Maurizio Berti

A heritage of coral stone

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Photo of the cover by Maurizio Berti: Somaná, Mozambique (2015).

Grudou-se à
que as desfa
posição aos
fesa do reb
periódica do
ainda sem u
desmoronam
ares de pedr
coberturas.
(Júlio Carri

To Marina and Mattia Jacopo.

Grudou-se às pedras de coral um tempo cansado que as desfaz na fragilidade da sua completa exposição aos elementos da natureza. Sem a defesa do reboco, sem o cuidado da reabilitação periódica dos seus proprietários, sem um uso e ainda sem um futuro economicamente sustentado, desmoronam-se as paredes, desmontam-se os pilares de pedra, apodrece o madeirame, abatem as coberturas.

(Júlio Carrilho, 2005)

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0.1. Research topics

In my studies I've dealt with five main topics.

The first one describes a method to organise the natural and historical contexts. Nature and art form an important part of our heritage and, as such, they can be critically interpreted.

In the second I have developed the issue of how coral reefs have been studied and the interest they have raised in the past, using the fundamental works of naturalists, geologists and travellers of the 19th and early 20th centuries.

In the third I have focused on the previous studies on the use of coral limestone in buildings.

The fourth topic examines the methodologies aimed at conserving the historical settlements on the tropical coasts, giving special attention to the environment.

Then, in the fifth and last topic I have analysed the experiences related to field studies. Particular attention has been given to coastal settlements in East Africa: Zanzibar, Lamu, Ilha do Ibo, Ilha de Moçambique, Inhambane, discussing the technology and the methodology used, fields still relatively unexplored.

0.2. Underlying issues

The idea of this paper originated in the city of Inhambane in 2004, watching the disintegration of the coral stone walls occurred after the first observations; its main cause has been attributed to the presence of water soluble salts. The salts are sodium chloride ($NaCl$), alone or with other components. In aqueous solution they can be absorbed from the environment, but may be present in the building materials, in solution or in a crystalline state. During my research and thanks to systematic observations in Inhambane, in Ilha de Moçambique and in Ibo the phenomenon of disintegration was ascribed to a simple cause/effect process.

As the geographical regions where these phenomena occur are really widespread, it seemed appropriate to adopt a scientific approach, since the topic hasn't been much discussed in the literature about heritage conservation.

My research, in this way, has led to the recognition of large and complex phenomena where the crumbling coral masonry can be contextualized. Nowadays, these phenomena can be dealt with thanks to the tools of technology and history but, in addition, I have tried to compare the natural phenomena with the cultural ones.

In recent years, some historical sites on the coast of East Africa and Arabian Peninsula have been restored and some limited recovery programs are ongoing, confirming the local and international cultural interest starting with the inclusion of Ilha de Moçambique (UNESCO, 1991), Zanzibar (UNESCO, 2000) and Lamu (UNESCO, 2001) on the List of Historical and Cultural Heritage[1].

A closer examination of some restorations shows that the diseases of coral stone buildings are often misunderstood and sometimes treated with low efficiency; only seldom a proper and lasting success has been obtained.

0.3. Research objectives

My studies are aimed at two main subjects, giving special attention to the maintenance culture.

The first was the development of tools and methods useful for the knowledge and mastery of physical and chemical phenomena of coral stone buildings, and assisting in their restoration and maintenance practices.

The second objective was the organisation of general and specific problems in accordance with the idea of preserving coastal settlements in an optimal equilibrium with the natural environmental assets.

In both of these goals are special partners involved: the owners of sites and architectures, administrators both public and private, restorers and conservators of the natural and cultural heritage.

[1] (ICOMOS). World heritage in Africa. Technical report, ICOMOS Documentation Centre, 49-51, Rue de la Fédération, 49-51, 75015 Paris, France, July 2006.

0.4. Discussions

The examination of the laws and standards of both local and international level has been accompanied by field observations, where the role of governments and NGOs in heritage management can be more easily evaluated.

Discussions about various subjects of this study were held at Universities where the data was collected or in places where the cases were observed: the PhD Course in Riqualificazione e recupero insediativo at the University of Rome La Sapienza, Italy; the Faculdade de Arquitectura e Planeamento Físico in the Eduardo Mondlane University of Maputo, Moçambique; the International Centre for the Study of the Preservation and Restoration of Cultural Property, ICCROM in Rome; the United Nations Educational, Scientific and Cultural Organisation (UNESCO) - Regional Bureau for Science and Culture in Europe (BRESCE) - Antenna Office in Sarajevo; the Aga Khan Foundation - Office in Maputo Moçambique; the ArchNet at the Massachusetts Institute of Technology.

Part I.

Coral stones

1. The physical and historical contexts

The geography of the coral reefs: Updating - Typologies - From reefs to platforms. **The path of knowledge:** Travellers' journals - How Sofala faded away between the rivers and the ocean - Coast and coral stone buildings - From Zanzibar to Inhambane - Coral stones for constructions.

1.1. The geography of coral reefs

1.1.1. Updating

As in other fields of scientific knowledge, the observations on the natural and anthropological environments are based on mensural surveys. In the maps obtained from fieldwork we can delimit the extent and distribution of coral reefs and, in time, we can record and measure the decrease or increase of the organic materials.

Generally speaking, the total area covered by coral reefs is still uncertain. In 2003, the Integrated Global Observing Strategy (IGOS) estimated the global extent of coral reefs to be between 0.3 and 3.9 million sq km. IGOS explained the big difference between the minimum and maximum values was due to the inaccurate description of the available field data and to the lack of an unequivocal meaning for the expression *coral reefs* in the experts' language. The same limitation was also found in the careful census of coral reefs published in the monumental World Atlas of Coral Reefs where only the biologically active areas are considered, regardless of the substrates or adjacent limestone deposits[1].

[1]Integrated Global Observing Strategy - IGOS, *A Coral Reef Sub-theme for the IGOS Partnership. Reports from the Coral Reef Sub-theme Group, IGOS Approved by the Partners*, 5th June 2003, p. 29 Appendix 2 (in: http://www.igospartners.org/ - date: 21.6.2009). The objectives of a number of international bodies concerned with global environmental problems converge on IGOS through

Recently, more precision in regional and local monitoring has improved the surveying procedures, connecting more closely the biology and the geography of the coastlines with the anthropological problems and the human settlements.

The Global Coral Reef Monitoring Network (GCRMN) is an operative structure of the International Coral Reef Initiative (ICRI) and a partnership among governments, supranational institutions and non-governmental organisations, dealing with coral reefs and their ecosystem conservation in accordance with international conventions. Since its establishment in 1996, GCRMN has published five reports (1998, 2000, 2002, 2004 and 2008). They were compiled using data and information collected in regional observation stations by hundreds of experts around the world. The periodic review of sites and data by local, regional and national institutions, scientific centres, governmental and non-governmental organisations has succeeded in adopting coherent and homogeneous procedures even in different contexts, each one characterised by peculiar and complex problems. Their aim is to keep a detailed updating on the global and regional reefs. Consequently, agencies can more easily upgrade their policies for improving the conservation of reefs and the lives of the human communities living close by. Such policies can solve temporary emergencies and problems of reefs conservation over a long period of time.[2]

Scientific literature typically states that coral reefs are located between the Tropics. But corals can reproduce in other marine areas with similar local conditions. In the surrounding areas residents often use coral limestone as construction material.

The main builders of coral reef are coelenterates, divided into different orders: corals, sea fans, madrepores. At the base of a coral reef formation there are embracing skeletons (exoskeletons) and calcium carbonate the polyps produce during their life cycle. The presence of symbiotic unicellular algae called zooxanthellae is of great importance within colonies of coelenterates. That alga is a part of the metabolism of polyps and provides them with oxygen; it also contributes to the process of construction of the limestone skeleton. Drilling bodies,

research, operations and long-term programs.

Mark D. SPALDING, Corinna RAVILIOUS and Edmund P. GREEN, *World Atlas of Coral Reefs, prepared at the UNEP World Conservation Monitoring Centre*, University of California Press, Berkeley 2001.

[2] Bibliographic references of the last report out of five by the Global Coral Reef Monitoring Network - GCRMN: Clive Wilkinson editor, *Status of coral reefs of the world: 2008*, Global Coral Reef Monitoring Network - GCRMN and Reef and Rainforest Research Centre, Townsville 2008.

Corals may reproduce in other marine regions where the environmental conditions are similar to the Tropics' [*M.B. Modified map from http://www.lib.utexas.edu/maps/world.html. The names of the States have been written according to ISO 3166-1.*].

Figure 1.1.: Geographical belt of the coral reefs.

such as sponges, worms and bivalve molluscs, together with scrapers, parrot fish and sea urchins, demolish the calcareous skeletons in order to feed on the polyps or zooxanthellae living there. The sediments are deposited in the cavities formed among the skeletons of coelenterates; the result is an initial process of diagenesis. Calcareous algae, calcareous encrustations produced by bryozoa and other minerals cemented together give structural stability.

Above, I have sketched a schematic definition of the coral reef conditions in a biologically active context. Actually, a vision on coastal settlement problems requires a constant attention to the cliffs geographical environment because they are not steady but constantly changing.

In a meeting held in 2007 at the National Museum of Geology in Maputo, geographer Patrícia Oberreuter explained to me some aspects of the geography of the Quirimbas Archipelago and of the mainland coast, emphasizing the morphological variability of the region. She called that area a geographic laboratory where, day after day, the observer can study the formation of new peninsulas, the transformation of the lagoons, the remodelling of the inlets and so on. All of them are the effects of two key fronts in the environmental conflict between continental and surface ocean waters.

The geographical transformation of the sea coast can be seen in its becoming seasonal, but sometimes the influence of geology on geography is not immediately perceived. The range of geological phenomena is determined by cycles of transformation occurring in millions of years, according to the theory of plate tectonics, now accepted by the majority of the scholars dealing with earth sciences[3]. An example of how geology can affect the geography of a coastal area can be found in the presence or absence of ground water under the inhabited platform reefs; another example involving the inhabited areas is the rising of the sea level as a result of global temperature increase. The phenomenon may go back to remote as well as recent geological times. This last example is a topic of study that has emerged during the observations of different levels of reef sedimentation at different heights of the soil, in coastal areas as in Marsa Alam on the Red Sea (2001), in Pemba (2002) in Ilha de Moçambique (2002), in Inhambane (2005, 2009) and Ibo (2007, 2008, 2009). The geography of the coral reefs in those areas mainly depends on the most recent changes in global temperature.

Geologists tell us that glaciers advanced and retreated several times during the last 2 million years. The last major glacial advance began about 100,000 years ago with an about two degree cooling of the Earth's climate. The polar ice caps grew and spread to lower latitudes. The glaciers were also present at higher altitudes near the equator. They reached their maximum extent about 18,000 years ago, covering 1/3 of the continents. About 15,000 years ago the Earth's climate warmed again and the glaciers melted rapidly with a consequent rise in the sea level[4].

[3] Here I refer to: Graham R. THOMPSON and Jonathan TURK. *Introduction to physical geology*. Saunders College, Fort Worth, 1998; Michele MAINELLI. *Bioermi a Rudiste nel cretacico del Matese orientale*. Arti grafiche la regione, aprile 2002. Thompson and Turk clearly reconstruct Alfred Wegener's (1880-1930) theory of continental drift with reference to the most commonly accepted theory of plate tectonics (pp. 30-32).

[4] *Factors that cause coastal emergence and submergence.*

Tectonic processes, such as mountain building or basin formation, can cause a coastline to rise or sink. Isostatic adjustment can also depress or elevate a portion of a coastline. About 18,000 years ago, a huge continental glacier covered most of Scandinavia, causing it to sink isostatically. As the crust settled, the displaced asthenosphere flowed southward, causing the Netherlands to rise. When the ice melted, the process reversed. Today, Scandinavia is rebounding and the Netherlands is sinking. These tectonic and isostatic processes cause local or regional sea level changes but do not affect global sea level.

Sea level can also change globally. A global sea level change, called eustatic change, occurs by three mechanisms: changes in water temperature, changes in the volume of the mid-oceanic ridge, and growth and melting of glaciers... Temperature changes and glaciation are linked. When global temperature rises, seawater expands and glaciers melt; when temperature falls, seawater contracts and glaciers grow.

Graham R. THOMPSON and Jonathan TURK, *Introduction to physical geology*, Saunders College, Fort Worth 1998, pp. 323-324.

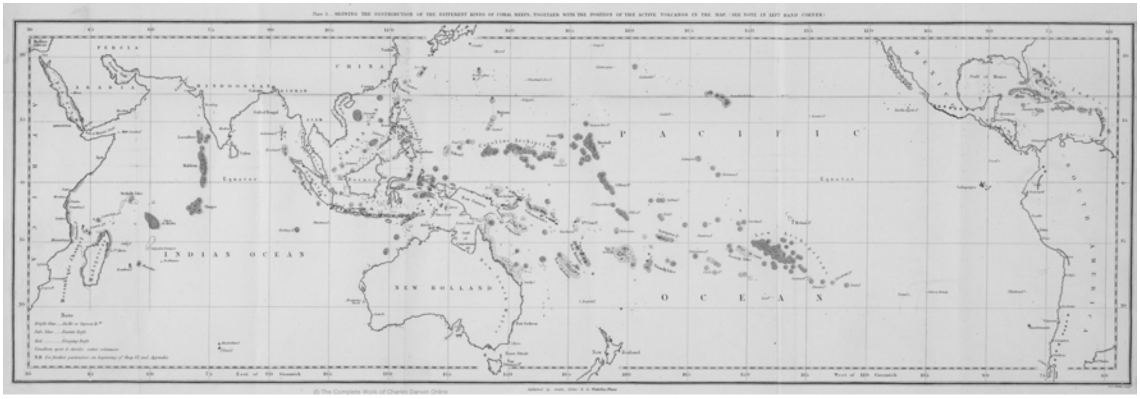


Figure 1.2.: *The distribution of the different kinds of coral reefs* [*Darwin, 1842*.].

1.1.2. Typologies

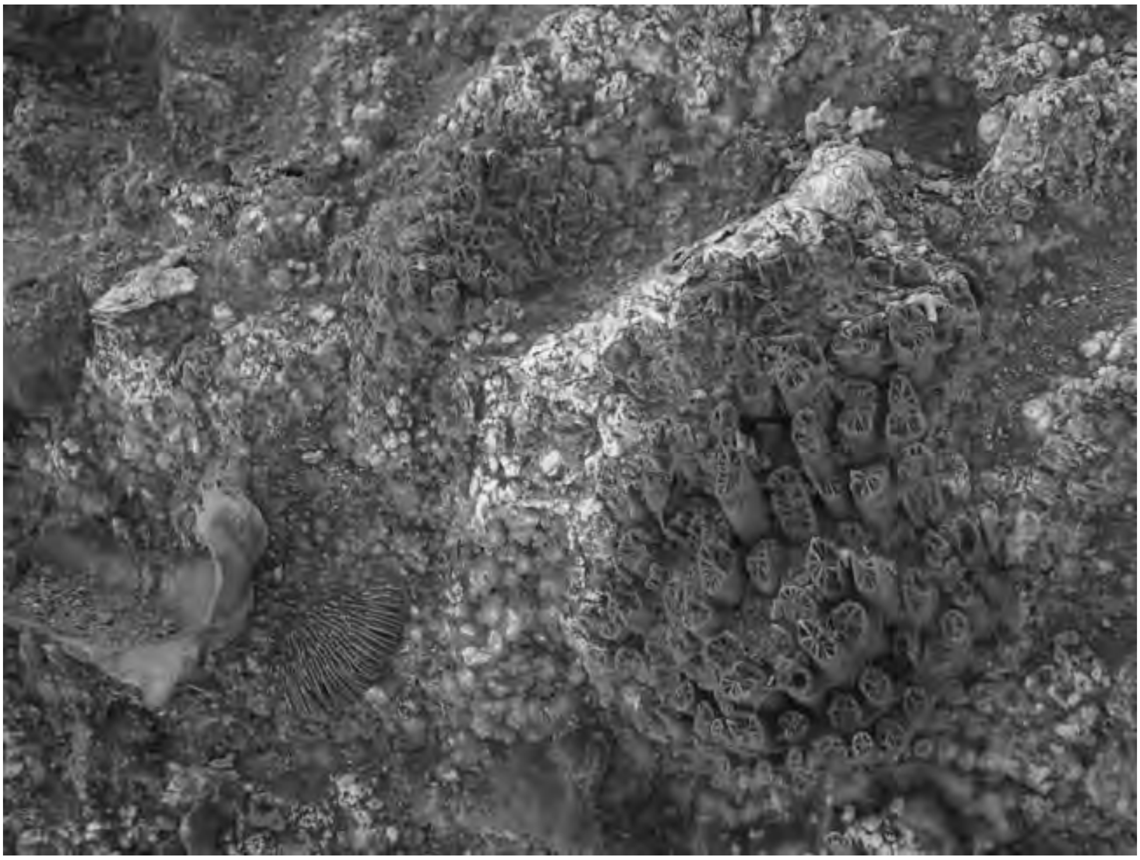
Contemporary scientific literature still relies on the issues of naturalist Charles Darwin's theory (1809-1882) on the formation of coral reefs[5]. This theory identifies three types of formations due to the geological phenomena, the wave motion and currents: *the fringing reef*, *the barrier reef* and *the atoll*.

The fringing reef forms along the junction between the continental coast and the islands in tropical seas. It rests directly on the coast even when separated from the shoreline by a shallow lagoon. That type is present in the South Pacific, partly in the Caribbean sea, along the coast of East Africa and on both coasts of the Red Sea.

The barrier reef develops off the coast of the \continental mainland. The more or less extended channel separating it from the mainland can have its origin in the sea currents erosion or in the movement of crustal plates. It often looks more or less elongated and can be seen in the Great Barrier Reef in Australia (2000 km), in New Guinea and in most parts of the Caribbean sea. Cuba is almost entirely surrounded by coral reef, partly adhering to the coast and partly under the form of a barrier off the island.

A coral atoll is the result of the gradual disappearance of a volcanic island, owing to the combined actions between marine subsidence and erosion: the once fringing reefs have become a coral ring around a lagoon. They can be found in the Maldives and in the Polynesian atolls. The beginning of the 20th century witnessed a gradual overcoming of Darwin's theory, which was finding the main cause of a coral reef growth in phenomena of subsidence in some crust

[5] Charles DARWIN, *The structure and distribution of coral reefs. Being the first part of the geology of the voyage of the Beagle, under the command of Capt. Fitzroy, R.N. during the years 1832 to 1836*, Smith, Elder and Co., London 1842, pp. 214.



Past coral formations, above the present sea level. Marsa Alam, Red Sea.

Figure 1.3.: Coral formations on the Red Sea [*Photo by Marina De Gregoris, 2008.*].

areas; new theories on eustatic sea level changes explain temperature changes and glaciations as closely linked phenomena. It is proved that when global temperature increases, glaciers melt and seawater increases; when temperature drops, sea water and glaciers grow. As a result of glacial and interglacial periods, past coral formations colonized regions different from today's. Sometimes, like in the shores of the Red Sea and Moçambique, the past coral formations adhering to today's living ones can be easily observed, but at a higher altitude.

Darwin's three types are still the most useful and easy way to explain the formation of coral reefs; but the new studies and theories on temperature effects on the sea level changes during the geological cycles and the interest in ecology too have made the morphology of the coral reefs a very complex matter. To strengthen the point of view exposed in this paper, it is useful to refer to the concept of *carbonate platform*; actually, it can offer an appropriate classification of the complexity of the phenomena taking place in the sea cliffs.

In addition to the definitions of fringing reef, barrier reef and atoll, the coral reefs are now identified with other definitions showing a greater variety of types.

For example, the *apron reef* looks like a fringing reef but is very steep; it can be found on the coast and follows the outline of a peninsula. We talk of *patch reef* when referring to the often circular isolated rocks in a lagoon or coastal inlets. A *ribbon reef* is a narrow and winding long coral reef usually associated with an atoll lagoon. A *table reef* is an isolated rock similar to the type called atoll, but without a lagoon.

Geologist James Dwight Dana (1813-1895) discussed the reef theories with Darwin; his book on coral islands improves Darwin's previous studies on the same topic. He questions Darwin's three types considering improper, for example, the distinction between fringing reef and barrier reef. He proposes a categorization of the coral rock structure through the descriptions and arguments used in geography:

b. Structure of Reef Formations.

In the description of reef grounds or reef-formations there are several distinct subjects for consideration, as is obvious from the preceding remarks. These are-

1. Outer reefs, *or reefs formed from the growth of corals exposed to the open seas. Of this character, are all proper barrier reefs, and such fringing reefs as are unprotected by a barrier.*

2. Inner reefs, *or reefs formed in quiet water between a barrier and the shores of an island.*

3. Channels or seas within barriers, *which may receive detritus either from the reefs, or the shores, or from both of these sources combined.*

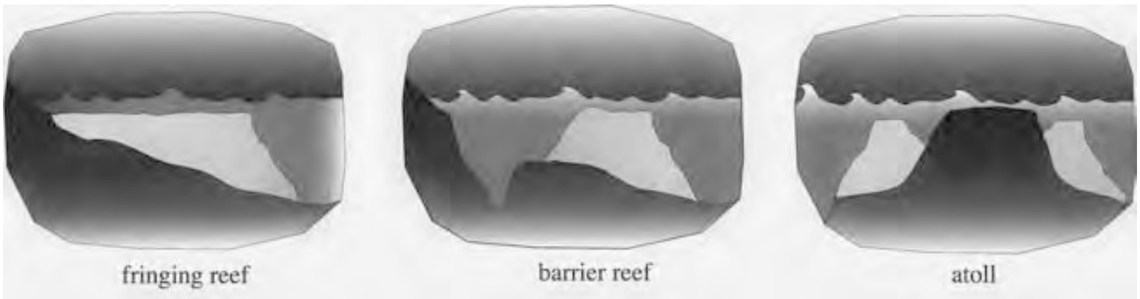
4. Beaches and beach formations, *produced by coral accumulations on the shores through the action of the sea and winds. The outer and inner reefs, channels, and beaches, act each their part in producing the coral formations in progress about islands.*[6]

1.1.3. From reefs to platforms

In an article, Russell Arthurton describes the long-term prospects of the ecological processes in the coasts of East Africa and provides an updated and clear description of the complexity of coral reefs[7]. Arthurton considers the biological activity as a kind of guidance for the shape the coasts are taking. The coast stability, however, is produced not only by the biological activity but also by a

[6] James Dwight DANA, *On coral reefs and islands*, G.P.Putnam & Co, New York 1853, p. 9.

[7] Russell ARTHURTON. *The fringing reef coasts of eastern Africa—present processes in their long-term context*, in *Western Indian Ocean Marine Science Association (WIOMSA)*, Vol. 2, No. 1, pp. 1-13, 2003.



The three main types of coral reefs were described in the early 19th century. They were defined in relation to geological phenomena, biotopes, marine currents and winds: *the fringing reef*, *the barrier reef and the atoll*.

Figure 1.4.: Diagram of the three main types of coral reefs [*M.B.*].

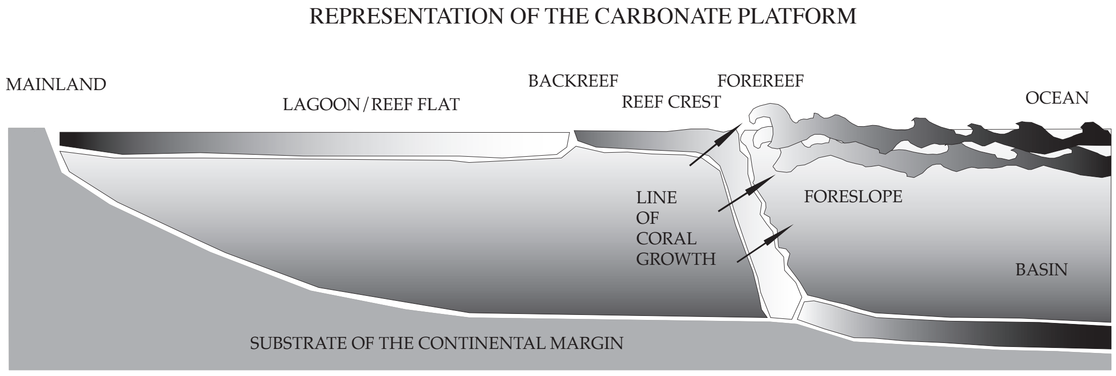
combination of physical and chemical processes of the various material elements which make up the continent and the ocean.

Arthurton looks at the African coast from Red Sea to the Moçambique Channel. The reefs are then classified into two main types: *fringing reefs* and *patch reefs*. Where the coast has a flattened continental profile, as on most of the Tanzanian coast, we are in the presence of patched coral formations. Where the coastal front is high and the final flattening end is missing, as along the coast of Kenya, the cliffs facing the ocean surf are dominant and can be found before deep lagoons.

A classification based on these two types, however, should not be regarded as exhaustive. During our observations on the shores of the Red Sea and on the coasts of the Quirimbas archipelago, it was difficult to find clearly characterised cliffs as the ones described by Arthurton. For the purpose of drawing a conservation program of coastal resources, cliffs and terraces should be considered as a sequence of accretion and erosion coming from changes in the sea level during the Quaternary. Sometimes, these processes affect carbonate sediment banks up to 100m thick in the area overlooking the ocean.

The formation process of the existing coral reefs can be summarised as follows: the bodies, animals and plants, with the ability to extract calcium carbonate from seawater are at the origin of the process. The progress of the construction on the cliff-edge oceanic habitat is accompanied by the formation of the *back-reef*.

The filling process of the areas behind the biologically active reefs was observed in the early 19th-century studies. Darwin constantly monitors it in his writings on coral reefs. His theory was based on extensive finds made on the Keeling atoll and Mauritius island, and was a subject of major importance in for-



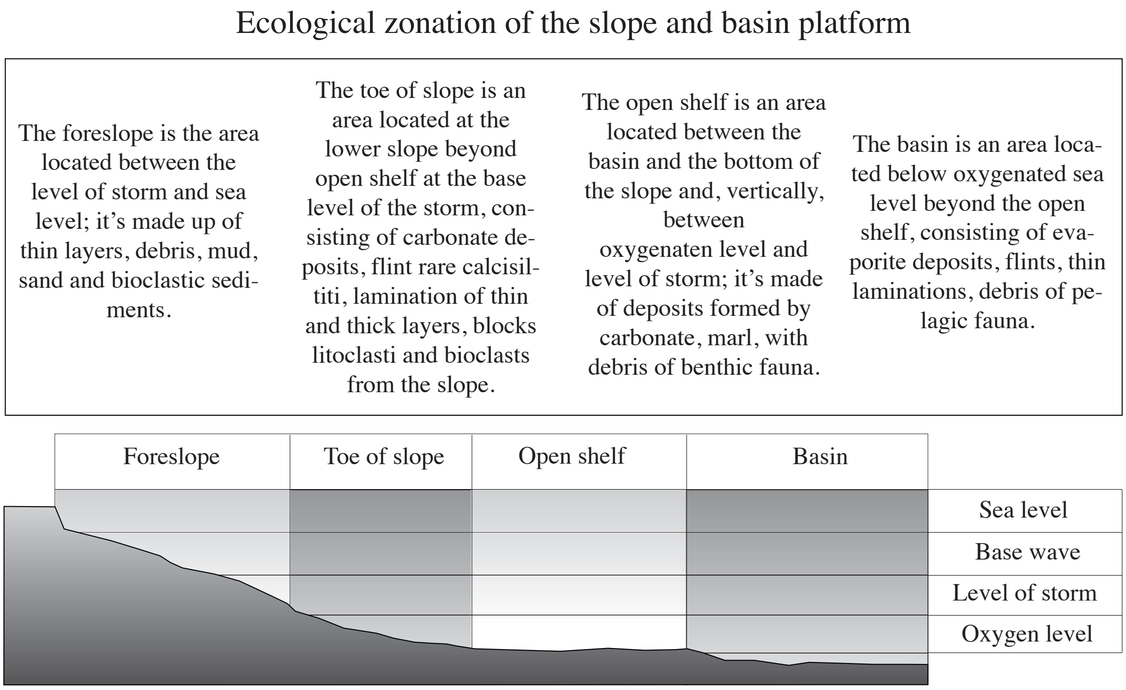
At the origin of the process there are organisms, animals and plants with the ability to extract calcium carbonate from seawater. The back-reef is forming while these organisms, defined total biota, build the reef. The process of filling the areas behind the biologically active reefs was observed in the early 19th-century studies.

Figure 1.5.: Diagram of the formation of the existing coral reefs [*M.B.*].

mulating the geographical typology of the atoll[8]. Progression in the coral reef height is the main topic Arthurton reviews in order to contribute to the policies of environmental protection, especially urgent now the tropical coasts are inhabited. Phenomena of biological neglect of the reefs, as a consequence of episodic sea level rises and falls in the past, are now well known. We thus learned that, in the process of cliff remodelling as a result of the changes in the sea level, the increase or decrease of soil materials involves the biologically active coastal fronts and the more or less large areas behind where limestone is sedimenting.

On the subject, Arthurton's work shows aspects directly referring to the maintenance and management of coastal settlements and to the conservation of biological reefs; as a matter of fact, settlements often occupy the land behind the cliffs in more or less invasive ways. Back-reef soils, when in connexion with biologically active reefs, are normally subject to low and high tide cycles (intertidal area) causing sedimentation and lime bringing. These platforms in progress, however, are eroded both by sea waves and by surface runoff coming from the continent. The surface layers of the newer platforms rest on previous sedimentation layers which are usually strengthened by diagenesis processes; they may also be found in a considerable state of erosion caused by meteorological phenomena during the past periods of air exposure.

[8] Charles DARWIN, *The structure and distribution of coral reefs. Being the first part of the geology of the voyage of the Beagle, under the command of Capt. Fitzroy, R.N. during the years 1832 to 1836*, Smith, Elder and Co., London 1842; Charles DARWIN, *Geological observations on the volcanic islands and parts of south America visited during the voyage of H.M.S. "Beagle"*, Smith, Elder, & Co, London 1876 [2nd Ed.].



The zoning of a cliff from its basin to the mainland is a useful model to simplify the understanding of a complex biological activity in the coastal environment. It's necessary to keep in mind the provisional nature of the environment. The surface layers of the newer platforms are based on previous layers of sediment that can be also characterised by erosion caused by meteorological phenomena occurred during past periods of air exposure. The study of erosion on the banks of past sedimentation is of great interest as the structures the coast will take in the future can be predicted.

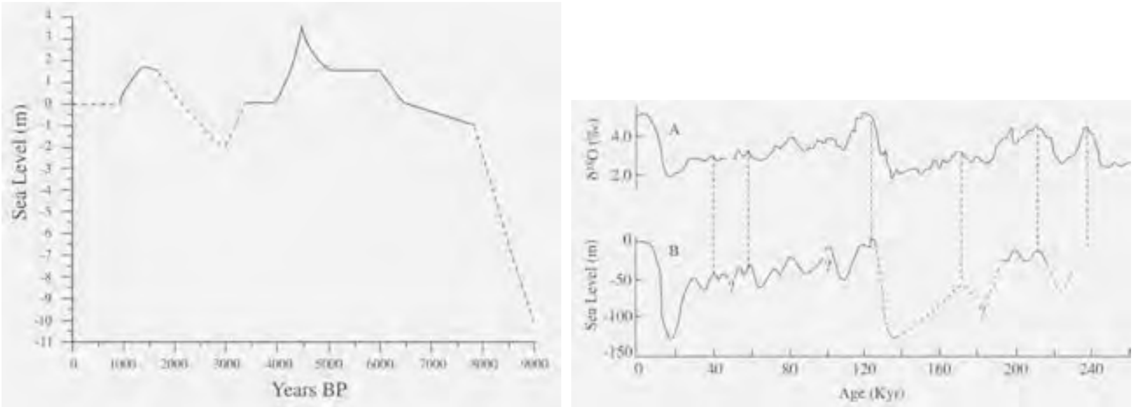
Figure 1.6.: Zoning of Morpho-Ecological units from the reef crest to the basin of a platform [*M.B.*].

The exploration of the erosion on the past sedimentation banks is of great interest. Arthurton assumes huge volumes of back-reef sediments were removed by one or more episodes of subsequent erosion.

The interest in these studies goes together with the observations effected in Ibo and Ilha de Moçambique. In particular, geophysical tools and concepts were necessary after finding three separate levels of coral sedimentation in Ibo and after surveys on the presence of *beach-rock* in Ibo, Pemba and Xai-Xai. There is also a geoarcheological aspect perfectly fitting the ecological sphere.

Studies on coastal stratigraphic sequences of sedimentary rocks led to the detection of significant soil changes during the Holocene, i.e. during the last 10,000 years. Their age can be evaluated throughout the comparison of a conventional pattern of the chronozone sequences with a pattern of conventional archaeological Holocene chronology. In fact, they go together with the path of cultural transformation of human societies, from the Mesolithic to the Middle Ages[9].

[9] A clear comparison between the late Pleistocene and Holocene chronostratigraphy and the chronology



The diagram of the sea level along the coast of South Africa during the last 9000 years [*M.B. Rewriting from PJ Ramsay, 1995*.].
Trends in the sea level over the last 240.000 years [*M.B. Rewriting from Geophysics Study Committee, National Research Council, 1990*.].

Figure 1.7.: Fluctuations of the sea level.

In 1995 Peter J. Ramsay, University of Natal, published a study where he pointed out at the altitude of the sea level during some important periods of stability from fluctuations along the southeast coast of Africa in the last 9000 years[10]. His study is based on the analysis of *beach-rock* samples taken on the coast from Vilanculos (Moçambique) to Sodwana Bay (South Africa). The sedimentary rocks are considered good indicators of a permanent sea level on the micro-tidal coasts[11] and, on the south-east African coast, they are the result of more or less prolonged episodes of levelling due to the stability of sea level rise.

According to Ramsay, the sea reached its present level about 6500 years ago; there after, the sea level reached a height of + 2.75m. That state persisted for a period of 2500 years arriving at + 3.5m, the highest level reached 4480 years ago.

of an archaeological site can be found in: Aldino BONDESAN, Sandra PRIMON, Valentina BASSAN, Andrea VITTURI et al., *Le unità geologiche della provincia di Venezia*, Provincia di Venezia e Università di Padova, Verona 2008, p. 174.

