GACIM & Universidade Portucalense

UNESCO World Heritage Site:

Island of Mozambique

Management, Conservation and Resilient Habitat in the face of Cyclones

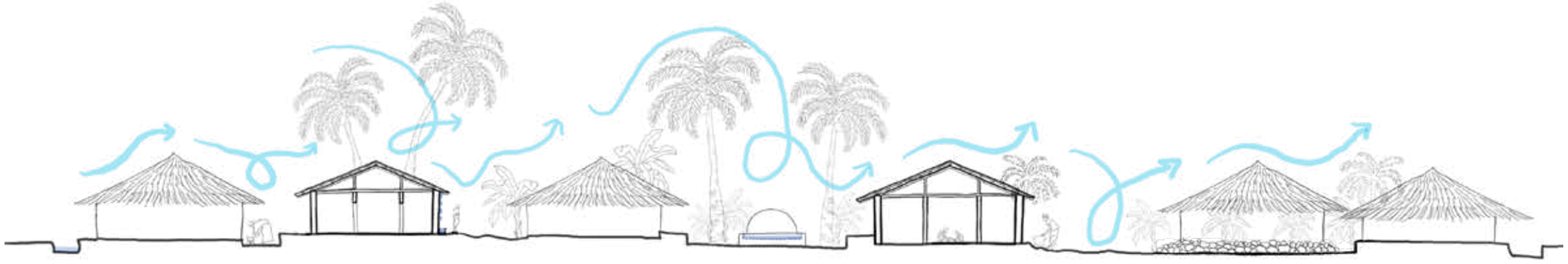


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"UNESCO World Heritage Site: Island of Mozambique, Management, Conservation and Resilient Habitat in the face of Cyclones"

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1 Framework





Figure 1.
Identification of listed heritage in the Island of Mozambique.

Credits:
Joaquim Flores, Susana Milão, Olga Álvarez

Introductory Note

This publication aims to present the participatory approach work carried out in close partnership between GACIM - the Conservation Office of the Island of Mozambique, the Portucalense University, and Mozambican consultants, between October 2024 and July 2025.

The Portucalense University team and the Mozambican consultants coordinated the implementation of the project 'Community Participation in Assessing the State of Conservation of Heritage and Resilience Mechanisms in Response to Risks and Disasters caused by Cyclone Gombe' promoted by GACIM and funded by UNESCO's World Heritage International Assistance Fund. This extensive and intensive work was structured around 4 pillars: **A.** Technical capacity building; **B.** Post-cyclone conservation status assessment; **C.** Development of a multi-sectoral management tool to respond to disasters; **D.** Preparation of a brochure with recommendations for a more cyclone-resilient habitat.

This publication does not replace the in-depth knowledge of local technicians, nor the know-how of local communities. Rather, it aims to present a tool for understanding ways to assess the island's state of conservation; to enable, through GIS, more effective management of the island's growing exposure to increasingly aggressive cyclones; and to present recommendations that contribute to strengthening the local habitat.



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Introductory Note from GACIM

This booklet is the result of the implementation of the project “Community Participation in the Assessment of the State of Conservation of Heritage and Resilience Mechanisms in Response to Risks and Catastrophes caused by Cyclonic Incidents”, funded by the UNESCO Heritage Centre – Paris | International Assistance No. 3428, in response to the cyclical occurrence of extreme events, in particular, cyclones on the Island of Mozambique.

The Island of Mozambique was inscribed on the UNESCO World Heritage List in 1991, in recognition of its Outstanding Universal Value expressed by the richness of its architecture, traditional building techniques, history and local traditions, resulting from past contact with different people and cultures. Given the frequent occurrence of tropical cyclones in the World Heritage Site, the attributes of the Island of Mozambique have been severely affected, which jeopardizes the maintenance of its integrity and authenticity.

Bearing in mind that global climate change is a reality today, it is necessary to provide communities with tools for the adaptation and mitigation of its effects, in order to strengthen community resilience. Thus, this booklet serves as a reference and technical support tool for local actions and initiatives, which can contribute to mitigating the harmful effects caused by cyclones. Likewise, we hope that this management tool can be used by all local stakeholders whose activities, directly

or indirectly, have impacted the conservation of the cultural heritage of the Island of Mozambique.

We commend the technical partnership between GACIM and the Portucalense University, the latter being the coordinator of the project's implementation, which also included the participation of Mozambican consultants. ●

Cláudio Zunguene
Director of the Island of Mozambique Conservation Office

Introductory Note from the Portucalense University

The Island of Mozambique has faced a large number of challenges related to its preservation and the survival of its communities given the growing vulnerability of its built heritage, a living heritage exposed to extreme weather events, especially cyclones.

Since Cyclone Gombe in March of 2022, the Island of Mozambique has continued to be affected by a high number of tropical cyclones: Cyclone Freddy in Feb. 2023, Cyclone Chido in Dec. 2024, Cyclone Dikeledi in Jan. 2025 and Cyclone Jude in Mar. 2025. The impact of this growing climatic phenomenon reveals the urgent need to develop resilient strategies for the protection of local communities and their habitat from the impact of natural disasters.

This project emerges as a response to this urgency, with the technical strengthening of local institutions and its community to manage and conserve their heritage and habitat.

The project was developed through: **(1)** Capacity building in (a) World Heritage; (b) Assessment and Conservation; (c) Management Instruments; and (d) Habitat Resilience. By means of: **(2)** Local assessment of damage caused by cyclones; **(3)** Conservation Status Survey; **(4)**Island Survey using Geographic Information Systems (GIS); and **(5)** Collaborative Mapping of risk elements associated with the impact of cyclones. With this approach it was possible to: **(6)** Identify the current state of the heritage; **(7)** Map the areas of greatest vulnerability; **(8)** Create an integrated management instrument; and **(9)** Define technical strategies for strengthening the habitat.

The good results of this collaborative approach were possible due to the professionalism, the work capacity and the dedication of all the teams involved in the project. This contributed to the empowerment of the communities that inhabit a living and vulnerable heritage of global importance. ●

Mariana Correia
Director of the Department of Architecture and Multimedia Gallaecia of the Portucalense University, researcher at CIAUD-UPT

2 Context



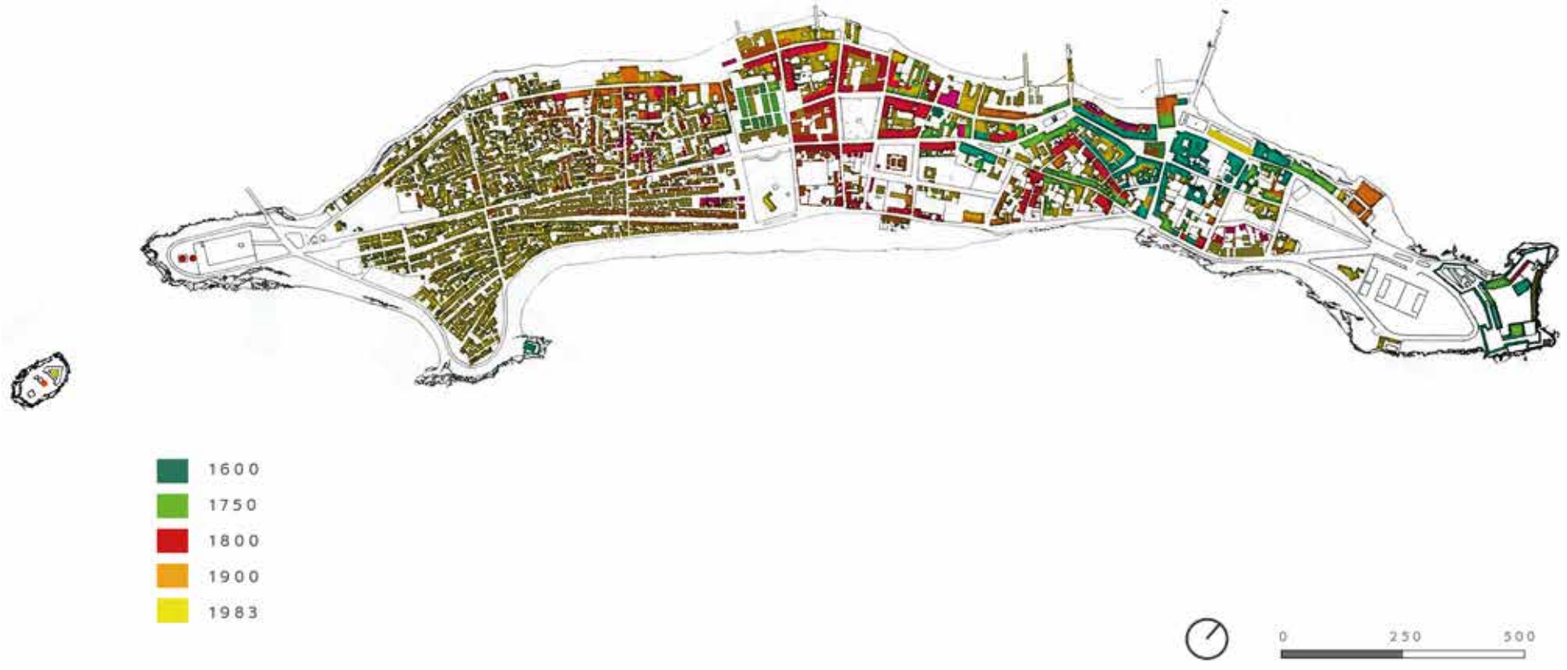

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Historical Note

The historical and morphological evolution of the Island of Mozambique results from the combination of diverse cultural, economic, and social dynamics that, over time, have shaped its urban character. The island's strategic location favored the reception and integration of different peoples and influences, from the initial presence of the Bantu people to the changes resulting from Arab influence, the expansion of Islam, and the commercial networks that were established there. This cultural convergence was reflected in the spatial organization and the diversity of buildings, allowing the development of a complex urban structure (UNESCO-CPM, 2025).

With the arrival of the Portuguese in 1498, a profound reorganization of the island began, marked by the construction of defensive and administrative buildings such as the São Sebastião Fortress, establishing a segmentation between the town of *Pedra e Cal* and the peripheral neighborhoods of traditional architecture. In the 17th and 18th centuries, economic growth, driven by trade, boosted urban expansion and deepened the division between the two main areas of the island.

At the end of the 19th century, after the transfer of the capital to Lourenço Marques, now Maputo, there was an economic slowdown due to infrastructure development in other regions. Several urban regulations and definitions of building materials sought to guide urban growth.



The 20th century highlighted the unique urban structure of the island, resulting from the coexistence of two areas with distinct but complementary urban characteristics: the town of *Pedra e Cal* and the town of Macuti. To the north, the town of *Pedra e Cal* developed from a consolidated and formal urban fabric, reflecting the historical evolution of the urban settlement. To the south, the town of Macuti developed in lower-level areas due to the historical extraction of coral stone used for construction in the northern zone. In this area, the urban fabric features main streets with a regular layout, but its occupation is more informal and dynamic, reflecting the progressive appropriation of space by the inhabitants, with Swahili-style buildings and the use of traditional materials and construction systems.

Following the country's independence in 1975, initiatives emerged to value the heritage and revive the traditional urban dynamics. The island's inscription as a World Heritage Site in 1991 boosted conservation and requalification processes of the built environment, reinforcing its historical and cultural relevance. ●

Figure 2.
Evolution of built historical periods on the Island.

Credits:
Susana Milão, Cristina Azevedo - adapted from Aarhus (1986).


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World Heritage List (1991)

The Island of Mozambique is a fortified island situated on a limestone coral reef at the entrance to Mossuril Bay, in the province of Nampula, in the north of the Republic of Mozambique. The island forms an archipelago with two small uninhabited islands, the islands of Goa and Sena. For almost four centuries, the Island of Mozambique was the capital of the country, playing a relevant role in the history of the Indian Ocean since the 10th century, due to the important intercontinental trade routes between Europe, Africa and the Indian subcontinent (UNESCO-CPM, 2025).

Under the UNESCO World Heritage Convention, the Island of Mozambique was classified as a World Heritage Site in 1991. This was an important recognition, which revealed the worldwide importance of this heritage of Universal Value. For this reason, the island must be protected and conserved so that it can be passed on to future generations.

Its classification as a World Heritage Site is because of the identification of the island's Outstanding Universal Value (OUV), which is structured by three important pillars: the first pillar is reflected in criteria (iv) and (vi), which defined its inscription; the second pillar is based on the justification of Integrity and Authenticity; and the third pillar, on compliance with the requirements for the Protection and Management of the site.

The Island of Mozambique Conservation Office (GACIM) has the important role of safeguarding these three pillars that govern and protect the classification of the Island of Mozambique as World Heritage.



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Attributes that express Outstanding Universal Value

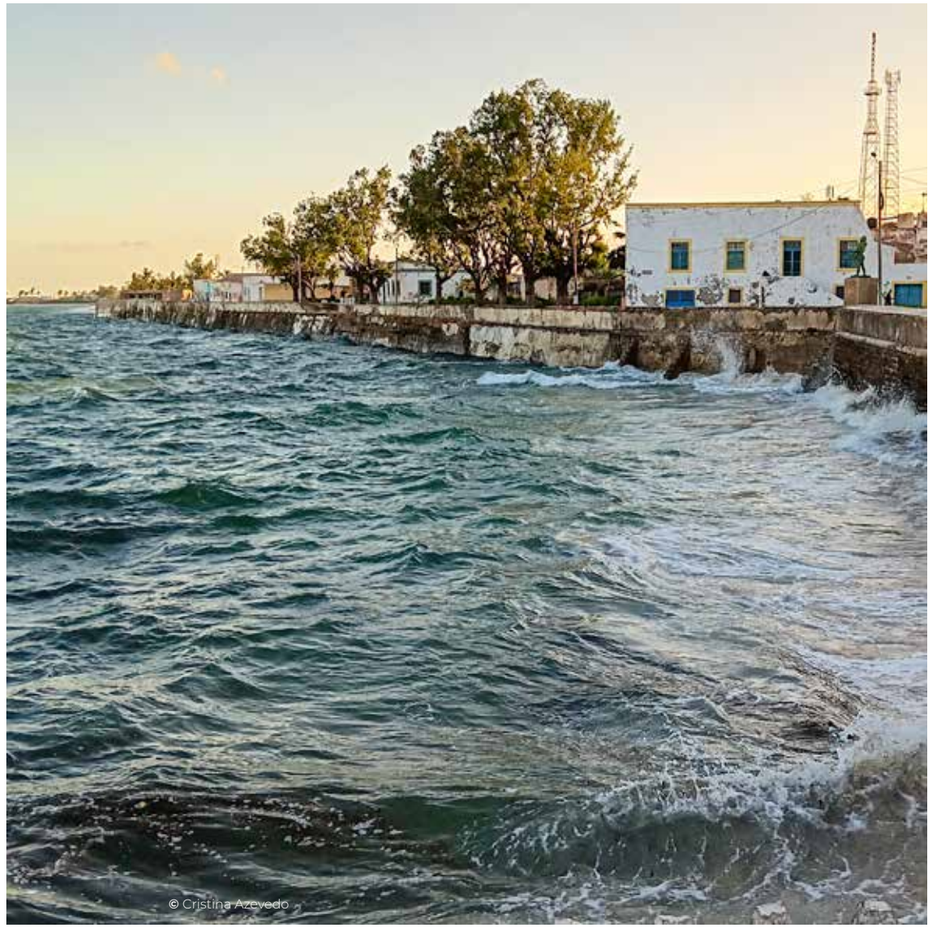
The Island of Mozambique presents a remarkable unity because of the continuous and consistent use since the 16th century of the same architectural and construction principles. The northern half of the island's architecture is influenced by Swahili, Arab, and European styles, and the south, by vernacular architecture, with traditional materials and systems of continental origin. The urban fabric and fortifications of the island are exceptional examples of this cultural diversity and the interaction of peoples of Bantu, Swahili, Arab, Persian, Indian, and European origin.

