for developing appropriate conservation and adaptation measures that respect the island's Outstanding Universal Value while enhancing its resilience to climate change impacts.

4. Conclusions

The architectural landscape of Mozambique Island is a witness to the island's resourcefulness in the face of geographical constraints and limited resources. What makes this analysis particularly intriguing is its contribution to the understanding of the island's development since its origins.

The inherent insularity of Mozambique Island led to the ingenious use of available resources, shaping two distinct architectural types of buildings that define the island's character. In the Stone and Lime town, the abundant stone from nearby quarries became the primary building material. This area is characterized by sturdy structures that have withstood the test of time. In contrast, the Macuti town showcases a different construction approach. Here, the resourceful use of vegetation creates unique and functional dwellings.

This dichotomy in building types not only reflects the island's material diversity but also the socio-economic divisions that have historically shaped its urban landscape. The island's insularity, coupled with poverty and scarcity of resources, presents both challenges and opportunities for sustainable development. While palm leaves and stone have been the traditional materials of choice, the lack of future availability of these materials put into consideration, the potential to explore other locally available sustainable building practices.

The most pressing issues in Mozambique Island, particularly in Macuti town, are related to public space, land erosion, and public health and sanitation. The area suffers from overcrowding and high population density, exacerbated by extreme poverty. There have been discussions about relocating some of the population, partly driven by the growing tourism industry. While this may seem like a solution, any proposals for change must be approached with great caution and sensitivity to the local community's needs and the island's cultural heritage. The balance between preserving the island's unique character and improving living conditions for its residents remains a delicate and crucial challenge for future development efforts.

In conclusion, the architectural dichotomy of Mozambique Island serves as a microcosm of the broader challenges facing African architecture and urban settlements. The island's unique situation provides a tangible example of how an approach to a framework can be applied to real-world scenarios, offering valuable insights for the management and preservation of built heritage across the African continent.

In this sense, future research on Mozambique Island's built environment should focus on developing a comprehensive framework for buildings and public spaces exposed to climate change. The study of international vernacular case studies contributes to obtaining knowledge and achieving valuable lessons regarding sustainable heritage intervention [31]. This framework will draw on lessons from past case studies and contribute to understanding the post-cyclone 2022 state of conservation. Key components for a local framework should include two main strategies:

(a) Management Tool based on GIS (Geographic Information System)—Development of a multisectoral management tool for a continuous assessment conservation update based on GIS.

a.1. Cartography Enhancement: provide a detailed survey identifying neighborhoods and cataloguing buildings, alongside unique heritage sites affected by Cyclone Gombe. This will involve mapping the most relevant neighborhoods, buildings, and public spaces to understand their current conditions and vulnerabilities. Verify existing cartography with classifications from previous reports, ensuring alignment with the latest inventory buildings. This will help identify overlaps and discrepancies, providing a clearer picture of the heritage landscape.

a.2. Risk Mapping: Production of risk maps using methodologies for modelling and assessing the impacts of sea-level rise, flooding from heavy rains, and wind effects from cyclones, as well as other climate change consequences. By visualizing these risks, the maps provide crucial information for urban planning, disaster preparedness, and climate adaptation strategies, helping communities and decision-makers better understand and address the complex challenges posed by changing environmental conditions.

(b) Community Engagement—Training and capacity-building initiatives will empower local communities to participate actively in assessing heritage conservation states and implementing resilience mechanisms against cyclonic risks. Strategies such as the involvement of various stakeholders, including residents as the best protectors of heritage, and protectors of the place; strengthening public education, with teachers and students as educators of strategies in assessing the conservation status of heritage; alliances with more international organizations and professionals, from adjacent areas, offering technical and financial support in the implementation of resilience mechanisms against cyclonic risks, could be implemented [32].

This approach to vulnerability assessment in cultural heritage contexts aligns with the evolving understanding of vulnerability reflected in recent ICOMOS documents. The consideration of public spaces and historical cartography adds depth to the assessment, potentially capturing the social and cultural dimensions of vulnerability that have gained prominence in recent definitions. Moreover, the strategy of involving communities in this assessment process resonates with the growing recognition of the importance of local knowledge and participatory approaches in vulnerability assessments, as highlighted in recent ICOMOS frameworks. This community-centered approach can contribute to a more comprehensive understanding of a site's adaptive capacity, a key component in modern vulnerability definitions. By integrating these various elements, this approach has the potential to provide a holistic view of heritage site vulnerability, aligned with a context-specific assessment framework, in the field of cultural heritage preservation; and considering a contribution for the future, as a resilient cultural place.

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