[10] Peter J. RAMSAY, *9000 years of sea-level change along the southern african coastline*, in *Quaternary International*, Vol. 31, pp. 71-75, 1995.

[11] On the average, there are three excursion ranges on a tidal coast:
— micro-tidal when the excursion is $<$ 2m;
— meso-tidal when between 2 and 4m;
— macro-tidal when $>$ 4m.
See also in US National Oceanic and Atmospheric Administration (NOAA): http://coris.noaa.gov/glossary/
1 - micro-tidal - coastal ocean or waterway with a low mean tidal range, e.g., less than 2 meters;
2 - meso-tidal - coastal ocean or waterway with a moderate mean tidal range, e.g., between 2 and 4 meters;
3 - macro-tidal - coastal ocean or waterway with a high mean tidal range e.g., greater than 4 meters.

Then a regression began, going down to the present level 3880 years ago. Approximately 3000 years ago the sea receded below - 2m as compared with today's level. Once again, 1610 years ago, it rose up to - 0.5m measured on the present level and finally reached its present level about 900 years ago.

The number of studies devoted to improving the methods for calculating the past sea levels in order to hypothesize the future with reliability has been remarkable. Studies on more geographically circumscribed phenomena, however, appear easier to check and to apply in the management of coastal heritage. I looked for similar data published in Ramsay's and Arthurton's books on Xai-Xai, Inhambane, Pemba, Ilha de Moçambique and Ibo. Several findings suggest practical trends as guides to methods and techniques in the conservation of sites, architecture and wildlife.

Some fieldwork cases have called for interesting comparisons among the study data on the phenomena and on the global sea level[12]. It happened, for example, with a coral reef located in Pemba 14m above the sea level, at an altitude well above those Ramsay knew of in the last 9000 years.

Arthurton deals with the subject referring to the coast of Kenya and he quotes a scientific hypothesis which says that, during the interglacial periods of high sea levels in the late Pleistocene (125 to 120 thousand years ago), the fringing cliffs had raised to approximately 10 m above the actual sea level[13].

[12] Geophysics Study Committee Commission on Physical Sciences, Mathematics, and Resources - National Research Council, *Sea-Level Change*, Studies in Geophysics - National Academy Press, Washington, D.C. 1990, p. 34. Caption: *Figure 4 (A) δ18O record for the past 240,000 yr from east equatorial Pacific core V19-30; and (B) sea-level curve for the Huon Peninsula recalculated to correlate with the δ18O record from core V19-30. Modified after Chappell and Shackle-ton (1986).*

[13] Arthurton, 2003, p. 3.

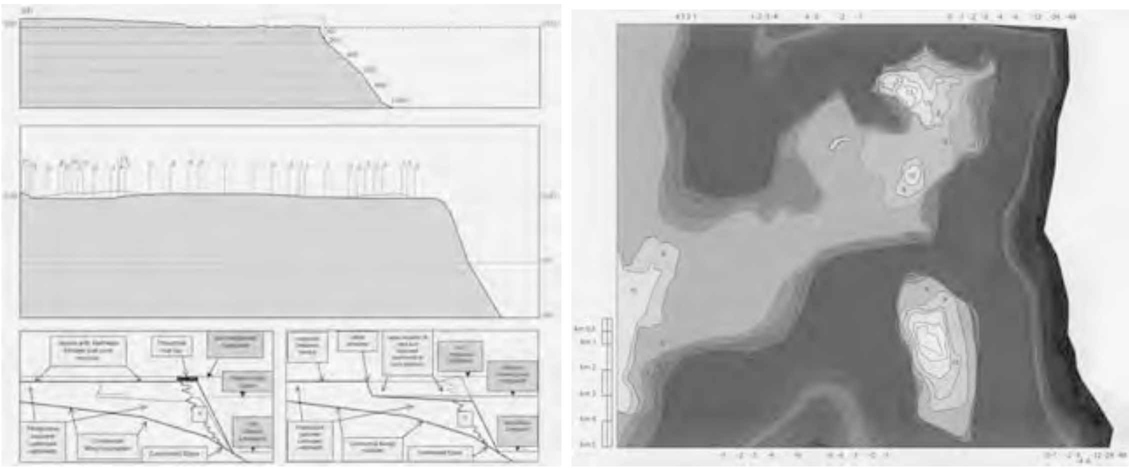
About the fluctuations of the sea level along the Brazilian coasts, see:

Fluctuaciones del nivel del mar - La reconstrucción de las fluctuaciones del nivel del mar en la costa brasileña fue realizada a partir de una serie de evidencias sedimentológicas y paleoecológicas. Para la región este de Brasil, se han identificado tres niveles de mar superiores al actual, denominados por Bittencourt et al. (1979), como transgresión antigua (>120.000 años), penúltima transgresión (= 120.000 años) y última transgresión (5.000 años). Los diversos trabajos sobre el litoral de Rio Grande do Norte evidencian la presencia de varios testigos de las fluctuaciones del nivel del mar, principalmente los niveles más elevados: - la presencia de terrazas marinas y paleo acantilados; - antiguas líneas de beach rocks; - paleolagunas y varias generaciones de dunas. Los testigos de niveles inferiores son más difíciles de determinar debido a su inmersión, aunque hayan sido identificadas por geofísica marina algunas evidencias, como la presencia de paleovalles fluviales en la plataforma continental e interrupciones en el aporte de material detrítico hacia la base del talud continental. La tendencia de un mayor período observado en el nivel medio del mar indica que la costa brasileña está sometida a una tasa de elevación del orden de 4 mm/año o 40 cm/siglo (Campos, 2003). Para el estado de Rio Grande do Norte, no existen observaciones a largo plazo del nivel medio del mar para que pueda ser determinada una tendencia fiable, sin embargo si consideramos las tendencias observadas en Recife (50 cm/siglo) y Belem (40 cm/siglo), podemos interpolar valores entre 40 y 50 cm/siglo, lo que correspondería a una elevación promedio de 0,45 cm/año;

Eugenio Marcos SOARES CUNHA, *Evolución actual del litoral de Natal – RN (Brasil) y sus*

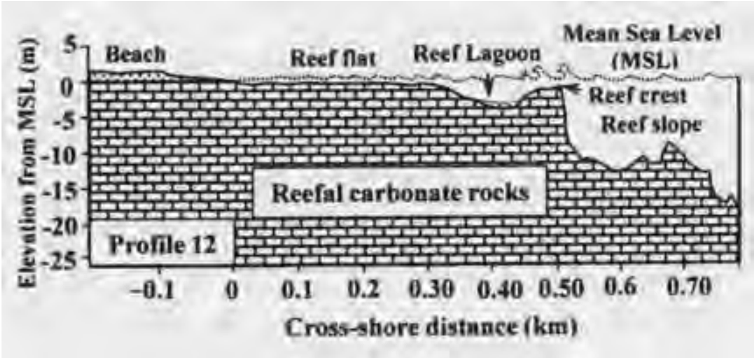
A coral reef was observed in Pemba, 14m above the sea level, at an altitude well above the ones granted by Ramsay along the last 9000 years. The level was measured through the geographical coordinates of Google Earth – 15/01/2009.

Figure 1.8.: Preliminary study journey to Ibo, May 2007. Observations on the sediment reefs in Pemba [*M.B.*].



Examining the coast of Kenya, Arthurton gives some scientific hypotheses; according to his studies, during the interglacial periods of high sea levels of the late Pleistocene (125 to 120 thousand years ago) the surf level on the cliffs raised to approximately to 10m above the current sea level because of transgression, while the marine regressions reached an altitude of over 100m lower than the current sea level.

Figure 1.9.: Setting R. Arthurton's method on Ibo platform [*M.B. and Arthurton, 2003.*] and level contour of the region around Ibo [*M.B.*].



Environmental engineering today is capable of elaborating models that prefigure the effects of changes in the environmental balance on the coast. This is a kind of studies with explicit purpose applications and they are often referred to as environmental impact studies. The extended section of coast south of Hurghada on the Red Sea is part of the projects that simulate the effects coastal currents on the reef would produce if an imaginary artificial excavation of the platform would be made. The effects of prefigured coastal transformation is indeed remarkable. The subject is treated in Omran E. FRIHY, Mohamed A. EL GANAINI, Walid R. EL SAYED, Moheb M. ISKANDER, *The role of fringing coral reef in beach protection of Hurghada, Gulf of Suez, Red Sea of Egypt*, in *Ecological Engineering*, 22, Elsevier Publisher, 2004, p. 18.

Figure 1.10.: A section of the coastal coral sediment near Hurghada [*Frihy et al., 2003, p. 18.*].

As mentioned above, the study of the deposits and erosion caused by variations in the level and by the waves at a depth of over 100m below the present sea level affects the policies of the coastal heritage, for the presence of ground water layers of continental origin. The interest is also due to the drainage characteristics specific to a widely porous limestone soil and to the resulting mechanical properties.

These topics relate to human settlements and their natural environment in the short and long term. They concern the study of sediments of limestone in general and corals in particular, located above the present sea level. These sediments are easier to observe and can give information on the geophysical phenomena to be expected in the future. Actually, the regeneration of the reefs as a result of the sea level rising, would naturally affect again the remains of those cliffs abandoned in the past stages of glaciation.

aplicaciones a la gestión integrada, Tesis Doctoral, Universitat de Barcelona, Barcelona 2004, p. 32.

The observations on the benches of limestone sediments of marine biota should not be separated from the general knowledge of the geophysical aspects of the substrate where they lay. Here this subject is only partially dealt with. I will just mention the important study on stratification, above and below the current average sea level, on the west coast of the Red Sea: Jean-Claude PLAZIAT, Frédéric BALTZER, Abdelmajib CHOUKRI, Odette CONCHON, Pierre FREYTET, Fabienne ORSZAG-SPERBER, Bruce PURSER, Annick RAGUIDEAU and Jean-Louis REYSS, *Quaternary changes in the Egyptian shoreline of the northwestern Red Sea and Gulf of Suez, Quaternary International*, Vol. 29/30, Pergamon Publisher, 1995, pp. 11-22.

In preparing and coordinating the various means necessary to achieve or maintain a long-term optimal balance between human settlements and natural heritage, the most urgent precautions should be aimed at managing the excavations for the materials needed for new buildings and also, at keeping the existing buildings. For that reason, carefully survey of the extraction sites of limestone and sand in Ibo, was undertaken. The knowledge of a coastal change model considering the geophysical and biophysical phenomena, as the one sketched by Arthurton, seemed necessary to express a critical assessment in managing extraction sites.

Fringing reefs form limestone cliffs emerging on the overall level of a platform. The growth process of the whole platform is driven by the deposits in the backreef, formed by mostly calcareous sediments of various products, first of all dried seaweed thalli deposited by tides and wave motion over the face of the cliff. The growth is increased by carbonate sediments produced by the fragmentation of shells and foraminifera, fragments of various minerals transported by waves and debris from the hard coral reef itself.

The other front of deposit supply is the continent. The shores of the mainland receive the sediments discharged from the inland, consisting mainly of thin quartz sand. The continental sediments, and the marine ones too, may be deposited along the lagoon canals; in this way they increase the size of the platform. In Ibo we observed the lagoon canals of the platform, now affected by tidal cycles, and have imagined their predominant past function as drainage channels. Our direct and simple observation identified the main cause of the presence of quartz sand accumulation excavated for construction purposes.

1.2. The path of knowledge

1.2.1. Travellers' journals

The Portuguese navigator Vasco da Gama sailed along a new sea route to India between 1497 and 1499; his journey started major changes in trade and in the relations between European, Arab and Indian towns. Thanks to the new route, the Portuguese strategy ended the commercial practice established among Venetians, Persians, Turks, Arabs and Indians. Dealing with the east coast of Africa, we have preferred to dwell on the gold rather than spice or other products trade, since the first documents on the presence of European travellers reveal that this business played an important role in determining the coastal settlements and the contacts among the different cultures.

In the late 15th century the Portuguese had planned two major explorations in the way to India, one by sea and one overland, even before da Gama's route. In 1488 Bartholomew Diaz had reached the Cape of Good Hope, while in 1489 Pero da Covilhã had travelled overland to Calcutta. The two travellers had shown a sea voyage from Portugal to India was very long and difficult; indeed, it would take a ship 6 or 7 months to sail along the coast of Africa. Therefore, a stop at suitable places was needed for the supply of food and water and for repairing the boats. The ports on the east coast were of particular importance because the route to India would start from there.

Pero da Covilhã's exploration can be shortly summed up as follows: once João II ascended the throne, he sent two monks and a layman to Jerusalem with the task of getting all available information about India and the lands of Prester John from pilgrims who had arrived in that city; if necessary, they were allowed to proceed further to the east. Since nobody in the group could understand Arabic, the mission was of little value and, indeed, they did not go beyond Jerusalem.

In 1487, the king sent Pero da Covilhã and Alfonso de Paiva on a second mission in the same area; the first had served as a soldier in Africa and could understand Arabic well. To make his task easier da Covilhã was given a map, perhaps copied from the Venetian Fra Mauro's, drawn in 1459. There, a sea passage around South Africa was indicated and it may have been used previously. Da Covilhã was heading to Abyssinia (the alleged kingdom of Prester John) to check there or further south if such a passage actually existed. Once in Cairo, he joined some merchants from Fez and Barbary and moved to Aden with them. There he sailed to India where he visited Goa, Calicut and other trade towns spices could be imported from.

From India he went back to the east coast of Africa and arrived at Sofala, the southernmost point inhabited by the Arabs. He visited the gold mines nearby and there he came to know that the Arabs had discovered that the sea along the southern part of Africa was a navigable route to the south-west. In Sofala he also obtained information about the island of the Moon, or Madagascar. Back in Cairo he sent a report to the king stating that the ships coming from the Guinea coast and heading south, could certainly reach the limit of the continent and the Eastern Ocean, going to Sofala and the Isle of the Moon [14].

[14] The short description was taken from Robert KERR, *A general history and collection of voyages and travels, arranged in systematic order*, Vol. XVIII [microform]: *Historical sketch of the progress of discovery, navigation, and commerce, from the earliest records to the beginning of the nineteenth century* / by William Stevenson, W. Blackwood, and T. Cadell, Edinburgh - London 1824, p. 178.

In his first sea expedition to India Vasco da Gama did not stop at Sofala, but at the island of Moçambique; in his report on the sailing along the East Africa coast he said that in the port of Sofala gold was traded and the traffic was ruled by the Arabs from there to Kilwa (in Portuguese, Quíloa). In their business Arabs wouldn't go beyond the Cabo das Correntes near the town of Inhambane. Sofala was the first major town on the east coast of Africa dealing with the Portuguese. During the second trip from India back to Portugal, Vasco da Gama stayed in Sofala 25 days and established a station for the gold trade.

In 1505 Pero de Anhaya built a fortress on the small island at the mouth of the Rio de Sofala. Here's a summarised description of the fortress and the region of Sofala in the story of Friar João dos Santos who lived there from 1586 to 1590:

The fortress of Sofala is twenty and a half degrees of latitude south and is situated on the eastern coast of Ethiopia. The fortress is near the sea and is placed in the middle of the mouth of a river which comes a hundred leagues from the coast in a land they call *Mocarangua*. The site has the characteristics of a lagoon. The river passes through a town called Zimbaoé, where Quiteve usually lives; he is the king of most of this land and of the River of Sofala. Along this river the residents of the fortress of Sofala sail to carry their goods to Manica, a land where there is a lot of gold, more than sixty leagues inland. There they sell their products and get a lot of gold strips, pieces and powder.

The fortress of Sofala has a square plan and is surrounded by twenty-five foot high walls. It has four bastions at the four corners, with heavy and light artillery; on the side facing the sea, there is a large two-story tower. The house of the Captain is adjacent to the tower. On the first floor there is a tank for collecting rainwater, used by the locals who prefer this water to the wells'. They do not drink the river water because it is very salty. In the fortress there is the church, which is the parish of the area. In the courtyard, on the side of the wall facing the village there is the store, where the merchandise from the Island of Moçambique and the ivory bought in the surrounding area are kept. Next to the fortress of Sofala there is a village with a Christian population of over 600 people (1586 to 1590), Portuguese, mestizos and natives. Here is a chapel dedicated to the Holy Spirit. Nearby there are two more chapels, one dedicated to Our Lady of the Rosary and the other to the Mother of God; the latter is the seat of pilgrimage and devotion by the locals. The inhabitants of the fortress are

In particular, from Pero da Covilhã's text: *that the ships which sailed down the coast of Guinea, might be sure of reaching the termination of the continent, by persisting in a course to the south, and that when they should arrive in the eastern ocean, their best direction must be to enquire for Sofala and the island of the Moon.*

mostly traders. Some are gold dealers in Manica and exchange it with clothing and other goods even on the captain's account; others are traders in the region of the Rio Save, Quirimbas Islands and other rivers flowing near Sofala. They trade ivory, amber, sesame, vegetables and especially slaves. Women are all employed in the cultivation of rice for most of the year and must plow, sow and clean; they work with spades and nobody uses ploughs.

Not far from the fortress of Sofala there is another village inhabited by Moors subject to the Christians. All are poor and miserable and usually work for the Portuguese sailors. Even the Moors are farmers and, as the Christians do, pay a tithe to the church [15].

In dos Santos' story, we can find more information on the construction of the fortress of Sofala and the difficult relations with the natives. Pero de Anhaya was sent there by El-Rei D. Manuel, with a fleet of six ships. After a very difficult journey, he reached the river of Sofala, where he entered with four smaller vessels, leaving the two large ones offshore, because they could not pass the sandbank. After landing, he began the construction of the fortress with the consent of the king of the land, who was a Moor named Zufe, completely blind because of an illness. When the fort was nearly completed, the king Zufe regretted his consent and, following the advice of his vassal chiefs, decided to kill the Portuguese and take their fort.

The betrayal was quickly discovered by an Abyssinian Moor named Açotes who lived in that land and was a great friend of Pero's. After his warning the Portuguese of the fortress prepared to resist the Moors, who relied on the surprise factor. They were wrong. Their impetus found a great resistance and they were forced to escape and go back to the fortified place where the king was. The Portuguese pursued them up to the house of the king himself. The blind king wanted to sell his life dearly and so he wounded the Portuguese closer to him with some shots of *assegai*; among them, Anhaya. But the resistance of the king did not last long and he was killed with a great number of his followers. The others were defeated and tried to escape.

Açotes had fought with his men on the Portuguese side and so got the title of King of the Moors of Sofala. He ruled all his life in peace with both the Moors and the Portuguese.

Pero de Anhaya ended the building of the fortress and died there. His place was occupied by Captain Manuel Fernandes, who was the procurator of the king

[15] João DOS SANTOS, *Ethiopia Oriental e varia historia da covsas no taueis do Oriente*, Manoel De Lira Impressor, Eura 1609, pp. 42-44 [Reprint as: *Ethiopia Oriental*, Lisboa 1891 - from: http://books.google.com].

The importance of Sofala was diminishing in the middle of the 16th century when the island of Moçambique played an important role on the main route to India and across the administrative mainland. On the right, the fortress of Sofala in 1929.

Figure 1.11.: *Cefala* in *Adèn, Arabiae felicis...*, 1534. The fortress of Sofala in 1929 [*Rufino, N° 09, 1929, p. 113.*].

in the area [16].

The importance of Sofala diminished in the middle of the 16th century when the island of Moçambique played a strategic role on the route to India and became the administrative centre of the mainland[17].

We thought it useful to read the journal of the voyage Duarte Barbosa made in 1514; he wanted to create a list of commercial or military sites along the route to India as drawn by Vasco da Gama. Written in 1516, the journal allows a first even if vague knowledge of the nature of the settlements along the east coast of Africa; therefore, we can perceive there the presence of signs ascribable to Arab culture, when the colonization process by the European states had just begun. We have read this journal in Giovanni Battista Ramusio's (1554) and Henry Edward John Stanley's (1866) transcripts[18].

In the description of Sofala, the soldier and chronicler Barbosa records a trade custom existing between Moors and Cafres in all the centres surveyed, from the islands of Uciques (Bazaruto) to the Isle of Quiloa (Kilwa). At Sofala collection centre the Moors, on board their boats, would bring their materials woven with

[16] Dos Santos, 1609, p. 46-48. The original text here translated can be read in the Appendix.

[17] RUFINO José dos Santos, *Álbuns Fotográficos e Descritivos da Colónia de Moçambique.*, [Companhia de Moçambique - A Cidade da Beira. Aspectos do Território], n. 9, 1929, p. 113.

[18] Giovanni Battista RAMUSIO, *Navigazioni e Viaggi*, in Marica Milanesi a cura di, in *I Millenni*, Giulio Einaudi editore, 6 voll., Torino (?) 1978-88, pp. 710-801 (original in the electronic edition of 03/06/1999 by: http://www.e-text.it/).

Duarte BARBOSA, *A description of the coasts of East Africa and Malabar in the beginning of the sixteenth century*, by Henry E. J. Stanley, The Hakluyt Society, London 1866.

inserts of coloured threads from distant Cambay (Khambhat). They weren't dyed because the Moors didn't know the dyeing techniques; however, they got in return the gold from the kingdom of Monomotapa[19].

As in every stage of the journey, here too the report will demonstrate how justified the Portuguese interest on the region was, for the presence of a large quantity of gold and for an easy, even if only commercial, advantage over the Arabs.

The description of the town of Zimbabwe where the king of Monomotapa often resided, shows traces of the atmosphere the historian Charles Ralph Boxer called the golden dream, a dream that will remain fruitless for decades.

Monomotapa was in many ways the Portuguese equivalent of the Spanish dream of El Dorado, and, as with the South American equivalent, many lives and much energy were vainly spent in pursuit of it. Most of the alluvial gold secured by the Arabs at Sofala in pre-Portuguese times certainly came from that region; but in trying to cut out the Swahili traders as middlemen in their dealings with the Bantu of the interior, the Portuguese - though few of them realised it - were cutting their noses to spite their faces[20].

Along with the description of places of the African coast from south to north, the focus remains on the gold mines, not considering other issues; the main theme remains the large business activity also involving India. Duarte will resume those themes when speaking of the centres north of Kilwa. In Kilwa he gives us the first evidence of learned Arab culture both in the urban and regional dimensions.

Duarte describes a new Portuguese route leading to India. So far Kilwa was the southernmost capital of Arabia Felix; its geographic centre is on the Red Sea, the territories of the Arabian Peninsula and the African Horn too. Kilwa is an island near the coast of Africa and is described as a town with beautiful Moor houses, built of stone and mortar. The houses are tall and have windows *alla maniera de' cristiani*. The town is divided by a road network. The terraced houses

[19] *The term "Swahili" a very loose designation at the best oftimes was never employed by the Portuguese; but it will be used hereafter to denote the Islamized East-Africans, whether of mixed or pure Arab blood, as opposed to the unconverted and less civilized Bantu tribes which inhabited the neighbourhood and the hinterland of the Swahili coastal towns. These unbelievers were dubbed "Kaffirs" by the Arabs, whence the Portuguese derived their word Cafres for the Bantu and negroes in general. There were also communities of Indian traders (Banyans) in some of the towns, but they were not then so important and ubiquitous as they subsequently became.*

Charles Ralph BOXER and Carlos DE AZEVEDO, *Fort Jesus and the Portuguese in Mombasa 1593 - 1729*, Hollis & Carter, London 1960, p. 14.

[20] Boxer and De Azevedo, 1960, p. 17.

are built in masonry and timber and there are plenty of gardens with fruit trees and water. The head of the island is the king. The small kingdom maintains a commercial maritime traffic based on the use of agile sailboats (dhows). Before the arrival of the Portuguese, the Moors of the King of Kilwa used to collect gold from their settlements in Sofala, Zambesia, Moçambique and Angoche and then sell it in the various centres of Arabia Felix.

Il linguaggio di questi è arabico, e tengono i libri dell'Alcorano, e grandemente onorano Macometto lor profeta. A questo re, per la sua gran superbia e per non voler ubbidire al re di Portogallo, fu tolto questo luogo per forza, onde uccisero e fecero prigione molta gente, e il re si fuggí della isola, nella quale il re di Portogallo mandò a fabricare una fortezza: e cosí tiene a sua ubbidienza e governo quei che rimasero ivi ad abitare[21].

We can read here a brief description of a civil territorial organisation, a condition Barbosa had not seen in Sofala, Zambesia, Angoche and Moçambique where the primitive forts in construction and the adjacent Portuguese farms still didn't offer an image of long-lasting settlements; the same was true for the existing Swahili villages. The attention reserved to the urban culture or territorial organisation of the Moors, up to the important commercial hub of Cambay, is reduced to a few expressions of wonder at the beautiful stone and lime houses of Mombasa, Melinda, Zeila. Then Barbosa developed an interest for the ongoing war for the control of the Red Sea and, before starting the journey to the Arab coast of the Indian Ocean, his attention was firmly focused on the Arab or Portuguese fortresses under construction; actually they were the only structures of territorial organisation providing military and commercial presence for the Portuguese[22].

[21] Ramusio, 1999, p. 716.

[22] *Suez. Lasciando questa terra del Prete Ianni e la costa del mar di questa ora detta Arabia, e voltando all'altra parte del mar Rosso, che anche si chiama Arabia, e li Mori la domandano similmente Barraaru, è una terra di porto di mare che ha nome Suez: e quivi li Mori di Zidem, porto di mare, portano tutte le spezie e drogherie, pietre preziose, perle, ambracan, muschio e altre mercanzie molto ricche delle parti dell'India. Di lí poi le caricano in camelli per terra per condurle al Cairo, e dal Cairo altri mercatanti le portano in Alessandria, di donde le sogliono portar via li Veneziani e altri cristiani. Questo traffico è cessato al presente in gran parte per cagione de' Portoghesi, i quali con la loro armata non lasciano navigar Mori nel mar Rosso. Il gran soldano signor del Cairo, che in questo riceve piú perdita che nessun altro, fece far un'armata nel porto di Suez, per la fabrica della qual fece condur per terra il legname e artegliaria e altre cose necessarie, in che spese molti danari: e quest'armata fu di navi e di galee, per poter passar con essa in India e impedir la navigazione a' Portoghesi. Fatta che fu quest'armata, passò con essa molta gente di diverse nazioni nella prima India, che è nel regno di Cambaia. Il capitan di essa era Amyrasem. Con quest'armata si riscontrò l'armata di Portogallo dirimpetto ad una città nominata Diu, e quivi combatterono molto fortemente, dove morí gran numero di gente. Alla fine i Turchi e i Mamalucchi furono vinti, e la lor armata fu presa tutta e parte abbruciata. E per questa e per molte altre vittorie che ebbero contra i detti Mori, si perdette la lor navigazione nel mar Rosso, e il detto porto di Suez resta senza traffico di spezierie.*

The aqueducts, Aden's for example, are among the few civil works deserving to be recorded. Duarte Barbosa's limited interest towards the settlements reveals, in some way, the initial state of a condition of secular instability on the west coasts of the Indian Ocean. Instability went together with the subjugation of the Arab-Swahili culture and with the cultural instability of the Portuguese colonialism itself. As far as the latter is concerned, only in the 20th century the Portuguese settlers and administration started a policy of settlements and infrastructures, which lasted a little more than half a century until the recent processes of decolonization[23].

In *The Journal of the Royal Geographical Society of London* Lieutenant William Wolfe published a story on voyages of exploration of the Arabic and African coasts on board SS Leven and Barracouta, under Captain William Fitzwilliam Owen's command between 1821 and 1826 [24]. Among the information gathered on the conditions of towns and settlements along the east coast of Africa there is one of the first definitions of the cultural identity we now call *Swahili*; it involves some settlements characterised by this very cultural identity.

To the southward of Juba, to the island of Chuluwan (Chiloane), *and perhaps to Delagoa* (Maputo), *the coast is inhabited by a race of Mahometan Moors, differing in language, person and character from the Arabs and native Africans; this people are now called Sowhylese* (swahili). *The river Juba is described as rising in Abyssinia, and may be navigated in boats for three months from its mouth; the passage across the bar is narrow, but has plenty of water. The coast and most of the islands to the southward of the river are of madrepore*[25].

The condition Wolfe records in Patta (Pate), the main island of Lamu archipelago, is bleak. Clearly the town had an important position in the past and, at the time of their rule, the Portuguese had also built a fort. Now the inhabitants, impoverished, lived in houses made of perishable materials with basic construction features, quite different from the urban dwellings of the highest

Ramusio, 1999, pp. 720-721.

[23] José Roberto BRAGA PORTELLA, *Descripçoens, memmórias, noticias e relaçoens. Administração e Ciência na construção de um padrão textual iluminista sobre Moçambique, na segunda metade do Século XVIII*, PhD Thesis, Universidade Federal do Paraná, Curitiba 2006, p. 86-91;
Alexandre LOBATO, *Colonização senhorial da Zambézia e outros estudos*, Junta de Investigação do Ultramar, Lisboa 1962, pp. 114-116.

[24] William WOLFE, *Narrative of Voyages to explore the Shores of Africa, Arabia, and Madagascar. Performed in His Majesty's Ships Leven and Barracouta; under the direction of Captain W. F. W. Owen, R.N. By Lieutenant Wolf, R.N.* In: *The Journal of the Royal Geographical Society of London*, Volume the Third, John Murray - Albemarle-Street, London 1834, pp. 197-223.

[25] Wolfe, 1834, p. 209.

Arab culture as, for example, described by Duarte Barbosa 300 years before.

The town is small and scattered, the huts are in the Arab style, of an oblong form, standing east and west, composed of reeds and stakes well plastered with mud, the roof not resting on the wall, but supported by rafters a few feet above the eaves, and projecting far beyond the building[26].

Great Quiloa (Kilwa), once an opulent town, had lapsed into a state of precarious dwellings.

Quiloa was one of the most considerable Arab possessions; the climate obliged the Portuguese to abandon their conquest, after having erected a fort, but the town never again rose to its former state; a miserable village occupies the site, and wretched hovels are blended with the ruins of the once opulent city: it is now under the Muskat government[27].

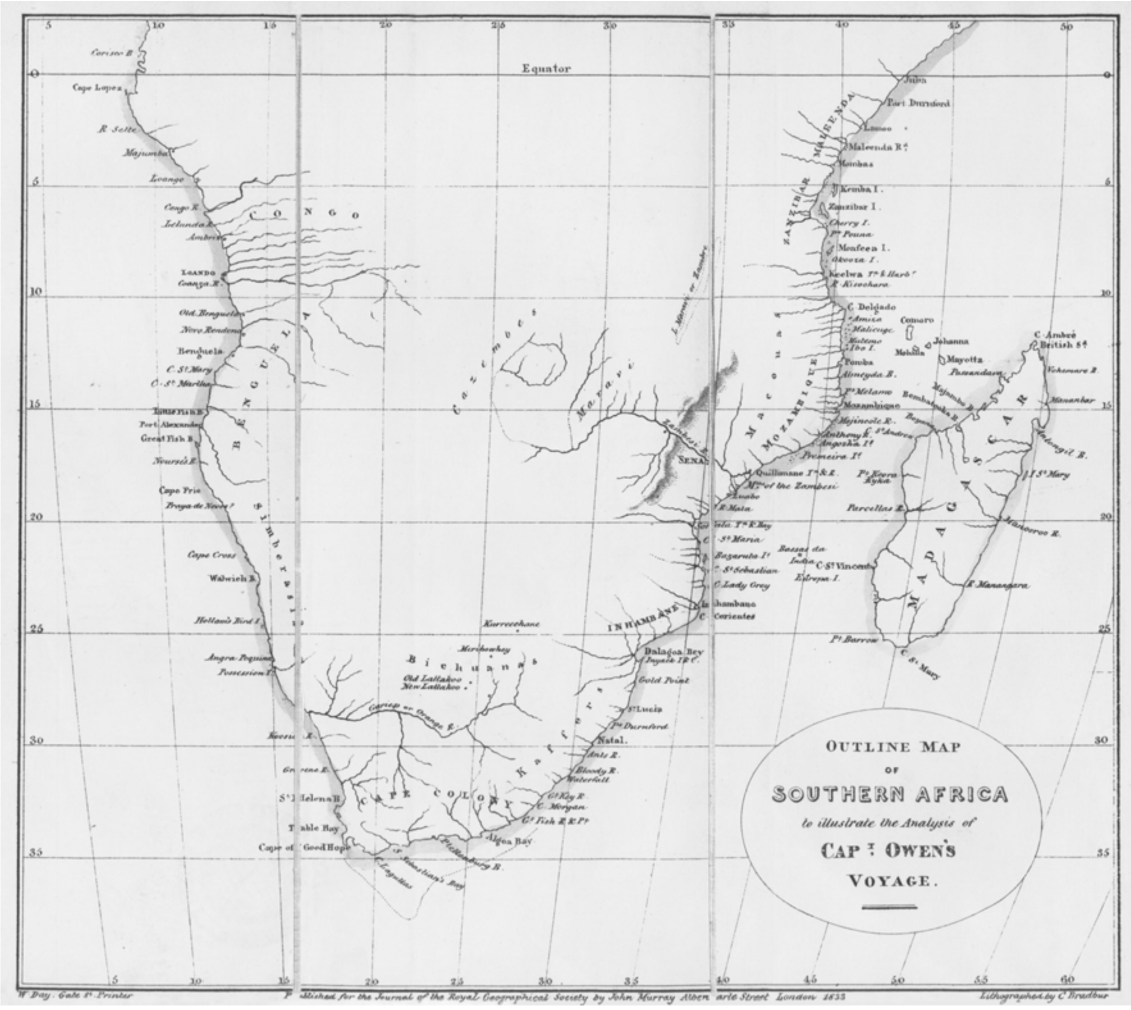
The description speaks of the Quirimbas archipelago too where the islands are formed by coral reefs. The town of Tho (Ibo) is described as the north frontier post in the region dominated by the Portuguese. The small fortress and the two stone and lime forts had made Ibo the best fortified place of the Portuguese dominion in the early 19th century.

Coasting along a low, rocky, unfathomable shore, and passing Cape Delgado, they anchored at the Querimba Islands, which lie immediately to the southward. They are all low, formed of coral, with long flat reefs extending eastward. The harbours are excellent; but Ker and Querimba are the only two inhabited. The town of Tho is the frontier Portuguese post to the northward, and is more strongly fortified than the generality of their possessions. It contains one large fort, built in 1791, and two smaller ones. The garrison consists of two hundred soldiers, either creoles or negroes[28].