These are the attributes, representative of its history and remarkable cultural continuity that express the Outstanding Universal Value (OUV) of the Island of Mozambique. These may include tangible and/or intangible characteristics and/or processes related to social systems or cultural practices. These features may also be expressed through form and design; materials and substance; use and function; traditions, techniques, and management systems; language and other forms of intangible heritage; and spirit of the place, among other factors (CPM, 2024, par. 82, p. 32).

The attributes of an inscribed property are thus the elements that represent the inscription criteria on the site, but which may also incorporate the integrity and authenticity of the classified site. The legislation protecting the site and the implemented management system must also preserve the tangible attributes and safeguard the intangible features, as well as the associated processes.

3 Climate Change




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Climate Change in Mozambique

Climate change is one of the greatest global challenges of our time, impacting ecological, social, political, and economic systems across the board. The Intergovernmental Panel on Climate Change (IPCC) defines climate change as any significant alteration of the climate that persists for a prolonged period and can be attributed to both natural variability and human actions that alter the composition of the atmosphere (IPCC, 2021). This phenomenon manifests itself through an increase in the global average temperature, changes in precipitation patterns, a greater frequency of extreme weather events, and rising sea levels, among other effects. According to the IPCC (2023), the global average temperature has already increased by approximately 1.1°C since the pre-industrial period, primarily due to the emissions of greenhouse gases (GHG), such as carbon dioxide (CO2), methane (CH4), and nitrogen oxides (N_2O).

The causes of climate change can be divided into natural and anthropogenic. Natural causes include volcanic eruptions, solar variations, and changes in Earth's orbital cycles. Anthropogenic causes are predominantly derived from the burning of fossil fuels, deforestation, intensive agriculture, and land use, which are responsible for emitting large volumes of greenhouse gases into the atmosphere (Stern, 2007).

In the context of Africa, particularly in Mozambique, climate change has severe consequences. The country is considered

one of the most vulnerable in the world to climate disasters, ranking 7th in the Global Climate Risk Index (Germanwatch, 2021). Between 2000 and 2022, tropical cyclones, floods, and droughts affected millions of people, resulting in significant human, economic, and environmental losses (INGC, 2009; World Bank, 2023).

In Mozambique, the main observed climate effects include an increase in the national average temperature, irregular rainfall, alternating periods of severe drought and destructive floods, rising sea levels in coastal areas, coastal erosion and salinization of agricultural soils, and the intensification of tropical cyclones.

The INGC report (2009) projects that, by 2040, more than 900,000 people may be forced to migrate due to rising sea levels and the loss of habitable land. Vulnerability is exacerbated in coastal and island areas, such as the Island of Mozambique, where population growth, disordered occupation, and fragile infrastructure hinder resilience to climate shocks. ●

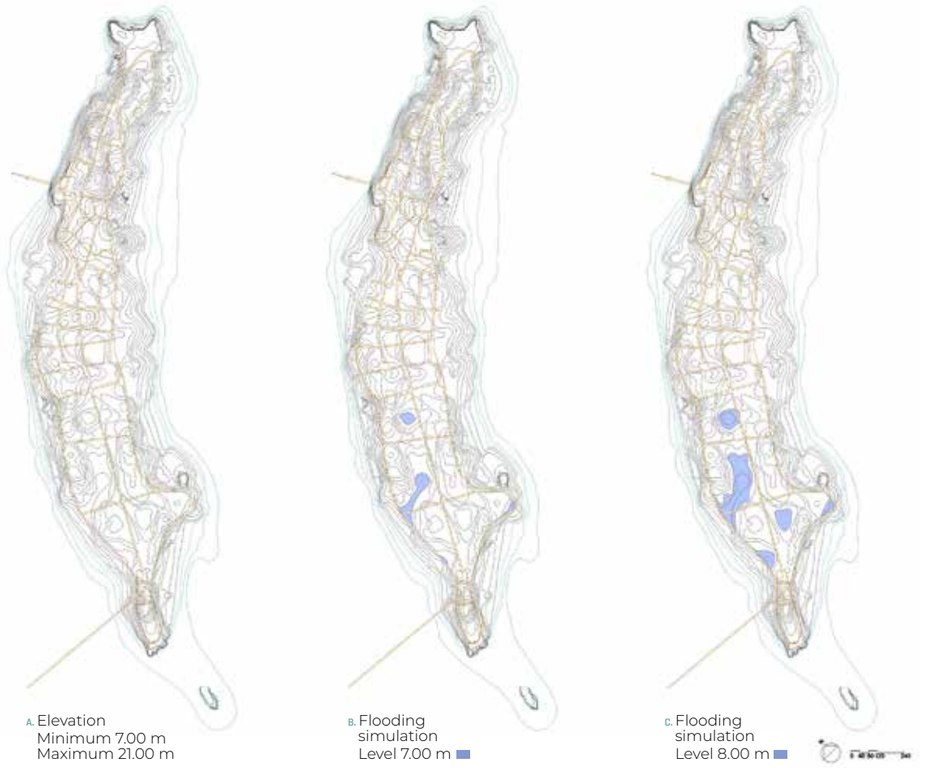


Figure 3.
Topographic mapping with reference to public streets: from sea level to flood zones.

Credits:
Joaquim Flores, Susana Milão


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Major Extreme Weather Events

The Island of Mozambique, due to its coastal geographic location and low altitude, is particularly exposed to several extreme weather events, which have increased in frequency and severity in recent decades. These events put human lives, livelihoods, infrastructure, cultural heritage, and local ecosystems at risk.

According to the Island of Mozambique's Local Adaptation Plan (2019), the main extreme events recorded in the region include: tropical cyclones and strong winds; torrential rains and floods; prolonged droughts; coastal erosion; sea level rise; heat waves; and uncontrolled wildfires. These events disproportionately impact the most sensitive sectors of the local economy: rainfed agriculture, artisanal fishing, and tourism.

The National Institute for Disaster Risk Reduction and Management (INGD) and the participatory assessment carried out during the preparation of the Local Plan identified a significant increase in the frequency and intensity of these events, highlighting the following notable events:

Table of Tropical Cyclones on the Island of Mozambique (1994–2025)

Cyclone	Year	Category (Saffir-Simpson)	Wind Speed (km/h)	Impact on the Island of Mozambique
Nádia	1994	Category 3	~180 km/h	Destruction of hundreds of homes, loss of life, damage to schools and public services.
Jokwe	2008	Category 3	~195 km/h	Severe damage to coastal infrastructure, schools, and power grids.
Hellen	2014	Category 4	~240 km/h (not a direct impact)	Heavy rain and strong winds on the north coast.
Kenneth	2019	Category 4	~220 km/h	Indirect impacts on the island; massive destruction in Cabo Delgado.
Gombe	2022	Category 3	~185 km/h	Direct damage: destroyed houses, affected schools, communication and electricity outages.
Freddy	2022	Category 5 (excepcional)	~270 km/h	Indirect impact: heavy rainfall, rough seas, and risks of coastal erosion. The longest-lasting cyclonic event in history.
Chido	2024	Category 4	~220 km/h	Severe indirect damage; houses destroyed nearby.
Dikeledi	2025	Category 2	~156 km/h	Direct damage to homes, schools, and infrastructure.
Jude	2025	Category 3	~195 km/h	Floods, power outages, damaged homes.

Table 1.

Credits: INGD

In addition to atmospheric events, epidemics of “matequenha,” a locust plague, and cholera outbreaks, were exacerbated by poor sanitary conditions after the floods (PLA, 2019).

The impacts of these extreme events range from human losses to property destruction, food insecurity, and loss of rent:

- Agriculture suffers from crop destruction, soil salinization, and water scarcity;
- Fishing is frequently interrupted during strong winds and cyclones, resulting in loss of equipment and a drop in catches;
- Tourism, a strategic sector for the Island, is impacted by damage to heritage and urban infrastructure;
- Coastal erosion compromises housing and access roads, and threatens historical areas listed as World Heritage Sites by UNESCO.

These impacts are aggravated by structural vulnerability factors such as poverty, low education levels, lack of adequate drainage networks, and fragile housing.

Climate models project increased rainfall intensity in northern Mozambique (where the island is located), continued sea level rise, and greater cyclone intensity (IPCC, 2021). This imposes an urgent need for local adaptation and institutional strengthening. ●



Tropical Cyclones on the Island

Tropical cyclones are intense atmospheric systems that form in warm ocean waters. They are characterized by strong winds, heavy rainfall, and storm surges. The coast of Mozambique is one of the most exposed African regions to cyclonic activity in the southwest Indian Ocean (WMO, 2019).

Mozambique has a long history of devastating tropical cyclones. According to the World Bank (2023), the frequency and intensity of cyclones hitting Mozambique has increased since the 1980s, with estimates pointing to category 4 and 5 events becoming more common by the end of the century.

Cyclones cause a range of material, social, and environmental damage on the Island of Mozambique:

- Housing: houses with zinc roofs are destroyed by the winds, and many families lose their homes.
- Education and health: schools and health centers are non-operational for weeks.
- Water and sanitation: supply systems are interrupted, resulting in outbreaks of cholera and diarrhea.
- Tourism and heritage: historical buildings suffer deterioration, affecting the island's image as a tourist destination and threatening the cultural heritage listed as a World Heritage Site.

The vulnerability of the island's population is exacerbated by factors such as poverty, disordered urbanization, and informal

housing. The SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis carried out in the Local Plan reveals:

- Weaknesses: lack of adapted infrastructure, scarcity of civil protection equipment.
- Threats: increased frequency of events and environmental degradation.
- Strengths: strong community organization and experience in reconstruction.
- Opportunities: integration of new technologies and international cooperation projects (UNCDF, 2022).

Mitigation and Adaptation Strategies

Mitigation involves actions that seek to reduce or avoid the emission of greenhouse gases (e.g., energy efficiency, reforestation). Adaptation refers to adjustments in natural or human systems in response to the current or expected effects of climate change (IPCC, 2022).

The Local Adaptation Plan for the Island of Mozambique (2019) proposes a set of **priority measures**, including:

- Strengthening coastal infrastructure (dikes, retaining walls);
- Rehabilitation of houses with wind and moisture resistant materials;
- Planting of mangroves and rehabilitation of dunes as natural barriers;
- Community early warning systems using megaphones, radios and colored flags;
- Environmental education in schools and local resilience committees.

These measures align with the principle of Nature-based Solutions (NbS), promoted by the IUCN and adopted by entities such as UNDP and the World Bank.

Projects and Best Practices:

- LoCAL/UNCDF Project: funds interventions led by local governments focusing on community-based adaptation. The Island is one of the pilot areas, with actions aimed at

mangrove restoration and sustainable drainage (UNCDF, 2023).

- Education and community mobilization: campaigns by INGC and NGOs such as Care and Helvetas strengthen local capacities for resilience.

Challenges and Opportunities:

Among the main challenges to the implementation of the strategies are:

- Lack of stable funding;
- Limited technical capacity in local authorities;
- Conflicts over land occupation in at-risk areas.

On the other hand, the following stand out as opportunities:

- Availability of international support (Green Fund, UN, EU);
- Growing interest from the private and tourism sectors in ensuring resilient infrastructure;
- Integration of the Local Plan with the ENAMMC and the commitments of the Paris Agreement.

Climate Governance and Public Policies

Climate governance in Mozambique is organized at the national, provincial, and local levels. At the central level, the Ministry of Agriculture, Fisheries, Land and Environment (MAPTA) coordinates the National Strategy for Adaptation and Mitigation of Climate Change (ENAMMC). The National Institute for Disaster Risk Management (INGD) leads the emergency response.

At the local level, Municipal Councils, such as that of the Island of Mozambique, have the competence to develop and implement local adaptation plans, in coordination with partners such as UNDP, UNCDF, and Universities, among others.

At the island level, a Multi-Sectoral Team was established to respond to extreme events, given the challenges faced by communities and World Heritage. The team is composed of members from different sectors and specialties to ensure a broad and coordinated approach, as indicated in the following table:

Function	Responsibility
Government Representatives Local/Municipal	To provide administrative support and integration with public policies.
Civil Engineers and Urban Planners/SDPI	To analyze and propose adaptations in critical infrastructure and vulnerable urban areas.
Specialists in Cultural and Historical Heritage Management /GACIM	To lead actions for the protection and preservation of architectural and cultural heritage.

Function	Responsibility
Meteorologists and Climate Change Specialists	To predict weather events and provide data for preventive planning.
Environmental Technicians	To monitor and propose conservation actions for the natural environment, especially mangroves and coastal areas.
Community Organizations and NGOs	To represent the local community, promote engagement and implement awareness-raising actions about the importance of World Heritage.
Risk Management and Disaster Specialists	To coordinate rapid and safe responses to extreme weather events affecting populations and World Heritage.
Academics and Researchers	To contribute to studies on the impact of climate change on World Heritage and possible adaptation strategies.

Table 2.

Credits:
Agostinho Mabota

Relevant Policies:

- ENAMMC (2013–2025): establishes national guidelines for climate action, with specific targets for community adaptation, water security, and agroecology (MICOA, 2013).
- National Territorial Planning Policy: provides for the incorporation of climate risk into urban licensing.
- Paris Agreement (2015): Mozambique submitted its Nationally Determined Contribution (NDC) with adaptation and mitigation targets, including actions in coastal areas (UNFCCC, 2016).

The success of climate governance depends on the active participation of communities. The Local Plan promotes resilience committees with community representation, including women, youth, and traditional leaders.