Together with Lamo (Lamu), where houses are grouped according to the typical Arab city, Mombas (Mombasa) presents an optimal condition from the commercial point of view and promises future prosperity. However, Wolfe states that the town is divided into two parts, one for the Arabs and one for the Swahili. Their condition is miserable.

There is not a more perfect harbour in the world than Mombas, with good anchorage, well sheltered, shore steep-to serving as wharfs. and a rise and fall of twelve to fourteen feet. The city is built on an island three miles long and two broad, surrounded by cliffs of madrepore which might be rendered impregnable. It has great commercial facilities, and if occupied as a military station would be very serviceable in promoting the civilization of central Africa. The town is divided into two parts, one inhabited by the Arabs, the

[26] Wolfe, 1834, p. 210.
[27] Wolfe, 1834, p. 211.
[28] Wolfe, 1834, p. 212.



Darwin didn't visit most parts of the African coast with coral reefs, but their presence is evidenced to him by the descriptions of Captain Owen, published in the Journal of the *Royal Geographical Society of London* (1832) and in the two volumes of *Narrative of Voyages* (1833).

Figure 1.12.: *Outline Map of Southern Africa to illustrate the Analysis of Capt. Owen's Voyage, London 1833.*

other by the Sowhylese, all in a wretched state[29].

Wolfe's writing is a brief, full of gaps summary of the narration Captain William Fitzwilliam Owen published in 1833 on the same exploration voyages of the Arabic and African coasts. It partly refers to Owen's work for its documentary value of the historical reconstruction of a crucial phase of the early 19th century European colonialism in Africa and, more generally, in the regions along the Indian Ocean. Owen is mentioned because he was a renowned geographer who gave an important contribution to the knowledge of the oceans, coastal mainland, islands and coral reefs.

[29]Wolfe, 1834, p. 210.

In his draft of *The distribution of the different kinds of coral reefs* in *The Structure and Distribution of Coral Reefs* of 1842, Darwin reports some stories of his contemporary fellows; among them, Owen's journeys. Darwin didn't visit most parts of the African coast considered as coral reefs but their presence is evidenced by Captain Owen's descriptions, published in *the Journal of the Royal Geographical Society of London* and in the two volumes of the *Narrative of Voyages* of 1833. A narrative of the same travels was published by Captain Thomas Boteler in 1835. Darwin quoted Boteler when preparing his map on coral reefs; Boteler took part as an officer in the same exploration under Owen's command[30].

Owen deals with matters relating to corals when from Delagoa Bay he lands at Moçambique harbours. The description of Moçambique, as to organisation and urban planning, takes into consideration three main aspects: accessibility of the coral reef, military fortifications and urban structure. On the urban structure, Owen gives an appropriate observation:

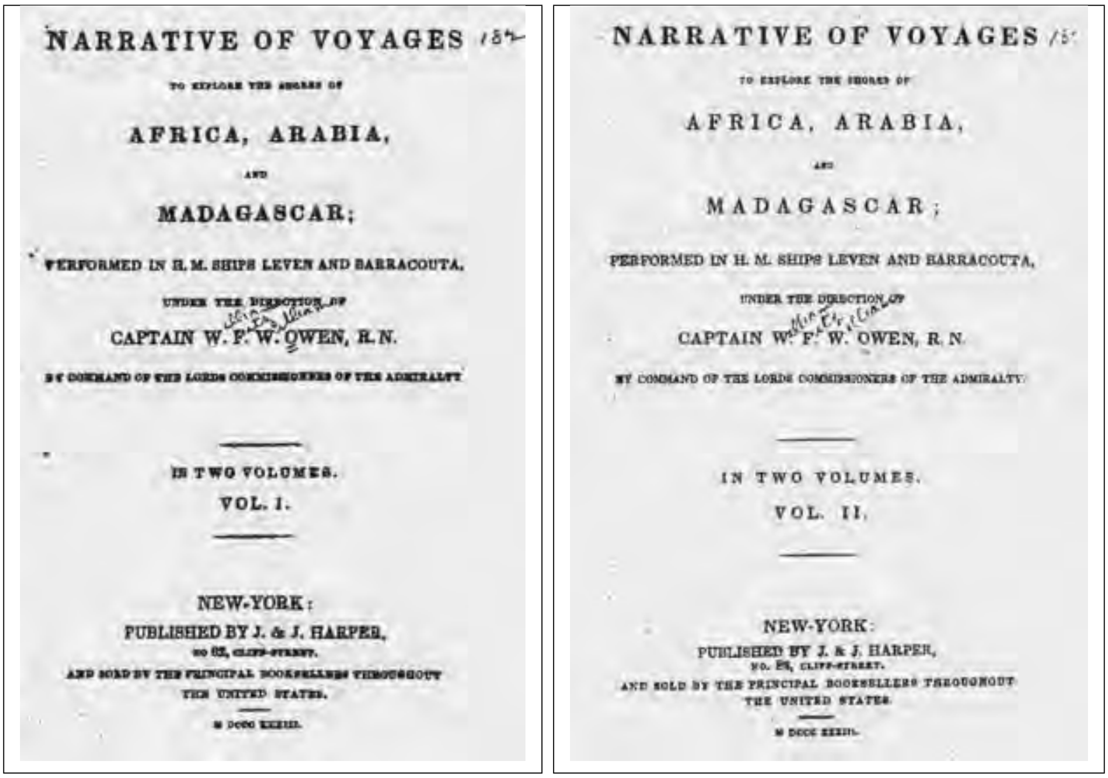
The streets in the city are narrow, although the houses are generally lofty and well constructed, but as the place itself is fast sinking into insignificance, so the finest of its buildings are falling rapidly into decay. Mozambique, like many other cities of the world, is now reduced from its ancient wealth and vice-regal splendour to the almost forgotten seat of desolation and poverty[31].

The journey the Admiralty had planned included a second mission to Delagoa. During the transfer Owen describes the characteristics of the Mozambican coast from north to south. From Moçambique to the Bazaruto Islands, the coast is bordered by a bank of 4 to 5m high sand deposits, covered with low veget-

[30] Darwin cites Owen using in particular: William Fitz William OWEN, *Particulars of an Expedition up the Zambezi to Senna, performed by three Officers of His Majesty's ship Leven, when surveying the East Coast of Africa in1823*, in *Journal of the Royal Geographical Society of London*, Vol. 2 (1832), pp. 136-152; James HORSBURGH, William Fitz William OWEN, *Some Remarks relative to the Geography of the Maldiva Islands and the Navigable Channels (at present known to Europeans) which separate the Atolls from each other*, in *Journal of the Royal Geographical Society of London*, Vol. 1 (1831), pp. 72-92. Darwin also quotes from the two volumes of Narratives of Voyages by Owen. The first volume I have consulted was printed in New York, while the second volume was printed in London, both in 1833: William Fitz William OWEN, *Narrative of Voyages to explore the shores of Africa, Arabia and Madagascar - performed in H. M. ships Leven and Barracouta*, publ. Richard Bentley, vol. I., London 1833, pp. 259; William Fitz William OWEN, *Narrative of Voyages to explore the shores of Africa, Arabia and Madagascar - performed in H. M. ships Leven and Barracouta*, vol. II., publ. J. & J. Harper, New York 1833, pp. 420.

Finally, for mapping coral reefs along the same coast, Darwin cites the captain Thomas BOTELER, *Narrative of a voyage of discovery to Africa and Arabia, performed in His Majesty's ships Leven and Barracouta, from 1821 to 12826. Under the command of Capt. F. W. Owen, R. N*, 2 vv., London 1835. For a desired completeness, Owen has literally rewritten on the *Narrative of Voyages* some parts of the diaries published by Boteler.

[31] Owen, vol. 1, 1833, p. 122.



NARRATIVE OF VOYAGES

TO EXPLORE THE SHORES OF

AFRICA, ARABIA,

AND

MADAGASCAR;

PERFORMED IN H. M. SHIPS LEVEN AND BARRACOUTA,

UNDER THE DIRECTION OF

CAPTAIN W. F. W. OWEN, R. N.

BY COMMAND OF THE LORDS COMMISSIONERS OF THE ADMIRALTY.

IN TWO VOLUMES.

VOL. I.

NEW-YORK:

PUBLISHED BY J. & J. HARPER,

NO 82, CLIFF-STREET,

AND SOLD BY THE PRINCIPAL BOOKSELLERS THROUGHOUT THE UNITED STATES.

M DCCC XXXIII.

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In his text on the formation of coral reefs, Darwin cites Owen, drawing from several sources, including: William Fitz William OWEN, *Particulars of an Expedition up the Zambezi to the Seine, performed by three Officers of His Majesty's ship Levant, When surveying the East Coast of Africa in 1823,* in *Journal of the Royal Geographical Society of London*, Vol. 2 (1832), pp. 136-152; James HORSBURGH, William Fitz William OWEN, *Some Remarks relative to the Geography of the Maldiva Islands and the Navigable Channels (at present known to Europeans) which separate the Atolls from each other*, in *Journal of the Royal Geographical Society of London*, Vol. 1 (1831), pp. 72-92; William Fitz William OWEN, *Narrative of Voyages to explore the shores of Africa, Arabia and Madagascar - performed in H. M. ships Leven and Barracouta*, publ. Richard Bentley, vol. I., London 1833, pp. 259; William Fitz William OWEN, *Narrative of Voyages to explore the shores of Africa, Arabia and Madagascar - performed in H. M. ships Leven and Barracouta*, vol. II., publ. J. & J. Harper, New York 1833, pp. 420.

Figure 1.13.: The title pages of both volumes of the *Narrative of Voyages* by William Fitz William Owen *[http://books.google.com]*.

ation[32]. There are just a few trees confined to the many river banks. Some rivers carry such a quantity of muddy deposits to colour the ocean water up to seven kilometres from the coast. In addition this stretch of coast has a profile of land and sand dunes from 15 to 200m high, with black rocks or large stones scattered here and there; their appearance looks somewhat anomalous. So from Bajon Head south of Angoche to St. Lucia river in Natal, it is very difficult to find rocks on the coast, with the exception of the coral reefs of Angoche and Bazaruto, a small rock off Cape Correntes at Inhambane. Owen indicates the presence of deposits of hardened clay along the coast of Delagoa[33]. Fragments of the description of a coast subject to significant fluvial deposits rapidly transforming its profile are present again in the narration of the journey from Delagoa to the north.

In his description of the region and the town of Quelimane, Owen notes that in the houses of the white settlers bricks and tiles made of fluvial deposits had been used. The recording of the use of these building materials is interesting because it differs from the practice on other coral islands in the north, where people used to build with coral stones.

Here's the description of the houses in Quelimane:

The houses generally contain only one story, the floor being elevated a little above the ground to avoid the marshy dampness and miasma that evaporate from the soil. The roofs project several feet beyond the walls, and rest at their termination on a row of pillars, forming a broad and commodious gallery or verandah, to which, during the heat of the day, the Portuguese retire to smoke cigars, or enjoy the refreshing coolness of the breeze. In most of the best houses, as a substitute for glass, they use the pearl oyster shell, the epidermis and outer coat being first detached, a process which renders it sufficiently transparent for anyone inside to distinguish objects but not to be seen from without. The huts of the blacks are of various sizes and shapes, but more commonly approximate to that of the English cottage. They are small, and built of the different species of reed that grow in the river, frapped neatly together. The roofs are thatched with the coarse grasses that

[32] *From Mozambique to Bazaruta Islands, the coast is bounded by a bank from twelve to fifteen feet in height, covered with bushes, through which, in various parts, the sandy formation is visible.*
Owen, vol. 1, 1833, p. 129.

[33] *This coast is a continued tract of land and sand-hills from fifty to five or six hundred feet high, with a few straggling black rocks or large stones, whose appearance seems rather anomalous; for from Cape Bajone, not far from Mozambique, to the river St. Lucia, there can hardly be found a stone any where near the sea, except the coral reefs of the Angozha and Bazaruta Islands, a small rock off Cape Corientes, and another spot near Lagoa river, and Cape Reuben at the entrance into English River, which last two places have some rocks of indurated clay.*
Owen, vol. 1, 1833, p. 106.

Figure 1.14.: Ruins of the fortress of Sofala [*Photo by Daniel P. Sobreira, 2007.*].

cover the country. None have more than one door, which serves the various purposes of an entrance, not only for the inhabitants, but for light and air, and an exit for the smoke, or for part of it; for the inhabitants are frequently seen rushing from their gloomy and sooty abodes to escape its stifling effects. They study no order in their arrangement, but build them promiscuously among the cocoa-nut and mango trees, which are planted in avenues parallel to one another, the space between being cultivated with vegetables or rice, the latter from the nature of the soil, being the most productive[34].

1.2.2. How Sofala faded away between the rivers and the ocean

François Balsan led a series of investigations between Zimbabwe and Moçambique from 1962 to 1966, in order to find the ancient routes of the gold trade. He worked in the kingdom of Monomotapa for the Arab traders first and then for the Portuguese. As to the topics covered in this paper, the story of this contemporary traveller offers interesting news and some hints on Sofala and its territory[35].

In 1962 Balsan was in the area now called New Sofala and met Gaetano de Piedade Monteiro, a mestizo aged 85, nephew of the last Goan Governor of the fortress of Sofala. Monteiro had learnt that his grandfather was the supervisor of the ivory and slave dispatches coming from inland and heading west about three times a week. The Arabs would gather the goods and the people on the beach in

[34] Owen, vol. 1, 1833, p. 179.

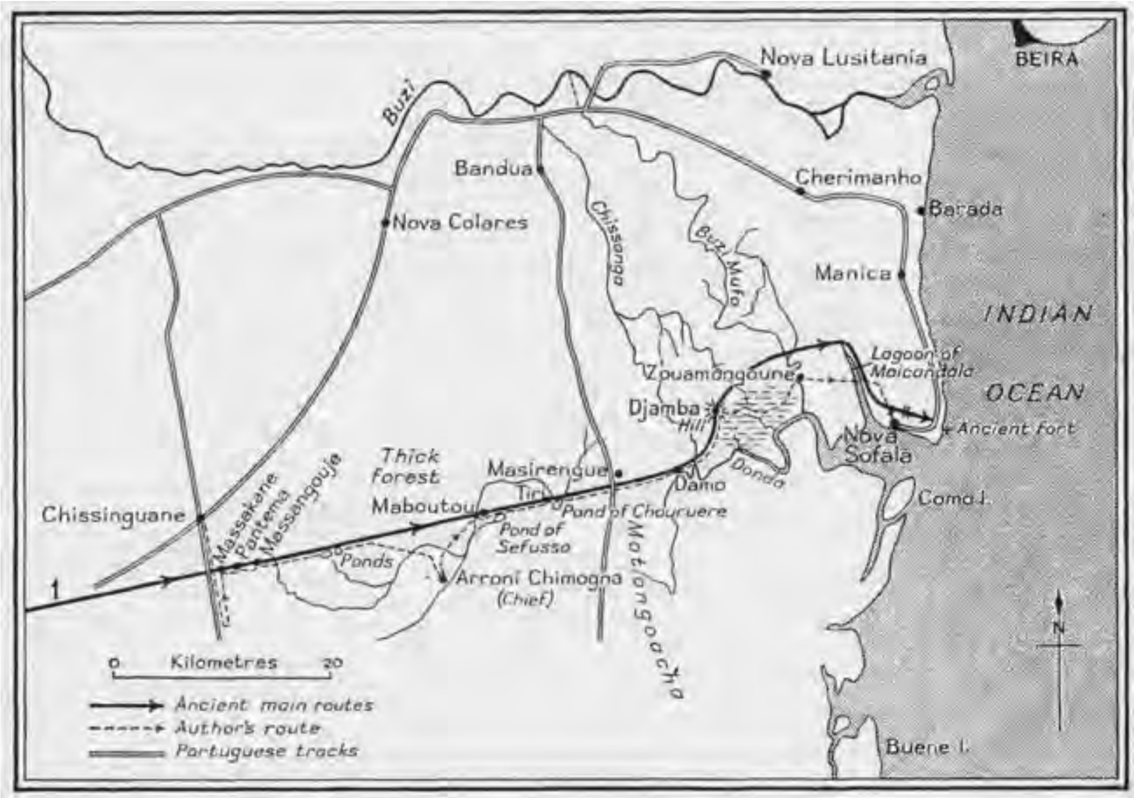
[35] François BALSAN, *Ancient Gold Routes of the Monomotapa Kingdom*, in: *The Geographical Journal*, Vol. 136, N. 2 (Jun. 1970), pp. 240-246.

front of the fortress. The dispatches proceeded overland using the old Monomotapa kingdom tracks Balsan wanted to rediscover. Monteiro also recalled that when he was a boy, the fortress of San Gaetano was still existing. The same was reported by Mustapha Faqir Din, keeper of the Muslim cemetery, and considered the warden of Muslim history in Sofala. He showed the place of the first Arab settlement on the beach, completely eroded by the waves, together with the also disappeared villages at Inhyacambo and Stura, a little further north. He pointed at the graves of Sheikh Sayed Suleiman and Azula Abduramane who, he said, lived before the coming of the Portuguese around 1400 A.D.

Once he knew there were deposits where the old Sofala stood, Balsan continued his program to trace westbound the direct route to the interior region of the Monomotapa kingdom. Now he wanted to head towards Chibabava, a place located about 150 km from where he was and where two tracks were crossing - one leading east to Zimbabwe and the other leading to the Save river to the south. The halfway place called Chissingane could be reached either directly via a large swamp depression called Motongoacha or turning around the perimeter of the swamp on a paved runway. The path through the swamp was still used by locals coming to Sofala from the west and Balsan decided to explore that part with particular care. However, Faquira Din didn't recommend to walk that long distance, which required the help of an experienced guide and a column of bearers on foot; so Balsan decided to use a jeep and drive along the road surrounding the swamp. But it was only a delay .

In 1966 Balsan came from Zimbabwe along the way he thought to be a second gold route, running south along the Save and ending in the port of Mambone. Then, he wanted to resume the exploration interrupted in 1962; so, coming from Chissingane, he stopped at Djambi where he organised a transfer along the path of Motongoacha to reach the settlement of Sofala[36]. He succeeded in his intent even if the journey wasn't easy owing to mud and dirty waters. He believed

[36] *I still had to check the link Chissinguane-Sofala, which I had neglected; for this I therefore came back in 1966 to Chissinguane. The Sofala path ran very distinctly towards the east on a straight line's distance of fifty kilometres through tropical forest, before reaching the edge of the flooded motongoacha. Then the road wrapped the Donda meanders, ran up north well marked, till the huts of Djamba, which stood on a soft hill; further on began the marshland. The oldest inhabitant of Djamba sent me on a short cut that solitary walkers take nowadays, as in former times any small column of carriers would have done. But he explained that the real traffic path curled northwards to cross the Buzi (Mufo) on a good ford and to avoid the lagoon coming from the bay; it pointed afterwards towards Sofala. The Buzi, called today Mufo (dead), was the bed by which the river (that now frays its direct way towards the ocean) threw itself not long ago in the Bay of Sofala. Portuguese pioneers such as Antonio Fernandez in 1514 called it Rio de Sofala.*
Balsan, 1970, p. 242.



From 1962 to 1966, our contemporary traveller François Balsan led a series of investigations between Zimbabwe and Moçambique following the tracks covered by the Arabs and the Portuguese to trade the gold extracted and processed in the kingdom of Monomotapa. He gives interesting hypothesis on the ancient settlement of Sofala and its territory.

Figure 1.15.: Map of the investigations made by François Balsan in the region of Sofala [*Balsan, 1970, p. 243*.].

Figure 1.16.: Hydrographic maps of the region of Beira. Foz do Pungue, 1890; Foz do Pungue and do Buzio, 1991 [*Biblioteca Nacional de Portugal, 1890 and 1891*.].

it was the same road explorer Antonio Fernandez travelled in 1514. Today it is still occasionally used by locals. The report and my own stay in Chibabava, Estaquinha, Beira and Barrada, in 1999, studying the current maps and the historical cartographic documents allow us to limit some issues concerning the material weakness of the territories with such geographical characteristics; as a consequence, the historical sources giving indirect evidence may no longer be objective, cultural and natural, when the sites have disappeared or are completely transformed. In presenting his historical reconstruction of Sofala, historian Malyn Newitt admits its antiquity, tracing its origin back to before the 9th century. He doubts its location was steady in time because of floods and deposits caused by the river Rio Buzi. For this reason, small or large villages were often abandoned and rebuilt within the whole basin area[37].

Here are the reproductions of two maps - 1890 and 1891 - of the *Commissão de Cartographia* of the administration of the Portuguese State for the estuaries of the

[37] Malyn NEWITT, *História de Moçambique*, Publicações Europa-America, Mem Martins 1997, p. 25 [I. ed. 1995].

Claro que Sofala não era a única cidade mercantil desta costa, e os geógrafos árabes referiam~se com frequência ao «território de Sofala» como toda uma região, e não um simples lugar. No século XVI, havia uma série de cidades costeiras que se estendiam pelo menos até a sul do rio Save. Algumas milhas para além de Sofala encontrava-se Chiluane, descrita pelos Portugueses como uma villa dos mouros, *situada numa ilha a pouca distância da praia, o tipo de lugar adequado ao estabelecimento ao longo de toda a costa oriental africana. O mais remoto destes colonatos era o das ilhas Bazaruto, que, no século XVI, eram conhecidas por Hucicas ou Vacicas. Todas estas cidades poderão, de algum modo, ter participado no comércio do ouro do interior, mas Sofala era o porto* par excellence *do comércio do ouro, tudo levando a crer que as cidades costeiras de menores dimensões tanto transaccionavam outras mercadorias consideradas valiosas em termos internacionais como, e nas palavras de Duarte Barbosa, deviam a sua existência ao comércio «do arroz, milho-miúdo e carne, que enviavam para Sofala em pequenas embarcações».*

Newitt, 1997, p. 27.

rivers Pungue and Buzi[38]. The maps represent a symbolic synthesis of the most relevant environmental characters in the area thanks to the close sequence of the updating of the deep sea soundings, as accepted by the Portuguese Commissão de Cartographia. It may be noted that the yearly changes are considerable. In our case, the role of main port Beira was assuming forced accreditation procedures and controls of the seabed in order to make sure it was fit for the docking of the ships. The waterways were narrow and subject to frequent and substantial fillings.

Today, the Mozambican rivers still periodically cause violent floods in vast territories[39]. The size of the fluvial deposits can successfully oppose the action of ocean tides and create new coastal profiles. Even nowadays Beira must cyclically drain its channels and basins to maintain the productivity of its commercial port.

The historical maps of the region are mainly used for navigation and then give limited geographical data for the inland, at least until the late 19th century. In the first maps or views of Sofala and its port there is Ilha de Misat, a major sandbar at the mouth of the Rio de Sofala which was part of the port system. The fortress was located in the island at the centre of the mouth of the same river, protected by the sandbar called Ilha de Misat. Today, only the foundations of two walls partially submerged by the tide remain. The sandbar marking the harbour no longer exists and the island at the centre of the river mouth, where the fortress was located, is only a fragment.

From direct observations, we can assume that the main cause of the disappearance of Sofala was the Rio Buzi, called Rio de Sofala in the 16th and 17th centuries. The first evidence confirming the hypothesis is suggested by the presence of an immediately recognizable limited depression to the northwest of the ruins of the fortress of Sofala and of the small conglomeration nearby. The depression, with traces of crop production, could be the riverbed that once enveloped

[38] 1. Biblioteca Nacional de Portugal, Reconhecimento hydrographico da foz do Pungue [Material cartográfico] : Província de Moçambique : Costa Oriental d'Africa / Commissão de Cartographia ; levantado em Novembro de 1889 pelo Sñr. pelo sr. Hillestrom por ordem da Companhia de Moçambique. - Escala [ca 1:120000], 6 Milhas [marítimas] = [9,50 cm]. - [Lisboa] : Lith[ographia] da C[ompanhi]a N[acion]al Editora, 1890.

2. Biblioteca Nacional de Portugal, Reconhecimento hydrografico da foz do Pungue e do Buzio, com parte do curso deste rio [Material cartográfico] : província de Moçambique : Costa Oriental d'Africa / Commissão de Cartographia ; levantado em Novembro de 1890, pelo guarda marinha Guilherme Ivens Ferraz. - Escala [ca 1:66000], 6 milhas [marítimas] = [16,90 cm]. - [Lisboa] : C[ompanhi]a N[acion]al Editora, 1891.

[39] For a concise knowledge of the seriousness of the floods in Moçambique between 1997 and 2007 see: *Mozambique - Sofala Province - Rapid Response Inundation Map*, Dartmouth Flood Observatory - Dartmouth College, Hanover 2007. The region south of Beira is among the ones most affected by this natural phenomenon.

the island towards the northwest. The riverbed in the south-east is still in use seasonally, but almost completely buried by alluvial deposits.

On the Google satellite map we tried to recognize the riverbeds connecting to the Rio Buzi, noting the conditions of its water activity. The abandoned riverbeds, indicated with a dotted line on the graph, overlap the present course of the Rio Buzi; they show that, in the past, the river had changed its course which is different from the present, in the south and north territories. The tips of the mouth of the Rio de Sofala enter into the vast marshy area called Motongoacha; it is primarily fed by two rivers, Buzi and Chissanga Mufo (Dead), which are tributaries of Rio Buzi[40]. The area should be considered as a lagoon in transformation where continental and ocean waters mix on the surface of the land: when the river basin is overcharged the area is flooded, while it is reached by oceanic tides in the dry seasons . The erosion of the ancient site of Sofala was then due to the combined action of the water flood and of the sea, flood dynamics having a greater impact.

The limited availability of data on the construction of the fortress does not allow sure hypothesis on the building types or the materials used. However, the news Carlos de Azevedo reported from the chronicler Gaspar Correia - that is for the construction of the fortress of Sofala were used materials imported directly from Portugal, such as pre-cut stones [41] - invites to reconsider the subject of materials. In the historical reconstruction of the earliest events of the fortress of Sofala by historian Alexandre Lobato, we read that until the end of 1506 the fortress was formed by a paling and a ditch. Masonry was limited to the cottage built in 1506 with lime from Kilwa and stones brought by a brig. Presumably the merchandise was kept there. Only at the beginning of 1507 did unloading of stones for the construction of the fortress start.[42] Were the stones also transported from the north coast? Unfortunately, for this paper, it was not possible to compare on-site the documentary sources with the remains of the present fortress.

[40] Here's the map of the subsequent investigations by François Balsan in the region of Sofala [in Balsan, 1970, p. 243]. The two rivers Chissanga and Buzi Mufo are clearly marked in the cited *Mozambique - Sofala Province - Rapid Response Inundation Map*, where we can immediately perceive that the flooding of the whole region is caused by the overflowing of rivers Chissanga, Buzi Mufo and Buzi [Dartmouth College, Hanover, 2007].

[41] *... at Sofala the provisional fort was entirely reconstructed some time later with cut stone shipped from Portugal*.

Boxer e De Azevedo, 1960, p. 97.

[42] The information related to Sofala Lobato got from file records is intertwined in a complicate and sometimes contradictory way. See Chapter *Fundação de Sofala*, in Alexandre LOBATO, *Colonização senhorial da Zambézia e outros estudos*, in *Estudos Moçambicanos*, Lisboa 1962, pp. 27-49.

Among the other events of the relatively short existence of the fortress we witnessed the tormented rethinking of Pero de Anhaya, the manufacturer himself, who built a double temporary paling filled with earth; once initiated, the work came to a stop. After the first excavations for the foundations he had realised it was impossible to give the building a satisfactory static structure. He asked for Viceroy Don Francisco de Almeida's authorization to suspend the work and used various arguments: the poor geographic location, the unhealthiness which had already caused the spreading of disease among his men, and last, the fact that Sofala was easier to reach for the development of regular commercial activities provided by a more favourable place such as Ilha de Moçambique. A simple *feitoria* would be sufficient, as it had been the custom of the *Mouros* merchants for years. It was a reasonable plea but, evidently, it was postponed and focus given to more pressing priorities of the conquest policy[43]. According to reports, the stones of the fortress no longer on site were transported hundreds of miles further north to Beira, to build the cathedral[44].

A cautious assumption may still be advanced. In the second volume of his *Narrative of Voyages*[45] Captain Owen wrote about the conditions of the inhabitants of the Moorish town about 400 m south-east of Sofala; there the population, mostly women with children, lived in decadent conditions while the adult males lived and worked in Ilha de Moçambique. The small town, however, still existed. We believe that it no longer existed in 1929, considering the state of abandonment

[43] I found this topic in: José Roberto BRAGA PORTELLA, *Descripçoēs, memórias, noticias e relaçoēs . Administração e Ciência na construção de um padrão textual iluminista sobre Moçambique, na segunda metade do Século XVIII*, PhD Thesis, Universidad Federal do Paraná, Curitiba, 2006, p. 70.

The whole chapter of Gaspar Correia's chronicle concerning the construction of the fortress in Sofala can be found in the Appendix .

Gaspar CORREIA, *Lendas da India por Gaspar Correa publicadas de ordem da Classe de Sciencias Moraes, Politicas e Bellas Lettras da Academia Real das Sciencias de Lisboa sob a direcção de Rodrigo José de Lima Felner*, Typographia da Academia Real das Sciencias, 6 Vol., Lisboa 1858-1863. Correia describes a period of time between 1495 and 1561.

[44] *Little remains of the Portuguese settlement today. Most of the stone from the fortress was removed to Beira to construct the cathedral there; only a few blocks remain, washed by the waters of the Indian Ocean, for the site now lies well below the high-water level. The outline of the fort can be traced at low-water spring tides, when the walls are marked by lines of rubble and midden debris. Pottery, imported china, beads, elephant tusks, fishing weights, human bones, and other traces of human activity are scattered throughout the ruins and along the high-water mark for several hundred yards on either side of the fort. Surface collections from the site have now yielded a considerable quantity of cultural material, but unfortunately, owing to the waterlogged situation of the site, excavations are quite impossible without enormous expenditure on shuttering and breakwater works.*

Brian M. FAGAN and James KIRKMAN, *An ivory trumpet from Sofala, Mozambique*, in *Ethnomusicology*, University of Illinois Press, Vol. 11. N. 3, 1977, p. 368.

[45] Owen, Vol. II, 1833, p. 401.

Figure 1.17.: Recognition of the Rio Buzi river beds and the remains of the island fortress of Sofala [*Credit mapping: Google Maps and Google Earth.*].

of Sofala as represented in the photograph reproduced here by José Rufino dos Santos[46]. In only one century Sofala, the most important Swahili town of the territory south of Kilwa, had disappeared.

From the observations on the coast between Sofala and Beira we can state that the Portuguese didn't ignore the forces and coastal character of the places where they had built their settlements. However, we must carefully reflect on the data the past history presents to our society and consider the consequences seriously. The relative stability of the historical settlements on the coast with coral reefs allows a reflection on the problems of cities and towns. They had to choose long lasting solutions for defending their settlements from environmental degradation. But, when we examine the towns built on the coasts subject to the opposing forces of the seasonal river floods and the oscillation of cyclic tides, we cannot draw the same conclusions. The speed and extent of natural disasters haven't allowed a narrative of observations and reflections that these phenomena must necessarily have caused in the society, after each disaster. Based on such a narrative, which is the collection of a critical urban and environmental knowledge expressed in time, we can decide the sort of culture fit to influence the best land management policies and settlements policies.

More than Beira, the city of Maputo on the bay at the mouth of the rivers Maputo, Matola, Tembe, Umbeluzi and Incomati is the best example of the economic and social costs paid by a well-settled urban area in a geographically inadequate area. The northern coast of the bay was, and partially still is, characterised by extensive lagoons with huge volumes of water cyclically filled and

[46] Rufino, 1929, p. 113.

emptied according to tidal cycles and the flow of continental waters. Since the late 19th century, urban management has practised the reclamation of the lagoons with subsequent building works. It has happened in varying degrees depending on the period of administrations. Nowadays there are just a few reclaimed places which aren't periodically troubled by phenomena such as river floods, floods prevented by a low flow capacity of rainwater to the sea, by cyclones, or simply by tides .

1.2.3. The coast and coral stone buildings

The origin of coral stone buildings is still a little studied subject, probably also because of the perishability of the material itself. However, we can give a few examples chosen among the oldest known finds from different regions.

The Dictionary of Islamic Architecture affirms that a 3rd - 1st century frame of Hellenistic style was reused in a 7th - 8th century Islamic tomb near Al-Rih on the Red Sea Sudanese coast; it is considered the oldest coral stone artefact known today in the regions historically dominated by Arabic culture. Al Rih or Er Rih is an island about 210 km south of Port Sudan. [47].

Port Honduras is located between the towns of Punta Gorda and Punta Negra, on the southern coast of Belize. It overlooks a reef platform numerous sandbanks emerge from, resting on isolated outcrops of coral (patch reefs) locally called cays or Cayos. The edge of the platform where the reef is biologically active is from ten to forty kilometres from the coast.

In Wild Cane Cay and Frenchman's Cay systematic archaeological studies have been carried out on some remains of the coral stone foundations belonging to buildings of the ancient Maya Post Classic era and dated between 900 and 1500[48].

[47] Andrew PETERSEN, *Dictionary of Islamic Architecture*, Routledge Publisher, New York 2002, pp. 54-55. [I ed. 1996].

Among the earliest of the Muslim trade centres recorded on the Red Sea coast of the Sudan is the site of Badi on the southern tip of Er Rih or al-Rih island, some 210 km south of Port Sudan. This site, according to historical sources, appears to have been occupied from the mid-seventh century (Hebbert 1935:308). The first historical mention of Badi, a reference to the expulsion there of one Abu Mihjan al-Thagafi in 637 by Caliph Umar ibn al-Khattab (Kawatoko 1993b:189), also indicates that, like the Dahlak islands, it was initially used as a penal colony or place of exile. It would, however, appear to have fairly rapidly assumed an important trade role, a function it continued to maintain until the late twelfth century.

Timothy INSOLL, *The archaeology of Islam in Sub Saharan Africa*, Cambridge University Press, Cambridge 2003, pp. 91-92.

[48] It refers primarily to studies by Heather McKillop. Heather MCKILLOP, Aline MAGNONI, Rachel WATSON, Sharon ASCHER, Terrance WINEMILLER, and Bryan TUCKER, *The Coral Foundations of Coastal Maya Architecture*, in *Archaeological Investigations in the Eastern Lowlands: Papers of the 2003 Belize Archaeology Symposium*, vol. 1, edited by J. Awe, J. Morris, and S. Jones, Belmopan

Historian and linguist Mohamed Ibrahim Loutfi listed 79 archaeological sites in the Maldives islands, more than half belonging to the pre-Islamic period (Buddhism and Hinduism), i.e. before 1153. The remains of the pre-Islamic and the following Islamic periods demonstrate the use of coral stone[49].

From these examples we can say that, both along the coasts of Africa and Asia and in Central America, the use of coral stone in constructions occurred well before its spreading during the colonial rule between the 6th and 19th century. However, the European building technology based on the use of lime and stone was widespread during the colonial expansion; it was introduced in areas where it had not been practised or its use was increased where it already existed. For example, in the detailed account of Captain William Waldegrave written in 1830, on the geography of the archipelago of the Society Islands, we can read that on the island of Otaheite (Tahiti) the coral stone was employed for the construction of masonry buildings; also in Papetoai on the Isle of Eimeo (Moorea), an octagonal church was built[50].

1.2.4. From Zanzibar to Inhambane

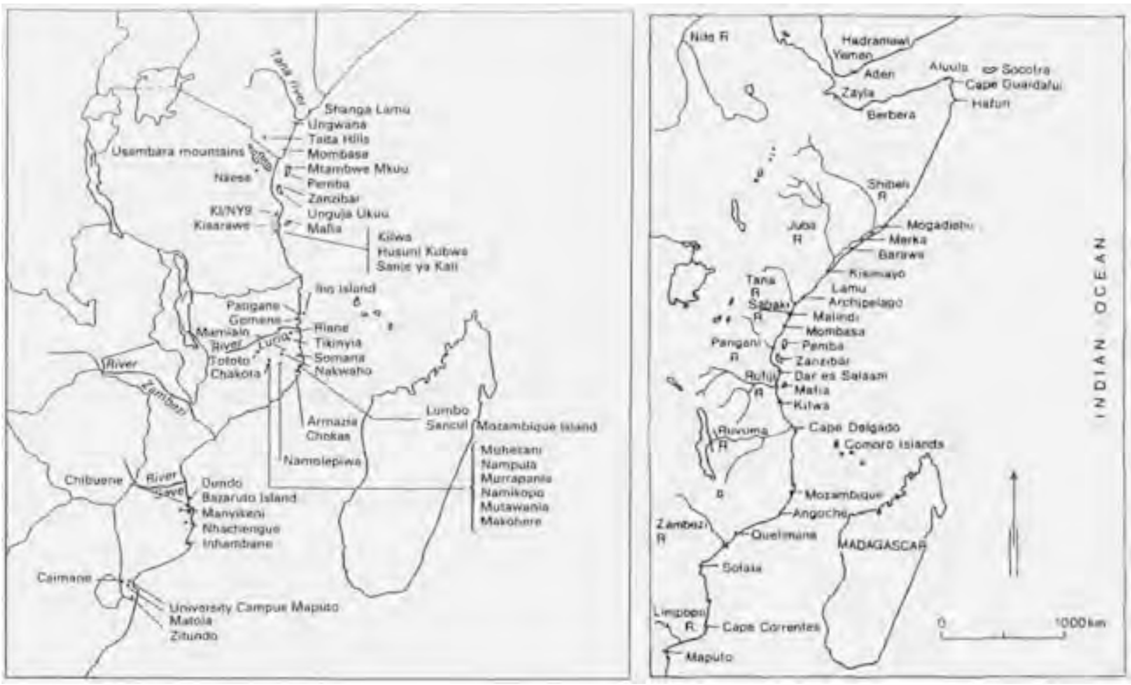
Let's now examine the Arab expansion on the Indian Ocean coasts, and specifically, the settlements on the African coast of the Swahili society. There we have examples or remains which historians and archaeologists have dated and given sure connotations, although limited in number. However, the individual building episodes known today can at least clarify some points and give an overall

2004, pp. 347-358 [Institute of Archaeology, NICH, Belize]. For the chapter *Coral Architecture*, see: Heather Irene MCKILLOP, *In search of Maya sea traders*, College Station: University of Texas Press, 2005, pp. 171-183.

49 Mohamed Ibrahim LOUTFI, *Monuments and cultural heritage of the Maldives*, in "Seminar on the conservation of asian cultural heritage – Current problems in the conservation of stone", November 13-15, Kyoto 1990, [typescript in Library ICCROM - Roma].

50 *Parfai's* [house] *was larger, equally clean, with a pounded coral floor, a few chests, and other furniture. The brothers were building a decked boat, of nineteen tons, of native wood; the work was good, and he was very proud of it. He showed me the frame of the new church, which was well constructed. When I remarked that I hoped soon to hear that they were building stone churches and stone houses, he replied, "One step at a time - we cannot go so fast." Stone is found in great abundance, either of volcanic rock or of coral, and the coral burns into excellent lime; but a second work of such magnitude probably is too much to expect of the Otaheitans. A stone octagon church was built at Papetoai, island of Eimeo, of heron coral. The labour was extreme, and it was some years in building. The island produces excellent timber in very great abundance. It is to be found in the interior, on the South Side, and all over Tiarabooa.*

See: *XI - Extracts, from a Private Journal kept on board H.M.S. Seringapatam, in the Pacific, 1830. Communicated by Captain the Hon. W. Waldegrave, R.N. Read 24th June, 1833*. In: *The Journal of the Royal Geographical Society of London*, Volume the Third, John Murray - Albemarle-Street, London 1834, pp. 177-178.



The sub-region between Zanzibar and coastal Inhambane [*by Sinclair, 1991, p. 183.*] and the region of Swahili influence [*by Chami, 1998, p. 201.*]. Along this coast Swahili people built their settlements and constructions of coral limestone, from the 10th to the 16th century. Most of the architecture in coral limestone, however, belongs to the following colonial period.

Figure 1.18.: The region of Swahili influence.

Figure 1.19.: Coral stone walls of the Friday mosque *H* in Shanga [*Horton, 1991, p. 109*.].

physical and temporal context to the process of coral stone technology dissemination in the western Indian Ocean[51]. The historians who deal with historic pre-colonial architecture in this region have often been concerned with the complex cultural influences which took place on the African coast. Arabs and, later, Swahili groups designed, constructed buildings and used the coral limestone along the African coast between the tropics, following the architectural culture and technology of the African inland and of the Arab world; but they show different cultural influences due to the trade with India, Persia and the faraway islands in the Indian Ocean up to Indonesia[52]. Recent excavations at the site of Shanga offered new data for the historical reconstruction of the architectural Swahili culture. This archaeological site is located on the island of Pate, one of the main islands of Lamu Archipelago (Kenya). Archaeologist Mark Horton believes the site was inhabited by a proto-Swahili population in the V-VI century; the social organisation was the result of migrations of pastoral peoples of the Neolithic era who went west towards the coast at the beginning of the Iron Age[53].

Once again, Horton's studies are useful when we examine the aspects relating to the use of coral stone in Shanga, setting them in the historical context of

[51] To get an idea of the distribution of Swahili settlements in the precolonial period see the map reproduced from Paul J. J. SINCLAIR, *Archaeology in Eastern Africa: an overview of current chronological issues*, in *Journal Of African History*, No 32, 1991, pp. 179-219; Felix A. CHAMI, *A Review of Swahili Archaeology*, in *African Archaeological Review*, Vol. 15, No. 3, 1998, p. 201.

[52] James HORNELL, *Indonesian influence on east african culture*, in *The Journal of the Royal Anthropological Institute of Great Britain and Ireland*, Vol. 64 (Jul. - Dec., 1934), pp. 305-332.

[53] Mark HORTON, *Shanga: The Archaeology of a Muslim Trading Community on the Coast of East Africa*, British Institute in Eastern Africa Memoir 14, London 1996.

Arab architecture. The object of study is the Friday Mosque of Shanga, and more specifically, the archaeological remains of the eight mosques on the same existing sediment. The mosque, built around 1000, survived the abandonment of the town in 1425. It is made of coral limestone, as it was the previous building known as H mosque and dated around the beginning of the 10th century[54]. The porites coral technique should come from the Red Sea, for the presence of such reefs and the ongoing use of porites coral in today's buildings.

The buildings studied by Horton in Shanga exist only up to the floor level, so we can't guess their full height, even though the laying of the foundation pits have sometimes produced some convincing suggestions on the existence of flat roofs. However, the approximate height hasn't been found. The thickness of the walls of the first mosque in coral stone (H mosque), the amount of debris found, the presence of stairs unsuitable for a low building have suggested it must have been a multi-storey tower building. The author uses examples for this type of construction still visible on both coasts of the Red Sea; it also seems likely that the using of porites corals has started there.

The tower palaces of the kings of Askum can be appropriately compared only from a formal point of view; they continued to be built until at least the 7th century. In Askumite architecture, for example in Dongur in the 7th century where buildings and courtyards covered an area of 3000 sqm, the emphasis was given by the monumental entrance stairs, echoed in the building of Shanga and nearby Manda; there it was found a porites coral building with an entrance staircase of four steps.

Horton believes the opening of trade routes between East Africa and the Red Sea in the 10th century was an appropriate context for the transmission of architectural styles to the south; he also notes that the Askumite buildings are similar not only in style, but also in size to the examples of East Africa. The porites coral in Shanga is used not only in mosques but even in a group of buildings that formed the small town centre. Again the primitive wooden walls were replaced with stone work. The last wooden mosque (G mosque) was replaced by a stone building (H mosque) exactly when the same happened with the other

[54] *The earliest possible date for the tree stump would be 685 and for mosque C 720; at 68 percent these dates are 710 and 785. A date for mosque A would, on calibrated dates, lie within the range 750-850. The archaeological and ceramic evidence would point to the earlier end of this range. A possible dating scheme would be: mosque A to the second half of the eighth century, with decadal rebuildings of the flimsy structures A, B, C, to say ca. 800 and generational rebuilding of the more substantial D, E, F and G to ca. 900; the stone mosque H in use ca. 900-1000, replaced by mosque J ca. 1000*. In: Mark HORTON, *Primitive Islam and Architecture in East Africa*, in *Muqarnas*, Vol. 8, K. A. C. Creswell and His Legacy, (1991), p. 110.

buildings. The centre of Shanga may have covered up to 8000 sqm, and should have reached a monumental view with the construction of a complex of civil buildings with a very small mosque at their centre .

In his study Horton shows that East Africa is a fruitful area to understand the origins of Islamic architecture. The sites are available for archaeological excavations, being mostly in a state of abandonment and the soil of coral and laterite the stratigraphy are well preserved; it allows archaeologists to identify even ephemeral particulars to document the transition from wood to stone.

When he examines the archaeological sites of Lamu, Horton states that the dating cannot go back beyond the 7th century; further excavation could push back their origins assuming in Shanga, for example, a cultural influence of the first Umayyad period[55].

It is likely that these studies will have interesting results for the simple fact that a regional trade network is historically defined by the routes based on the closest Red Sea ports, and by the routes based on the ports of the Persian Gulf. In the area under Umayyad cultural influence, we can observe that there are intermediate maritime stations linking the route between the African and the Persian coasts; they may reveal pre-Islamic cultural influences, and therefore the idea that the use of coral limestone has originated along the Red Sea coast, should be reconsidered[56].

We can also make a link with the ancient port of Qal'at al-Bahrainis connecting, it with the use of coral limestone. It is a very important archaeological site for its anthropogenic sedimentation starting from the 3rd millennium, with remarkable examples of military architecture since the 3rd century B.C.; there the coral limestone had a different use in modern and pre-modern eras, but probably even in more ancient times[57].

Several reasons may explain the continued existence of the oldest mosques of coral limestone in the various centres inhabited by Arabs and Swahili peoples along the African coast. A key reason seems to be the singular characteristic of these monumental buildings since their founding. The monumental character, however, was proportionate to the settlement which was mostly modest or poor.

[55]Horton, 1991, p. 113.

[56]See Petersen, 2002, p. 55.

[57]Qal'at al-Bahrain has been a site of the World Heritage List since 2005. Motivations: United Nations Educational, Scientific and Cultural Organization - UNESCO, *Decisions of the 29th session of the WorldHeritage Committee*, Convention Concerning the Protection of the World Cultural and Natural Heritage, the World Heritage Committee, Twenty-9th Session, Durban 10 - 17 July 2005.

The description of the presence of coral limestone buildings can be found in Petersen, 2002, pp. 30-31.

Figure 1.20.: The Great Mosque of Gedi, the mihrab and minbar [*Photo by James de Vere Allen - ArchNet, 1988.*].

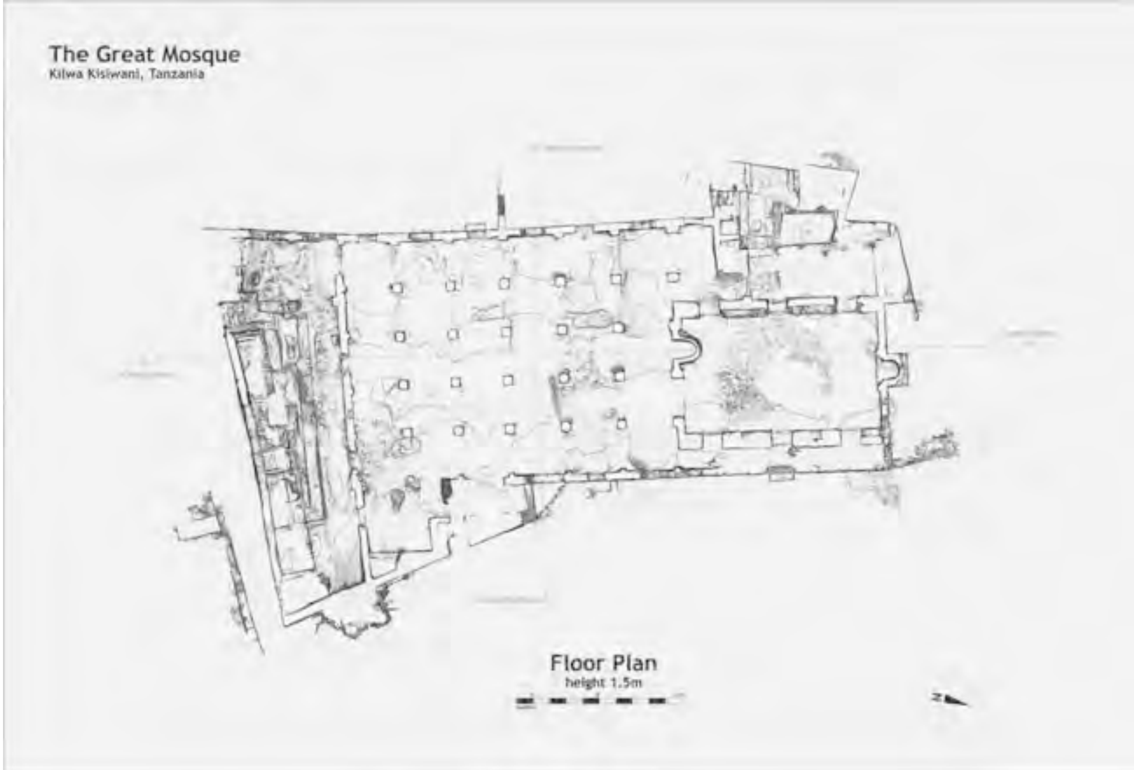
In centres of regional importance such as Kilwa, the Great Mosque was flanked by the fortified palace of Husuni Kubwa; but in smaller centres, collection and delivery points of commercial products, the mosque was often the only architecture and such characteristic remained at least until the colonial European establishment in the late 16th. In centres like Sanga, it happened that the development of the economy achieved a new urban emphasis and involved the restoration of an old mosque; but lots of towns were abandoned for commercial, military or environmental reasons, without having a chance of crystallizing in steady urban shapes. Thus, only the buildings constructed with durable materials such as coral rocks, were able to partially resist time.

Among the major pre-colonial mosques built in coral stones there are the Kizimkazi mosque in Zanzibar, the mosque of Manda, three mosques in Mogadishu and the Great Mosque in Kilwa. The Kizimkazi mosque in Zanzibar was rebuilt in the 18th century, but its foundations go back to the 12th century. The Christian church built by the Portuguese in the 16th century was transformed into a fortress when the Sultanate of Oman acquired Zanzibar in 1730. In 1832 Zanzibar became the capital of Oman. The urban adjustment to the new administrative functions entailed a radical restructuring of the urban conditions in the old Unguja Ukuu of the 8th century, adopting traditional construction methods but using very different building materials, including bricks, also widely used.

Remains of coral buildings are found in many islands such as Pemba and Tumbatu. In Jongowe, a town on the island of Tumbatu, there is a vast archaeological area which includes a group of houses and a mosque dating from the 12th and 13th century; the mosque reveals some finely worked decorative coral stones. On the east coast of Pemba, in Pujin, there are the remains of a pre-colonial fort dating back to the 16th century. The archaeological site of Ras Mkumbuu in Pemba is very extensive and includes the remains of a mosque, a burial site with pillar tombs and a large number of houses; the complex goes back to the 14th century. Following the most popular model of pre-colonial mosque there are three rows of pillars dividing the space of the prayer hall to support the structure necessary for a flat roof.

Gedi is a settlement founded on the Kenyan coast near Malindi in the 13th century but its remnants were still visible in the 15th century. The Great Mosque is one of the best preserved examples of its type. It is built in the widespread pre-colonial style of East Africa, with a flat roof supported by rectangular stone pillars. The pillars are aligned in three rows of six each while the middle row is aligned with the axis of the *mihrab*. The roof structure is made of two wood frames; the beams of the main frame rest on the pillars, while the secondary frame consists of smaller beams orthogonally mounted on the main ones[58]. As in the oldest hall of the Great Mosque of Kilwa, even in the Mosque of Gedi the pillars are arranged in a rectangular rather than square frame, as it is often seen in architectures with rectangular plans. That solution optimizes the use of the beams: the larger ones are placed on the longer sides of the rectangular plan, the smaller beams cover the span corresponding to the short sides. At Kilwa and Gedi the main beam is directed toward the mihrab, then lengthwise, while in other mosques the main beams are usually placed transversally to the longitudinal axis. Probably, the two solutions show a different perception of the prayer hall which is ritually oriented to the wall towards the Mecca. Examining the pre-colonial architecture of the Swahili coast, Mark Horton studied the influence of the system of flat roofs called *tembe* he had seen in an archaeological interpretation of Shang mosques. The roofing system comes from the plains of the Masai area of Lake Manyara in Tanzania and its influence on the building habits on the east African coast confirms the multicultural features of Swahili

[58] Petersen, 2002, pp. 96-97.



The Great Mosque of Kilwa consists of two main parts, a smaller one in the north with sixteen partitions spaces and a wider in the south with thirty partitions. The ruins of the northern part date from the 11th century, but there were changes at the beginning of the 13th. Between 1300 and 1320 Governor of Al-Hasan ibn Sulaiman added a large covered courtyard with thirty coral stone pillars and a separate room covered by a dome of about 5m in diameter.

Figure 1.21.: *Floor plan of the Great Mosque* in Kilwa Kisiwani, Tanzania [*Aluka, Department of Geomatics, University of Cape Town, The Heinz Rüther Collection.*].

society, which had significant influence in the east and west territories[59].

A second site of archaeological interest is the great palace of Gedi probably built for the Sultan of Malindi. The building is included in a system which probably housed the court of the sovereign. The palace has a remarkable plani-volumetric complexity resolved in a fairly simple building type. The group of houses in Gedi witnesses a highly interesting process of formal evolution that lasted from the 14th to the 16th century. This refinement was the prototype of the residential Swahili architecture of the 18th century[60].

The main buildings at Kilwa are the Great Mosque, the Little Mosque, the mosque of Jangwani, the Malindi Mosque, the Palace and Fort Gereza. The best known building of Kilwa is the Great Mosque, a large, articulated structure built in different phases. The building consists of two main parts, a smaller section in

[59] Horton, 1991, p. 111.
[60] Petersen, 2002, p. 97.

the north with sixteen partition spaces and a wider one to the south with thirty partitions. At the foundation level of the smaller section there are remains going back to the 10th century. The permanent and visible ruins of the northern part date back to the 11th century, but were changed at the beginning of the 13th. Archaeologists believe that this primitive nucleus was probably covered with a flat roof supported by nine wooden columns, as in the Great Mosque of Shang. At a later stage, between 1300 and 1320, a large covered courtyard with thirty stone pillars of compact coral and a separate room covered by a dome of about 5m diameter were added on the south side of the building. The courtyard was rebuilt several times during the 15th century and covered with an arched roof of domes and barrel vaults supported by octagonal pillars[61].

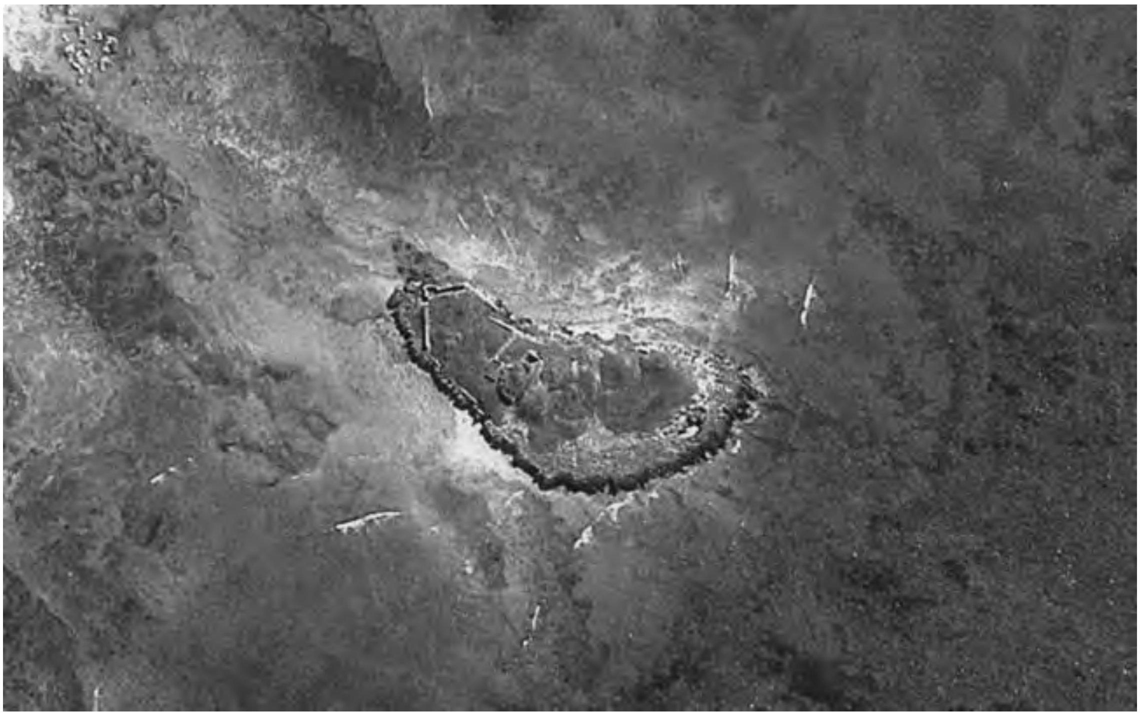
South-west of the Great Mosque there are the ruins of two smaller mosques: the first is called Little Mosque while the Malindi Mosque is next to Jangwani on the sea and on the north-east of the Great Mosque. The mosque, constructed in the mid-15th century, adopts a new building type Mark Horton believed to have been introduced by the Arab governor al-Hasan ibn Sulaiman in the first half of the 14th century. The domes and vaults have an open extrados made of coral stones and conglomerate lime; the sovereign adopted it in the covered courtyard of the Great Mosque and his palace[62].

The systematic spreading of coral limestone made possible a major transformation in its use. Lime, obtained cooking the limestone itself, made possible the building of walls and vaults where the inert material could be used in large or small forms when necessary. It was a great advantage especially because it didn't require a long work for supplying limestone: it wasn't necessary to select it in order to choose the best material, that is the most compact and with small pores. That quality was necessary when precise square blocks were required. Porites corals were extracted for this use and the operation would take place under water. But we should keep in mind that mud too was useful for the assembly of squared blocks of coral. It is an ancient technique employed from the second

[61] Petersen, 2002, p. 151.

[62] *The most famous ruler among the Mahdali is al-Hasan ibn Sulaiman Abu'l-Mawahib (c.1310–1333), who was ruling when Ibn Battuta, who wrote a lengthy description of the town, visited in 1331. Al-Hasan ibn Sulaiman was a major builder, and to his rule can be attributed the two major architectural treasures of Kilwa—the southern extension of the Great Mosque and his unfinished palace Husuni Kubwa. Both make extensive use of domes and vaults, and Husuni Kubwa (a combined market and royal palace) is the most innovative of all Swahili architecture. Chittick's excavation recovered its complete plan and dating evidence that placed its construction c. 1300–1320.*

Mark HORTON, *Introduction to Kilwa Kisiwani*, http://www.aluka.org/ - Downloaded 28/02/2010.



Somaná is a coral platform constantly beaten by the sea. The access conditions especially for large boats are very difficult. Even the archaeological remains seem to show that the settlement was designed to be oriented towards the mainland, and not towards the ocean.

Figure 1.22.: The small island of Somanà in the north of Nacala bay with the ruins surveyed by Ricardo Teixeira Duarte [*Google, 2010.*].

millennium b.C. along the Nile, there used with larger blocks of sandstone.

As far as we know, we can say that pre-colonial architecture rarely made use of coral rocks along the Mozambican coast, despite the excavations and archaeological studies which have investigated several sites offering new and significant contributions to the deepening of the history of African society in general and in particular of the Swahili people.

Chibuene (Vilanculos), an archaeological site 1500 km south of Kilwa and 250 km south of Sofala, was a centre of settlement and trade from the 8th to the 9th centuries. The tools found there include the site in the extended network of Swahili relations, linking Manda, Shanga, Kilwa and the Comores Islands. It was abandoned from 1000 until 1450 approximately without leaving traces of permanent settlements [63].

Ricardo Teixeira Duarte's systematic study in 1993 on the Swahili presence in northern Moçambique is still a fundamental text referred to by archaeological

[63] Thomas SPEAR, *Early Swahili History Reconsidered*, in *The International Journal of African Hstorical Studies*, Vol. 33, No. 2, 2000, p. 264.

and historical contributions. Teixeira Duarte analyses the sites and objects in the physical conditions of their environment, carefully examining soil characteristics, vegetation and climate forecast. His cognitive approach can be usefully applied to matters of historical architecture; that is what we tried to do in the present paper, keeping in mind that the physical environment or the architectural site must be evaluated in their historical perspectives.

The stretch of African coast studied by Teixeira Duarte is approximately between the 11th and 15th parallels; at its ends the Rovuma River in the north and Ilha de Moçambique in the south. In two of the many sites considered, Gomene and Somanà, the traces of coral stone buildings were discovered and observed.

On the coast about 20km south of Pemba, there is Gomene a small promontory on the carbonate platform, surrounded by a fringing reef. The site of about a thousand square meters is encircled by a perimeter wall constructed with juxtaposed blocks of coral stone; they have some slits with profiles of squared stone. At the base it measures between 80 and 90cm and in some places reaches a height of two meters. The archaeologist thinks the date of the construction is recent, between the 18th and 19th century, contradicting the view that it is a site of the Zimbabwe culture. He notes that the absence of binding mortar in the masonry means we cannot refer to a Swahili presence; then he attributes the wall a defensive function devised by the Macuas against the assaults of the Ngunis.

Somanà is a small coral island of about three thousand square meters. It is located on the north coast of Nacala bay about 100km north of Ilha de Moçambique and preserves architectural Swahili remains. The ruins are the only examples of Swahili architecture south of the Rovuma and are dated, cautiously, in the 12th and the 15th centuries; more probably, close to the 16th century, when the Portuguese arrived.

This is the situation recorded during the 1986 excavation:

The island of Somaná is located on a coral reef which is constantly battered by the sea. It has extremely difficult access conditions for boats, especially for large ocean going vessels, although the nearly bay of Nacala has excellent conditions for shelter and access facilities for all crafts. This is an area rich in fish, shell fish, crustaceans, and other sea food. Good hunting facilities were certainly available nearby, on the mainland in the past. The region is dry with 800 mm annual average rainfall. Special attention should be given to the wealth of shells of the coral reef, nameIy Cypraea annulus, Cypraea moneta, Nerita albicila and Nerita plicata. About one km to the north of the island there is a mangrove swamp. Nowadays the island is uninhabited, although on the neighboring mainland population density is high, notably of the Macua group, and agriculture, hunting and *foraging (primarily of shellfish during low tide) and trade are the main activities. On the midland close to the island wells with brackish albeit drinkable water. The site of Somana is spread over a small island and extends to the nearby mainland. On the island ruins of a building and a cistern still remain together with remains of a wall. On the mainland, although traces of walls are visible, no buildings are still standing. There is still evidence of a wall around the perimeter of the island, in some parts almost intact, in other places totally destroyed. This wall, reaching about 2.5 m in the intact portions, was built with coral stones cemented by a lime mortar made out of shell lime and sand. In some places in the middle of the wall rectangular holes were opened up wIth an appropriate dimension of 10 by 30 cm. The wall is divided into two layers; the bottom one with uncut blocks of coral and the top one with trimmed blocks. The kind of stone used is slightly different in both layers and in some parts there is evidence of what could have been a plaster covering. In addition to the wall there are more two constructions on the island, a cistern with capacity of 5.62 by 3.47 by 1.35 meters, and a building measuring 16 by 4.20 meters, divided into a central and two lateral compartments and a terrace accessible by a staircase from the exterior. All the constructions are made from coral stone with lime and sand mortar, and some of the walls still show evidence of being covered by plaster. From the central compartment measuring 6.18 by 3.20 meters, a door (which still shows evidence of porites coral decoration), gives access to another compartment of 5.05 by 3.20 meters. On the, opposite side there is another compartment of 3.20 by 3 meters, which might have been used as a cistern, since the only access to it would have been through an internal window, so far the only window found in the building. There is still evidence of the insertion holes for the wooden poles to support the roof, and also the open spaces on the top of the windows and doors, once occupied by supporting wooden lintels. Two doors gave access from the outside to the central compartment, one artistically worked in dressed and carved "porites" coral, with floral motifs which immediately identifies it as a Swahili construction. This door can be considered an architectural masterpiece, from the jambs and archivolts which developed in three recessed orders of arches, the apex of which form small ogival or keel-shaped nicks, to the pilasters, spandrel and entablure each of which are decorated with geometrical motives. Between the architrave and the entablure is a frieze with herringbone mouldings, and the architrave is decorated with round bosses and floral motifs. The decorative motifs, unfortunately very much eroded, were executed in low relief. These constructions all conform to the characteristics of Swahili architecture. On the central compartment two panels with three rows of niches each pose questions about the function of this construction. The absence of midrib shows that this was not used as a mosque. Similar niches were found in the ruins of the Kilwa Sultans palace Husuni Kubua, from the 14th century. Both panels are very damaged,*

Platin digger (Acropora coral) on the Mahébourg platform, in Mauritius [*Walker, 1962, p.328.*].
Bearer of coral rocks for constructions, Nusa-Dua beach (Bali) [*Photo by Daniele Carlon, 1981.*].

Figure 1.23.: Coral stones from the sea.

but some remains show that they were carefully carved in polities coral, representing real doorways in miniature. The ruins of Somaná are poorly conserved and in a state of disrepair. The walls are near collapse and components of the main doorway have already begun to fall. A larger part of the wall which surrounds the island has already fallen and the few parts that are still intact will collapse any moment, due to erosion by the sea of the coral platform that constitutes the island. Vegetation (growing in the walls) and destructive action by people are other of the degradation factor that affect this monument. Consolidation of these ruins is urgent and vital. [64].

In addition to a rigorous survey of the rediscovered archaeological site, Teixeira Duarte tells us something interesting for our story on the architectural heritage and natural coral reefs in the region of the Quirimbas: namely, that the architectural remains of Somanà demonstrate the use of coral limestone. The work varied according to the different quality of the stones used and the types of construction. The formal models are specific to the advanced Swahili culture. All that suggests to consider the Mozambican region with the same historical interest now reserved for the most famous sites along the African coast further north, such as Kilwa and Sanga. Finally, let's remember the scholars' strong plea to undertake the necessary actions to protect these precious remains, now abandoned and forgotten.

1.2.5. Coral stones for constructions

In his archaeological examination of the Friday Mosque of Shang, Mark Horton describes the materials used to build the first stone mosque, the mosque H in his list.

The first stone mosque was built directly over the post holes of mosque G. It was constructed of neatly shaped porites coral (that is, undersea coral quarried by divers and shaped while still wet), bonded by mud with a white plaster face.[65]

Horton finds some cultural connections between the islands of Lamu and Yemen, in the walls and in the use of coral stones rather than in the architectural form. The stonework of porites coral is a traditional technique in use on the shores of the Red Sea; it suggests that the model spread further south along the African coast.

The technique that uses porites coral appears to have been introduced from elsewhere, and the Red Sea would be the most likely candidate, given the distribution of similar corals in this area and the continued use of porites coral in building to this day.[66]

The walls discovered in Shanga are built in square limestone blocks on the exposed sides, both inside and outside the building, while the surfaces contained in the walls are hewn. The archaeologist defines the connecting element with the term mud, without revealing the nature of the compound materials.