According to the World Bank (2023), adaptation policies with gender equity and participatory management are more effective, promoting greater local ownership and sustainability of results.

Mozambique has access to multiple international climate finance mechanisms:

- Green Climate Fund (GCF);
- Global Environment Facility (GEF);
- UN Adaptation Fund.

However, access to these funds is still limited due to a lack of local technical capacity to develop structured and monitorable projects.

The national climate monitoring system is in the consolidation phase. The use of tools such as LGSAT (Local Governance Self-Assessment Tool) and resilience indicators proposed by the UNCDF are being adapted to the municipal context, as are other tools developed by INGD. ●



4 Post-cyclone Conservation Status Assessment





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Post-cyclone Assessment

Assessing the conservation status of buildings after tropical cyclones is a fundamental step in understanding the real impacts of extreme events on the built heritage of the Island of Mozambique. A rigorous and systematic assessment of the damage allows for documentation of the changes suffered, identification of critical areas, and recognition of the vulnerability patterns that may worsen in future events.

More than a simple damage survey, this assessment is an essential tool for understanding the degree of preservation of the buildings and their capacity to maintain the characteristics that confer cultural and historical value to the urban ensemble. In the context of the Island of Mozambique, classified as a World Heritage Site, monitoring the state of conservation is indispensable to guarantee the protection of its features that justified its international recognition and exceptional value.

In addition to forming the basis for responsible planning of future actions, the post-cyclone assessment reinforces the importance of systematic recording methods, which promotes a culture that values local knowledge and regular monitoring. This chapter presents the approach adopted to assess the state of conservation of buildings after cyclones, highlighting the importance of a careful and shared assessment of the heritage's condition as a first step towards its safeguarding.

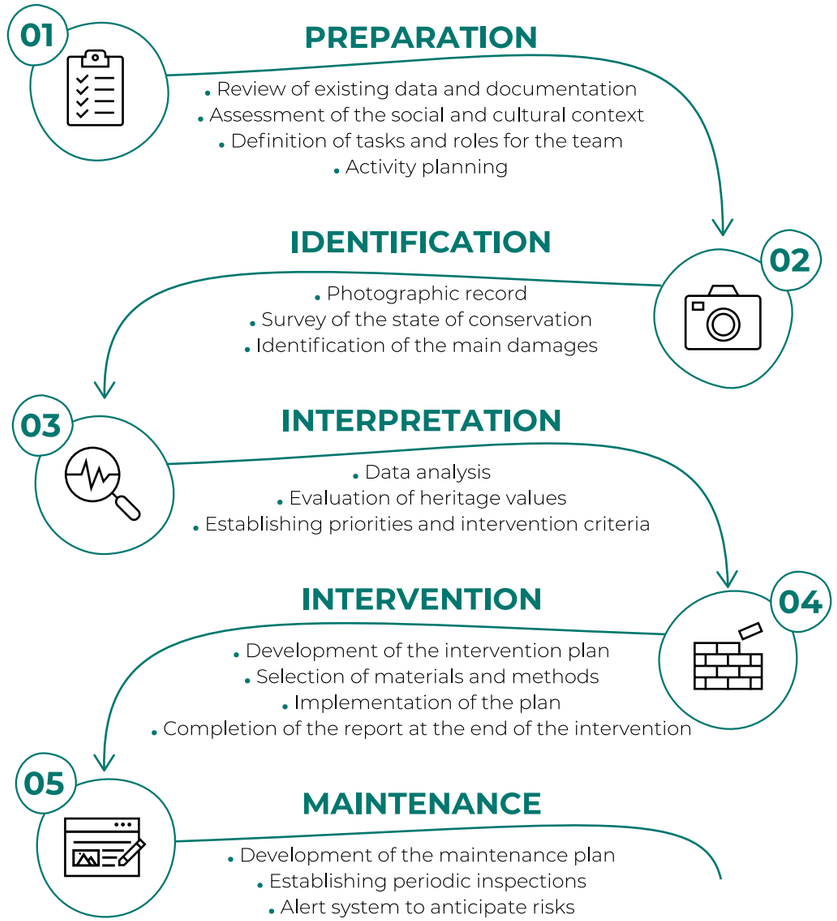

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Building Conservation Status

Assessing the state of conservation is not an isolated or purely technical exercise, it is an essential step in building a shared vision of heritage, bringing together institutions, technicians, decision-makers, and communities. In this project, this collaborative dimension was addressed through online Capacity Building courses aimed at training not only technicians and students, but also representatives of the local community.

The training was based on three fundamental axes: Methods for assessing the state of conservation; Intervention strategies and techniques; and Planning for the conservation and preservation of built heritage. The content combined theoretical sessions with practical activities, including in situ assessments of the state of conservation of heritage buildings, the development of intervention proposals, and conservation plans adapted to the local context.

The in-person component of the project was equally important. The team went to the Island for direct meetings with GACIM technicians and community representatives, allowing for a more detailed understanding not only of the observed material problems, but also of the social, cultural, and organizational challenges that affect heritage conservation. This integrated approach valued local knowledge, strengthened available technical capabilities, and promoted dialogue among the various actors involved.



Credits:
Telma Ribeiro, Cristina Azevedo

Additionally, digital inventory sheets were produced for each building on the island using GIS tools. These sheets were designed to be permanently updated whenever relevant changes or damage occur, transforming the inventory into a living instrument for monitoring, planning, and anticipating risks. This way, the assessment of the state of conservation becomes more than a static record of problems, resulting in a dynamic and shared process, supported by local tools and capabilities, that allows for planning more effective interventions and promoting heritage resilience in a sustainable way.

To carry out a good survey and management of the state of conservation, the following steps should be followed: **Preparation**, **Identification**, **Interpretation**, **Intervention**, and **Maintenance**. These steps offer a clear and participatory framework for organizing the assessment and ensuring that it serves as a solid foundation for future preservation and management strategies.

The assessment of the building's state of conservation carried out within the scope of this project followed international recommendations, ensuring a systematic approach comparable to the best practices in heritage conservation. To facilitate the technical characterization and uniform recording of degradation phenomena, the ICOMOS-ISCS glossary (2008) served as a basis for classifying the observed pathologies into five main groups: Fractures and Fissures, Detachments, Material Loss, Chromatic Alteration, and Biological Colonization. This structure guided the fieldwork and the preparation of inventory sheets, ensuring clarity in the description of the damage and facilitating dialogue between technicians, decision-makers, and the community regarding intervention priorities. ●

Forms of Degradation

FRACTURES AND FISSURES

Fractures and fissures are discontinuities in the material that cause its separation. Fractures can be structural.

DETACHMENTS

Detachment involves a separation of the material into layers or into granular disintegration.

MATERIAL LOSS

Material loss represents the absence of elements or parts of the material for various reasons (erosion, physical damage, granular disintegration, etc.).

CHROMATIC ALTERATION

Alteration of the original color of the material, whether due to the accumulation of dust and dirt, or due to chemical reactions and natural aging of the material.

BIOLOGICAL COLONIZATION

Colonization of the material in the form of plants and microorganisms such as bacteria, algae, fungi, and lichens. It can also include animal nesting and pest infestation.




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Post-cyclone Mapping

In conjunction with the post-cyclone assessment, a survey was conducted based on inventory sheets in a GIS environment developed for the project. The survey, which covered 50 buildings in the town of *Pedra e Cal* and another 50 in the town of Macuti, made it possible to assess the state of conservation of the Island of Mozambique. The classification followed four categories (good, reasonable, poor, and ruin), allowing for the construction of an updated picture of the conditions of the urban built environment.

Of the total buildings analyzed, only 25% were in good condition. The majority showed signs of moderate or severe decay (64% in reasonable or poor condition), with the remaining 11% in ruin. This data highlights the urgent need for continuous conservation and intervention strategies. The prevalence of buildings in reasonable condition reinforces the importance of regular and accessible maintenance actions, preventing these properties from devolving into more severe states of decay.

The pilot survey formed a solid methodological basis for future, broader mapping actions. Digital inventory records have allowed for the recording of the current condition of buildings, making it possible to keep the registry updated whenever relevant changes occur. The process can continue to expand progressively to other buildings, reinforcing the planning capacity and preventive response by technical teams and the community.

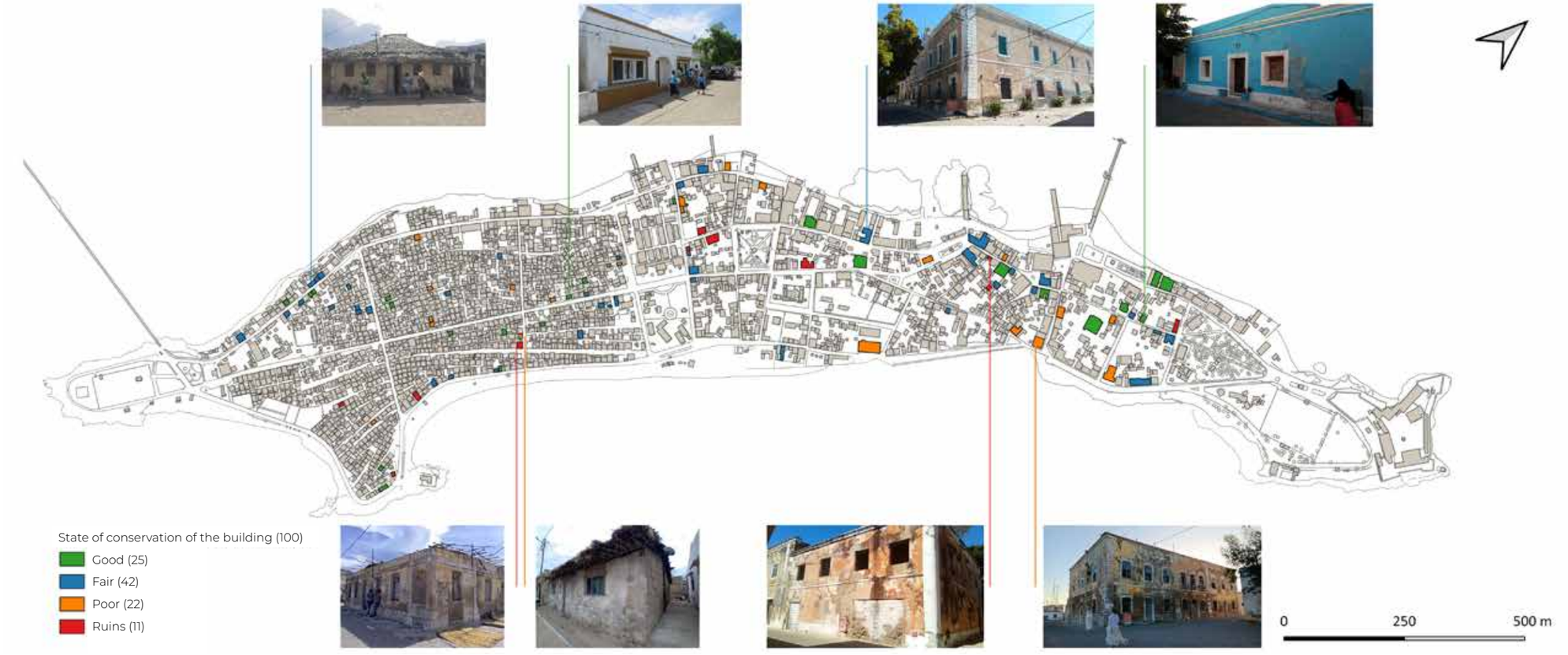


Figure 4.
Sampling of the State of Conservation in May 2025.

Credits:
Telma Ribeiro, Joaquim Flores, Olga Álvarez



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Laws and Reference Documents

The chart summarizes the most relevant historical, architectural, urban, artistic, and landscape formations of the Island of Mozambique. It highlights the role of Law No. 10/88, which supports the 1991 nomination dossier, and the Specific Statute of 2006, as initial milestones in a set of legal instruments aimed at the protection and management of cultural heritage, with a view to its preservation and promotion of sustainable development. More recently, the 2016 regulations and the 2021–2025 Management Plan have reinforced conservation measures, cultural criteria, and public awareness of the benefits associated with the inscription as World Heritage.

In addition to the legislative dimension, several authors have addressed the value of the built environment on the Island of Mozambique. It is worth highlighting the contribution of Alexandre Lobato (1945), who emphasized the historical, architectural, and urban dimensions, and the relevance of the Blue Book (Aarhus, 1986), a fundamental document that supported the island's nomination for the UNESCO World Heritage List.

Another relevant contribution is that of José Forjaz (2010), who classified and typified the buildings of the town of *Pedra e Cal* and the town of *Macuti*, based on the construction techniques and materials used, highlighting the prevalence of wattle-and-daub constructions and roofs with natural fibers.

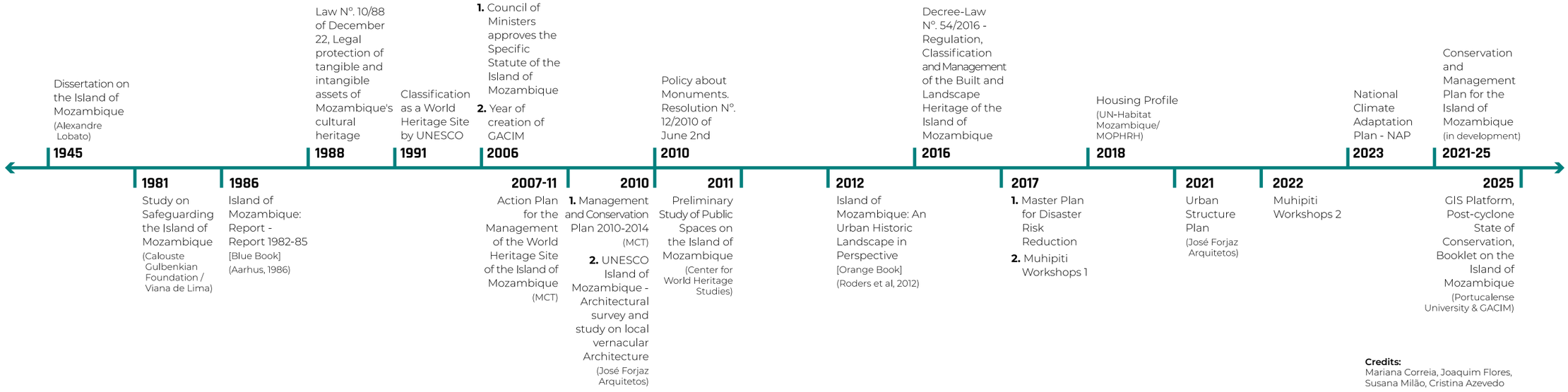
In turn, the contribution of the so-called Orange Book (Roders

et al., 2012) stands out, updating the data from the Blue Book on the state of conservation of the buildings, and proposing an integrated approach in light of the concept of Historic Urban Landscapes.