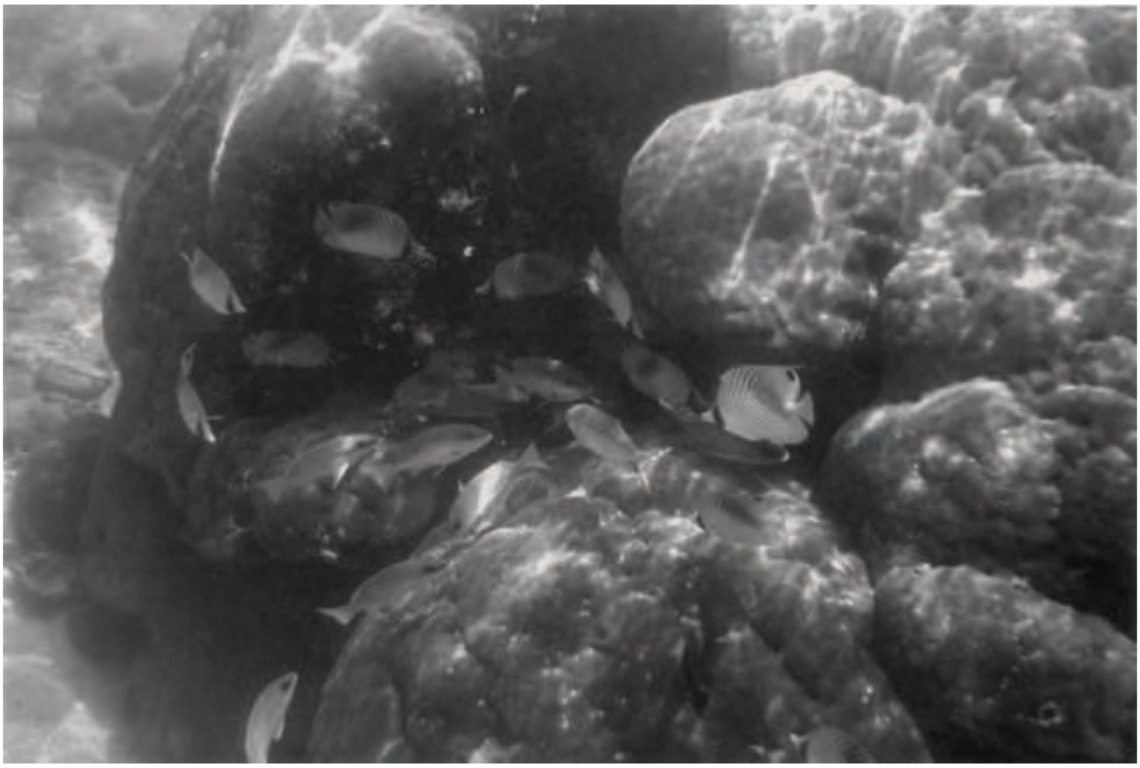
In the *Dictionary of Islamic Architecture* by Andrew Petersen the entry *Coral* describes the use of the coral rock in general. For the construction of buildings two main types of coral stones have been used: fossil coral extracted from the coast sediments and corals cut straight from the sea floor. The fossil coral stone is more suited to the construction of bearing walls while the coral removed from the reef, such as porites, is fit for blocks or slabs suitable for architectural embellishments, like the doorposts or niches of the *mihrab*. In fossil sediments we may find *Rugosa* corals, an extinct animal; it takes the form of irregular blocks known as *coral rag*. Although it can be cut into blocks, the faces cannot be smoothly finished and then a plaster must be applied to get a flat surface.

Live corals are relatively easy to be cut from the cliff, and once hardened by exposure to the air, they can be treated to get a smooth finish. The coral reef preferred for constructions belongs to the porites because of its vascular structure that makes it compact and easy to carve. However, it is not the only

64 Ricardo TEIXEIRA DUARTE, *Northern Mozambique in the Swahili World. An archaeological approach*, in *Studies in African Archaeology*, 4, by Repro HSC, Uppsala 1993, pp. 61-68. For a more detailed quotation see: Teixeira Duarte, 1993, pp. 63-65.

65 Horton, 1991, p. 108.

66 Horton, 1991, p. 114.



Butterflyfish (Chaedoton lunula) and dory snapper (Lutjanus fulviflama) in a Porites boomie at Lighthouse Reef, Bazaruto Archipelago. [*Photo by Marcos Pereira, 2002.*]. From: Pereira, M. A. M., E. J. S. Videira, H. Motta, C. M. M. Louro, K. G. S. Abrantes and M. H. Schleyer (2003). *Coral reef monitoring in Mozambique. III: 2002 report*. MICOA/CORDIO/ WWF. Maputo, Moçambique Coral Reef Management Programme.

Figure 1.24.: Porites.

type used. In the site in Ras al-Hadd in Oman, at least seven types of coral from reef were identified in some constructions of the 11th century [67].

An important feature is the limestone morphology. The coral genera and their species, as a result of different local or regional environments, give rise to limestone structures very different as to uniformity, pore size and distribution. They determine the degree of workability, the nature of the building and the duration in time, once the material is placed.

If the quarries are just emerging from the ground, the limestone may have an initial diagenetic stage, sometimes with reduced mechanical properties. The outcropping types are coral reefs in a most advanced state of compactness, similar to the intermediate stage of diagenesis in sedimentary rocks, as it can be seen

[67] Petersen, 2002, pp. 44-45.
See Appendix for the entire entry *Coral*.

Stone and lime sediments of corals, algae and corals. The image on the right derives from specimens of a marble store on the California coast, the one on the left shows a section of a wall in Ilha de Moçambique.

Figure 1.25.: Coral stones for constructions [*Photos by: right, Unknown; left: Mohamad Arif, 2005.*].

even in the Barbados island. Then, limestone can be polished. Fossil limestone formed on skeletons of extinct corals such as colonies of Rugosa, Scleractinia and Tabulata, can be used to make objects for the market of semi-precious stones. In buildings, this limestone is fit for a good finish and allows laying the pieces regularly with enticements of small thickness mortar.

The reefs may be in a less advanced stage of compaction when layers of calcareous concretions produced by earlier generations, similar to a biologically active coral, are present. The blocks with uniform pores and reduced openings may sometimes be carved in low relief to compose architectural rings or partitions. The most suitable is the stone originated from a porites coral, which is pretty common in different regions and can be found in very large banks. The most common buildings, especially from the colonial era, have coral rubble masonry with large pores requiring a surface finish with lime plaster and periodic repainting.

The limestone substrate of a living coral reef can be easily cut. As mentioned above, limestone significantly improves its mechanical strength after a prolonged exposure to the air completing the calcification process; it can be normally used in constructions of one or two floors. Limestone cutting and excavation underlay the construction cycle and influence the whole cycle. The most used kind of stone, usually with large pores, comes from the reef segment colonized by

Acropora corals which live a little below the sea level. The stone originating from porites, with a regular porosity, can occupy a segment of the deeper reef. In the first case, the removal may be effected in the open at low tide. The porites stones, instead, must be dug in water or fossil coral limestone quarries, with a technological expense far greater than the one necessary to the collection of Acropora limestone.

In his study on the cliffs of the coast of Brazil, John Casper Branner begins with an important point:

There is no more striking geologic phenomenon along the eastern shores of South America than the stone reefs of Brazil. These reefs are supposed by many persons to be of coral, and this error has been propagated by writers of books of travels and by works on the navigation of the south Atlantic... In Brazil the only men who really seem to know the difference between the two kinds of reefs are the lime-burners who make lime of the corals, and a few of the masters of barcaças, *or sugar boats. Among these men distinction is made between the coral rock, which they know as* pedra de cal *(lime rock), or as* cabeça de carneiro *(sheep's head, referring to Porites and other solid heads), and the sandstone which they call* pedra de encantaria*; that is, stone used for window and door sills and facings, as the reef rocks have been used from the earliest times.*[68]

Although divided into two distinct parts, one related to the sedimentary rocks and the other to the predominant formations of coral reefs, the two categories often coexist and are in a mutual phenomenological dependence. Under the methodological aspect the above text retains a considerable relevance for the problems of knowledge and conservation of the natural coastline. For the purpose of this paper, it is interesting to note how accurate the description of the coast of Brazil is; the author also records a devastating exploitation of the deposits of coral limestone still happening on the islands, bars and reefs by producers of lime, as in Parahyba do Norte[69].

In a 1962 study on the lime industry in Mauritius, Jesse Walker points out that during the 2nd World War the reefs of the Pacific atolls were routinely dredged to get chips and limestone fragments to build the foundations of airstrips and roads. The same material was used as aggregate in concrete and as raw material for lime. The production process described by Walker is part of a social and economic process that affects the whole island:

[68] John Casper BRANNER, *The stone reefs of Brazil, their geological and geographical relations, with a chapter on the coral reefs*, in *Bulletin of the Museum of Comparative Zoology at Harvard College*, Vol. XLIV, Geological Series, Vol. VII, University Press: John Wilson and Son, Cambridge USA 1904, p. 4.

[69] Brabber, 1904, pp. 232-235.

Since Napoleonic days the population has been almost entirely dependent on the sugar industry. About 40 per cent of the 720 square miles is planted to sugar cane, which accounts for more than 98 per cent of the exports. Twenty-four sugar factories now produce more than 600,000 tons of sugar each year and, in the process, use some 5000 tons of lime as the principal chemical agent in clarifying the cane juice. Virtually the same amount of lime is used by the building trades, and small quantities are used also in the tanning industry and as a soil conditioner.[70]

Below, the lime production process is briefly described; the author reveals a practice of taking material from the reef and back-reef very similar to that being used in the East African coast for the supply of building stones.

The diggers in Mauritius normally extract the coral directly from the reef. The corals growing in the lagoons are generally too soft for a convenient production of lime. Due to the large waves crashing on the coast in the south and east, people prefer to get the coral from the flat-shaped back-reef; anyway, they also pick it up in the west coast but in smaller quantities. Most workers take off the coral with iron bars at low tide. Only rarely they get it underwater at a depth exceeding one meter; on the west coast some diggers use long tongs to remove and lift deep water corals at fifteen feet from the edge of the cliff.

Corals are transported in canoes or rafts, directly to the furnaces or to the beach. The coral on the beach is usually transported to the furnaces by carts pulled by oxen or donkeys, but trucks are also used. Some kiln owners have reduced the costs of transport building moorings near the oven.

The diggers work on the reef an average of two or three times a week, depending on weather conditions, the capacity of the furnaces and the distance of the excavation site. The capacity of the furnaces determines the intensity of the activities and also the work time of the men.

Although the furnaces cook any type of shell or coral, including giant clams, the Acropora corals (local name *platin*) are preferred, coming in large sheets from the back-reef platform, together with the clear and rounded porites coral locally called *tête de mort*. Platin is more compact than tête de mort and gives a larger quantity of product; on the other hand, we must consider *tête de mort* has fewer impurities and thus produces a superior quality lime.

The higher quality is more important in the sugar cane bleaching than it is in the building construction[71].

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[70] H. Jesse WALKER, *Coral and the lime industry of Mauritius*, in *The Geographical Review*, Vol. 52, N. 3, American Geographical Society of New York, July 1962, pp. 325-336. Here: Walker, 1962, p. 327.

[71] Walker, 1962, pp. 327-332.

2. The coral limestone heritage

The cultural and the natural heritage: Contexts and heritage conservation - Standards for the preservation of the cultural and natural heritage on the tropical coasts – How to reach an equilbrium between the natural and human environments - Stones, lime, sand and *murrapa*.

2.1. The cultural and the natural heritage

From the papers of institutions linked with UNESCO[1], two themes have been growing in importance over the years and have become a significant part of the intergovernmental policies on heritage conservation. They are the attention to cultural values and the interest in the environmental and regional contexts. Actually, this trend is a real cultural strategy which allows the development of policies for the promotion and management of the local cultural heritage also in countries almost entirely devoid of excellent ancient architecture, but rich in deeply rooted ethnic values and environmental treasures.

These considerations can be very usefully applied to Sub Saharan Africa. These countries were involved in the major recent initiative *Africa 2009 Programme*, an ambitious but honestly concrete supranational program, which aims at an institutional structuring of the management of the cultural heritage in Sub Saharan regions and takes into account the new awareness of local tradition and environment values. The same Icahm Charter[2], in the field of archaeology, merely sets out general principles, as it states that the unique culture of a site is the only one entitled to have its own conservation policy[3]. In an explicit ref-

[1] United Nations Educational, Scientific and cultural Organization, 1946.

[2] Icomos Charter for the protection and management of the archeological heritage, 1990.

[3] *Integrated protection policies - Article 2.*

The archaeological heritage is a fragile and non-renewable cultural resource. Land use must therefore be controlled and developed in order to minimise the destruction of the archaeological heritage.

Policies for the protection of the archaeological heritage should constitute an integral component erence in the text, Icahm Charter refers to the previous Icahm Venice Charter[4] where art.1 suggests a new meaning for the word *monument*, overcoming its etymology; it can be given to various objects and contexts and include all expressions of the different civilisations[5].

The conservation of the megaliths of Bouar in the Central African Republic and of Sine in Senegal is an example of the new outlook[6]. They are subject

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of policies relating to land use, development, and planning as well as of cultural, environmental and educational policies. The policies for the protection of the archaeological heritage should be kept under continual review, so that they stay up to date. The creation of archaeological reserves should form part of such policies.

The protection of the archaeological heritage should be integrated into planning policies at international, national, regional and local levels.

Active participation by the general public must form part of policies for the protection of the archaeological heritage. This is essential where the heritage of indigenous peoples is involved. Participation must be based upon access to the knowledge necessary for decision-making. The provision of information to the general public is therefore an important element in integrated protection.

From: *Charter for the protection and management of the archaeological heritage, prepared by the International Committee for the Management of Archaeological Heritage (ICAHM) and approved by the 9th General Assembly in Lausanne in 1990*. From http://www.international.icomos.org/charters/arch_e.htm.

[4]International Charter for the Conservation and Restoration of Monuments and Sites, 1964.

[5]*Article 1.*

The concept of a historic monument embraces not only the single architectural work but also the urban or rural setting in which is found the evidence of a particular civilization, a significant development or a historic event. This applies not only to great works of art but also to more modest works of the past which have acquired cultural significance with the passing of time.

From: *International Charter for the conservation and restoration of monuments and sites, IInd International Congress of Architects and Technicians of Historic Monuments*, Venice, 1964, adopted by ICOMOS in 1965. From http://www.international.icomos.org/charters/venice_e.htm.

[6]The megaliths of Bouar are located in the northwest of the Central African Republic. They were discovered in the late fifties of the 20th century by Commandant Jean d'Arbaumont. Their archaeological study began in 1962.

Les processus de dégradation qui affectent ces pierres sont dus à:

- *L'érosion très active dans la région, causée par les précipitations qui bouleverse parfois profondément les sites et a fait tombé une partie des pierres dressées.*
- *L'amplitude de la variation thermique quotidienne de 19° à 24° C pour les températures nocturnes à 35° - 40° C pour les températures diurnes ainsi qu'aux feux de brousses fréquents dans la région. Ce qui a pour conséquence,*
- *L'éclatement superficiel de la roche qui émousse les contours de la pierre. Ce phénomène a été observé sur 59 % du total des pierres.*
- *La fracturation de la masse du granite.*
- *La présence des boeufs dans la zone dénude le sol et permet l'érosion susmentionnée en plus des dégâts directs qu'ils causent aux monuments*
- *L'exploitation de certains secteurs pour les cultures et les habitations sont aussi un facteur de perte de certains tazunu.*
- *Ces derniers temps, dans des lieux publics à Bangui on constate la présence des pierres prélevées sur des monuments mégalithiques de Bouar*.

Alfred Jean-Paul NDANGA, *Exemples de patrimoine culturel immobilier de la Centrafrique. Les megalithiques de Bouar*, in Patrimoine culturel immobilier en Afrique. Cours Régional Africa 2009 EPA, Porto Novo, Bénin 2 septembre - 22 novembre 2002, p. 13.

to conservation problems different from the other megaliths of the Atlantic or Mediterranean coasts. In each region monuments with the same formal or structural characteristics present different conditions depending on the specific positions of their sites. The historical investigations show the large size and peculiar characteristics of the most famous megalithic monuments but, at the same time, they confirm the fragmentation of many discovered episodes; in those cases a more critical interpretation suggests to be careful in the historical reconstruction and in the generalizations of the local cultures of the ancient times.

The term *megalithic culture* contains the idea of a phenomenological synthesis sometimes difficult to be accepted when we refer to the cultures of different peoples distributed in different and remote regions and covering a considerable period of time - between the 5th and 1st millennium B.C.

The perspective and the critical tools of a conservator/curator, and not of a historian, are principally directed to the object and its context. Sometimes the critical correlation of a historic or prehistoric object of art with its environment involves a suspension of any historic and aesthetic disbelief about the object itself. The indirect sources necessary to know the stages of a distant physical remoteness are often missing; that is an obvious problem for the objects of prehistoric art. In such a case the object itself becomes a documentary text and also the context can be investigated as a documentary text. In this perspective, the story expands without set limits and in his task the curator may recur even to disciplines such as geoarchaeology, geology, geography etc.

Sometimes an artefact of the past may not be investigated because of the disappearance of its textual features, due to human actions or physical environments. In a contextual analysis the aggressive, stable or cyclical dynamics can be iden-

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For more see: Ian SHAW and Robert JAMESON edited by, *A Dictionary of Archaeology*, Blackwell Publishers ltd, Oxford - Malden 1999, p. 31.

Also in the 3rd millennium BP (uncal) interesting developments were taking place in the savanna of the Central African republic. There, in the Bouar region, numerous megalithic monuments (called locally tazunu) were being constructed. These tazunu, which number in the hundreds, consist primarily of stone aggregations of approximately 10 m in diameter and 1 to 2 m in height, with a series of monoliths placed at or around their summit. Six tazunu have been excavated and dated, providing absolutely no evidence for inhumations, but featuring dates on associated charcoal falling between uncal 2800 and 2000 BP. Associated material culture from excavations has been rather sparse but includes some ceramics, ground stone and lithics (David 1982). In terms of function, these monuments have usually been viewed as territorial or group lineage markers.

The site Baro, with its holy pond, is located in the region of Kouroussa in Upper Guinea. It is a cultural landscape, characteristic of the Sudanese-Guinean associative culture. See: NDANGA Alfred Jean-Paul, *Exemples de patrimoine culturel immobilier de la Centrafrique. Exemples de patrimoine culturel immobilier de la Guinee*, in Patrimoine culturel immobilier en Afrique. Cours Régional Africa 2009 EPA, Porto Novo, Bénin 2 septembre - 22 novembre 2002, pp. 27-28.

tified and linked with the offences an object of art has suffered.

For example, African curators and ecologists are not able to deal with the phenomenon of the considerable temperature difference between day and night, causing the exfoliation of the surface of granite boulders and leading to the total disintegration both of rocky hills in the savannah (*inselberg, kopje*[7]) and of the megaliths in the sub-Saharan regions. A parallel reading of the object and its context may give also the succession of the different conditions determined by slow environmental dynamics, such as the storage of material or, on the contrary, the subtraction of material due to dissolution, caused by rainwater or the sliding action of water on the soil surface.

The holy pond of Bôlé near the village of Baro in Guinea is an example of cultural values associated with a natural landscape. It is a veritable shrine to which people give mythological meanings. For at least seven hundred years the site has been venerated by thousands of believers who flock to the annual ceremony, even from far away regions. The presence of similar sites shows that the course of nature can be associated with a cultural process, belonging to oral civilisations as well as to the so-called prehistoric ones.

In sub-Saharan Africa the issues of architecture and historic sites conservation have been updated thanks to the impulse of the new cultural policies in the different fields of research due to appropriate regional and international intergovernmental direction. For example, the Facultade de Arquitectura e Planeamento Fìsico in Maputo was involved in the preservation of the architectural and urban heritage in Moçambique; a systematic research conducted from 1995 to 2008 which overcame the common practice of presenting the so-called colonial architecture as the only heritage objects to be preserved. Local and foreign scholars have recovered the pre-colonial settlement and housing cultures and have changed the historic perspective of urban and colonial architecture; in this way we have experimented with concrete and updated ways to preserve and enhance the historic heritage after independence.

Unfortunately, in this part of Africa the participation in the international debate on restoration and the knowledge of the methodologies developed in the European restoration sites are not sufficient to start an effective regional policy for conservation outside Europe. As well as the inadequacy of certain recurring European models, African architects, historians and curators must reckon with the strong character of their traditions, with the weakness of their new States

[7] *Inselberg* is the most common term used internationally to describe an isolated rocky hill resistant to erosion, which rises from a surrounding plain. In South Africa similar formations are common, often of granite, and are known by the name of *kopje*.

and with the unfamiliarity of most African ethnic groups with colonial models.

Julio Carrilho, a qualified scholar of Swahili architecture, has been working for the government and has studied subjects directly linked with the conservation and restoration of the island and town of Ibo. As to the conservation of the sites of colonial settlements in Ibo and in the northern region of Moçambique, his studies and evaluations can be summarized as follows:

1 A sustainable restoration of monuments should consider first the actions necessary to improve the conditions of the population living in the so-called 'informal' areas; the improvement may give people a sense of social belonging empowering their cultural identity. In a society conscious of its own culture the participation of the key actors of development and cooperation - private enterprises, NGOs etc. - would become easier;

2 It is difficult to reproduce on a large scale the techniques and materials used in the past; those techniques involve the intensive use of natural elements of great ecological, environmental and landscape value, such as corals and mangroves - now protected by law - or natural resins and palm leaves the mats called *macúti* are made with. This exploitation could be justified only if critically practised, with a selective and exemplary role in the beginning and carrying on of the restoration works;

3 The symbolic importance many people give – such as those of Guinea and the island of Ibo - to particular trees and shrubs sacred by the celebration of various rituals, recommends to deal with the natural elements as they were parts of historic architecture and to make a list of them in view of a real conservation program;

4 It would be proper, if not indispensable, to associate restoration with the interest and participation of local people, struggling at present with major problems of survival. This approach has been successfully tested with programs devised for the environmental rehabilitation and restocking of game in northern Moçambique during the past two decades;

5 Apprenticeship must be integrated with training. Apprenticeship and training are both needed to improve the skills of the operators and to spread the awareness of the values of a people's cultural heritage;

6 A self-conscious, motivated and permanent public management may phase out robberies and destructions of the heritage. There are widespread attitudes being the result of political and financial pretexts that create the view that an architecture of slaveholders doesn't match the most authentic historic identity of the region.

Carrilho's reflections also consider the issue of international cooperation for the conservation and restoration of the national heritage. As to Moçambique, he believes that, at present, the State is unlikely to have the necessary resources to implement the conservation of the natural and cultural heritage. Some associations and institutional organizations are aware that the basic evidence of the history and identity of Moçambique must be preserved, because the disappearance of evidence would lead to the loss of the elements a collective identity rests upon and is internationally recognized.

Actually, activities relevant to knowledge and conservation have been undertaken and are being implemented thanks to technical and financial aids from the international community. However, as to international cooperation, he follows UNESCO policy and hopes that two basic conditions in the field of heritage conservation will be held to render it widespread and effective:

1. *symmetric information of the parts – that is each part must fully understand the ability and willingness of the other;*

2. *the possibility of exchanging and agreeing on the ideas put forward, namely: no imposition of the objectives and processes by donor countries, nor paternalistic, simplistic or blind acceptance of the will of the beneficiary country by the donor*[8].

Once these basic principles have been agreed upon, heritage conservation will ensure the contextual economic rehabilitation of the objects to be retained and, at the same time, will reform their fruition adapting them to the social welfare and excluding a deformation of the local cultural models.

As to the cultural administration, Carrilho boasts an important political experience allowing a complex assessment and adequate proposals for the solution of the problems related to the preservation of the regional heritage. His arguments deal with the honesty, efficiency, knowledge and competence of the local public administration. He notes that the participation of the population and of other development institutions is closely tied to special interests; therefore, the central government must help to harmonize the interests expressed by today's increasingly complex society, particularly in the legal, financial and technical assistance. A supranational culture of the national and regional heritage and its values, together with an appropriate public presence may ensure a proper conservation supported by the pillars requested by UNESCO - a complete documentation, proper administration and effective protection by law[9].

[8] Júlio CARRILHO (with the cooperation of Anselmo CANÍ), *La piccola città di Ibo: considerazioni su recupero e restauro*, edited by M. Berti, *La gestione del patrimonio ambientale. Sulla via della conservazione africana*, ARKOS, vol. 4, Firenze 2003, p.72.

[9] Text of the Convention for the Safeguarding of Intangible Cultural Heritage - Convention for the

When associated with an institutional cataloguing of the heritage – I'm thinking of the expression *Heritage Catalog* - the documentation procedures may take precedence over any laws and public administration. Then, the administrative procedures should give way because most rules are unequivocal and fixed when compared with the flexibility and instability of knowledge; knowledge in itself has its own peculiar characteristics and is a regeneration process[10].

The regeneration of knowledge depends on a lot of converging factors and on the arguments re-proposed in the presence of new factors or in the disappearance of the existing ones.

A documentation experience particularly innovative in methods and revealing in results was conducted by the Faculdade de Arquitectura e Planeamento Fìsico in Maputo, during an intense academic activity between 2000 and 2006. The

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Safeguarding of the Intangible Cultural Heritage Paris, 17 October 2003 -The General Conference of the United Nations Educational, Scientific and Cultural Organization (UNESCO), meeting in Paris, from 29 September to 17 October 2003, at the 32nd session:

... *Article 13 – Other measures for safeguarding*

To ensure the safeguarding, development and promotion of the intangible cultural heritage present in its territory, each State Party shall endeavour to:

(a) adopt a general policy aimed at promoting the function of the intangible cultural heritage in society, and at integrating the safeguarding of such heritage into planning programmes;

(b) designate or establish one or more competent bodies for the safeguarding of the intangible cultural heritage present in its territory;

(c) foster scientific, technical and artistic studies, as well as research methodologies, with a view to effective safeguarding of the intangible cultural heritage, in particular the intangible cultural heritage in danger;

(d) adopt appropriate legal, technical, administrative and financial measures aimed at:

(i) fostering the creation or strengthening of institutions for training in the management of the intangible cultural heritage and the transmission of such heritage through forums and spaces intended for the performance or expression thereof;

(ii) ensuring access to the intangible cultural heritage while respecting customary practices governing access to specific aspects of such heritage;

(iii) establishing documentation institutions for the intangible cultural heritage and facilitating access to them.

See also: Maurizio BERTI and Júlio CARRILHO (2005). *Conservazione del Patrimonio storico e ambientale nell'Africa Sub-Sahariana*. ARKOS, vol. 12, Firenze 2005, p. 9-12

[10]This consideration, as the following ones, comes from the experience of study and practice made on the basis of an agreement between the Corso di Dottorato di Ricerca in Riqualificazione e Recupero insediativo held at the University of Rome La Sapienza and the non-governmental organization Intersos., from August 2008 to December 2009. The arguments were made up by some conservation projects supervised by UNESCO and by the Institute for Conservation and Restoration (ICR), with funds of the Italian government in the region of Pejë/Peć - Kosovo. On this occasion I took part in the drafting of the project to support the management of technical data and decisions on cultural heritage. This project was proposed and developed by the Directorate General for Development Cooperation - Central Technical Unit of the Ministry of Foreign Affairs/Unità Tecnica Locale of Belgrade (UTL) - Belgrade-Pristina-Rome 2009.

Besides, I refer to some experience in teaching and research activities in the Faculdade de Arquitectura e Planeamento Físico of Maputo (MZ) from 2000 to 2006.

initial idea consisted in the starting of a systematic study of the architectural and environmental heritage of Moçambique in order to give a first assessment of the traditional ways of living, with a view to their future development. As the territory was large, an agreement between the University and Ministério da Educação (MINED) - the public institution with the most widespread presence throughout the country - was really needed.

With the help of the Ministry contacts were made with officials representing the schools in the suburbs of towns and cities such as Lichinga, Inhambane, Maputo, Ibo, Channel, Pemba, Xai-Xai. Each school was given a throw-away camera and a form to detect the most important elements of a village.

Soon, the researchers realised that the most valuable result didn't consist in the large volume of information nor in the confirmation of the stability of traditional settlement patterns; those schemes had been perpetuated thanks to the maintenance of traditional techniques in all the regions of the country. The most interesting result, instead, was the discovery of unforeseen original selection criteria the volunteer detectors, who were officials of the Ministry, had adopted in the census. In the assessment of the results it was noted that if the researchers had been specialists - anthropologists or architects - most likely they would have looked for objects belonging to the already known iconography of scientific literature and may have neglected the faint but unmistakable trends of the new architecture; they found transformations due to cultural influences and to the imagination of today's manufacturers, but consistent with the traditional architecture[11]. Those changes were highlighted by detectors in their voluntary census.

Proposals for a heritage catalogue. The idea of widening knowledge through the investigative activity of local but not specialized researchers was evaluated and discussed, in order to see whether it could be applied to the formulation of the Heritage Catalogue in Kosovo, a region with different natural and cultural characteristics. Some investigation options have emerged from simulations involving the support of institutional and non institutional subjects and advanced technology at a low cost.

On special occasions we publicly celebrate our heritage, for example in the *European Heritage Days* and the *International Day for Monuments and Sites*. The re-

[11] A brief assessment of this experience *Arquitectura tradicional, arquitectura pobre... ou, mais simplesmente, arquitectura* can be found in Sandro BRUSCHI, Júlio CARRILHO, Luís LAGE, *Era uma vez uma palhota... História da casa moçambicana*, Facultade de Arquitectura e Planeamento Físico, Maputo 2005, p. 43.

gional localization of these celebrations means that the organization of meetings and themed events can become an opportunity for youth involvement. During a day, specially reserved to the young, groups or youth organizations present their programs and describe the results of the work undertaken for the knowledge or the improvement of their cultural heritage. The necessary guidance and coordination could be played by the regional directors of the institutes for heritage conservation. The Ministry of Culture, through its regional institutes, could invite groups and cultural associations to freely adopt an object of artistic or natural value to start on a path of study and cultural care. The participants could access the catalogue through school networks (Internet), public libraries or at the regional branch of the Institute for the Conservation of Heritage. The GIS (Geographic Information System) will provide easy access for no evolved consumers who, however, should be allowed to unload and transfer data. Teaching laboratories will be activated for the study of traditional crafts and techniques, acting as centres of data collection, documentation and didactic activity.[12]. The young and the community groups organically involved can become authors of a systematic recording of craftsmanship in their living places, through digital photographs and written accounts complying with the essential forms prepared. These studies and records may be material deposited in the Catalogue, if produced and processed in a manner compatible with the catalogue itself. For this task a facilitator is required, who may establish a link between stakeholders and the catalogue system. The operator could work at a regional level and find a seat in the regional Institute for Heritage Conservation. A good knowledge and recognition of the cultural value of a site require frequent contacts. For a site or object adopted by groups or cultural institutions visits will be more frequent and their elaborations will become material of the Catalogue. For more sporadic controls, visitors can prepare themselves drawn news from the catalogue itself.

The preservation of the spiritual or immaterial heritage is perhaps the highest point of consciousness of the various regional civilisations. The papers and

[12]From GIS (Geographic Information System), considered in the project *Repubblica del Kosovo. Institutional building a sostegno del Ministero della Cultura, Gioventù e Sport. Realizzazione di un sistema di gestione di dati tecnici e di supporto alle decisioni sul patrimonio culturale - Bozza finale p. 16.*, I'm willing to quote only the following consideration: *La geo-referenziazione dei beni culturali secondo un sistema GIS, che a differenza d'altri tipi d'individuazione su base testuale (indirizzi, catastali, ecc.), consente la individuazione univoca attraverso la loro collocazione sulle cartografie che rappresentano un territorio, e, che possono essere condivise da altri o possono risultare facilmente normalizzabili o omogeneamente diffusi* (Geo-referencing of the cultural heritage according to a GIS system which, unlike other types of text-based identification - addresses, registry data, etc.. - allows the unequivocal identification through their locations on maps representing a territory and can be shared or easily standardized or evenly distributed).

recommendations of Institutes, such as UNESCO, or International associations have long established the principle that the uses and immaterial expressions of specific social and regional groups are a value to be retained. This new awareness has made possible the access to supranational policy formulations for heritage preservation even to States possessing a few artistic monuments, but rich in traditions of oral culture and natural monuments.

The young, thanks to their widespread presence on the territory and their natural curiosity, can become actors in a systematic collection of data pertaining to oral culture. In particular, the current digital/electronic media of recording permit the systematic documentation of artistic expressions in the fields of music, songs and dance at a very low cost.

A separate area should include stories or family traditions and the traditional norms of social behaviour. Language is one of the most obvious identification of a social group. The maintenance of different languages in one nation maintains a state of cultural wealth and has a special potential of turning people to reading, literally, the documents of the past and being architects of their own history.

The collection of data describing the traditions, habits and memories of strongly characterized places and groups could be undertaken by special procedures designed ad hoc. If there is a group already oriented to different aspects of culture, it could itself implement an organized record of a particular object or phenomenon of tradition. Otherwise, an institution or an outside group which has adopted a place or a heritage object could engage in a dialogue and be available to learning; in doing so these same groups will give the details of their heritage identity. It could be a good exercise in dialogue, especially if undertaken by the younger age groups.

2.2. Contexts and heritage conservation

The issue of the relations between archaeology and restoration is a task which goes beyond the aim of my studies. Generally speaking, however, an initial explanation of some links existing between archaeology and restoration can be achieved using the principles related to the definition of the restoration of an artwork, as it was developed by Cesare Brandi.

For example, Brandi's first axiom is a methodological approach admitting an archaeological trend in restoration: *si restaura solo la materia dell'opera d'arte* (only the material conditions of the artwork must be restored). This certainty explicitly acknowledges which is the primacy in the consideration of an artwork: *la con-*

sistenza fisica (the physical substance)[13]. We have opened this part of the study simply looking at the physical substance of the phenomena. The arguments related to the dual character now commonly associated with the term heritage, i.e. the cultural and natural characters, are handled by keeping the attention, as far as possible, on the physical data that can more easily allow a comparison between culture and nature.

Following Brandi's way of thinking, and then still largely within the cultural sphere, we can record some conscious openings of horizons regarding an art object entrusted to the curator for custody or restoration.

In Salvatore Boscarino, for example, we can see a clear perception of the enlargement of the meanings that have gradually been attributed to the term *monument*, at least during the last forty years[14].

[13] Let's remember the famous definition of restoration of an artwork in Cesare Brandi: *il restauro costituisce il momento metodologico del riconoscimento dell'opera d'arte, nella sua consistenza fisica e nella sua duplice polarità estetica e storica, in vista della sua trasmissione al futuro* (restoration is the methodological moment of recognition of a work of art in its physical substance and in its dual aesthetic and historical polarity, in view to its transmission to the future). Brandi continues: *La consistenza fisica dell'opera deve necessariamente avere la precedenza, perché rappresenta il luogo stesso della manifestazione dell'immagine, assicura la trasmissione dell'immagine al futuro, ne garantisce quindi la recezione nella coscienza umana* (The physical consistency of a work must necessarily take the precedence, because it represents the place where an image shows itself, ensures the image transmission to the future, and then guarantees its reception in human consciousness).

Cesare BRANDI, *Teoria del restauro*, Giulio Einaudi Editore, Torino 1977, p. 6 [1st ed. 1963]

[14] Boscarino writes:

Il nostro restauro quindi non può essere semplicemente architettonico e non può ammettere la suddivisione in restauro architettonico e urbano, sostenuta e promossa dalla burocrazia universitaria, ministeriale e dagli esperti cooptati. Il nostro restauro è quello che con termine antico, ma comprensibile e compreso in tutto il mondo, viene detto "dei monumenti" e che si è formato attraverso l'elaborazione della scuola italiana del restauro - che conta ormai cento anni di vita e si riconosce in Boito, Giovannoni, Sanpaolesi, Pane, De Angelis, Bonelli, Grassi e Di Stefano e negli apporti fondamentali di Argan, Brandi, Bianchi-Bandinelli, Longhi, Calvesi, e via dicendo - alla quale apparteniamo, pur nella diversificata, dialettica, dinamica, rispettabile posizione di ciascuno. Evidentemente, però, oggi dobbiamo anche registrare l'estensione che ha avuto il termine "monumento", che è diventato talmente vasto da comprendere un grande numero di oggetti e di cose, sino ad arrivare all'ambiente urbano e naturale, per cui l'etichetta di fautori dell'accademismo monumentalista, che ci viene continuamente attribuita, appare ingiustificata. Tuttavia bisogna chiaramente affermare che questa estensione del termine non può comprendere tutto il costruito, il continuum edificato sul territorio (Our restoration therefore cannot simply be architectural and cannot accept the division into urban and architectural restoration, supported and promoted by the university and ministerial bureaucracy, and by co-opted experts. Our restoration consists in the so-called restoration of "monuments", an old but understandable and widely understood term, which has been forming through the development of the Italian school of restoration - now one hundred years old and which goes back to Boito, Giovannoni, Sanpaolesi, Pane, De Angelis, Bonelli, Grassi and Di Stefano and in the fundamental contributions of Argan, Brandi, Bianchi-Bandinelli, Longhi, Calvesi, and so on. We belong to that school, which is diverse, dialectical, dynamic and ready to accept everybody's position. Clearly, however, today we must also record the extension of the word "monument" that has become so broad as to include a large number of objects and things, up to the urban and natural environment; so the label of 'advocates of monumentalist academicism' that

A long and thorough theoretical elaboration on the theme of monuments in relation to environment can be found in Giovanni Carbonara's writings and teaching. The scholar registers with meticulous attention the Italian debate held in the 70's and 80's of the last century, among the new architectures designers, city planners and curators. In Cesare Brandi's instances the analysis is mostly maintained on the urban environment where, however, there is a critical reading of the links established among monuments, the town, aesthetics and history. Carbonara repeatedly refers to the time category, recognizing that it determines multiple levels of reading in history and of appreciation in the aesthetic field thanks to the surviving objects. Time has thus revealed a new interpretative key of urban environment and of the traditional idea of a monument; furthermore, *space* and *environment* have been overcome as Paul Philippot suggests, in favour of the use of the term *context*, as we shall see later, which is the place where the phenomena are in dynamic relationship among themselves[15]. *Restaurare non significa certo ristabilire una perduta identità del luogo, né il suo stato al momento in cui l'opera fu costruita; significa, invece, stabilire un'identità, spesso totalmente originale,*

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we are constantly given, appears unjustified. However, it should be clearly said that this extension of the word may not include everything built on the territory).

Salvatore BOSCARINO, *Storia e storiografia contemporanea del restauro*, in Gianfranco Spagnesi edited by, *Storia e restauro dell'architettura. Proposte di metodo*, Istituto della Enciclopedia Italiana, Roma 1984, p. 53.

[15] *Context refers to an object's immediate surroundings, inasmuch as these determine the approach and, thus, the correct interpretation of the object; that is, the frame of a picture, traditional surroundings of a monument that are essential to its scale and significance and social circumstances in which the object is or was used, this consideration being especially important for liturgic or ethnographic objects. In some cases, the context may be an object, as is the case, for instance, of minor architecture in historic centers, when no individual building is a work of art but the whole becomes a monument in itself (e.g., the Campo dei Fiori in Rome). An object should never be deprived of its context, if the object is to avoid becoming isolated and "museumized," that is, segregated from life. The recognition of the value of the whole and the object's context leads logically to the principle that every object should, whenever possible, be conserved in situ if one wants to save the full value of the whole and of the parts. This applies to wall paintings, altarpieces and sculptured decoration. It also applies to architecture and to its architectural or natural surroundings. Exceptions to this principle must be made, however (e.g., in situations where a fresco or building can be preserved only by disassembling and moving it, even though the movement will produce unavoidable and irreparable damage). The open-air museum is an emergency solution and is almost a contradiction in itself, since vernacular architecture is existentially linked to its surroundings, even more so than major monuments that can impose themselves on their surroundings. Hence, there is the almost inherent tendency of the open-air museum to evolve into a Disneyland: No longer is it a preservation of history in the present, but rather a projection of fantasy into objects of the past, which is a special variety of faking*.

In Paul PHILIPPOT, *Historic Preservation: Philosophy, Criteria, Guidelines*, in *Preservation and Conservation: Principles and Practices*, Proceedings of the North American International Regional Conference, Williamsburg, Virginia, and Philadelphia, Pennsylvania 1972, Preservation Press, Washington, D.C. 1976, pp. 271-272.

con le nuove relazioni apportatevi dal tempo. Non si tratta, dunque, della negazione di se stesso, né della rinunzia alla propria identità (che non può non essere identità storica) da parte del monumento, né della ri-creazione di un'identità originaria. Misurarsi con l'ambiente storico vuol dire sapersi confrontare con le trasformazioni ed anche con le offese che il tempo, alterando l'ambiente, ha portato alla fabbrica, spesso ad opera dell'uomo e sovente per sole ragioni pratiche (Restoring does not mean to recover a lost identity of a place, nor its state when the work was built; it means to establish an often completely original identity, with the new relations coming with time. It is not, therefore, a negation of the object itself, nor the monument's renunciation to its own identity - which cannot be an historical identity - nor the re-creation of an original identity. Facing the historical environment means a confrontation with the changes and also with the offences that time, altering the environment, has led to the artefact, often made by men only for practical reasons).[16]

Experts coming from urban or architectural restoration have been offered a significant reassessment of the relationship between archaeology and restoration by the archaeologists who, in recent times, have been restoring architectural or urban monuments. The influence of archaeology has opened new ways of interpreting the relationship established over time between the object and its environmental context. In the case of art objects, our perception of the relationship between historical data and aesthetic values has been renewed by archeology.

One of the most obvious limitations of the approach to the subject of archaeological interest by an architect/curator is the practical function of historical architecture and the prevailing customs men are still keeping alive in their territories.

Riccardo Francovich says there is problematic symmetry between archaeology and restoration, defining it as *l'oggettiva dicotomia fra il momento conoscitivo e il momento di destinazione d'uso o di riuso, con particolari problemi per le emergenze monu-*

[16]Giovanni CARBONARA, *Avvicinamento al restauro. Teoria, storia, monumenti*, Liguori Editore, Napoli 1997, pp. 632-633.

The problem of the monument in relation to its monumental context and concepts expressed by Philippot, has been already set by Carbonara in Giovanni CARBONARA, *La reintegrazione dell'immagine*, Bulzoni Editore, Roma 1976, pp. 161-164.

... *È in base a questa istanza storica che l'allargamento, non del concetto ma del campo d'azione del restauro, trova la sua giustificazione teorica: nella coscienza che qualunque espressione umana, dal più piccolo oggetto alla configurazione di un territorio, è segno di civiltà, documento di storia e, già solo per questo, considerabile sotto l'aspetto della sua conservazione* (... Following this historical instance the enlargement not of the concept but of the working field of restoration, finds its theoretical justification: in the consciousness that any human expression, from the smallest object to the configuration of a territory, is a sign of civilization, an historical document and, for that reason, notable under the aspect of its preservation).

In Carbonara, 1976, p. 164.

mentali e per il sopravvissuto (the strict dichotomy between the cognitive moment and the destination of use or reuse, with particular problems for emergencies and the survived monuments)[17]. When applied to the restoration of a piece of architecture or an architectural complex, the stratigraphic reading seems to be an exercise largely derived from archaeological practices.

The combined stratigraphic readings based on measurements of the horizontal and vertical planes of an ancient building reveal the history, structure and material conditions, often being the most reliable data for preservation of the heritage[18]. The examination of the stratigraphic data of a heritage object must be undertaken with regard to the physical conditions even for a long period, in order to satisfy the questions of the observer. If the observer is part of the preservation process, it will be possible to obtain critically tested data to draw up an effective conservation plan or, if necessary, a respectful restoration project.

Archaeology has influenced the practice of architectural and urban restoration improving the attention paid to material data; therefore, archaeology itself can influence the improvement of the management programs of the inhabited coastal areas as well, and not only the particular exercise to identify and characterize the historical data. An examination of the contemporary coastal processes and changes in the reef ecosystems of the past or in the future, can help establish appropriate safeguards against the problems caused by the natural phenomena of the sea, climate variability and human activities.

In 1982 Karl Wilhelm Butzer published his book *Archaeology as Human Ecology*[19]. In the introduction he states that he chose that title to emphasize the dynamic interactions between human groups and their environments. This complete and exhaustive text is a true paradigm for the science of archaeology and proposes, through case studies, a selection of models suited mainly to the training of archaeologists and the guidance of their applications.

The author aims at orienting the reader to think in terms of interdisciplinary practices and calls attention to the links already identified among the various phenomena he describes rather than on the techniques used. In his statement Butzer especially addresses the archaeologist but not only; indeed, in the introduction, he elaborates and explains his ecosystemic approach applied to various

[17] Riccardo FRANCOVICH, *Archeologia e restauro: da contiguità a unitarietà*, in "Restauro & Città", a.1, n.2, p. 15.

[18] The theme of the stratigraphy reading is clearly explained in Roberto PARENTI, *La lettura stratigrafica delle murature in contesti archeologici e di restauro architettonico*, in "Restauro & Città", a.1, n.2, pp. 55-68.

[19] Karl Wilhelm BUTZER, *Archaeology as Human Ecology: Method and Theory for a Contextual Approach*, Cambridge University Press, New York 1984 [1st ed. 1982].

fields of research through a range of environmental categories entirely appropriate to the analysis and treatment of the coastal settlements by the curators of pieces of architectures and inhabited settlements. In short, the general definition of the field investigation means the overcoming of the word *environment*.

This term is often used to refer to the collection of data that configure static and defined fields of inquiry. In order to highlight the links among the various phenomena in the fields of investigation, Butzer replaces the term *environment* with *context*, but promptly declares that the etymology of the term context is to be found in the Latin verb *contexĕre*; in this way he gets derived or relative meanings such as weaving and connecting[20]. The most distinctive character of this context lies in the dynamics occurring in the interweaving of the phenomena that can be detected either on a single artefact and in a constellation of sites.

By definition, the context is given in four spatial and time dimensions. In this four-dimensional space-time context, the cultural and natural spheres reveal themselves through their own internal dynamism and through their complex relations. This paradigm, which is often called *systems theory*, was discussed and applied by the scientific community with frequency and intensity during the 60's and 70's of the last century but, as Butzer notes, with limited research results. One reason for the still ongoing scientific interest was the flexibility with which this model can be applied by different research disciplines such as archaeology, biology, and environmental sciences in general.

In the same field of inquiry different disciplines can flow freely with the ability to solve one problem rather than another, according to a specific program, and with the possibility to reconsider problems left aside in previous phases of study. In any case, scholars declare their opinions, stating that this theory of system recognition is the most appropriate to integrate an environmental dimension in an archaeological context. Giving more attention to sites and artefacts, the contextual archaeology theorized by Butzer looks toward the multidimensional expressions human decisions assume in relation to environment, thereby fostering a holistic research on the complex interactions among the various phe-

[20] *It is my belief that the concept of* environment *should not be considered synonymous with a body of static, descriptive background data. The environment can indeed be considered as a dynamic factor in the analysis of archaeological context. The basic ingredients of archaeology are artefacts and their context, ranging from food residues to sediment and landscape matrix. The term* context *means many things to many people, but the word is derived from the Latin verb* contexere, *"to weave together" or "to connect." For archaeology, context implies a four-dimensional spatial-temporal matrix that comprises both a cultural environment and a noncultural environment and that can be applied to a single artifact or to a constellation of sites.*
In: Butzer, 1984, p. 4.

nomena of cultural, biological and physical importance.

If we give up the idea of coming to a final order in the different phenomena studied, the dynamics and the equilibrium among them spring up more clearly. In this approach five main categories have been identified: space, size, complexity, interaction and state of equilibrium or stability[21]. These categories, taken from geography and biology, can be applied to archaeology and anthropology and define spatial and temporal dimensions according to scientific standards, measurable with repeatable procedures. Especially with reference to the categories of *Interaction* and *Equilibrium state*, we have thought this system of approach appropriate for our studies and that is why we tested it during a limited experimental observation on the island of Ibo.

2.3. Rules for the preservation of the cultural and natural heritage on the tropical coasts

In general, the temporal durability of the historic buildings is mainly determined by the physical and cultural context where the buildings are. Referring to the context is a necessity, especially if we deal with the subject of the conservation of coral stone buildings. The cultural aspects are of great complexity and interest. For instance, history and economy must be counted among such topics and nowadays they have become decisive reasons for starting small or large restoration and rehabilitation works.

My studies consider some issues of the physical context of these buildings, with the awareness that, at present, the physical realm of the natural environment interacts with the cultural aspects of human society. The physical context of this architectural heritage is, indeed, the coral reef and, for that reason, we have described some of its aspects.

There is an extremely delicate balance between the various entities allowing the survival of the natural biological cycle in the coral reef; so it is inconceivable that the maintenance of architectures built with coral limestone can be made at the expense of the reef itself. Yet, the state of material degradation facing much

[21] *Five central themes are singled out for specific emphasis, namely, space, scale, complexity, interaction, and stability or equilibrium state (Butzer, 1978a). These concepts were originally geographical or biological, but they have direct anthropological and archaeological applications, and they incorporate spatial as well as temporal dimensions. Furthermore, each of these properties is measurable and therefore replicable, and so amenable to scientific study (Butzer, 1980f).*
In: Butzer, 1984, p. 7.

of the architectural heritage of the Mozambican coast after nearly two decades of neglect, would require a significant new supply of materials from the coast, for structure restoration and major works of maintenance; but in this case, building materials of different origin must be mainly used - alternative materials with durable and tested compatibility with the existing old ones.

In Moçambique the law for environmental protection is facing a very complex interweaving of natural phenomena - droughts, floods, cyclones, El Niño, the coast erosion. The difficulty to resist the impetus of the natural forces is greatly accentuated when we add the heavy effects of human activity, inappropriate for the land use - pollution, depletion of coastal vegetation and marine fishing not compatible with the maintenance of the resources. We can confidently expect that the planning of the efforts and resources will lead to a gradual control of most of the mentioned phenomena, but the maintenance of the coral reef, which is also a part of the protected area, is proving impossible. Let's simply refer to the *Global Coral Reef Monitoring Network Report* by the *Australian Institute of Marine Science*[22] to understand that the biological and environmental disasters caused by El Niño in 1997-98 and the river floods in 2001-2002 almost escape human control.

In the recovery program of Ilha de Moçambique developed by the Gabinete Técnico do Ministério da Cultura, Juventude and Desportos we can identify the methodological and procedural frame the State has devised for the preservation of the heritage on the island[23]. The study mainly develops the conservation problems in a coherent way and with a methodological approach consistent with international literature. For this reason it might be the regulatory framework for the conservation of the historical and architectural heritage of the whole Mozambican Community, including the urban centres of Ibo and Ilha de Inhambane.

One of the biggest challenges is the economic burden for the maintenance of

[22] The first readings were made in Global Coral Reef Monitoring Network - GCRMN, *Status of Coral Reefs of the World: 2002*, Edited by Clive Wilkinson, Australian Institute of Marine Science, Townsville 2002.

In particular, I'm referring to David OBURA and contributors – Louis CELLIERS, Haji MACHANO, Sangeeta MANGUBHAI, Mohammed S. MOHAMMED, Helena MOTTA, Christopher MUHANDO, Nyawira MUTHIGA, Marcos PEREIRA and Michael SCHLEYER, *Ch. 4. Status of coral reefs in Eastern Africa: Kenya, Tanzania, Mozambique and South Africa*, pp. 63-78.

The state of coral reefs is updated periodically by the Global Coral Reef Monitoring Network - GCRMN.

[23] (...) *Programa de recuperação da Ilha de Moçambique. Conservação do Património Histórico*, Gabinete Técnico do Ministério da Cultura, Juventude e Desportos. Republica de Moçambique, Junho de 1995, [typescript].


Left: the restoration of the flat roof and the renovation of the rainwater system for getting drinking water.
Right: the demanding restoration of a mansion with faux marble or *marmorino* decorations.

Figure 2.1.: Private houses under renovation in Ilha de Moçambique [*M.B., 2009.*].

old buildings by the inhabitants. Clearly there is no commensurability between the average income of the owners and the price for a proper rehabilitation of the houses; then, the Gabinete Técnico has proposed a cheaper way out, that is a greatly simplified checklist of maintenance works, promoting at the same time a widespread activity for restoration the owners should literally carry on on their own. This point is very difficult to treat in itself and doesn't seem so important as the other arguments of the program - archaeology, history and social organization.

The heritage value of old architecture is expressed in its being a unique document, considering it in historical and archaeological terms; but, from the architectural point of view, it derives from its unique architectural qualities. If we choose to keep the formal qualities of an ancient building, appropriate ways and means should be adopted. But in this way the path will be longer. If we renounce to an immediate and widespread action leading only to an improper rehabilitation, in favour of provisional essential works allowing the daily life in the houses, we can get the time needed for the training of local professionals who can resume the traditional practice for these architectures, in a more adequate way than the ordinary citizens.

In its development, this conservation process is made easier by the presence of a solemn example. The restoration of the Fortaleza de São Sebastião in Ilha seems an example of best practice according to methods and practices more

Figure 2.2.: Rehabilitation of the Fortaleza de São Sebastião [*M.B., 2009*].

careful and advanced. We are talking of the restoration of one of the most important monuments of the East African coast. The reading of only two reports allows to grasp the importance of the cultural and political process UNESCO has succeeded in starting and bringing almost to completion within two decades, despite a civil war was devastating the region. These reports express a synthesis between the policy of recovery and an original contribution to the preservation of a heritage foreign, by culture and social conditions of origin, to the people living there and, therefore, potentially at risk of neglect.

We will deal with some of those aspects in the presentation of the study case of Ilha de Moçambique, in the next chapter[24].

The restoration of the fortress of Ilha de Moçambique isn't an example of a cultural policy aimed at emblematic and boastful works; it is determined in ways and times by the following criteria of UNESCO World Heritage List: *Mozambique 1991 – Island of Mozambique / Ile de Mozambique (Criteria C iv – vi) The fortified city of Mozambique is located on this island, a former Portuguese trading-post on the route to India. Its remarkable architectural unity is due to the consistent use, since the 16th century, of the same building techniques, building materials (stone or macuti) and decorative principles*[25].

2.4. The natural and human environments and their equilibrium

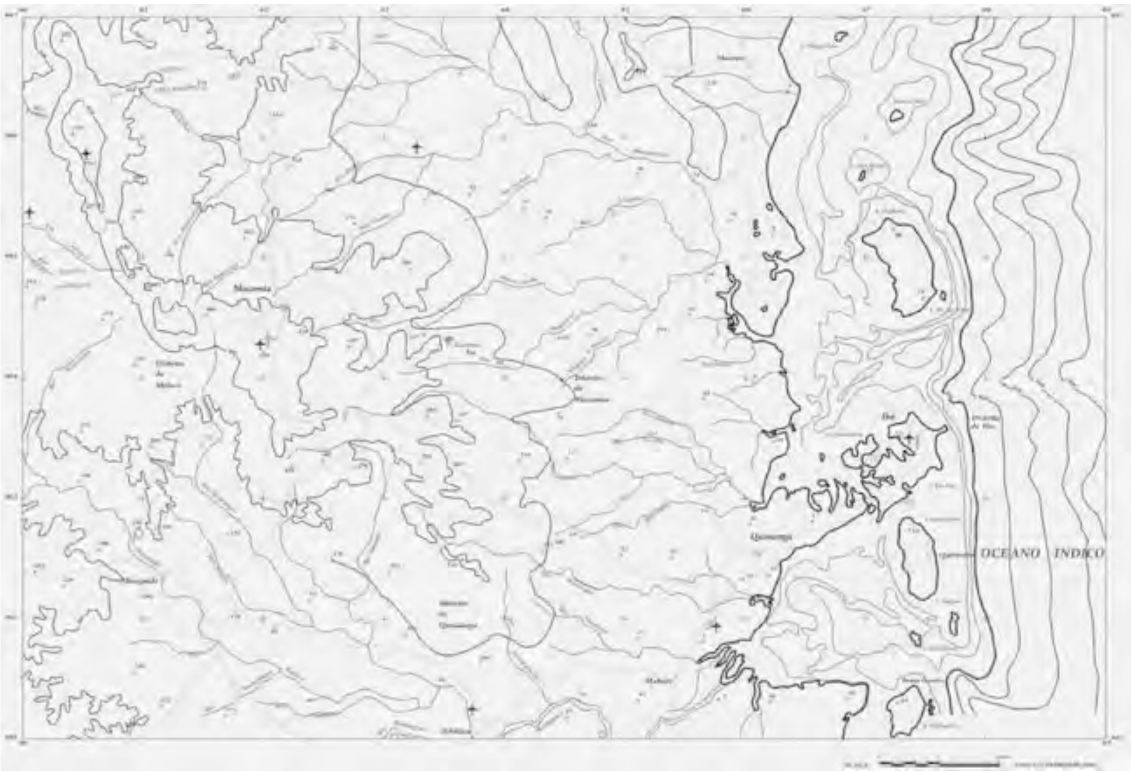
I made three study visits to the Island of Ibo, two in 2007 and the last one in 2009. The observations, discussions and studies conducted during the first two stays have produced a contribution for the preparation of the Urban Plan of Ibo.[26]. The remarks given below have been fully incorporated into the Plan.

Guidelines for the Conservation of Ibo.

[24] Final Report: UNESCO, *Ilha de Moçambique - World Heritage Site. A programme for Sustainable Human Development and Integral Conservation*, Sylvio Mutal by, Mission May 15 - July 15, 1999.
Lazare ELOUNDOU e Jana WEYDT editado por, *Fortaleza de São Sebastião. Ilha de Moçambique*, Centro do Património Mundial da UNESCO, Paris 2009.

[25] ICOMOS Documentation Centre, *World Heritage in Africa*, in *Description of the World Heritage Sites with a bibliography of Supporting Documents at the ICOMOS Documentation Centre*, Paris 2006, pagg. 53-54 e 81-82. *Periodic reporting exercise on the application of the world heritage convention in africa form Convention concerning the Protection of the World Cultural and Natural Heritage Periodic reporting on the African sites inscribed on the World Heritage List.*

[26] Governo da Província de Cabo Delgado, Direcção Provincial para a Coordenação da Acção Ambiental, Universidade Eduardo Mondlane, Centro de Estudos para o Desenvolvimento do Habitat, *Plano de Urbanização da Vila do Ibo, Vol. 1 - Inventário e Diagnóstico, Vol. 2 - O Plano e seu Regulamento*, Maputo Maio 2008.



Overlapping of cartographic data from two maps: the *Carta Hidrográfrica da Foz do Rovuma ao Ibo* of the Instituto Hidrográfico de Lisboa, 1964 (work copy by courtesy of Patricia Oberreuter) and the *Plano Topografico base, hoja 1 e 2*, 1997 in the *Libro Blanco de los recursos naturales de la provincia de Cabo Delgado (Mozambique)* - Agencia Española de Cooperacion Internacional - Union Europea (A copy can be found at the Faculdade de Arquitectura e Planeamento Físico of Maputo).

Figure 2.3.: Mainland, lagoon, islands and continental edge [*Rewriting by M.B.*].

Explanation:
I designed a section extending between the mainland and the continental edge on a track crossing Ibo, combining data from two maps: the *Carta Hidrográfrica da Foz do Rovuma ao Ibo* of the Instituto Hidrográfico de Lisboa, 1964 (work copy by courtesy of Patricia Oberreuter) and the *Plano Topografico base, hoja 1 e 2*, 1997 in the *Libro Blanco de los recursos naturales de la provincia de Cabo Delgado (Mozambique)* - Agencia Española de Cooperacion Internacional - Union Europea (copy at the Arquitectura e Planeamento Físico in Maputo).
The hypothesis to be checked consisted in the possible presence of a deep freshwater layer from the mainland; the town of Ibo could draw from there substituting the current shallow wells subject to biological contamination.
This idea was implemented in *Plano de Urbanização da Vila do Ibo* approved in 2008; therefore some in-depth surveys were carried out in the summer of 2009, to determine, definitively, the levels of the drinking water layer. The results of the analysis are not available yet.
The schematic section of the thickness of the continental edge the island of Ibo rests upon is not intended to suggest the existence of a single massive coral reef and sedimentation bank. Actually, in Ibo I found the presence of rock outcrops with a very hard texture, typical of conglomerates. I spotted them along the path which leads to the airfield from the *open grassy plain* south of the crop fields. Such a presence may indicate that the continental rock reaches the ocean at the current levels of the floor, even if surrounded by coral sediment.

Figure 2.4.: Section extending between the mainland and the mainland edge [*M.B, 2007.*].

I. Two ways to define the context.

The problems of heritage conservation in Ibo may be treated within the context set by the reports dealing with the relation between the natural and the anthropic systems. The choice of two restrictive categories such as the natural system (a not cultural system) and the anthropogenic system (a cultural system) is postulated because it allows to organize the knowledge of natural and human phenomena and their reciprocal influences clearly, making easier the subsequent development of the regulatory principles of conservation on the island[27]. Actual actions for the restoration of the architectural and environmental heritage of Ibo result in a problematic vision of the phenomena internal to the two systems and those occurring in their competition; in this way the techniques and methods most suitable for not compromising the good balance between man and nature will be clear. Maintaining an equilibrium between man and nature seems to be the best way to enhance Ibo.[28]

II. General features of the context of Ibo[29].

As in geoarcheological and archaeological studies, I believe that it is useful to consider the objects as events, even for the preliminary studies of a plan for maintaining the environmental and architectural heritage; in other words the objects should be placed in the four space-time dimensions[30]. In this way we treat each artefact or a set of artefacts in a larger context, where the complex

[27]Methodological reference: Butzer, 1982; Angelucci, 2004-05.

[28]The following considerations are a part of my studies for my Doctorate in Riqualificazione e Recupero insediativo and refer to my second research journey to Moçambique (from September 15 to October 17, 2007); they are a contribution to the preparatory studies for the Urban and Environmental Master Plan of Ibo.

I was invited by the Director of the Faculdade de Arquitectura e Planeamento Físico of Maputo and the Director of the Centre de Estudos do Desenvolvimento do Habitat - CEDH in the same faculty and I was enlisted in the team of experts from the CEHD - the Center in charge of drafting the master plan of the island of Ibo. The mission took place from 20th to 26th September 2007. The group consisted of various experts: Prof. Arq. PhD. Júlio Carrilho - history of architecture; Prof. Arq. PhD. Luis Lage - urban and architectural surveys; Prof. Arq. Albino Mazembe - urban planning; Prof. Eng Civ. Bellarmino Mongane - technological systems; PhD. Eng. Erasmo Nhachungue - environment; Prof. PhD. Raphael da Conceição - social and anthropological problems; Prof. Carlos Serra - legal and procedural aspects; Civil Eng. Fernando Mazuse - hydraulic devices and health.

Investigations, surveys, site visits and interviews were conducted systematically in collaboration with the local and regional public administration. I was part of the team as an expert in restoration. Like the other experts, I was asked to draw a report based on my skills.

[29]I prepared my second study visit to Ibo, from 21st to 26th September 2007, with the help of Dr Patricia Oberreuter, geographer of the National Museum of Geology in Maputo. She suggested that in Ibo as well as in the whole Quirimbas Archipelago processes of coastal morphogenesis of considerable geographical interest are now happening, such as the remodelling of natural islands and peninsulas. This idea underlies my observations of Ibo environment (Oberreuter, 2004).

[30]Angelucci, 2004-05.

relationship between the natural and the anthropic systems is evident, both with respect to the present time (the object) and with respect to the past or the future (the event). The *space-time* category used on this occasion doesn't mean the will to introduce a topic of theoretical discussion but it is a simple reference to tools and methods with beneficial effects for the preservation of the island heritage. If we keep in mind the time nature of the anthropogenic events, we will increase the process of reconstruction of the island history and, consequently, it's a way to set the terms of its heritage[31]. The final task is the introduction in the Urban and Environmental Plan of Ibo of a methodology that explores the present and the past to see the future in a critical and responsible attitude. The idea that every past and present artefact can be interpreted as part of a climate, as part of the geological and geomorphological context, as a product of a system of technologies and cultures of particular social groups, makes it very difficult to imagine a definition of the heritage of Ibo. As to architecture and more generally to the settlements, the processing of the data useful for the recognition of the heritage may be made in a provisional way foreseeing frequent revisions, even in the near future.

III. Starting data collection.

Certain aspects of the conservation of historic architecture were highlighted during the general meeting the team of the Plan held with the administrators of Ibo on September 22, 2007. They are as follows:

1. Part of the population emigrated from the island in recent years is now coming back. The number and the quality and generation range of the returning individuals haven't been evaluated yet; all the same, the Plan can be considered as a conservation basis for the areas of settlement expansion;

2. In particular, as to the works of recovery of the *cidade formal*[32], local and natural resources for building, such as sand and limestone, are required. The local supply of sand is dealt with as a problem of administrative arrangements. A sand quarry within the formal boundaries of the town was forbidden because it threatened the surrounding buildings. The local supply of sand is a matter for curators from at least two aspects - the excavation sites and the quality of the extracted sand;

3. The theme of restoration regarding the houses of coral limestone is very delicate. In a dozen of cases, the community has been offered the choice between restoration and reconstruction. In choosing between the two options we must

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[31] Butzer, 1982.
[32] Carrilho, 2005.

keep in mind the island manufacturers have lost memory of the old techniques. The construction of new buildings in municipal lots where the ruins have lost any heritage value or where no buildings were standing is seen as a better choice;

4. Administrators must maintain an accurate control on the town's formal buildings. For various reasons, the Administration is trying to keep the houses in ruins or uninhabited free from weeds, but sometimes to no effect. The ruined houses should be 37, while 203 are lived in; the people surveyed in the formal town number to 260;

5. Houses are currently traded with clear speculation intents. The houses are purchased in ruin, the site is cleaned up, but recovery does not follow. The Administration seems unsure of how to manage the phenomenon, perhaps because of the absence of suitable means of intervention.

IV. A first approach to the natural environment[33].

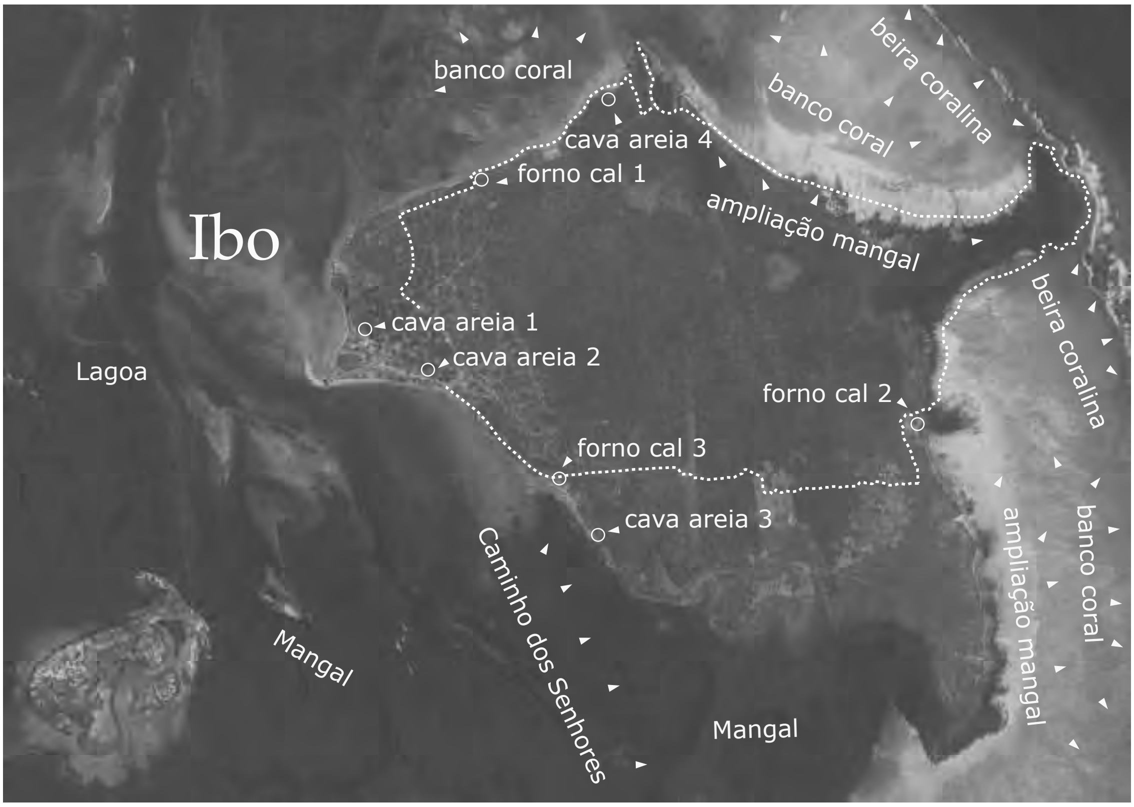
1. Monumental places.

In our recognition, artefacts of historical interest and with some monumental character have been identified. Waiting for a more thorough and systematic study of their specific value, the importance the local population gives them should be rapidly assessed. We identified a Hindu cemetery, an Islamic cemetery, a probable colonial fort now called *casa das cobras*, the lighthouse keeper's house, the Catholic cemetery, a cemetery area north of the Catholic cemetery passing the road connecting the airport to the formal town. These sites are abandoned. A more systematic survey could accurately define the entire system of cemeteries, in use or abandoned, in order to design some monumental areas bound together and protected by the public administration, easy to be historically and culturally identified, of each existing or previously having existed community on the island.