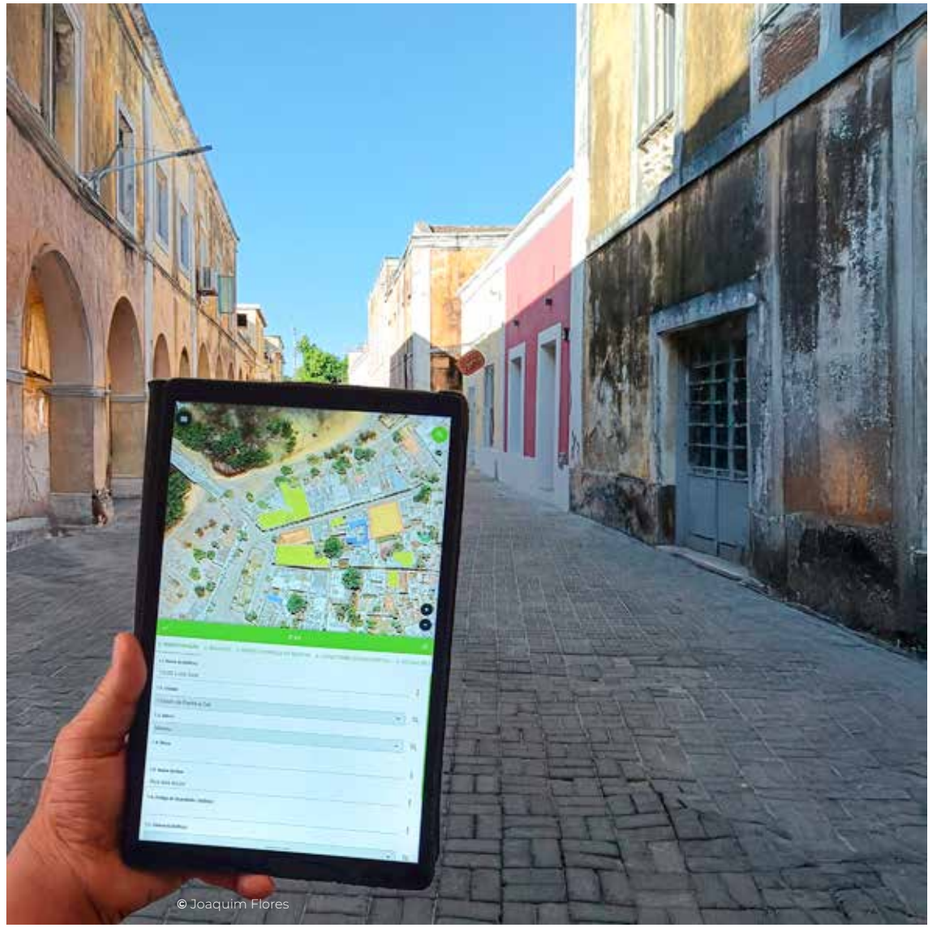
Finally, Silje Sollien (2014) explored urban transformations in the town of Macuti through the analysis of buildings and interviews with residents. Her research valued vernacular architecture and urban planning in contexts characterized by poverty and limited institutional capacities.

These different complementary perspectives highlight the historical and cultural evolution of the built environment on the Island of Mozambique while addressing the challenges of conservation and opportunities for heritage enhancement, and demonstrating the interaction between traditional techniques, contemporary practices, and urban management strategies (Alcolete, 2024). ●

The Island of Mozambique - Key Dates and Documents



Credits:
Mariana Correia, Joaquim Flores, Susana Milão, Cristina Azevedo


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GIS-Based Management Tool

The management of World Heritage sites presents complex challenges that require integrated approaches and the articulation of different types of information. Geographic Information Systems (GIS) stands out as an essential digital tool in this context, allowing the integration, analysis, and visualization of spatial data in a thematic and dynamic way. The use of GIS facilitates monitoring, planning, and informed decision-making, becoming a strategic instrument for the efficient management of these sites.

In addition to enabling the creation of georeferenced heritage inventories associated with social data, GIS plays a central role in responding to challenges such as climate change, by allowing the mapping and simulation of risk situations affecting World Heritage. Mobile GIS applications reinforce this capacity, facilitating data collection, both in inventories and in climate or humanitarian emergency scenarios (Siegmund et al., 2024). Recognizing the potential of GIS, UNESCO developed an online platform (UNESCO, 2023a) dedicated to the storage and sharing of geographic data, promoting the protection of features that express Outstanding Universal Value and the resilience of sites in the face of climate threats. To ensure the effectiveness of this approach, technical recommendations were issued (UNESCO, 2023b) that guide the integration of data into the platform, with the aim of supporting managing entities in the production of information and the preparation of periodic reports. In the medium term, the goal is integration

with the Conservation Status Information System, and thus GIS becomes fundamental for the continuous monitoring and conservation of World Heritage sites.

The implementation of the Geographic Information System (GIS) on the Island of Mozambique was carefully structured to maximize resources, ensure integration with global platforms, and keep costs low while paying special attention to local technical capacity building. The process began with the selection of appropriate IT tools, opting for open-source programs such as QGIS (2025) and QField (2025), which allow, respectively, the processing of data in the office and the collection and updating of information in the field. The implementation of mobile applications, such as OSMTracker (2025), facilitated the georeference recording of trails, features, and photographs during the survey campaigns. Each of these tools produce files compatible with ESRI systems (2025), a reference in the global GIS market, which ensures integration with the main institutional platforms without the licensing costs.

In addition, specific training was provided for technicians from GACIM, CACIM, and other technicians on the island, enabling them to manage the World Heritage site using GIS.

The implementation process continued with the selection and preparation of cartographic databases, using the available digital information, even if these presented limitations due to the absence of metadata. In addition to historical cartography and various surveys published in a report, two CAD maps and high-resolution aerial images obtained by drone were identified, the latter not being georeferenced. One of the CAD maps presented a detailed survey of part of the town of Macuti, but the rest of the island was represented inaccurately.

It was also possible to identify that this cartography was created using the CRS (Coordinate Reference System) - EPSG 3037 (Moznet/UTM37S), a system used in this area of Mozambique. Because it is the official CRS and has reasonable compatibility with the Google satellite image, this cartography and CRS were assumed as the initial basis for the development of the system for the Island. The other existing digital cartography presented a homogeneous level of detail throughout the Island and was used in administrative representations. However, it did not have an associated CRS, and it was found that, geometrically and geographically, it was not compatible with the other cartography. Given these limitations, it was decided to georeference the blocks not rigorously defined in the first cartography, using the 13 drone images that were georeferenced from the base cartography and Google satellite images.

Within the framework of integrating complementary data, a layer from the Google Open Buildings project (Google, 2025a) was incorporated. This layer provides free mapping of buildings in resource-limited regions, supplying polygons used in GIS and with Google Plus universal codes (Google, 2025b), allowing any building to be identified on Google Maps, even in contexts of total urban informality. Despite some inaccuracies in the building boundaries, this base was adopted for the built area, anticipating some adjustments during the insertion of survey data. The building inventory sheet was built on this layer, allowing connection with previous surveys and future updates.

During the training, relevant institutional GIS data were presented, such as the Mozambique National GIS Network (National Agency for Geo-Spatial Development, 2023) and the Africa Geoportal (ESRI, 2023), which can be integrated into the system. All georeferenced data were organized into layers in QGIS, supporting island management, field survey planning, and the structuring of digital inventories. This methodological

process ensured the creation of a robust GIS, adapted to the local context, with international integration and flexibility for future updates and expansions.

The data acquisition process for GIS on the Island of Mozambique began during a training course on the creation of an Information Management Tool, in which participants were trained in GIS handling and the use of the QField application. In March 2025, divided into six groups, the trainees surveyed 63 buildings distributed across the island: 40 in Macuti Town and 23 in *Pedra e Cal* Town. The buildings were surveyed using a specific diagnostic and conservation form developed in the context of the respective training course. In the field, they recorded the precise location of the buildings, constructive characteristics, state of conservation, pathologies, uses, and other relevant features, using smartphones equipped with QField. The photographs that were taken were associated with each record, ensuring traceability and efficient updating of the database. After the fieldwork, the collected data was transferred to GIS, validated, and integrated into the database, allowing the creation of thematic maps, such as the state of conservation of the buildings. In May 2025, the Portucalense University team conducted two survey sessions on the island using Qfield, based on the improved inventory form, considering previous experience and GACIM recommendations. In the first session, houses in the town of Macuti were visited, encompassing the neighborhoods of Macaribe, Litine, Areal, and Esteu, including properties rehabilitated after Cyclone Gombe and the Casa dos Contos. In the second session, buildings in the town of *Pedra e Cal* were surveyed, including some previously inventoried in 1982, allowing for comparison. Due to time constraints, the team opted to record 360-degree videos with 5K resolution, enabling subsequent detailed analysis of the buildings and completion of the forms, as well as creating a historical record

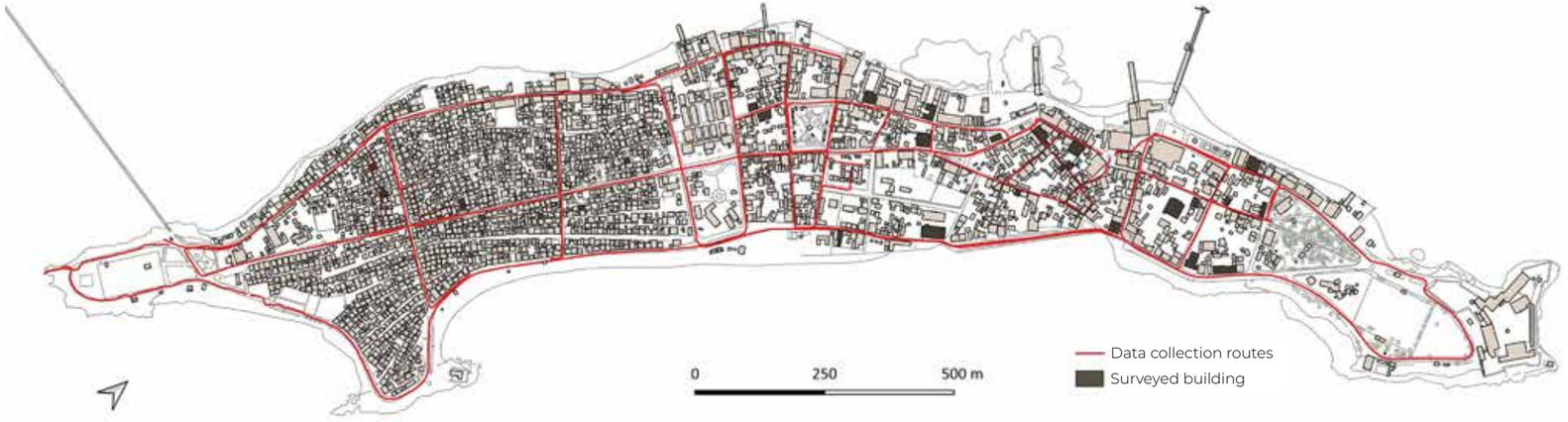


Figure 5.
Survey route and buildings surveyed up to May 2025.
Credits:
Joaquim Flores

for future comparisons. The survey was conducted on foot and in an open van belonging to GACIM, with the routes recorded and georeferenced using the OSMTracker application, which was also used during the visit to Mossuril, a mainland area from which the traditional materials for Macuti houses come.

This process enabled the introduction of a multi-sectoral management system approach for the Island of Mozambique, based on a Geographic Information System. This dynamic process allows local teams to develop the system from this foundation and, with the technical training provided, populate it over time with information that will make it useful for this function, not only in terms of asset and administrative management, but also in assimilating information related to climate change, thus mitigating the respective risks. ●



Multisectoral Team and its Management

The management of the urban heritage of the Island of Mozambique, recognized as a World Heritage Site, should be guided by the concept of the resilience cycle, which implies a continuous and adaptive approach of prevention, planning, response, and recovery in the face of challenges. In this context, the establishment of a multisectoral team represents a fundamental strategy to guarantee the sustainable and participatory conservation of this island territory, of high historical and cultural value.

The multisectoral team includes representatives from public institutions, the private sector, civil society, academia, and local communities. This diversity of members allows for the articulation of technical knowledge—such as architecture, engineering, urban planning, and the environment—with traditional knowledge and everyday experiences of the resident population. This composition reinforces the legitimacy of decision-making processes and ensures a more inclusive and effective approach.