2. The expansion of the island.

Some areas have been identified where *mangal* (mangrove) is biologically expanding. They are surely growing along the edge of the forest on the mineralised coral reef to the north and east. It is still to be determined if mangroves are growing along the edges of the forest facing south and west and, at the same time, it must be checked where the points of erosion or deposit of soil are and whether there are areas in regression. The configuration of the equilibrium processes among the current natural phenomena is to be determined in order to

[33] In our investigation program on the urban and island environments, Júlio Carrilho led the surveys along an 11km long path on some cultural and natural attractions. The characteristics of these sites refer to the arguments summarized above in sub-paragraphs I. and II. The study group was formed by the two local guides, J. Carrilho, A. Mazembe, C. Serra, F. Mazuse and myself.



Field observations made by the author on Ibo Island during the second study tour. The surveys carried out in some cultural and natural attractions, along an extension of about 11km. The contour line of the island was travelled on September 23, 2007 from 6.45 to 14.00.

Figure 2.5.: Map of the second research path in the island of Ibo [*M.B, 2007*].

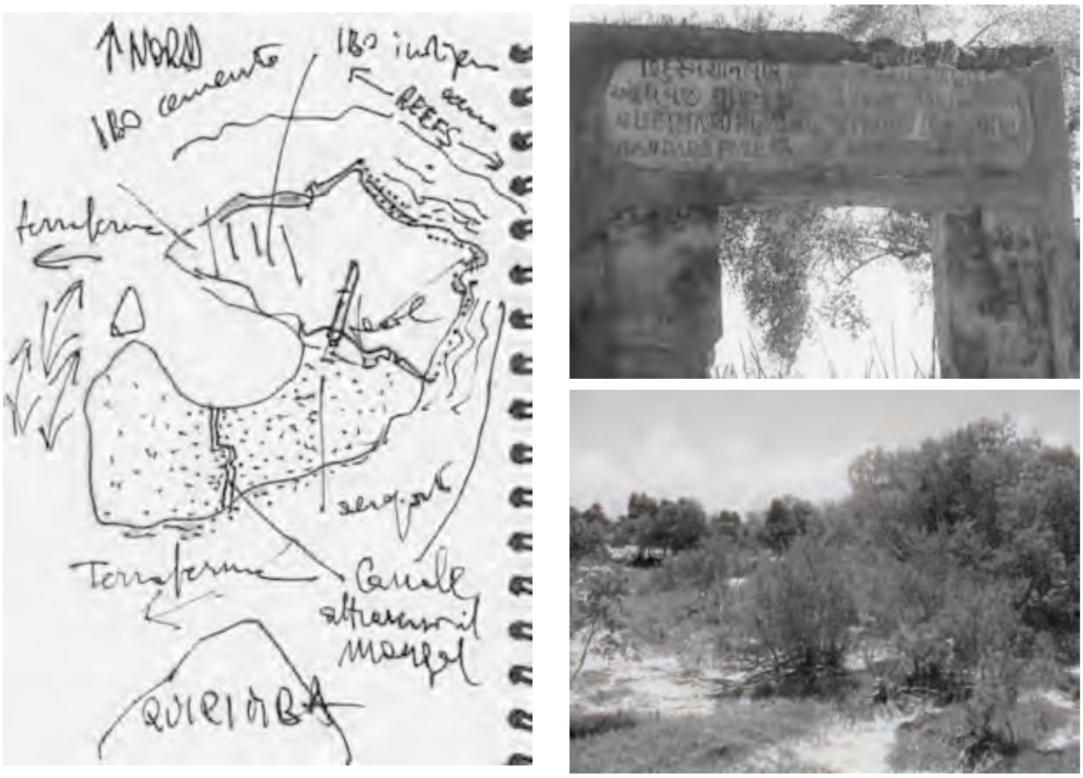


Figure 2.6.: Ibo. General reconnaissance of the island. Portal of the Hindu cemetery. The expansion of scrub mangroves [*M.B., 2007.*].

know the most suitable areas of use or exploitation, e.g. those for cutting the timber needed for the maintenance of buildings.

3. The lime kilns.

We identified three open kilns for firing lime. Unlike the closed furnaces, the open ones are not very efficient. They require large quantities of fuel (mangrove) and do not allow a uniform burning of the processed mineral. Furthermore, we observed that a substantial part of the load wasn't completely burnt and then probably it will not be used and will be thrown away. If, otherwise, the non-calcined limestones are mixed with ones calcined (quicklime), the lime will be obtained with poor mechanical properties during the process of re-carbonation. There is, however, a great advantage in the open kiln technology because the calcined limestone may take advantage of rainwater for the final hydration process. But the casual aspects of this last step make uncertain the benefit.

The problem was discussed with Mr. Jamail Almasse, an experienced local builder, and, as a result, we now believe that closed kilns are to be preferred. The creation of a closed kiln could bring some interesting advantages: in the presence of a fixed structure the administration could have an easier control on lime production, a new enterprise could rise, lime production would have a

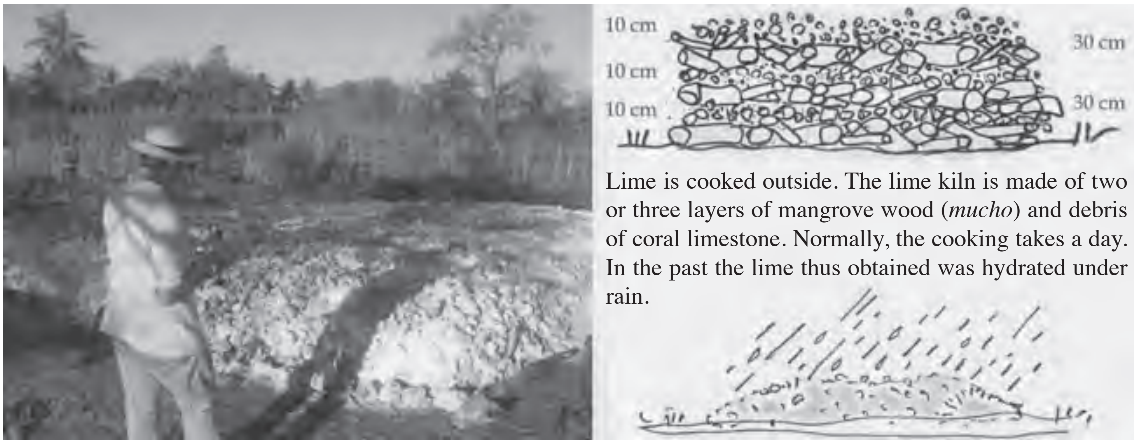


Figure 2.7.: The kiln for baking lime in activity. It is located close the Catholic cemetery [*Photo by Luís Lage, 2007; left: M.B.*].

constant quality level and, finally, it would save a lot of combustible material.

4. The coral reef and the limestone quarries.

We observed that the loads of the three open kilns consisted of fragments and debris of mineralised coral limestone. We were unable to visit the specific places where limestone is extracted. From information obtained from the manufacturer of one of these kilns and Mr Almasse, as well as on the basis of observations effected during the reconnaissance, it appears that the calcareous material is usually collected in the most accessible parts of the coral reef along the north and east sides of the island, preferably in the compact coral concretions with thin pores. In view of a coming major restoration project of public or private historic buildings of the formal city, it is essential to define precisely the places and manners for the collection of limestone in order to minimize the degradation of the coral reef facing a strong demand.

5. The sand pits.

After the prohibition of extracting sand near the houses for safety reasons, the Administration has authorized excavations in an area next to the Catholic cemetery on the edge of the sea. It was not possible to visit the new pit, but we examined the extracted sand. The sand excavated in a now closed pit – probably a marine deposit – is different from the sand of the new pit, probably coming from a river deposit; in fact, it is grey and full of granules of silica and quartz. A thorough understanding of this material and of the place of its extraction is important both for preparing the mixtures of mortar required for the construction or repairing of the buildings and for improving the knowledge of the soil taking into account the presence of ground water at superficial or deep layers. The presence of water layers at different levels influences the problems

Sedimentary bank of coral limestone giving the material for making mortar.
The sand quarry located in the urban area, now closed.

Figure 2.8.: Bank of limestone on the west side of the island and sand quarry located in the urban area [*M.B., 2007.*].

of drinking water supply and domestic or social pollution. Both problems are dealt with in the Plan.

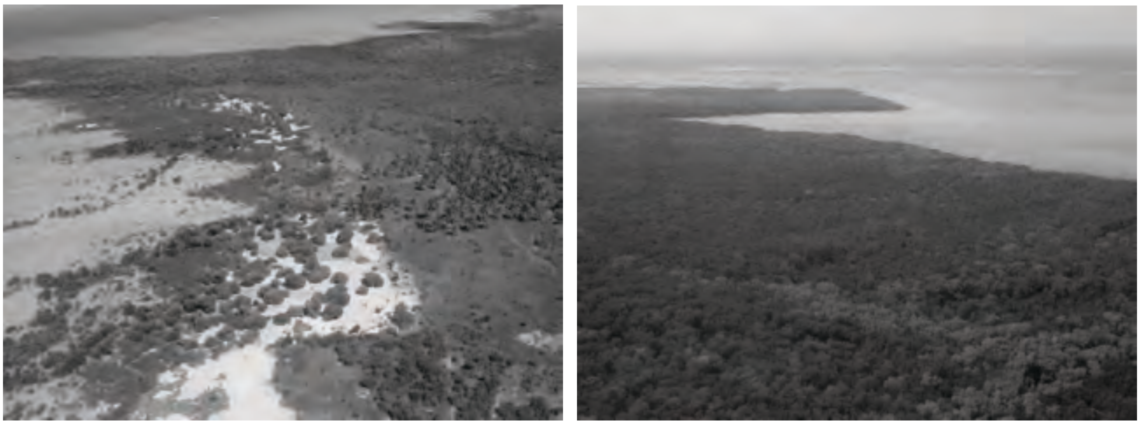
6. The impenetrable mangrove area.

Two main possibilities of penetration into the forest of *mangal* in Ibo are being considered, even if they show strong limits: along the outer edges and from the artificial track called *Caminho dos senhores*. The observation of the existing pedestrian paths suggests that there is a local custom to access the mangroves, coming from the inland. On the other hand, it seems impossible to reach the mangroves from the sea. In any case, it is essential to detect the sites and traditional methods of exploitation of the mangrove timber for carpentry, constructions, and so on in order to assess their compatibility with the natural system. The conditions of the *Caminho* will be evaluated in the proposals of the Plan, thinking also of tourism or local communications, especially with the island of Quirimba. Here we should consider whether we can use this canal, dug in the 18th century[34], for a cheap exploitation of timber for local constructions. In particular, the invading trees found along the approximately 10 km long edges of the channel could be used to feed the lime kilns. The timber could be cut during the maintenance works of the channel.

7. The still cultivated fields.

Crops - rice, vegetables, fruit – and their geographic positions on the island are of great social and cultural interest. The Plan should have a specific preliminary study to include, at least in general terms, some administrative arrangements

[34] Carrilho, 2005.



The mangrove forest has very different characteristics from area to area. The two images show the patch of mangroves distributed on the coasts in the north of the island of Ibo.
In the image on the left the coast is facing the lagoon and is in an evident state of a growing biological activity.
The image on the right represents the most battered part overlooking the ocean. Its vitality is proved by the compactness and the size of the mangrove forest.
Access to *mangal*, where possible, is from the island. We think important to note places and traditional methods of harvesting timber for mangal carpentry, construction, etc., in order to assess their compatibility with the natural system.

Figure 2.9.: Mangroves (*mangal*) in Ibo [*M.B., 2007.*].

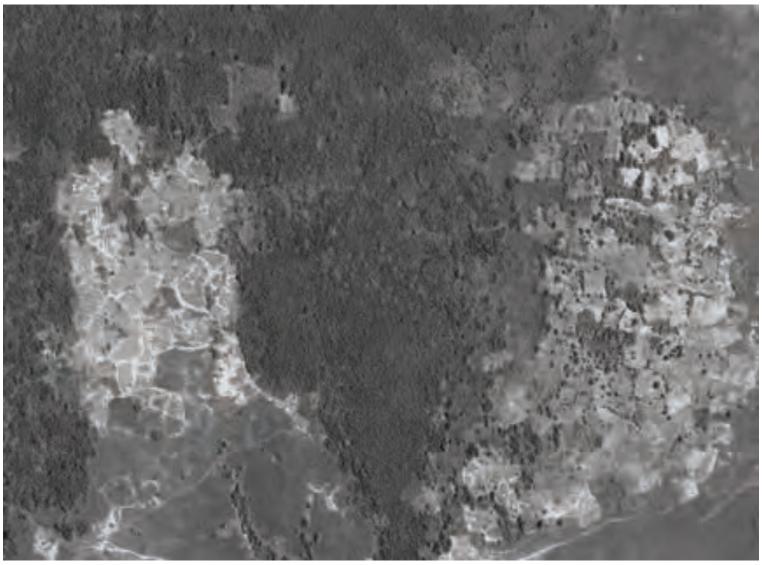


Figure 2.10.: Ibo: right, fields for growing rice; left, fields for vegetables [*Google and FAPF - UEM, 2006.*].

for the protection and development of this unique and interesting model of agricultural production.

8. Roads and paths.

The sign most clearly representing the urban culture and environment on the island of Ibo may be the network of roads and footpaths. In comparison with the environment conditions in Ibo, the network of the existing routes is in a well balanced state between the natural and the anthropic systems; as such it can be proposed in the Plan as a model for study and application. In the preliminary studies the entire network of permanent routes will be pointed out, including the ones no longer used but still remembered. In particular the fishermen's paths recognizable even when underwater at high tide will be tracked.

V. Hydrogeology.

1. Drinking water and domestic pollution of the soil.

During the collection of the existing studies related to Ibo and the Quirimba Island Park and in related discussions, it was immediately evident that the knowledge of the hydrogeological conditions of the soil and subsoil of the environment is not a scholastic precondition with the only aim to set a limit to the problem in a comprehensive and exhaustive way. The presence on the island of approximately 150 domestic water wells drawing on an average of only 10m and the geological belonging of the island to the same alluvial basin as the continent[35] strongly oriented the Plan proposals for an adequate intake of water, to minimize the effects of pollution on the domestic soil.

These data suggest to reconsider the idea that water on the island is drawn from a local reservoir exclusively fed by the seasonal rains falling on the soil. The interest shown above for the sands is also aimed at seeking confirmation of the existence of more or less deep continental layers stretching from the mainland to the edges of the continental rift.

2. Environmental impact.

In the studies on environmental impact for the project *TiGen de mina de areias minerais, Província da Zambézia, Moçambique (Coastal & Environmental Services, 1998 vol. 4)*, in a stretch of coast between Quelimane and Ligonha (mouth of Moebase) a phenomenon of interchange of salt and sweet water was observed at the level of the water table, caused by the oceanic pressure during the cycles of high tide; this phenomenon was significantly increasing during the rainy periods. The proximity of this stretch of coast also studied under the hydrological aspect and the fact that it belongs to the same alluvial basin make us wonder

[35] Rovuma Basin, in: Lächelt, 2004.

whether similar phenomena can be found in Ibo.

VI. Priorities in conservation practice.

The Plan must also determine the creation and development of a program where actions are based on priorities corresponding to a scale of urgency, listed according to the granting of poor or sporadic loan funds. The recent administrative choice requires that the owners of buildings in the formal town, even the not inhabited or ruined ones, must keep the property free from natural vegetation for the improvement of public hygiene; it is an important contribution to the conservation of architectural heritage. The vegetation growing among the ruins does not protect them, for example, from sun or rain, but hides the ruins and the buildings in a state of neglect, thereby preventing a visual daily inspection of the progress of degradation: a visual inspection is the first stage of the procedure for the conservation of an artefact.

Another administrative good choice was the suspension of the demolition and reconstruction works of the promenade parapet beginning at the Pousada TDM. The priority and necessity of demolishing what already exists, even if architectonically poor, should be carefully evaluated. Moreover, we considered questionable the construction of a massive enclosure for the children's games we observed in the middle of the main town square; its presence distorted its theatrical aspect as a whole. If there is availability of funds for the town thanks to a special donation, the works corresponding to a hierarchy of the actual needs for the conservation of Ibo are to be privileged. It is to be asked why donors have not considered to restore the west front of the formal town where there is an ongoing - not recent - evident phenomena of erosion and collapse that threaten almost all the buildings on the front.

Another case showing a wise approach in the safeguarding of the heritage of Ibo can be seen in the temporary constructions devised to protect the monumental buildings where restoration is particularly expensive or where further study is necessary to develop the methods suitable for recovery. An example is the Fortim de Sao Jose where an appropriate technology for making the flat roof of one of the casemates is still to be developed; there, a temporary roof in galvanized sheets was set up.

Nowadays in Fortim de Sao Jose, two tests of grouting on the walls on either side of the entrance door can still be seen after two years from their application. We agree that tests should be done to check a technology before its widespread application but it is necessary to emphasize what the test itself reveals - these stucco works should not be repeated. The mortar applied at the time has gradu-

In Ibo we can witness an ongoing phenomenon on a major urban scale. The west front of the formal city is the side of the inner harbour where the public and private docks insisted. In his studies on the island Carlos Lopez Bento found that the structural sinking of this part of the city has an important historical precedent in 1788 with the collapse of Fortim de São José, which subsequently had to be rebuilt. This serious and obvious phenomenon of collapse affecting almost all the buildings of that front should be a priority for action, in the physical interest of the part of town positioned further back.

Figure 2.11.: Front of the port of Ibo. The buttresses are designed to prevent the rotating movement of the walls [*M.B., 2007.*].

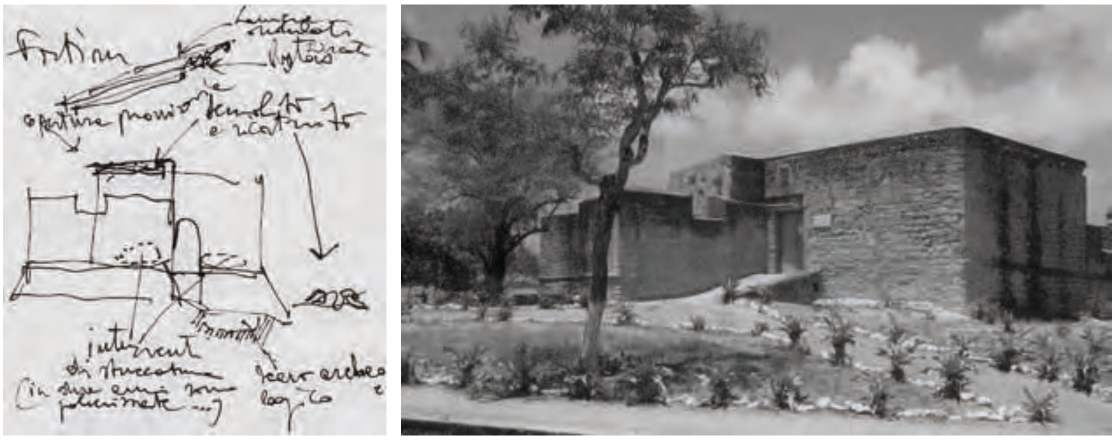


Figure 2.12.: Fortim de São José. Provisional coverage of the casemates, pending the completion of the restoration project [*M.B., 2007.*].

ally crumbled into dust accumulating at the foot of the wall. The inadequacy of the mortar mix is among the reasons that led to the ineffectiveness of these tests; it is clear that the lime used had not reached a state of homogeneous solution[36], because the limestone lumps are not calcined or aren't extinguished in many parts of the stucco that still stand in the grouting wall.

The ability to manage and operate in the conservation field for practical data and information can be assessed with confidence. The experiments in progress, after the first uncertainties, seem to go the right direction. However, the plan must include an essential but strict protocol stating the modes of operation and supply, to ensure the current balance between nature and society, achieved during a several centuries old competition, will last.

2.5. Stones, lime, sand and *murrapa*

Stones[37].

I studied the documents published and discussed in the considerable investigation work of sociologist Bento Carlos Lopez[38] on the peoples and territories north of Moçambique and I attentively listened to the opinions collected during

[36]See point 3 - the lime kilns.

[37]Some considerations on the different qualities of the rocks according to their diagenesis process and to their use in construction can be found below in the section *Ilha de Moçambique, third study case* of the next chapter.

[38]Carlos Lopes BENTO, *As ilhas de Querimba ou de Cabo Delgado : situação colonial, resistências e mudança : 1742-1822*, Universidade Técnica de Lisboa, 2 vv., Lisboa 1993.

In particular see *Fortificações militares*, in Capítulo VIII , *Símbolos do domínio português: o poder político-administrativo*, v. I.

Figure 2.13.: Ruin studied for analysing the behaviour of soluble salts contained in the coral limestone, in Rua Maria Pia [*M.B., 2007.*].

Figure 2.14.: Fortim de São José. Grouting tests after two years from work [*M.B., 2007.*].

my study visits in Ibo; then, I decided to check where exactly on the island the construction stones were extracted. Only on my third visit I fully realised the meaning of the answer given by the local *pedreiros* to the question asked during my first visit, i.e. where the coral stones used in pieces or square blocks came from. The answer had always been: *Em todo lado*.

I was able to observe two examples of houses under construction in the area now called *informal*. Indeed, the coral rocks, used in pieces with a cracked red earth binding element mixed with water and lime, were extracted in the *quintal* (yard or garden) belonging to the houses. When we dig just a metre deep in the layer of sand and topsoil, coral limestone ridges are readily available; so, the pieces can be easily extracted and used on the building site.

In Ibo there is a place called *kumáwe* (*ku* = area, *máwe* = stone) in the regional *kimwani* language. We found that the site corresponds to the highest point of the island, at an altitude of 13m on the present average marine level. Here, in many points, traces of the excavations for the extraction of limestone can still be seen. Some seem to go back to ancient times, others are more recent. In the quintal of some houses it is still extracted for the local market. The *kumáwe* limestone - a madrepore and not a coral stone - is very compact and uniform in texture so that it is directly cut in orthogonal profiles to obtain regular blocks more suitable for the construction of houses of higher quality. It is more suitable for the construction of walls with overlapping stones and can be classified under the term bioclastic rock. It differs from another quality of stone, also used in constructions, called bioerma rock we can find in clusters where there are often scraps of coral skeletons.

As to the stone quarry used to build the great fortress of São João Baptista, the depression of the soil nearby was thoroughly searched; in the historical maps it is called *Pántano secco na estiagem*, but no convincing traces of excavations have been found. There is still a strong possibility that the depression may actually have been produced by the excavations for the construction and supply of the building materials. Bento's quotation, here fully reported, is very clear and deserves to be taken into account in future observations:

"A cisterna ou poço que deveria ser construída no seu interior, como era habitual, e havia sido recomendado por Moçambique, não foi incluída na planta então traçada "por se poder fazer fora um depósito para as águas da chuva, a pouca distância do forte, no lugar que pretendo abrir uma pedreira na qual pode ser que apareça água nativa, mas quando não apareça, sempre a cavidade que se fizer pode servir para cisterna que se fará (...) e se lhe pode encaminhar as águas dos terrados dos edifícios do mesmo forte e não

At the fortress of São João Baptista in Ibo there is a depression in the soil called *Pántano secco na estiagem* in the historical maps. Accurate observations were conducted with the aim of recognizing convincing traces of excavation, but to no result. There is, however, a strong possibility that this depression may actually have been produced by the excavations made for preparing the construction and supply of the building material of the fortress.
From: *Planta Cotada de Villa Ibo Comprehendendo apenas o bairro dos Europeus*, Sociedade de Geographia de Lisboa, Portugal 1886 (as a source of bibliographical references: http://africanmapimages.grainger.illinois.edu/afm0001295.jp2).

Figure 2.15.: A 1886 map of Ibo with the Forte de São João Baptista. The depression of the soil at the fort [*M.B., 2009.*]

é defeito grave ficar fora a água sendo em distância de tiro de mosquete, como insinua Mrs. Blon (...) e Cavaleiro de Ville"[39].

On the contrary, the observations made at the Fortim de Santo António have immediately revealed traces of excavation. The sediment where the military building stood was a large outcropping of compact limestone coral. The sharp cut of the rock on the north and east sides at the base of the building shows the edge of the flattened area around; even the more pronounced depression north of the fort may be the result of excavations made to extract the construction material.

Lime.

During my three visits to Ibo, from 2007 to 2009, a total of five open kilns for firing lime was observed and counted. Some of them are cyclically reopened, like the two at the Catholic cemetery. Others were found in a state of abandonment, at the different times of my visits, as in the case marked as number 2 in the map of the 2007 visit, located on the east coast. The news gathered and direct verification of this last kiln provided evidence of a handmade product to

[39] Bento, 1993.
I was unable to locate the original quotation: *A.H.U., Doc. Av. Moç., Carta de 30/5/1792, cit.*. I apologize with the Author.

Traces of excavation are very clear around the Fortim de Santo António. The sediment of this artefact is a large layer of compact coral limestone. The rock cuttings on the north and east sides behind the building show the limits of the flattened area around. Probably even the more pronounced depression north of the fort is the result of the excavation carried out to extract the building material.
From: *Planta Cotada*, 1886.

Figure 2.16.: The Fortim de Santo António in the 1886 map. The profile of the cuts on the reef [*M.B., 2009.*].

The limestone of the *kumáwe* in Ibo, which should be called madreporic rather than coral, is very compact and uniform in texture so that it is cut straight from the layer in orthogonal profiles to obtain regular blocks more suited for building higher quality houses.

Figure 2.17.: Quarries of coral rock to Ibo [*M.B., 2009.*].

This kiln, examined in August 2009 at the entrance of the new *Tikidiri* Community hotel of the Aga Khan Foundation in Ibo, shows the original materials and the shape of a traditional outdoor kiln. Two kinds of load are prepared for the cooking: shells (more precisely here: murex shells; Phyllonotus, a mollusc of the gastropod family) and fragments of mineralised coral limestone where portions of the skeletons of coral colonies can be seen. Lime is used for regular whitewashing, essential as a protective coating of coral walls, and for making mortars and plasters. It is known in Ibo as well as in Ilha de Moçambique that the lime produced from burnt shells is of higher quality and is used in preference for interiors or paintings. The same practices are in use on the Red Sea coast. Aylin Orbasli relates of their use on the east coast and especially in Al Wejh, the place where walls are treated with lime made from shells (Orbasli, 2009.).

Figure 2.18.: The lime kiln at the Community hotel of the Aga Khan Ibo Foundation [*M.B., 2009.*].

From the very first observations on the sands used in constructions it was evident that they were silica sands rather than limestone. The experts would say the material was not imported from the coast by boat, but taken from the island itself. Hence the idea of studying the reasons for the presence on the island of river sand deposits in the absence of rivers and near the sea. The studies led to the knowledge of significant changes of the soil as a result of recent fluctuations in the sea level leading to the deposition of river sands and the presence of ancient coral reefs.

Figure 2.19.: Overview of the canal bordering the area of the cemetery, east of the island of Ibo [*M.B., 2009.*].

be sent to Pemba, a town of some importance on the mainland coast at about 100km south of Ibo. Loans coming from different parts have been checked. The limestone to be burnt is sometimes chosen according to its intended use. The lime derived from shells is preferred to be used in whitewashing.

According to Mr. Jamail Almasse, the local manufacturer we interviewed, the best quality of mortar for plastering walls is obtained from coral porites taken from the sea on the edge of the reef platform near the lighthouse, on the north-east. as Júlio Carrilho pointed out. A visual inspection revealed that the limestone taken from *kumáwe* site and around the military barracks near the palm grove was of excellent quality for the production of lime. This limestone is very compact, uniform and has a very minute crystal grain.

Between 2008 and 2009 a new and important restoration activity in the urban core of Ibo was launched. To meet the needs of the new construction sites, the sand pits in areas outside the town were expanded. In particular, the two most important ones are located close to two cemeteries, the Hindu in the north and the Muslim in the south. The sandy cap covers the ridges of the coral reef of the recent past.

Figure 2.20.: The sand pit in the cemetery areas east of Ibo [*M.B., 2009.*].

Sand.

From the very first tests carried out on the sands used in construction sites it was obvious that it was made of silica rather than lime. Workers reported that the material was not imported from the coast, but taken from the island itself.

In May 2007 I examined the quarry in the middle of the *cidade formal*, still used for small constructions because it was deemed appropriate for mortar mixes. Quite appropriately the following year the administration decided to prohibit collection, as the stability of the abandoned houses around was threatened. The existing quarries were extended or new ones were opened in other areas outside the town to meet the needs of the many restoration building sites opened between 2008 and 2009. In particular I examined the two main ones, curiously located near two cemeteries, the Hindu on the north and the Muslim to the south.

As it was relatively easy to verify the siliceous or calcareous nature of the sand I examined three samples taken from three different quarries[40]. The test stated that it was a predominantly silica sand, because there wasn't any chemical reaction. When in contact with hydrochloric acid (Hcl), the silica sand remains in its state of physical integrity. On the contrary, lime sand in contact with acid reacts and releases carbon dioxide (CO_2)[41]. This simple experiment shows the continental origin of the sand deposits on the island and justifies the whole study of the previous pages, where we tried to link, even if problematically, sea levels, coral reefs and human settlements.

Murrapa.

Though mentioned by historian Alexandre Lobato and sociologist Carlos Lopes Bento[42], the use of a product called murrapa is indebted for its technological approach to two authors, Pedro Quirino de Fonseca and Julio Carrilho. De Fonseca writes:

[40] For this experiment I wish to thank my friends Luís Lage and Sergio Uate who gave me the sand samples I needed in a very short time.

[41] Gary NICHOLS, *Sedimentology and Stratigraphy*, John Wiley & Sons, Ltd., Chichester 2009, p. 29 [1st ed. 1999].

This same method was applied in the quoted study of Donatella Procesi (Procesi, 1993, p. 192).

[42] Alexandre LOBATO, *A Ilha de Moçambique* (Monografia), Imprensa Nacional de Moçambique, Lourenço Marques 1945, p. 26.

Carlos Bento, in his description of the method of production of mortar in Ibo, reports that *Para dar consistência e qualidade à cal juntava-se, durante a queima, uma espécie de cacto, cujo nome desconheço, que fornecia uma substância leitosa, pegajosa como a cola* and he also cites Lobato.

Carlos Lopes BENTO, *As ilhas de Querimba ou de Cabo Delgado. Situação colonial, resistência e mudança (1742-1822)*, vol. I, Universidade Técnica de Lisboa, Lisboa 1993 [consulted from 2006 to 2009 in: http://pesodaregua.com.br/capaeindice.htm].

When we cut the stem of *murrapa* an abundant colourless and odourless liquid drips, similar to water. After a few minutes the liquid thickens and coagulates; in this way the holes of the smaller stems forming the bulk of the plant are closed.

Figure 2.21.: A branch with leaves and stem of *murrapa* about half an hour after cutting [*M.B., 2009.*].

Na Ilha de Moçambique e nas zonas costeiras de Cabo Delgado, começou-se a utilizar a cal fabricada das conchas e de parte das pedras de lastro que as naus traziam da Metrópole. A cal de conchas foi mais utilizada porque trazia grandes vantagens, dado ser fácil o seu fabrico e de muito valor a sua dureza, quando aplicada. Mais tarde começou a ser adicionada à cal de conchas um óleo conhecido por "óleo de murrapa" extraído dos caules dum pequeno arbusto. Este óleo era fabricado do modo seguinte: os caules eram cortados em pedaços, sendo colocados num recipiente cheio de água durante vinte e quatro horas. Passado este tempo formava-se à superfície da água uma camada gelatinosa e oleosa que constituia o produto que, adicionado à cal, lhe dava extraordinária rigidez, impermeabilizando por completo as argamassas e, implicitamente, as alvenarias[43].

In Brian Morris's systematic definition:

504. CISSUS INTEGRIFOLIA (Bak.) Planch

FZ 2; 449

Mthambe (Nthambitambi) Mpe/esya Mwanawamphepo

A large climber with tendrils growing to the tops of trees. Stems with dark red swollen nodes, exuding gum when cut. Leaves simple broadly ovate with acuminate apex and entire margin, petiolate (5cm) to 10 cm. Flowers small, yellowish green in cymes. Fruits red ellipsoid 2cm long. Roots large with reddish sap.

Often described as mwanawamphepo wang'ono, the roots are used for a variety of complaints. An infusion of the roots is often seen on market stalls, in bottles, the reddish

[43] Pedro Quirino DA FONSECA, *Breves notas sobre a evolução da habitação e construção em Moçambique*, in *Monumenta - Boletim da Comissão dos Monumentos Nacionais de Moçambique*, IV, 4, Lourenço Marques 1968, pp. 45-46.

A *murrapa* plant on the coast of Lumbo, near the Ilha de Moçambique. The trunks of *murrapa* are being soaked on the site restoration of the fortress of São João Baptista in Ibo.

Figure 2.22.: Plant of *murrapa and* soaking site [*M.B., 2009.*].

brown infusion often taken with that of Mondia whytei, to increase sexual potency in men. The root is also dried and pounded and the powder added to porridge and taken for the same purpose. An extract of the root, by either method is taken as a cure for rheumatism fevers, influenza, colds, and general stomach disorders. It has general and antibiotic properties. John Kirk in 1858 mentioned its use in the making of ropes, while Schoffeleers notes that this creeper is an indispensable element in the Chikwangali spirit ceremonies being associated with witches as a 'dirty' thing.

Widespread in Central and East Africa, being associated with woodland or riparian forests. Common in Malawi and collected from all regions and altitudes to 1800 m.

BM NJcha/olnje Hill, Zomba, 900 m, February 1980

BM 820 Masuku. Namwera 750 m, March 1980[44].

We have found in the excellent handbook *Conservation and Design Guidelines for Zanzibar Stone Town*, published by The Aga Khan Trust for Culture, the information that in Zanzibar a seaweed extract is used as a binder in lime whitewashing: *Binders - A very effective binder for use indoors is water in which seaweed has been boiled (Eucheuma Denticulatum commonly grows along the coast of Zanzibar). The liquid is allowed to cool and form a sticky gelatinous mass. Before use, it is thinned with boiling water and put through a fine sieve. Approximately half a litre of liquid is added to 20 litres of wash*[45].

[44] Brian MORRIS, *Chewa Medical Botany. A Study of Herbalism in Southern Malawi*, International African Institute, Ed. Lit Verlag, Hamburg 1996, p. 499.