The functioning of this team is structured precisely according to the phases of the resilience cycle: it begins with a shared assessment of vulnerabilities (natural, social, and infrastructural), followed by strategic planning, with the definition of joint priorities. The implementation of the actions emphasizes collaborative management, transparency, and the clear assumption of responsibilities. Subsequently, continuous

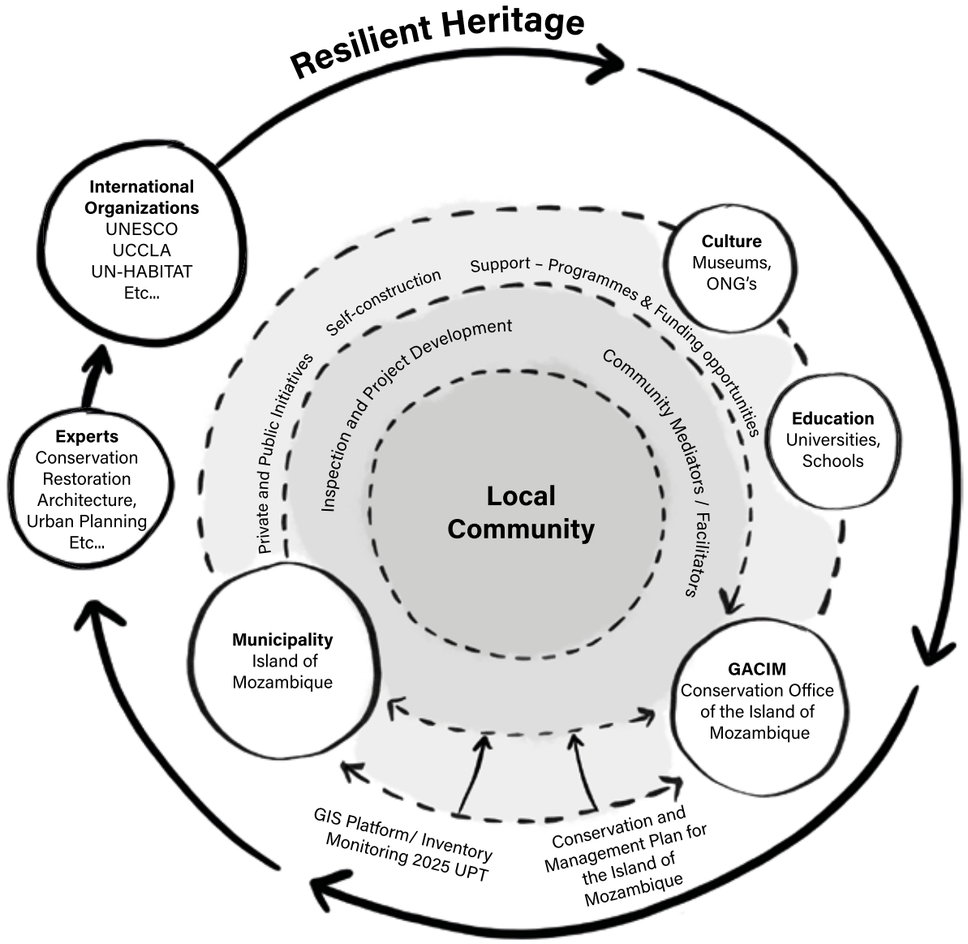


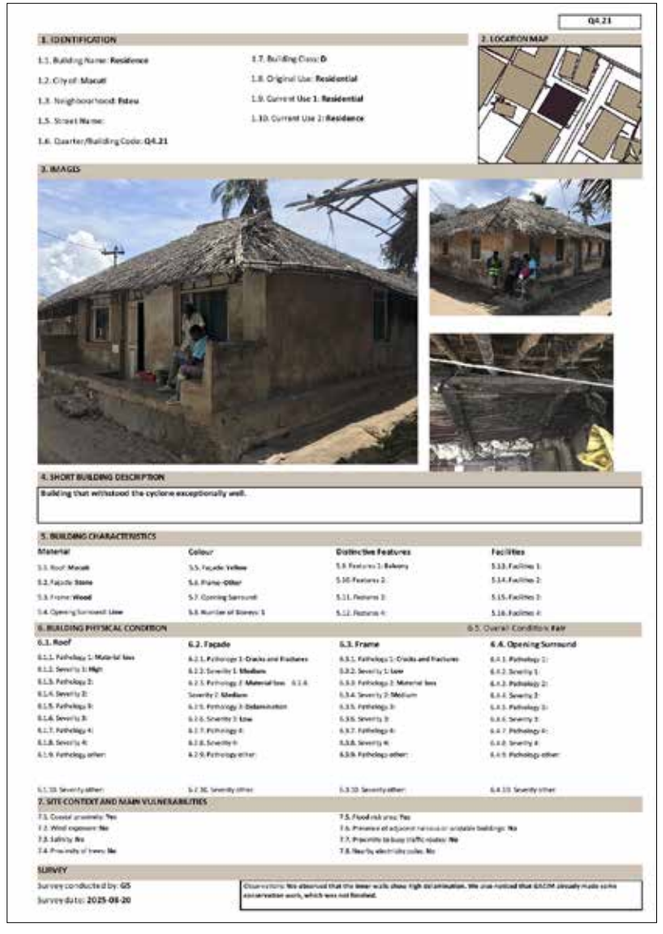
Figure 6.
The multi-sectoral team integrates diverse stakeholders which can contribute to a more resilient living heritage.

Credits:
Susana Milão, Cristina Azevedo

monitoring and necessary adaptations of the measures are carried out, depending on the results and the constantly changing context. In this process, the role of GACIM - the Conservation Office of the Island of Mozambique - stands out as a mediator and facilitator with the community, ensuring dialogue between technicians, authorities, and residents.

From an operational point of view, the use of fundamental tools such as the GIS/inventory — a digital platform that organizes and shares georeferenced information about the built heritage — is noteworthy. This system constitutes essential support for planning, facilitates the monitoring of interventions, and allows for the evaluation of results, contributing to the continuous improvement of conservation strategies.

Thus, the multisectoral team, based on the strategic role of GACIM and the innovative use of the GIS/inventory, can function as a dynamic and adaptive organism, capable of responding, learning, and evolving permanently. This framework places resilience at the heart of heritage management and conservation, promoting sustainable and inclusive solutions in the face of current and future challenges.


Q4.21

1. IDENTIFICATION

1.1. Building Name: Residence
1.2. City of: Macuti
1.3. Neighbourhood: Ilheu
1.5. Street Name:
1.6. Quarter/Building Code: Q4.21
1.7. Building Class: D
1.8. Original Use: Residential
1.9. Current Use 1: Residential
1.10. Current Use 2: Residence

2. LOCATION MAP

3. IMAGES

4. SHORT BUILDING DESCRIPTION

Building that withstood the cyclone exceptionally well.

5. BUILDING CHARACTERISTICS

Material	Colour	Distinctive Features	Facilities
5.1. Roof: Macuti	5.5. Façade: Yellow	5.9. Features 1: Balcony	5.13. Facilities 1:
5.2. Façade: Stone	5.6. Paint: Other	5.10. Features 2:	5.14. Facilities 2:
5.3. Frame: Wood	5.7. Opening Surround:	5.11. Features 3:	5.15. Facilities 3:
5.4. Opening Surround: Lime	5.8. Number of Storeys: 1	5.12. Features 4:	5.16. Facilities 4:

6. BUILDING PHYSICAL CONDITION — 6.5. Overall Condition: Fair

6.1. Roof	6.2. Façade	6.3. Frame	6.4. Opening Surround
6.1.1. Pathology 1: Material loss	6.2.1. Pathology 1: Cracks and Fractures	6.3.1. Pathology 1: Cracks and Fractures	6.4.1. Pathology 1:
6.1.2. Severity 1: High	6.2.2. Severity 1: Medium	6.3.2. Severity 1: Low	6.4.2. Severity 1:
6.1.3. Pathology 2:	6.2.3. Pathology 2: Material loss 6.2.4. Severity 2: Medium	6.3.3. Pathology 2: Material loss	6.4.3. Pathology 2:
6.1.4. Severity 2:	6.2.5. Pathology 3: Delamination	6.3.4. Severity 2: Medium	6.4.4. Severity 2:
6.1.5. Pathology 3:	6.2.6. Severity 3: Low	6.3.5. Pathology 3:	6.4.5. Pathology 3:
6.1.6. Severity 3:	6.2.7. Pathology 4:	6.3.6. Severity 3:	6.4.6. Severity 3:
6.1.7. Pathology 4:	6.2.8. Severity 4:	6.3.7. Pathology 4:	6.4.7. Pathology 4:
6.1.8. Severity 4:	6.2.9. Pathology other:	6.3.8. Severity 4:	6.4.8. Severity 4:
6.1.9. Pathology other:		6.3.9. Pathology other:	6.4.9. Pathology other:
6.1.10. Severity other:	6.2.10. Severity other:	6.3.10. Severity other:	6.4.10. Severity other:

7. SITE CONTEXT AND MAIN VULNERABILITIES

7.1. Coastal proximity: Yes
7.2. Wind exposure: No
7.3. Salinity: No
7.4. Proximity of trees: No
7.5. Flood risk area: Yes
7.6. Presence of adjacent noxious or volatile buildings: No
7.7. Proximity to busy traffic routes: No
7.8. Nearby electricity poles: No

SURVEY

Survey conducted by: GS
Survey date: 2025-08-20
Observations: We observed that the inner walls show high deterioration. We also noticed that GACIM already made some conservation work, which was not finished.

Credits:
Telma Ribeiro, Joaquim Flores, Susana Milão

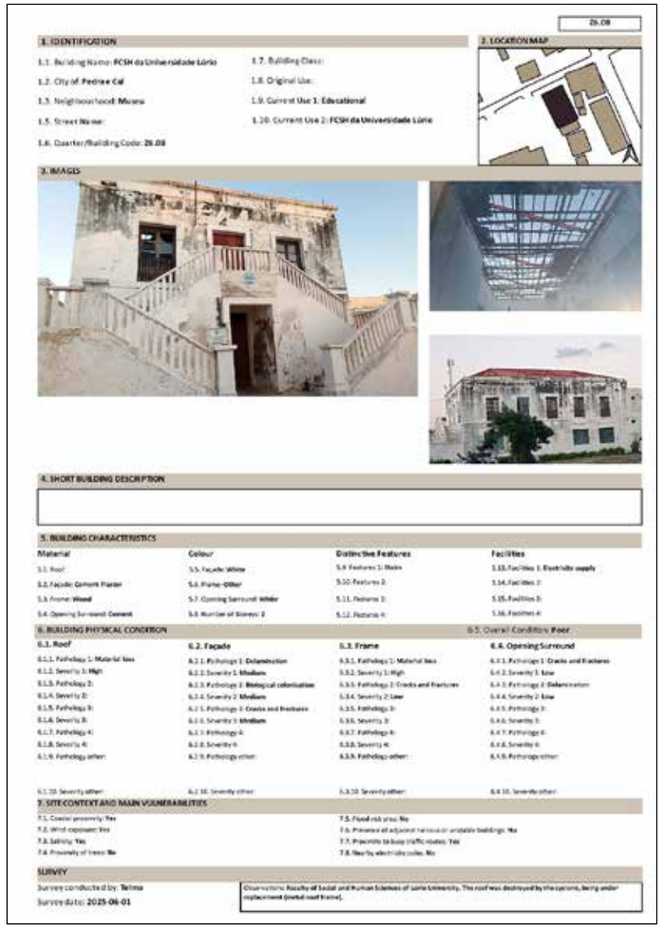
Inventory as a Monitoring Tool

Systematic inventory is an essential basis for the effective monitoring and management of World Heritage sites, allowing for detailed knowledge of the state of conservation, characteristics, uses, and alterations of buildings. This supports the definition of priorities, strategic decisions, and the assessment of impacts resulting from natural phenomena or human activities.

The inventory process for the Island of Mozambique was structured based on UNESCO recommendations and previous surveys. The inventory forms that were adopted include detailed fields such as:

- Building identification;
- Building location;
- Photographs and digital documentary record;
- Brief description;
- Architectural and construction characteristics;
- State of conservation and pathologies observed;
- Characterization of the surrounding area.

This information is collected digitally, integrating with the Geographic Information System (GIS), which facilitates the spatial visualization of data and cross-referencing with other information sources, such as historical cartography, aerial images, and previous reports.



1. IDENTIFICATION

1.1. Building Name: FCSH da Universidade Lúrio
1.2. City of: Pedrae Cal
1.3. Neighbourhood: Museu
1.5. Street Name:
1.6. Quarter/Building Code: 25.08
1.7. Building Class:
1.8. Original Use:
1.9. Current Use 1: Educational
1.10. Current Use 2: FCSH da Universidade Lúrio

25.08

2. LOCATION MAP

3. IMAGES

4. SHORT BUILDING DESCRIPTION

5. BUILDING CHARACTERISTICS

Material	Colour	Distinctive Features	Facilities
5.1. Roof:	5.5. Façade: White	5.9. Features 1: Stairs	5.13. Facilities 1: Electricity supply
5.2. Façade: Cement Plaster	5.6. Plinth: Other	5.10. Features 2:	5.14. Facilities 2:
5.3. Frame: Wood	5.7. Opening Surround: White	5.11. Features 3:	5.15. Facilities 3:
5.4. Opening Surround: Cement	5.8. Number of Storeys: 2	5.12. Features 4:	5.16. Facilities 4:

6. BUILDING PHYSICAL CONDITION — 6.5. Overall Condition: Poor

6.1. Roof	6.2. Façade	6.3. Frame	6.4. Opening Surround
6.1.1. Pathology 1: Material loss	6.2.1. Pathology 1: Delamination	6.3.1. Pathology 1: Material loss	6.4.1. Pathology 1: Cracks and Fractures
6.1.2. Severity 1: High	6.2.2. Severity 1: Medium	6.3.2. Severity 1: High	6.4.2. Severity 1: Low
6.1.3. Pathology 2:	6.2.3. Pathology 2: Biological colonization	6.3.3. Pathology 2: Cracks and Fractures	6.4.3. Pathology 2: Delamination
6.1.4. Severity 2:	6.2.4. Severity 2: Medium	6.3.4. Severity 2: Low	6.4.4. Severity 2: Low
6.1.5. Pathology 3:	6.2.5. Pathology 3: Cracks and Fractures	6.3.5. Pathology 3:	6.4.5. Pathology 3:
6.1.6. Severity 3:	6.2.6. Severity 3: Medium	6.3.6. Severity 3:	6.4.6. Severity 3:
6.1.7. Pathology 4:	6.2.7. Pathology 4:	6.3.7. Pathology 4:	6.4.7. Pathology 4:
6.1.8. Severity 4:	6.2.8. Severity 4:	6.3.8. Severity 4:	6.4.8. Severity 4:
6.1.9. Pathology other:	6.2.9. Pathology other:	6.3.9. Pathology other:	6.4.9. Pathology other:
6.1.10. Severity other:	6.2.10. Severity other:	6.3.10. Severity other:	6.4.10. Severity other:

7. SITE CONTEXT AND MAIN VULNERABILITIES

7.1. Coastal proximity: Yes
7.2. Wind exposure: Yes
7.3. Salinity: Yes
7.4. Proximity of trees: No
7.5. Flood risk area: No
7.6. Presence of adjacent noxious or unstable buildings: No
7.7. Proximity to busy traffic routes: Yes
7.8. Near by electricity poles: No

SURVEY

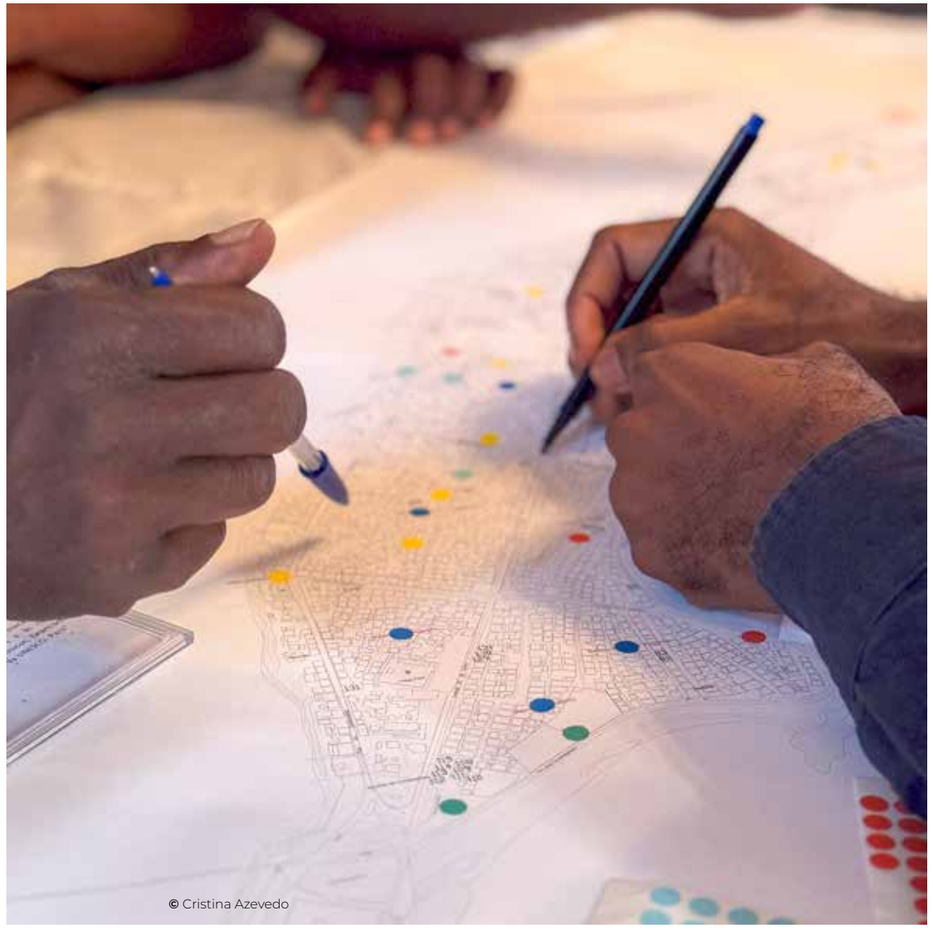
Survey conducted by: Telma
Survey date: 2025-06-01

Observations: Faculty of Social and Human Sciences of Lurio University. The roof was destroyed by the cyclone, being under replacement (metal roof frame).

Credits:
Telma Ribeiro, Joaquim Flores, Susana Milão

The link between the inventory and the GIS is a key factor: it enables continuous monitoring of heritage, quickly detecting patterns, degradation trends, critical areas, and intervention needs. GIS also allows for the easy updating of information — whenever new field campaigns or interventions occur, the data can be quickly incorporated, ensuring an up-to-date and useful database for managers, technicians, and local communities.

This dynamic method follows international guidelines, which recommend the regular updating of heritage inventories, as well as the production of maps and supporting documentation for conservation and enhancement actions in protected areas.



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Collaborative Mapping

Collaborative mapping is a fundamental methodological tool in heritage management, integrating geospatial information with the empirical knowledge of the local population (Nacher, 2013). Its value lies in incorporating social perceptions and everyday experiences into the decision-making process, allowing for a more situated and dynamic reading of the territory, especially relevant in vulnerable contexts, such as the Island of Mozambique.

Within the scope of the project on the Island of Mozambique, collaborative mapping was applied as a methodological axis during the capacity building course, focused on community participation in heritage conservation and technical capacity building for habitat resilience. This session, developed on the Island of Mozambique, brought together technicians from GACIM and CACIM, architecture students from Lúrio University, students from IMPIM - Polytechnic Institute of the Island of Mozambique, coordinators of local associations, religious leaders and representatives of civil society. The training was structured in three complementary stages, combining collective work, participatory cartography and individual reflection.

The first stage consisted of a group survey of the most significant risk elements associated with the impact of cyclones. Among the main risks identified were: destroyed roofs, damaged homes, flooded areas, fallen trees or branches,

lack of shelter, fallen power lines, blocked roads, coastal erosion, and landslides. An open category was also included so that participants could add other elements considered relevant, based on their direct experience.

In the second stage, participants worked on maps of the island, marking the different types of risks according to the timing of the extreme weather event: vulnerable areas and infrastructure before the cyclone, the most critical areas during the phenomenon, and zones with the greatest consequences in the aftermath. The third stage, addressed individually, focused on identifying and evaluating the community strategies adopted in response to cyclones. Reflections were made on which of these practices proved effective and which did not, as well as the functioning of the emergency aid provided by Civil Protection, the existence and accessibility of assistance spaces, and the overall effectiveness of institutional responses.

The analysis of the maps produced by the participants in the collaborative mapping exercise revealed fundamental information for understanding the impact of cyclones on the Island of Mozambique and for planning mitigation and resiliency strategies.

In the first stage, aimed at identifying the main risk elements, there was a relatively balanced identification of damage between the Macuti and *Pedra e Cal* areas. There was a similar record of destroyed houses and walls in both sectors (9 in Macuti, 8 in *Pedra e Cal*), and also of fallen trees (5 in Macuti, 6 in *Pedra e Cal*), with a higher incidence in the central longitudinal axis of the Island. In contrast, roof destruction showed higher values in Macuti (19) than in *Pedra e Cal* (13), reflecting the greater vulnerability of roofs in this neighborhood. Flooded areas were mainly identified in Macuti, which concentrated seven affected neighborhoods, contrasting with a single street marked in *Pedra e Cal*. Three road blockage points were also mapped during the cyclone: at the beginning of Avenida 25 de Junho (Macuti), on Travessa da Saudade (*Pedra e Cal*), and at the end of Rua dos Combatentes (near the garden).

Regarding shelter locations, although the total number marked was similar (3 in Macuti, 4 in *Pedra e Cal*), in Macuti there is a concentration in the same sector (Litine and Esteu), while in *Pedra e Cal*, the identified locations include schools and the São Sebastião Fortress. This data reveals the need to plan and diversify more shelter points, especially in higher elevation areas to reduce the risk in vulnerable coastal areas. Coastal erosion was another important factor of concern, noted more frequently on the eastern coast – especially on the shoreline and near the Fortress – but also on the western coast, with areas near the cemetery and the Jardim da Memória. It is therefore important to define safe refuge zones in the most exposed coastal areas, such as the Macuti neighborhood, particularly along Rua dos Combatentes.

In the second stage, focused on risk analysis at different moments of the extreme weather event, the groups highlighted Macuti as the area most affected by the last cyclone. They noted the eastern coast as the area with the greatest loss of roofs, collapsed walls, and destruction of houses, in addition to mentioning the destruction of the coastal wall in this same area.

In the third stage, of individual reflection on community strategies, valuable points emerged. The overall effectiveness of the radio, television, and SMS alert system, managed by INGD and INA, was highlighted, with clear guidelines for evacuating risk zones and protecting vulnerable people. However, there were disagreements about the best ways to protect houses – whether doors and windows should remain

open or closed. Structural problems were also mentioned, such as the drainage ditches in Macuti, which failed during the cyclone due to the interruption in the electricity supply, preventing the extraction pumps from working. This system, existing only in the central areas of the neighborhood, was designed to extract accumulated water in flood-prone areas due to their lower-level location, but proved insufficient under the extreme conditions of the event. Reports indicated significant material losses, although no loss of human life was mentioned. Another relevant point was the fundamental role played by family networks in emergency aid, an aspect that can be articulated in an even more integrated way with other support responses. Finally, a community perception of change was detected in the pattern of recent cyclones, with more intense winds affecting the western coast more significantly – from Rua da Solidariedade to Jardim da Memória – which may require a review of planning and response strategies.

This collaborative mapping exercise constituted a pilot project, functioning as a methodological rehearsal for future applications on a larger scale. The experience demonstrated the value of direct community involvement, combining local knowledge and technical analysis to create a solid foundation for participatory planning and the resilience of the heritage and settlements of the Island of Mozambique.

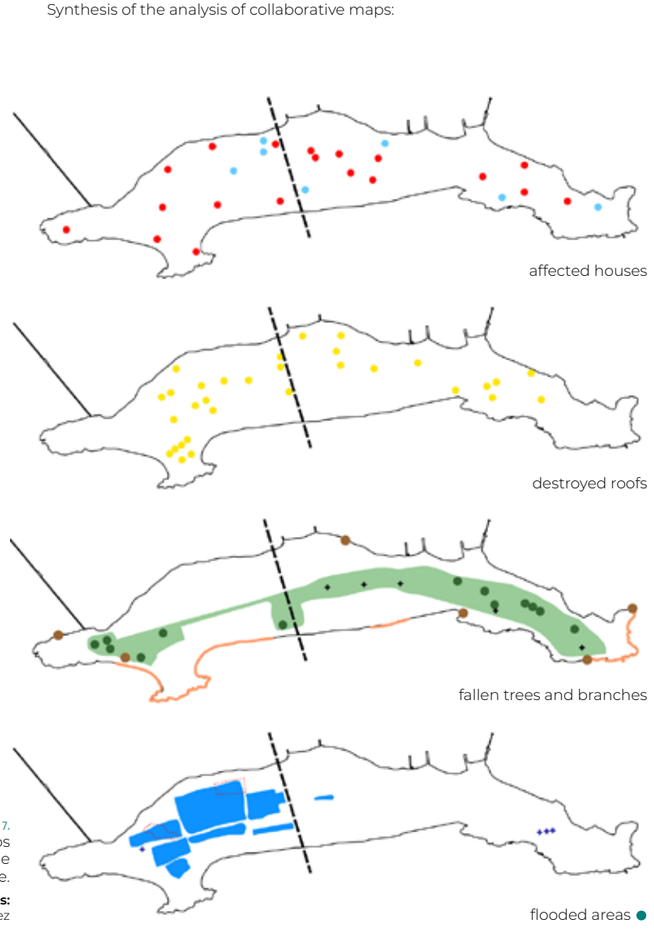


Figure 7.
Synthesis of collaborative maps developed in May 2025, after the impact of the cyclone.

Credits:
Telma Ribeiro, Susana Milão, Olga Álvarez

6 Recommendations for a More Cyclone-Resilient Habitat



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Participatory Guidelines for Action

Housing construction on the Island of Mozambique, strongly marked by family initiatives and self-produced practices, reveals morphological and constructive approaches that need to be valued. This results in solutions rooted in local know-how and adapted to the economic and cultural conditions of the island's context. These translate into empirically based responses to challenges associated with natural phenomena such as cyclones, floods, erosion, temperature variations, and high humidity. Recognizing the role of these practices is crucial in promoting integrated processes for heritage conservation, climate adaptation, and community resilience.

The result is recommendations for action that recognize the resilient potential of traditional construction practices and guide towards their recognition and technical qualification.

Resilience in the Context of Heritage

The vernacular architecture of the Island of Mozambique represents a cultural heritage of high value, with constructive solutions based on collective practical intelligence, articulating traditional knowledge, judicious use of local resources, and with resilient approaches that were developed over generations.

In the current context of climate change, valuing this living heritage requires more than its preservation: it demands its active integration into reconstruction processes, urban planning, and public policy formulation, guided by a holistic vision of resilience. The aim is to consolidate a systemic perspective based on communities, articulating environmental sustainability, spatial justice, and heritage continuity.

Beyond beneficiaries, the communities of the island are the protagonists in the continuation of their ways of life, blending tradition and reinvention in response to contemporary challenges. Promoting local inclusion, contextual intelligence, and practical innovation for heritage resilience, which implies recognising these communities as dynamic agents in constructing more cohesive, sustainable, and culturally anchored futures.

An articulated reading is proposed, integrating technical expertise, local knowledge, and the challenges posed by the climate crisis. These strategic recommendations acknowledge the enduring resilience of traditional construction practices and provide guidance on their recognition and technical

qualification. The intervention of an architect or of a technician should not replace these practices, but rather function as a facilitator of systems, promoting safety, comfort, and durability, while respecting local ways of life. Housing, in self-organised contexts, is not a final product, but a process of continuous transformation, in which each constructive decision represents a compromise between available resources, real needs, and deep-rooted ways of life. ●

Best Practices for Heritage Resilience

To cope with the impact of cyclones and other severe weather events, it is imperative to safeguard the built environment, such as urban planning, and living heritage.

Therefore, four essential lines of action should be considered::

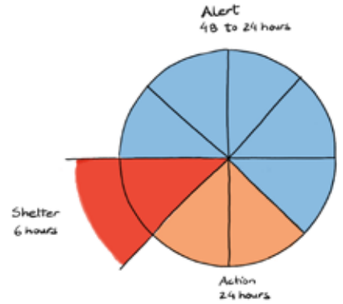
1. Reduce risk in the face of a cyclone;
2. Understand traditional materials and construction systems;
3. Implement mitigation and adaptation measures;
4. Carry out maintenance and preventive conservation actions..

Resilience is not just about withstanding the impact of a cyclone when it happens, but also about preparing and adapting to protect lives and property. With these practices, homes, communities, and heritage are strengthened. ●



Reducing Risk in the Face of a Cyclone

Preparing for extreme weather events should value local know-how and promote preventive actions that strengthen the resilience of homes and communities.



Credits:
Cristina Azevedo, Susana Milão

Mozambique's cyclone warning system uses a three-color code to inform communities about the amount of time available to prepare.

Since January 2025, the integrated PRISM platform has been strengthening this response, allowing for the recording of occurrences and real-time monitoring of wind direction and intensity, essential elements for more effective preparedness. By integrating data and promoting a coordinated response, PRISM contributes to continuous adaptation, reflecting the cyclical nature of climate phenomena and the importance of resilience in the face of these challenges.

**In the town of Macuti,
how can we reduce the risk of a cyclone?**



Introduce efficient (non-electric) drainage systems for rainwater runoff resulting from flooding.

Plant small and medium-sized vegetation for windbreaks around houses, which deflects and reduces wind force, and filters dust and sand during cyclones.

Adopt appropriate roof slopes. The safest roofs have a slope between 30° and 45°, which significantly reduces wind forces on the structure and can help protect the house from serious damage.

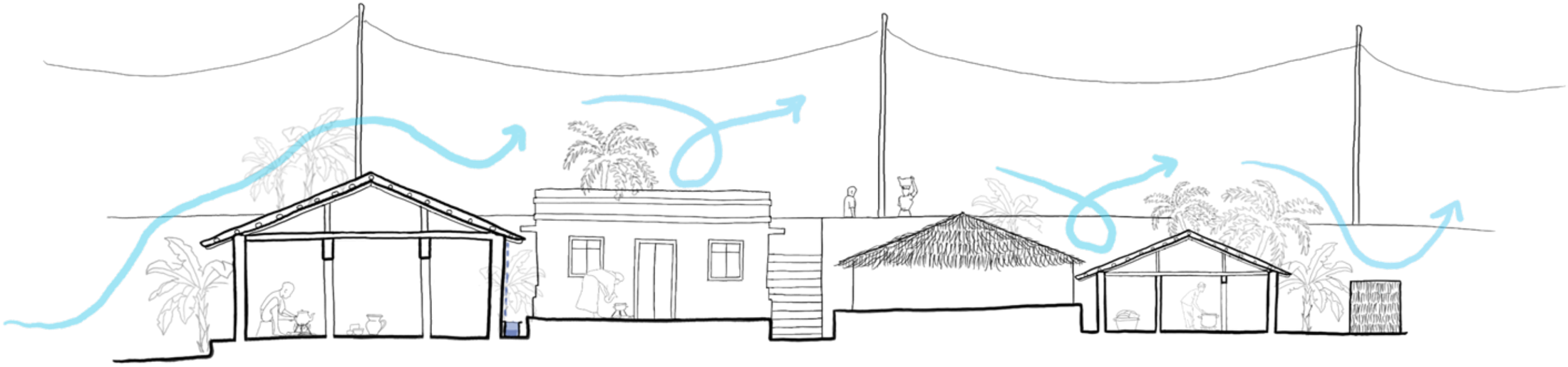
Preserve public fountains and cisterns.

Preserve public space for safe circulation in case of emergency.

Place stone foundations around the perimeter of the building for greater stability. This is a reversible solution that reinforces the foundations.

Figure 8.
Example of preventive actions to strengthen the resilience of housing and communities in the Quarhi neighborhood.

Credits:
Cristina Azevedo, Susana Milão, Telma Ribeiro, Olga Álvarez



Value structural flexibility with systems that adapt to wind forces without collapsing.

Avoid replacing traditional Macuti roofs with zinc or fiber cement sheets.

Preserve traditional pitched roofs, as lightweight flat roofs are more vulnerable to wind suction during cyclones.

Collect rainwater for domestic use.

Introduce efficient drainage systems to prevent rainwater accumulation inside houses.

Prioritize shelter locations at higher elevations.

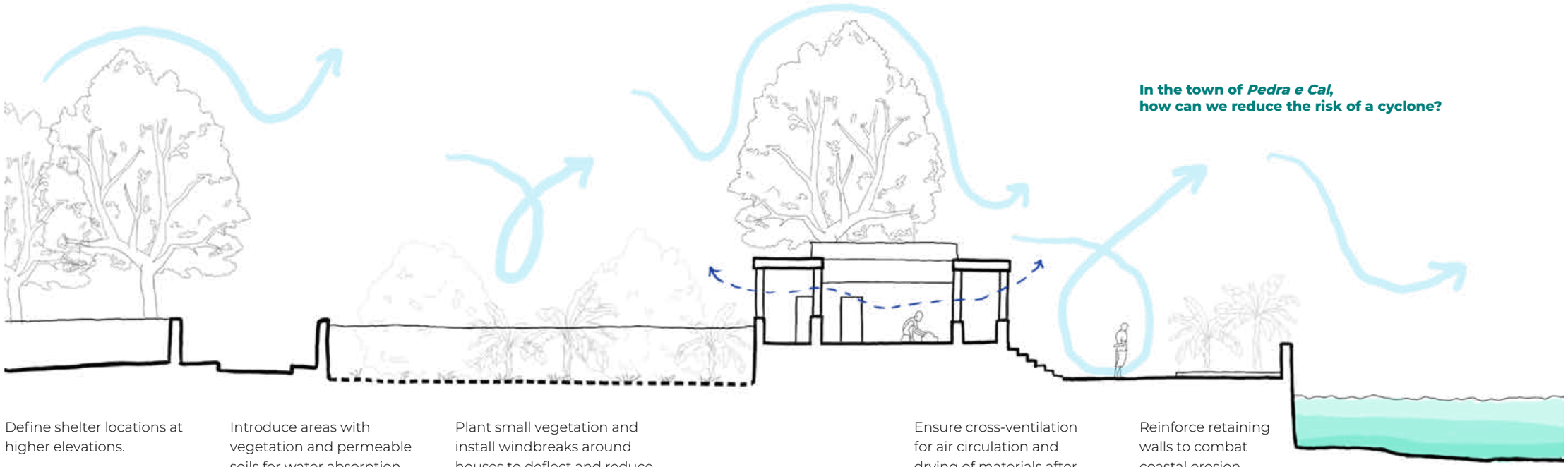
Use resilient local materials that take advantage of natural resources in a sustainable way.

Build latrines with natural composting solutions (dry system). ●

Figure 9.
Example of preventive actions to strengthen the resilience of housing and communities in the Litine neighborhood.

Credits:
Cristina Azevedo, Susana Milão, Telma Ribeiro, Olga Álvarez

**In the town of *Pedra e Cal*,
how can we reduce the risk of a cyclone?**



Define shelter locations at higher elevations.

Introduce areas with vegetation and permeable soils for water absorption.

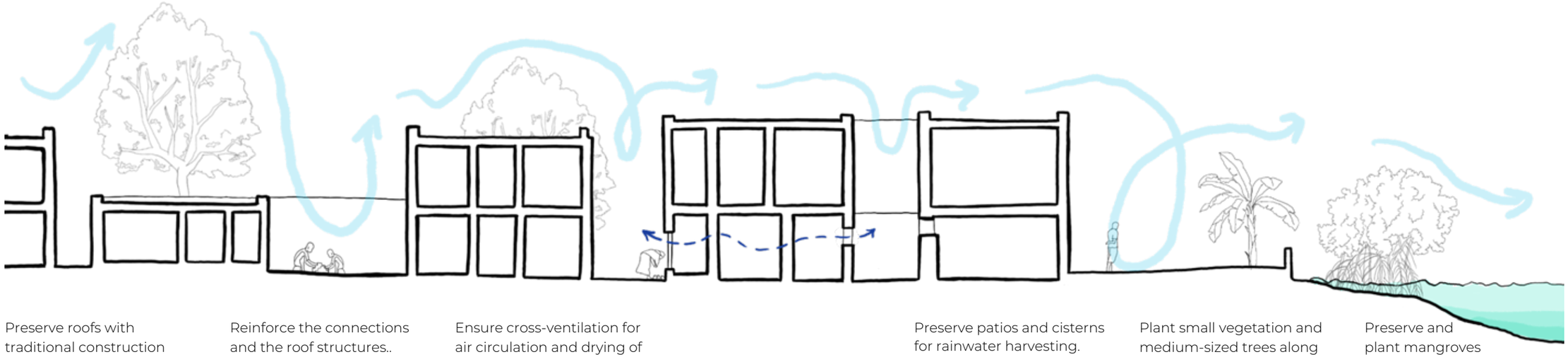
Plant small vegetation and install windbreaks around houses to deflect and reduce wind force, and filter dust and sand during cyclones.

Ensure cross-ventilation for air circulation and drying of materials after cyclones. Preserve and build traditional flat roofs. This type of structure increases the weight and resistance of the house.

Reinforce retaining walls to combat coastal erosion.

Figure 10.
Example of preventive actions to strengthen the resilience of housing and communities on Club Street.

Credits:
Cristina Azevedo, Susana Milão, Telma Ribeiro, Olga Álvarez



Preserve roofs with traditional construction systems (original and lacquered variant).

Reinforce the connections and the roof structures..

Ensure cross-ventilation for air circulation and drying of materials after cyclones.

Preserve patios and cisterns for rainwater harvesting.

Plant small vegetation and medium-sized trees along the shoreline to reduce wind impact.

Strengthen retaining walls to combat coastal erosion.

Preserve and plant mangroves along the shoreline.

Figure 11.
Example of preventive actions to strengthen the resilience of housing and communities on Arches Street.

Credits:
Cristina Azevedo, Susana Milão, Telma Ribeiro, Olga Álvarez

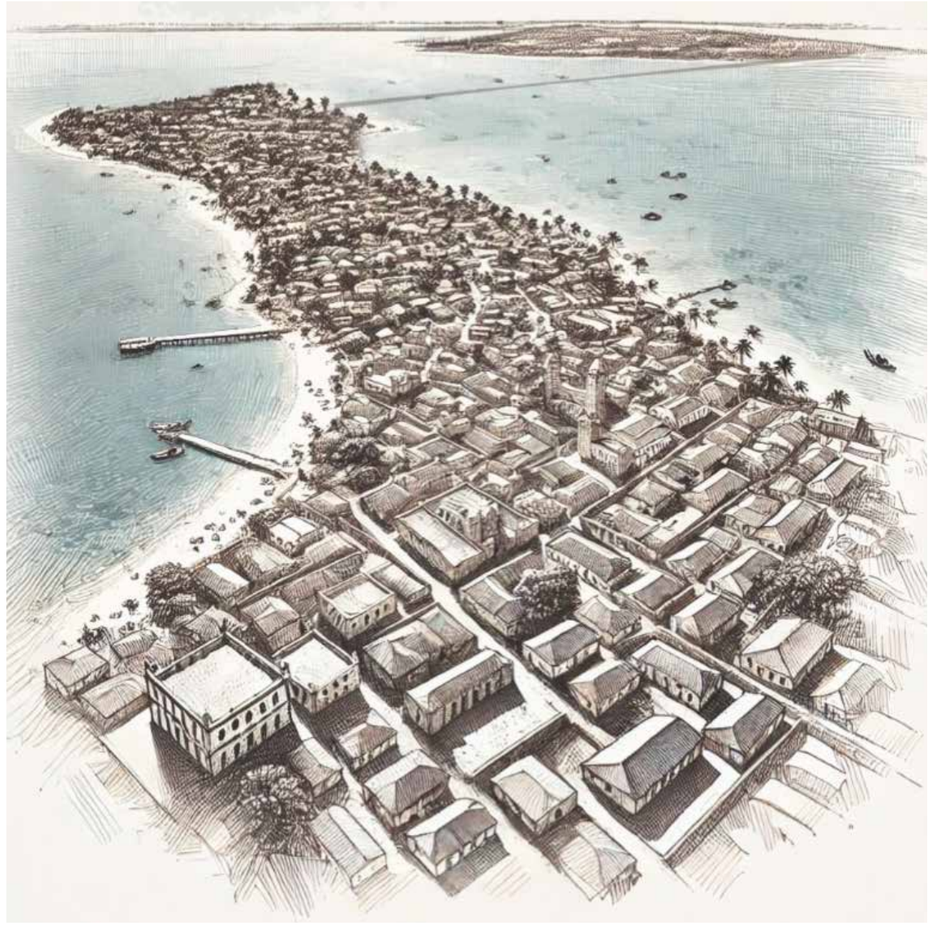


Figure 12.
Bird's eye view drawing of Mozambique island.

Credits:
Cristina Azevedo

Traditional Materials and Construction Systems

Most Suitable Traditional Materials

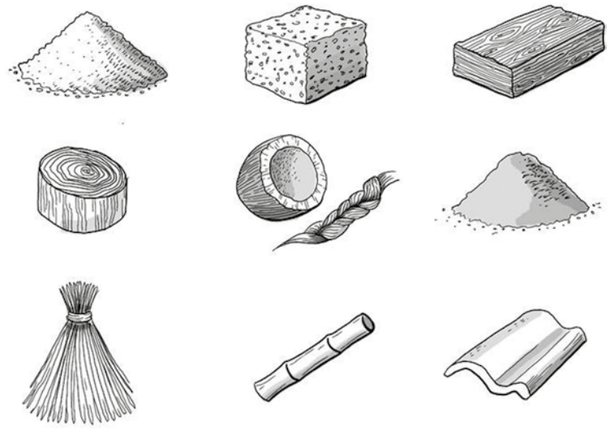


Figure 13.
Local traditional materials still in use.

Credits:
Cristina Azevedo

Adapting to the specific context of the Island of Mozambique ensures the continuity of lifestyles and cultural identity.
A deep understanding of local materials and techniques, and valuing traditional knowledge, is essential to promoting solutions that strengthen resilience by using materials such as: Lime, Coral Stone, Ironwood (Mecrusse) and Mangrove Wood, Coconut Fiber, River Sand, Grass, Bamboo, and Ceramic Tiles.


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The walls are constructed with **coralline limestone**, with shades ranging from gray to reddish and dimensions that vary according to the technique used.


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In the town of Macuti, **smaller stones** are used as infill in wattle-and-daub walls. While in the town of *Pedra e Cal*, larger stones are used in the walls and roof.


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Mangal wood, used in traditional construction for light and flexible structures, such as the framing of lacquered walls.


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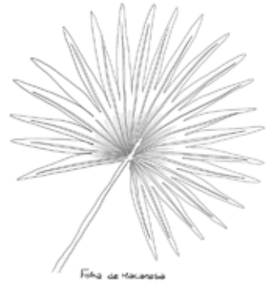
Pau ferro/ **Mecrusse**, a dense and resistant wood, used in structural elements and more durable finishes.

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Macuti (coconut leaf):

The main roofing material in traditional houses, offering good ventilation and thermal comfort.



Macarasa, a palm leaf that has been used in the roofs of the town of Macuti.


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Bamboo:
Used in the structure of the walls, due to its lightness and flexibility.


© Cristina Azevedo

Coconut fiber:
Used as a binding element in structural connections, ensuring strength and durability.

Macuti Town

- Wattle-and-daub walls are made of wooden stakes driven into the ground, between which bamboo canes are tied with sisal twine. The structure is filled with smaller coral stones. Then, the surface is plastered with lime mortar and is painted.

- Lacquered walls differ from the previous system in the way the walls are assembled and consist of a mat formed of thin mangrove rods, arranged side by side and tied firmly to each other, forming a continuous panel.

- The traditional roof of Macuti houses is made with a lightweight wooden structure, usually of mangrove or ironwood, over which previously prepared macuti strips are applied. These strips are overlapped and tied with coconut fiber, forming a resistant, ventilated roof well adapted to the island's hot and humid climate.



Figure 14.
Traditional roof of Macuti houses

Credits:
Cristina Azevedo, Susana Milão

Town of *Pedra e Cal*

- Masonry walls of coral stone are plastered with lime mortar and painted according to a traditional color system.

- In simple constructions, the stones are small and placed irregularly, while in higher quality constructions the 'box wall' technique is used, with two aligned facings and the interior filled with smaller stones.

- Houses in *Pedra e Cal* have two roof types: pitched in wood with ceramic tiles or flat in coral stone/lacquered stone.

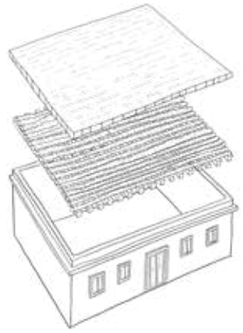
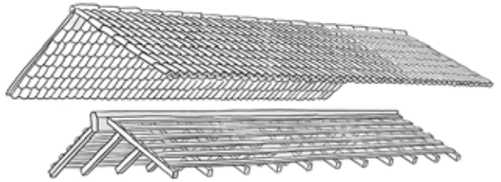


Figure 15.
Flat roof
(coral stone or lacquered stone slab)

Credits:
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Figure 16.
Pitched roof with wooden structure

Credits:
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Mitigation and Adaptation Measures

How to Recover Resiliently?

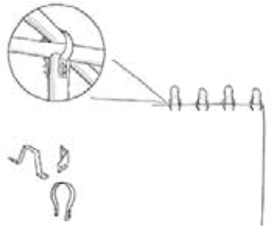
Following a cyclone, the sustainable conservation of the Island of Mozambique's heritage requires attention to specific restoration techniques: reinforcing roofs and walls, repairing pavements, finishes, openings, balconies, and gates using traditional methods. Implementing good maintenance practices with regular care, systematic inspections, and community involvement is fundamental to ensuring the preservation of memory and cultural heritage. A commitment to resilient practices allows the habitat to adapt and better withstand future extreme events, guaranteeing the protection of this living heritage.



Figure 17.
Traditional house in Macuti town.
Credits:
Cristina Azevedo

In the town of Macuti, how can we restore the roofs and walls of houses?

- Replace deteriorated roof elements: mangrove and bamboo support structures, and cladding. Avoid using zinc sheets on the roof ridge.
- Install wooden capping beams around the upper perimeter of the building's exterior walls to secure the roof structure.
- Restore wattle-and-daub walls by replacing missing filler elements and applying compatible mortars.
- Reinforce corners from the inside of the buildings by integrating tie rods.
- Reinforce roof-wall connections.



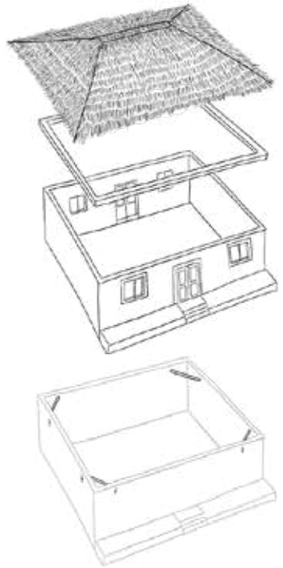


Figure 18.
Traditional house reinforcement in Macuti town.

Credits:
Cristina Azevedo

Given the total destruction of the roof, what can be done?

- Proceed with the restoration of the four-pitched roof for better wind resistance.
- Ensure a structure with standardized spacing of beams and purlins at regular intervals for uniform load distribution.
- Construct a roof with projecting eaves, fixed to the crowning beam to protect the walls from rainwater.
- Construct a ceiling using a traditional construction system based on ironwood/macrusse and mangrove wood, coated with lime mortar.
- In the construction of roofs in Macuti, it is recommended that the strips and layers be applied with adequate overlap, good density, and strong ties to ensure the durability and resistance of the roofing. ●

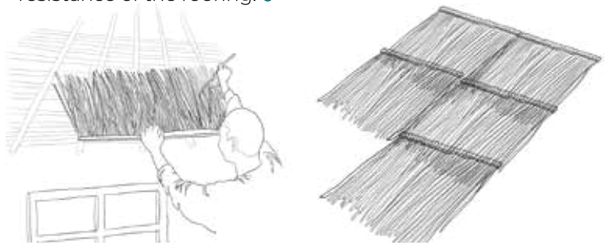


Figure 19.
Construction of traditional roofs in Macuti town.

Credits:
Cristina Azevedo

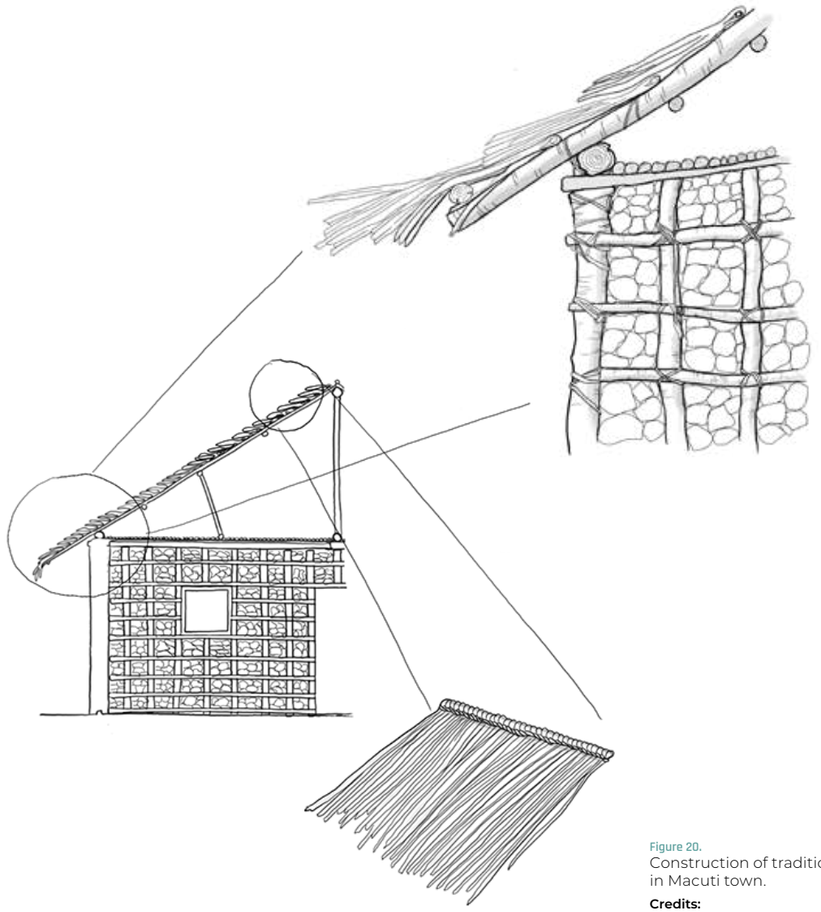


Figure 20.
Construction of traditional roofs in Macuti town.

Credits:
Cristina Azevedo, Susana Milão

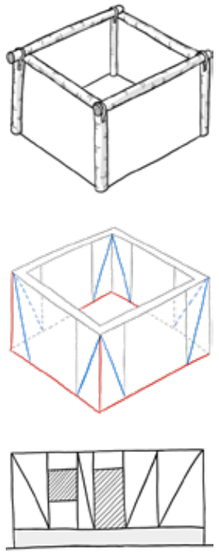
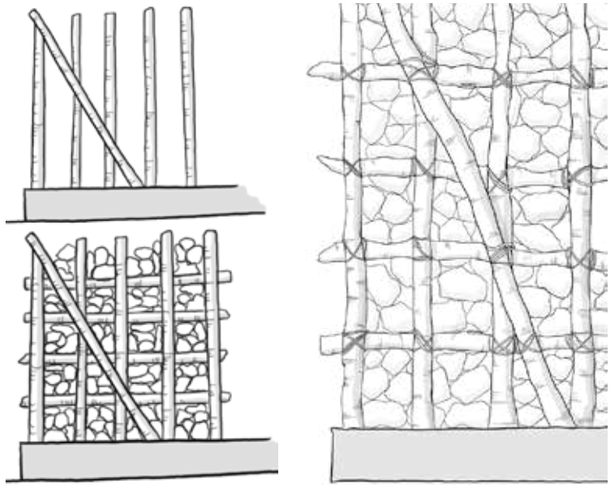


Figure 21.
Wall reinforcement in traditional houses in Macuti town.

Credits:
Cristina Azevedo, Susana Milão

How to reinforce walls?

- Reinforce walls with bracing, by placing diagonal elements, preferably at the corners of the buildings.
- Integrate larger wooden reinforcement elements at the corners of the buildings.
- Reinforce the connection between elements with strong ties.



In the town of *Pedra e Cal*, how to restore the roof and walls?

- Restore stone masonry walls by replacing missing elements and applying mortar with compatible materials.
- Reinforce the corners from the inside of the buildings, integrating tie rods.
- Restore and respect the color and heritage characteristics of the houses, including friezes, cornices, and quoins.

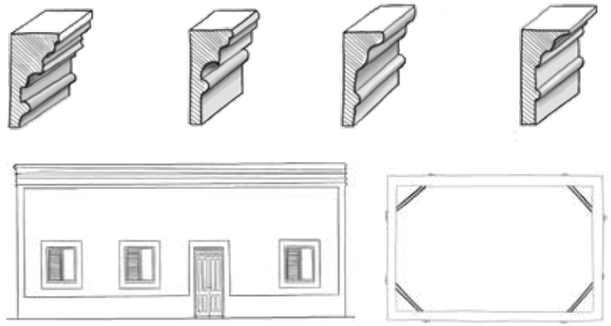


Figure 22.
Example of some cornices on traditional walls in the town of *Pedra e Cal*.

Credits:
Cristina Azevedo

In the town of *Pedra e Cal*, how to proceed when faced with roof destruction?

- Replace the deteriorated roof elements: the supporting structures and the coverings.
- Begin by consolidating the walls and, according to the characteristics of the house, proceed with:
  a) Construction of the roof with a wooden structure and traditional fixed tiles, a feature of historical memory to be preserved. When there are sheet metal coverings, these must have a thickness greater than 0.5 mm.
  b) Construction of a slab in the original system composed of main beams of 20x20 cm supported by a master beam, when necessary, and secondary beams to support coral stone slabs, leveled with mortar and gravel, and finished with lime, mulch and peanut or cashew oil-based waterproofing.
  c) Construction of slabs in the lacquered variant, which consists, when necessary, of replacing the coral stone slabs with thin mangrove rods, arranged side by side and coated with mortar and plaster and peanut or cashew oil-based waterproofing.
- Traditional thick stone roofs offer good thermal inertia and cool the interior through water evaporation (rain).
- Terraces and cisterns for water collection are important features to be preserved. ●

In the town of Macuti, how to strengthen the foundations of houses?

- Compact the soil in case of flooding and wait for the earth and materials to dry.
- In the absence of foundations, dig trenches inside the building to place ironwood pillars, infused with waterproofing and anchored in a concrete base with gravel, using iron rods and nails. These pillars will be placed strategically and tied to the external perimeter walls.

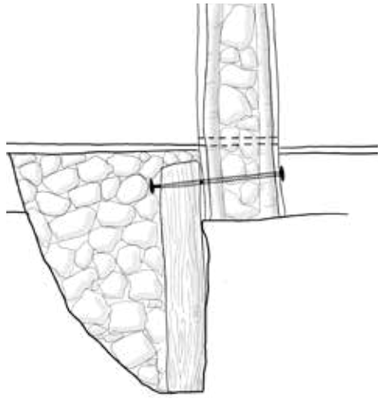


Figure 23.
Example of foundation reinforcement in a traditional house in Macuti town.

Credits:
Cristina Azevedo, Susana Milão

How to start construction?

- Place ironwood pillars (or equivalent wood), infused with waterproofing and anchored in a gravel and mortar base, using iron rods and nails.
- Reinforce the connection between walls and foundations by placing ties.
- Construct a floor with a slight slope to allow water (rain, floods, washing) to drain to the outside of the building.

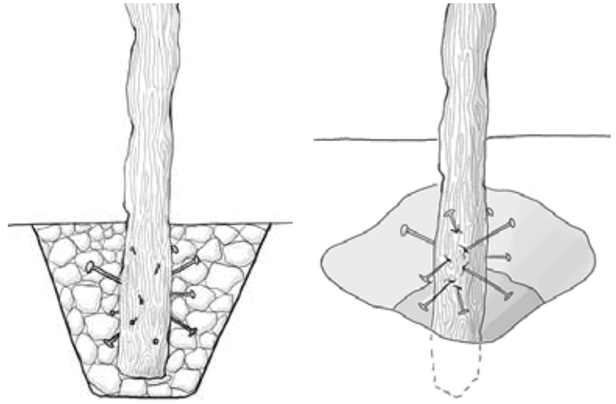


Figure 24.
Construction of wall foundations in the town of Macuti.

Credits:
Cristina Azevedo, Susana Milão

Good Maintenance Practices

Maintaining the houses, historical buildings, and traditional constructions of the Island of Mozambique in good condition is everyone's responsibility. Beyond the major reconstruction or restoration work that may be necessary after a cyclone, there is another fundamental aspect: regular and preventive maintenance.

In a territory subject to extreme weather events, maintenance is not just an aesthetic or cultural concern, it is also a resilience strategy – a practical way to protect lives, property, and collective history.

Good maintenance doesn't always require major work or many resources. Often, small actions, carried out with care and regularity, ensure the durability and safety of homes. These simple precautions strengthen the house and increase safety for those who live there. These are gestures that each person or family can incorporate into their daily lives and that, when done by the entire community, have a very positive impact on the island's collective heritage. ●

Maintenance and Preventive Conservation

Preventive Conservation

Preventive conservation is the set of regular care measures taken to prevent buildings from deteriorating. Instead of waiting for major problems to appear, this approach relies on careful observation and regular actions that help preserve buildings over time.

This type of conservation is fundamental in contexts such as the Island of Mozambique, where buildings are exposed to extreme weather events. With simple measures, such as checking the condition of roofs, cleaning gutters, reinforcing loose elements, or correcting leaks, it is possible to avoid greater damage and reduce future repair costs.

Preventive conservation is also a way to value heritage. By regularly caring for buildings, one actively contributes to preserving the identity and collective memory of the community. It is a shared effort involving owners, residents, technicians, and local authorities. ●

Small actions that make a difference

- Check the condition of the roof after heavy rains or strong winds, looking for loose or damaged tiles or macuti leaves.
- Clean roofs and gutters regularly to prevent the accumulation of leaves, debris, or sand that can cause leaks or excessive weight.
- Ensure that doors and windows close properly, preventing water and wind from entering during storms.
- Observe cracks in the walls and note their size and evolution for monitoring. Larger cracks may indicate structural damage.
- Clean the land around the house, removing debris or loose materials that could be carried away by wind or water, damaging walls or obstructing exits.
- The continuous preservation of buildings and ways of living requires a commitment to preventive maintenance and cultural appreciation.
- The implementation of a preventive assessment methodology based on checklists (with Yes/No) allows for quick and accessible diagnoses, even by non-specialists, promoting a culture of regular inspection.

A Simple Maintenance Plan

To keep a house or building in good condition, it's helpful to have a maintenance plan. It doesn't need to be complicated: simply organize the main checks and maintenance tasks over time.

A plan helps to avoid forgetting important tasks and allows the community or technicians to better plan actions, materials, time, and costs.

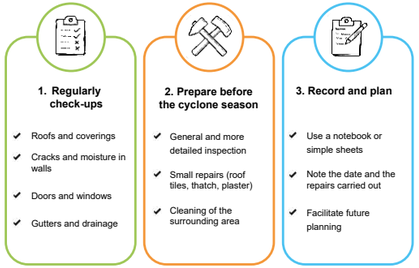


Figure 25.
General recommendations for home maintenance before cyclone season.

Credits:
Cristina Azevedo, Telma Ribeiro

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