[45] See fact-sheet 7 *Limewash*, in Tony STEEL and Stephen BATTLE, *Conservation and Design*

Cissus integrifolia (Baker) Planch.

Synonyms:	*Vitis integrifolia* Baker
Common names:	Depa-vine (E)
Frequency:	
Status:	Native
Description:	Robust climber. Stems woody when older, not winged, with forked tendrils, gum-like latex present. Leaves simple,broadly ovate, up to c. 10 cm long, hairless; margin entire to obscurely dentate. Flowers in leaf-opposed, branchedinflorescences, small, yellowish green. Fruit ellipsoid, c. 2 x 1 cm, hairless, red when ripe.
Derivation of specific name:	integrifolia: with entire leaves
Habitat:	In riverine vegetation.
Altitude range:	
Flowering time:	
Worldwide distribution:	Kenya, Tanzania, DRC, Malawi, Mozambique, Caprivi - Namibia, Zambia and Zimbabwe.
Mozambique distribution:	N,Z,T,MS,GI
Growth form:	
Insects (whose larvae eat this species):	**Hippotion celerio** (Silver-striped hawk, Vine hawk) **Hippotion osiris** (Large striped hawk)
Literature:	
Endemic status:	
Red data list status:	
Spot characters:	**Display spot characters for this species**
Comments:	
Content last updated:	Wednesday 21 January 2009

Other sources of information about Cissus integrifolia:

ePIC (electronic Plant Information Center): **Cissus integrifolia**
Flora Zambesiaca web site: **Cissus integrifolia**
Google: **Web** - **Images** - **Scholar**
GRIN (Germplasm Resources Information Network) taxonomy for plants report for **Cissus integrifolia**
IPNI (International Plant Names Index): **Cissus integrifolia**
Kew Herbarium catalogue: **Cissus integrifolia**
West African Plants database: **Cissus integrifolia**

Figure 2.23.: Mark HYDE and Bart WURSTEN, (2010). *Flora of Mozambique: Species information: Cissus integrifolia*. http://www.mozambiqueflora.com/speciesdata/species.php?species_id=137890, retrieved 5 June 2010.

The use of natural substances as binders, as binding materials in the mixture or as a protection should be studied as a specific theme. We know that the substance produced by the *murrapa* logs is used as a binder in lime mortar, as recommended by traditional practice, but there is no evidence as to the quality of the effects. It is well known, generically, the liquid produced by this creeper increases the hardening of the mortar.

I observed this effect in an earth plaster applied to the reed walls of a house at Lumbo near Ilha de Moçambique. This very resistant plaster was formed by a mixture of red African earth - perhaps with a moderate quantity of clay - and liquid *murrapa* in a water solution. I had no reports about the possible use of liquid *murrapa* as repellent or waterproofing on walls or terraces made of coral limestone. I have called it solution, but perhaps it is more appropriate to speak of an emulsion. Once clotted, this substance is almost insoluble in water. However, if the trunks of *murrapa* stems are crushed and put to soak in water for about a week, it continues to pour copiously a substance which tends to coagulate and separate from water. Until the liquid of *murrapa* is immersed in water, perhaps we can speak of a colloidal solution. This substance can pass from a liquid to a semi-solid state and vice versa when, for example, the contents are transferred from the soaking container to another one for sieving its impurities.

Guidelines for Zanzibar Stone Town, The Aga Khan Trust for Culture and UNESCO [undated]. (http://www.archnet.org: Battle, Stephen and Tony Steel. 2001. *Conservation and Design Guidelines for Zanzibar Stone Town*. Geneva: Aga Khan Trust for Culture).

From the Introduction of the Guidelines: *The Guidelines draw upon the experience gained during the rehabilitation of the Old Dispensary building funded by the Aga Khan Trust For Culture (AKTC), a Unesco funded training project at the Old Customs House, and more recently, the Community-Based Rehabilitation Programme co-funded by AKTC and the Swedish International Development and Co-operation Agency (SIDA) and carried out by AKTC's Historic Cities Support Programme (HCSP).*

3. Knowledge, conservation and restoration

Ibo, a first case study: *Plano de urbanização da vila do Ibo* - Reef, backreef and the island. **Inhambane, the second case study**: The degradation of the church walls of Nossa Senhora da Conceição in Inhambane - Well known physical and chemical behaviours - Capillarity - From dampness to instability - After the restoration of church of Nossa Senhora da Conceição, a new disruptive cycle begins - The hypothesis of an ancient disruption: was it caused by salts? **Ilha de Moçambique, a third case study**: Different hardness in coral rocks - The *Fortaleza de São Sebastião* - Restoration of the walls of an old *casa-feitoria* in Ilha de Moçambique.

3.1. Ibo, a first case study

3.1.1. *Plano de urbanização da vila do Ibo*

Historical framework To get an idea of the historic importance of the small town of Ibo, we are now briefly summing up its main events[1]:

[1] Here the chronology of the main historical facts of Ibo is reported almost completely, as summarized in Julio Carrilho's paper written for his degree. When I translated it, I omitted the sources he mentioned and reduced the list of events. For consultation, please refer to the original text, Júlio CARRILHO, *Arquitectura e Ambiente: Preexistências, transformações e desenvolvimento sustentável. O caso da Ilha do Ibo,* Tese de Doutoramento, Anexo VIII *Quadro cronológico dos principais factos com impacto no edificado*, Roma 2005, pp. 278-286.

The *Enquadramento histórico* of the *Plano de Urbanização da Vila do Ibo* can be found in the appendix, as it is a thorough overview of the history of Ibo.

Among the references quoted in Carrilho, but omitted here, I am pleased to mention Prof. Carlos Lopes Bento's fundamental contribution, particularly in his study: Carlos Lopes BENTO, *Uma experiência de desenvolvimento comunitário na ilha do Ibo, entre 1969 e 1972*, Separata do Boletim da Sociedade de Geografia, Série 115, Nn. 1-12, Janeiro-Dezembro 1997. Bento's studies have followed step by step the drafting of the *Plano de Urbanização da Vila do Ibo* from on several sectors - historical, anthropological and naturalistic.

1st century - Some contacts have been reported between the east coast of Africa and Arabia; furthermore, there is evidence of links with India;

800 to 900 - During the 9th century, the contacts between the Bantu peoples of the east coast of Africa and the peoples of the Arabian Gulf in time give rise to the Swahili ethnic group and culture;

13th - 15th century - Swahili civilization reaches its top;

1498 - Vasco da Gama's expedition arrives at the north part of Quissanga. The Quirimba islands depending on Kilwa are hostile to da Gama. A military expedition is necessary to subjugate them;

1522 - A large Portuguese expedition attacks Quirimba. The settlement built by Muslim traders on the island is looted and destroyed and the boats anchored in the harbour burnt. In this period the Portuguese D. Pedro de Castro's occupation starts;

1523 - At last, the Portuguese occupy the islands;

1570 - First law for the abolition of slavery;

1593 - The captaincy of Mombasa is established. Quirimbas are subject to the captaincy of Moçambique;

16th century (towards the end) - First reference to the *Prazos da Coroa* in the Quirimba islands;

1609 - Description of the first fortified settlement in Ibo;

1630 - Some pieces of artillery are recorded;

1645 - Slavery in Moçambique becomes legal, as Angola can no longer provide slaves to Brazil after Dutch occupation;

1645 to 1671 - The slave trade is the only economic activity in Moçambique, despite the efforts of some governments to develop agriculture;

1650 to 1730 - During the long struggle between the Portuguese and Omani Arabs, the Arabs destroyed most of the churches and stone houses;

1752 - The island of Ibo is subject to the Government of Cabo Delgado;

1756 to 1763 - Governor Melo Castro is the Regent of the colony and agriculture in the islands is developing. The capital town is moved from Quirimba to Ibo;

1760 - Construction of the parish church in Ibo. The church is located near the port. At the beginning it had low walls and a thatched roof. It was burnt during the looting by the Sakalava in 1808 and then rebuilt. Restored and subsequently renewed in 1902/1903 it was covered with Marseilles tiles still in place;

1761 - *Vila* Ibo receives the status of city and the *Câmara Municipal* (City Hall) is established. The *Fortim de São José*'s construction starts;

1764 - The municipal officials, the military commander and the Governor take office;

1787 - The Customs Office is installed in Ibo;

1789 to 1795 - Construction of the fortress of *São João Baptista*;

1794 - Opening of the channel through the mangroves, on the south of Ibo, in order to make shorter the path between Ibo and Quirimba;

1795 - Construction of the chapel of the fortress;

1796 - The French attack Ibo. The fortress plays an important role in its defence;

1797 - A part of the fortress is already in ruins;

1798 - 1082 inhabitants live in Ibo;

1805 - Restoration of the fortress and town;

1808 - The Sakalava from Madagascar loot the island. The town is partly destroyed and the churches of Quirimba and Ibo are burnt;

1816 - The Sakalava of Madagascar make their third and final attempt at taking the island of Ibo. For four months the population looks for shelter in the fort to defend themselves. The most intense period of attacks occurred between 1800 and 1817;

1819 - The fort called *Fortim de Santo António* is completed, to be rebuilt in 1848;

1825 to 1828 - Sebastião Xavier Botelho is Governor-General of Moçambique. The Quirimbas are repopulated and the infrastructures in Ibo are strengthened. The port is considered the most important in the region of Cabo Delgado;

1827 - The district of Cabo Delgado is established and based in Ibo;

1830 to 1840 - The first masonry house is built; it belongs to a private owner;

1846 - Construction of the cemetery adjoining the church;

1847 - The municipality decide to open a road leading to *Fortim de Santo António*;

1848 - The municipality decide to open a road leading to the fortress of *São João Baptista*;

1852 - The Governor's new residence is built; it will take its final shape in 1876. A school and a theatre are also built; *Rua do Teatro* will get its name from it;

1852 - Ibo's population raises to 2422 inhabitants;

1856 - Pigs and goats are not allowed to roam the roads of the island anymore;

1858 - The population rises to 5390 inhabitants; 2109 are slaves;

1873 - *Mujaca*'s lighthouse is built at the eastern tip of the island;

1878 - The municipality orders all the buildings within the urban area must enclose their gardens in walls;

1879 - Ibo customs building is being constructed; it still exists and has the same function;

Figure 3.1.: Population of Ibo according to the available sources [*Plano de Urbanização da Vila do Ibo*, *Vol. 1*, *p. 28*.].

1879 – A strong earthquake severely damages the municipal building and the church;

1880 - The new *Munáua* cemetery is built and outside of it burials are prohibited. The replacement of the *macúti* roof of the Council Chamber with a tile roof is being discussed. The repair of the still existing *Hospital do Ibo* is a complicated matter;

1883 - Construction of the Great Mosque of Ibo;

1884 to 1885 - Order of street lights from Bombay. Installation of street lamps with 100 lights coming from India;

1884 to 1885 - Pinheiro Chagas's scientific expedition;

1888 - Some small earthquakes with no damages;

1891 - A cyclone ravages Ibo and Quirimba causing dozens of casualties and massive damages;

1892 - The *Companhia do Niassa* is founded;

1894 - The urban limits of Ibo are settled;

1895 - The Chinese are allowed to migrate to the Portuguese colonies. A large group settles in Ibo and attends to the fishing of sea cucumbers;

1896 - The Municipality of Ibo doesn't exist anymore due to an order by Governor Mouzinho de Albuquerque. Municipalities are replaced by Directors from the Central Administration;

1897 - Ibo becomes part of the territory administered by the *Companhia do Niassa*;

1902 - The Government seat of Cabo Delgado moves to Porto Amelia, today's Pemba;

1929 - Porto Amelia (Pemba) becomes the capital of the Cabo Delgado Province;

1937 - Ibo masonry houses are mostly in ruins;

1943 - The three forts on the island receive the status of national monuments by decree from the Portuguese authorities[2];

1962 - The island of Ibo becomes a prison;

1969 to 1972 - The Mwana community, under the direction of Administrator Carlos Lopes Bento, creates an interesting experience of urban improvement, with the restoration of houses and roads;

1971 - On the island there are 139 wells for water supply; the population amounts to 3518 inhabitants;

1983 - Construction of the *Praça dos Trabalhadores*;

1984 - Construction of *Praça dos Heróis*;

2003 - In December, the plan for the constitution of the Quirimbas National Park (PNQ) is approved;

2008 - The *Plano de Urbanização da Vila do Ibo* is adopted.

Problems and proposals of the *Plano* The *Plano de Urbanização da Vila do Ibo* was promoted and carried out thanks to an agreement between the Direcção Provincial para a Coordenação da Acção Ambiental de Cabo Delgado and the Centro de Estudos de Desenvolvimento do Habitat (CEDH) of the Faculdade de Arquitectura e Planeamento Físico in the Universidade Eduardo Mondlane of Maputo[3].

An explicit declaration in the introductory notes to the documents states that the *Plano de Urbanização da Vila do Ibo* is justified both by the need to preserve the value of the historical and cultural heritage of the island and of the Quirimbas archipelago as a whole, and by the need to write the guidelines for the projects and tourism enterprises in the region. Only the rules of a plan can create the conditions able to maximize the positive effects and mitigate the negative ones a sudden and extensive tourism development could cause on the territories.

The plan complies with the superior level laws regulating the Parque Nacional das Quirimbas.

The Quirimbas Park was established in 2002 and is subject to a specific legislation[4].

[2] *Portaria de 3.4.1943.*

[3] Governo da Província de Cabo Delgado, Direcção Provincial para a Coordenação da Acção Ambiental, Universidade Eduardo Mondlane, Centro de Estudos para o Desenvolvimento do Habitat, *Plano de Urbanização da Vila do Ibo, Vol. 1 - Inventário e Diagnóstico, Vol. 2 - O Plano e seu Regulamento*, Maputo Maio 2008.

[4] Decreto do Governo n. 14 de 6 de Junho 2002. Rules as given by the Decree of institution:

As to the methodological approaches, the drafting of the plan acknowledged the directives of a very recent general system of national legislation and, for this reason, is still up-to-date. As already mentioned for the Quirimbas Park, the plan is strictly adhering to a national rule, *Lei de Ordenamento do Território*, which regulates the land use, a particularly important matter for a country which has witnessed recent radical changes in its social organization[5].

Systematic consultations with public and private stakeholders, still having continued relations with the island, have resulted in actual effects on the plan. The various officers and specialists, as well as the team leader, have compared and checked the existing studies, during their visits to the different sites of the island, giving a considerable personal contribution[6].

The plan provides two sets of general and specific aims.

Overall aims 1. The plan is based upon social and economic basic activities with the aim of ensuring a greater sustainability and profitability in the improvement of the living conditions of the population and taking into account the guidelines of the government. The administration should be offered the necessary tools for managing and controlling the island development, promoting its identity and the protection of its environmental, ecological and landscape potentialities;

2. It promotes integration among the different types of urban areas and directs the urban options to highlight people's contribution to the history of Ibo; at the same time it interweaves the different human presences which have given their contributions to a unified identity coming from different cultures;

3. It examines the need for intervention strategies involving the participation of all the subjects who have contributed to the creative development - public and private institutions, NGOs, Cooperatives and Communities – and promotes

República de Moçambique - Ministério do Turismo, *Plano de maneio. 2004-2008. Parque Nacional das Quirimbas*.

[5] *Lei de Ordenamento do Território*, Lei n. 19 de 18 de Julho 2007.

[6] Titulo: Plano de Urbanização da Vila do Ibo. Promotor: Governo da Província de Cabo Delgado, Direcção Provincial de Coordenação da Acção Ambiental. Elaboração: Centro de Estudos do Desenvolvimento do Habitat – CEDH, Faculdade de Arquitectura e Planeamento Físico, Universidade Eduardo Mondlane. Rua da Argélia nº 385 Maputo. Coordenação Geral: Júlio Carrilho (Team Leader) - Luís Lage - Albino Mazembe. Equipa Técnica: Júlio Carrilho, Arquitectura e Ambiente - Luís Lage, Arquitectura e Representação Gráfica - Albino Mazembe, Planeamento Urbano - Carlos Serra Júnior, Jurisdição - Erasmo Nhanchungue, Planeamento de Transportes - Belarmino Maongane, Electrotécnica - Fernando Mazuze, Aguas e Saneamento - Rafael da Conceição, Antropologia. Consultores: Maurizio Berti, Especialista de Restauro - Jesus Perez, Antropólogo. Colaboradores: Constaza Marchett - Luis Martins - Adriano Guambe - Paulo Ernesto - Mahomed Narotamo - Sérgio Uate.

the gradual recovery, restoration and compatible use of the buildings, giving priority to the monumental area of the town, most likely subject to degradation;

4. It considers the population of the island and its visitors as the principal target groups for the development plan;

5. The plan is dynamic and flexible in order to enable an easy integration and adaptation to the economic and social developments, both locally and in the region. The aim is to make Ibo the centre of the management of the Parque Nacional das Quirimbas.

Specific objectives 1. The plan promotes the recovery, restoration, protection and enhancement of the existing buildings; it also contributes to the acknowledgement, protection and promotion of the immaterial cultural heritage of the island;

2. It promotes human traditions and landscape values;

3. It protects the types and styles of architecture as they have been historically adopted, and at the same time retaining the possibility of adopting new types of design in appropriately managed situations;

4. It promotes environmental protection measures and put an end to the urban environment degradation;

5. It promotes the revitalization and re-utilization of the monumental buildings;

6. It promotes the recovery of parts of the urban setting where buildings are in a state of irreversible decay;

7. It promotes the discovery of the new necessary functions for the correct enhancement of the new economic activity - tourism;

8. It controls the use of local and other natural materials extracted *in situ*, so as not to conflict with the life of the resident population;

9. It improves the access to the island. The road system is an important element of urban integration and must be restored. It pertains to the various urban areas which, in their historical and formal difference, form a magnificent wholeness of the settlement. We have identified a formal/ monumental area, a transition zone and an informal area. Any urban improvement should achieve the improvement of the living conditions of the population;

10. It maintains and promotes the need for enhancing the capacity building of the local administrators; the plan cannot be put into practice without their involvement;

11. It promotes all the subjects' participation to the development of the condi-

Figure 3.2.: Ibo Island Lodge, a remarkable case of rehabilitation for élite tourism [*M.B.*, 2007.].

tions for implementing, monitoring and managing the plan[7].

In the plan the word dichotomy defines the sharp distinction between a well outlined and formally planned village - now often called *cidade de cimento* - and an informally clustered precarious settlement - today's *caniço*. The implicit idea of the plan is that the two components have different characters but are equivalent in their urban relevance; obviously, from a historical and aesthetic point of view, the well-ordered stone town was the part inhabited by the dominant class while the informal town was a shelter for the subordinate humanity. The plan, however, takes into consideration a third area or level, the places where changes occur. Generally speaking and considering the urban housing, the urbanized area is divided into three major residential areas with their own characteristics, namely:

(i) *Zona Formal* – Formal area;

(ii) *Zona Informal* – Informal area;

(iii) *Zona de Transição* - Transition area.

(i) The *Zona Formal* covers an area of approximately 23.3 hectares and consists of stone and lime buildings. It shows a clear overall picture and the geometry of its structure is clearly readable. This area is in a state of considerable neglect; about 20% of the total population live there. Since the late nineties, purchase transactions have been recorded, but rehabilitation works are rare;

[7] *Plano de Urbanização da Vila do Ibo, Vol. 1*, pp. 6-7.

(ii) The *Zona Informal* covers an area of approximately 68.4 hectares and consists of stone and lime or wood poles buildings largely covered with *macúti* - coconut palm leaves. It is the result of a spontaneous process of construction. In 2002, 2,538 people lived there, the equivalent of about 75% of the population on the island. The plan acknowledges that there is some difficulty in understanding their social organization. However, a definition - *contraditória expressão de zona de Insegurança estável* - was attempted; the area is now considered very dynamic with significant changes in the buildings;

(iii) The *Zona de Transição* covers an area of approximately 13.6 hectares; administratively, it is now part of the *Zona Formal* but actually it is the interface area between the *Zona Formal* and *Zona Informal*, with buildings generally made of stone and lime, but lacking a clear and recognizable structure of spacial organization.

In the 80's and 90's of the last century many houses of the *Zona Formal* were nationalized and let to various tenants, in particular to the technical staff of organizations operating on the island. The houses not managed by the state or not inhabited by their owners remained closed for years. They lacked routine care, periodic maintenance and conservation work, with the result that they reached significant levels of degradation. Degradation also affected the rented buildings. In particular, the analysis carried out while preparing the development plan led to believe that the causes of the unexpected degradation were to be found in the technical and financial incompetence of state institutions – the houses' owner – and in the inability of tenants or new owners to understand that the preservation of a building requires daily work or routine maintenance.

The survey and analysis based on various studies from 2001 to 2003 have produced the following data synthesis:

1. about 33% of the buildings are in an advanced state of decay, with no cover and large portions of walls ruined almost at ground level, with no windows nor doors and destroyed floors;

2. about 37% of the buildings still hold all the main components necessary for self preservation, but show signs of material ageing, water infiltration and various kinds of damages;

3. approximately 30% of the buildings are still in use, even if signs of severe deterioration are visible;

4. about 8% of the buildings were restored;

5. about 3% of the buildings are equipped with electric power.

In addition to the abandonment of buildings, the general situation of decay seems to be the result of two major natural phenomena: the high salt contents in the walls and the aggressive action of rainwater. As to the problem of salinity in the walls, in masonry with a high content of salt resulting from the materials used, the degradation processes occur when one out of the three elements of the context - temperature, water and salt - is altered; in this way an unbalance of the whole building is created. The plan notes that the walls of the buildings in the *Zona Formal*, still protected by a cover, plaster and paintings, have largely maintained their initial characteristics, even if washed by rain. The exam of the decay in the buildings in a state of abandonment has simplified the plan as follows:

1. roofs: ageing of the building materials; action of rain water facilitating attacks to the wood by fungi and termites; lack of maintenance;
2. walls: lack of maintenance; high salt contents; rainwater action; seismic activity;
3. floor: lack of maintenance; rainwater action;
4. doors and windows: lack of maintenance; rainwater action; ageing and wearing of the materials used (mainly ironware); looting of the components in order to re-use them for the restoration of the houses in the three identified urban areas.

3.1.2. Reef, backreef and the island

Ibo is a part of the Quirimbas archipelago. It lies between latitudes 12 ° 19 ′28 "and 12 ° 24′ 24" South and longitudes 40 ° 32 ′40 "and 40 ° 37′ 32" East. Its surface is approximately 15sq km and it is one of the largest islands in the archipelago. The shortest distance between the island and the mainland is 375m. The island is surrounded by coral reef in the north-west and large patches of mangroves in the southwest. Ibo is the chief town of the district bearing the same name. The district covers a total area of 47.5sq km and includes the islands of Rolas, Ninave, Fiõ, Matema, Igbo, Quirambo, Quirimba or Quilálea Quilaluia, and Sencar.

The geography of the district makes transport routes and communications difficult.

In Ibo, as in the other Quirimbas islands, there are no permanent streams; however, on some islands, and in Ibo as well, groundwater can be drawn from wells. Since the water from the wells isn't always drinkable, it is common practice to collect rainwater in tanks. Generally, in the east coast of Africa and in the Arabian Peninsula, this practice goes together with the presence of the flat roof

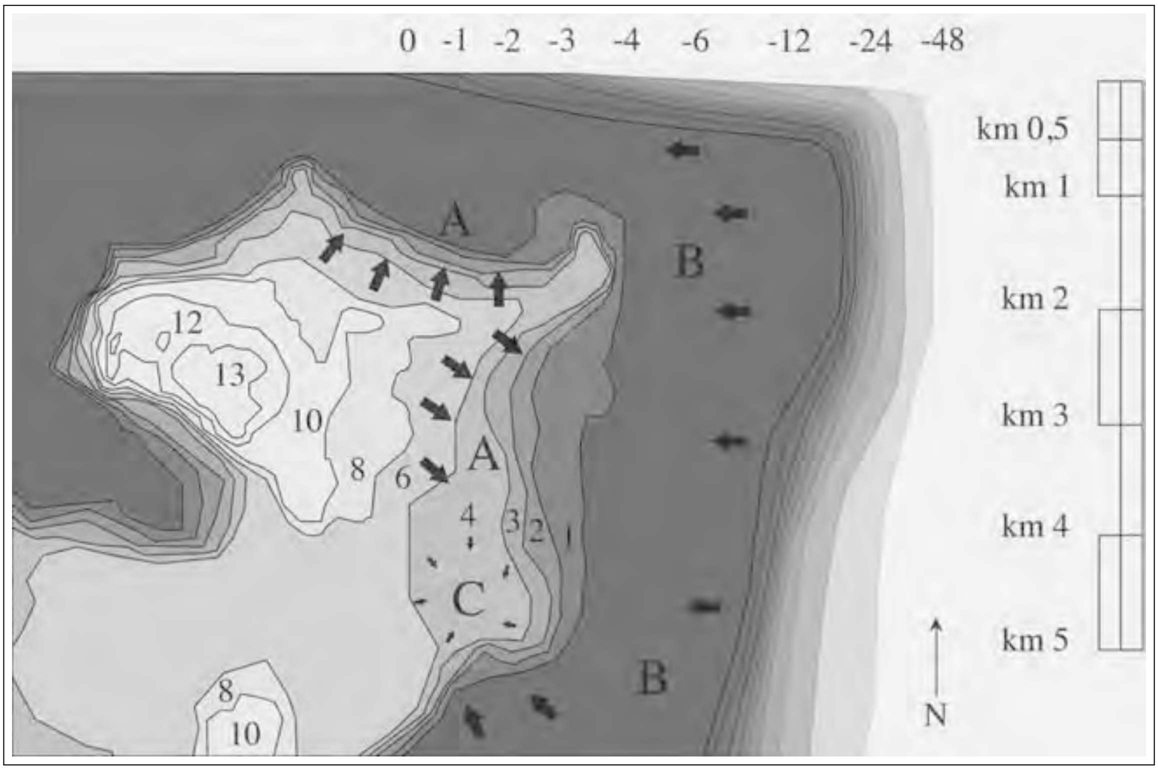


Figure 3.3.: Diagram showing the direction of water flow in Ibo. A: flow of rainwater; B: flow of the tides; C: open grassy plain [*M.B., 2009.*].

architectural style. In Ibo there are infiltration lines, especially in the plain with mangroves to the north and east, where the tidal flow and rain water meet. In the south-east, partly separated from the sea by dunes, a grassy open plain is stretched out. In the northwest there is an agricultural area and beyond, an area of scrubs bordering the airstrip.

The island is surrounded by a surface platform in the eastern area, overlooking the ocean and, at low tide, allowing the collection of seafood and shellfish.

As for the larger islands of the archipelago, Ibo consists of a rock deposit of surface coral limestone. There are dune formations, in some cases covered with *humus* produced by vegetation. Almost the whole island is covered with a thin layer of topsoil, where mangroves don't grow.

The still ongoing diagenesis process of rocks and deposits is at an early stage and, therefore, the ground is permeable and not very compact. However, the surfacing calcareous rocks often have a good degree of hardness and, in some deposits, they are compact and have a homogeneous texture.

The north and northeast coasts are bounded by coral rocks eroded by waves and with uneven sharp edges. Those rocky reefs protecting the back areas from high tides and storms have led to the formation of the backreef - today's island.

Figure 3.4.: The third study voyage to Ibo, August 2009. The surveys were effected from 17th to 21st August [*M.B., 2009.*].

Samples of remineralized Tridacna (*maxima* and *scaly*) can frequently be found on the soil of Ibo. This family of bivalve molluscs can usually be found along the coasts of the Indian Ocean and is now protected, as it can be seen from the UNEP report below. The analytical examination of the position of remineralized samples scattered on the soil of the island could allow to guess the land altitude in relation to the past sea levels, as Peter J. Ramsay did in his work on the levels of the south-east coast of Africa during the last 9000 years, based on the analysis of beachrock samples (Ramsay, 1995).
Mozambique Status: Occurs naturally (Wells, 1997). Management and trade: Mozambique exported large amounts of wild-sourced T. maxima shells between 1995 and 2001 with exports of 21- 64 tonnes a year together with up to 27,000 specimens in each year, virtually of which were destined for the European Union. It is not possible to convert weight to number of shells without information on the size of the shells which makes more detailed analysis difficult. There were no recorded exports in 2002 or 2003. Shell collection in Mozambique is regarded as being a subsistence activity, and no permits are required. Trade is regulated by the Ministry of Commerce, which issues licences for sale and export. CITES is implemented by the National Directorate of Forests and Wildlife (DNFFB), which issues all CITES permits and certificates. According to Marshall et al. (2001), CITES annual report data for exports from Mozambique may be based on permits issued rather than actual exports, which could explain the relatively lower imports reported from this country. T. maxima is listed as a "Species of Wild Fauna Requiring Special Protection" under the Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region; Protocol Concerning Protected Areas and Wild Fauna and Flora in the Eastern African Region. In Bazaruto National Park, efforts have been made to prohibit shell collection of Tridacna maxima and T. squamosa (DNFFB, 1995). As no trade in T. maxima from Mozambique has been reported since 2001, trade is currently of Least Concern. However, given the lack of information on stock status and management, and the high level of exports in previous years, trade in T. maxima from Mozambique in previous years, further clarification should be sought if trade resumes. (da: AC22 Doc. 10. 2, *Annex 8f, Tridacna maxima Röding, 1798. Mozambique Status*, pp. 113-114; in: Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and United Nations Environment Programme (UNEP), *Twenty-second meeting of the Animals Committee Lima (Peru), 7-13 July 2006* [*Official Documents*].

Figure 3.5.: Remineralized reef west of Ibo [*M.B., 2009*.].

Figure 3.6.: Coral ridges in the open grassy plains of Ibo, in the south-east [*M.B., 2009*.].

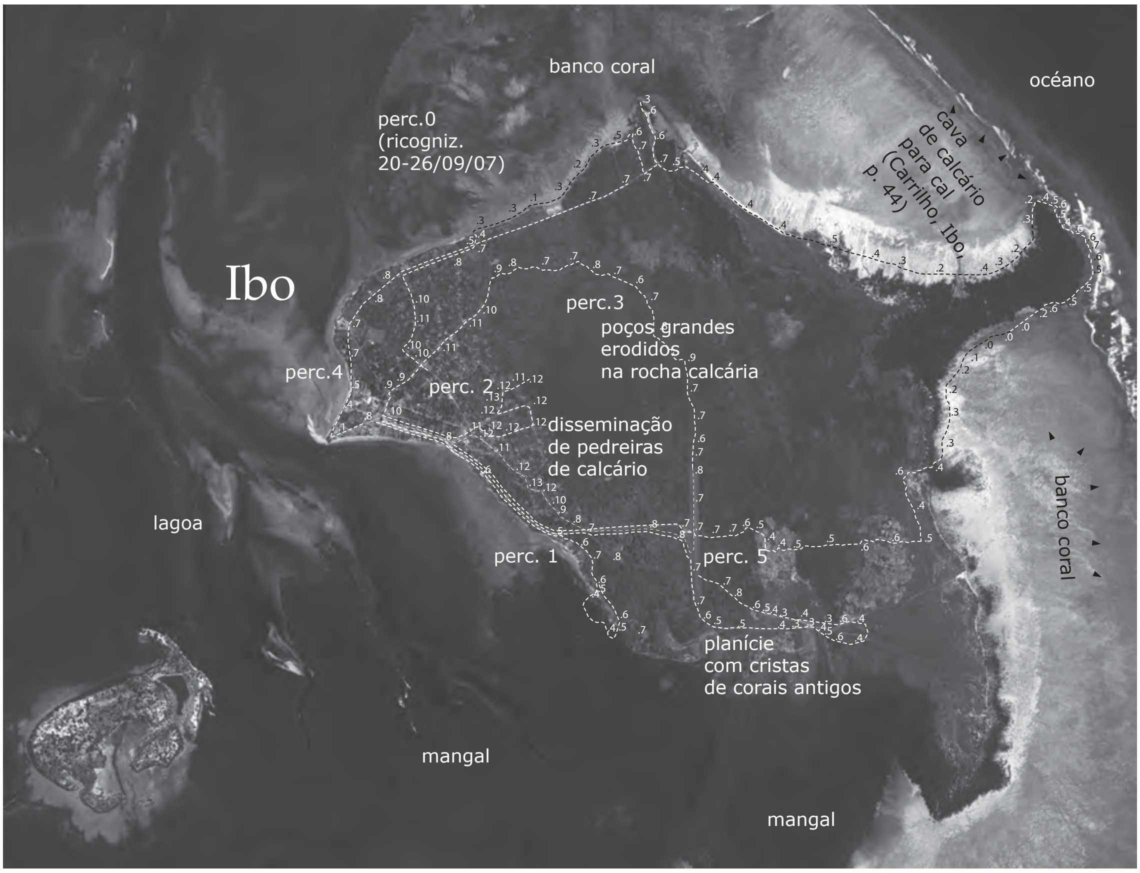


Figure 3.7.: Marking of the altitudes on the survey routes in Ibo [*M.B., 2009*.].

To the north, between the two rocky coasts, there are coastline areas with flat sand dunes, sedimentary rock slabs or beachrock, a coral platform that mangroves are colonizing and a sandy beach.

The so-called *porto interior* can be found on the west coast, with an inlet facing south. There, as in the whole south-west, the coast is characterized by a continuous sandy fringe and by the presence of low sand banks subject to the wind and tide erosion effects. All the front overlooking the harbour is guarded by protective walls.

The section of the port next to the church is mostly occupied by old commercial houses with their own docks. In that part, the protection walls are fitted with a system of counter-forts often close to collapse. Interestingly, an intact foundation wall is still there, even if the retaining wall has completely disappeared. At a first sight, the foundation wall is made of compact and very hard square stones, assembled with a very strong binder; it shouldn't be made of coral limestone.

We know, from historic, though few, information, that low intensity earthquakes occurred in the area; they may have influenced the conditions of the older buildings but, from this point of view, little is known.

If we consider the technology of wall building and the type of materials, a thorough observation and a study of the data on historical earthquakes in the region together with a systematic monitoring are required. One of the most interesting cases is the ongoing rotation of the apse wall in the parish church; anyway, it should be due to local subsidence or erosion. Some cases with severe defects in their structural conditions are highlighted as priority projects in the plan of restoration.

3.2. Inhambane, the second case study

3.2.1. The degradation of the church walls of Nossa Senhora da Conceição in Inhambane

My interest in the topics examined originated in a request for an opinion by the Director of Cooperação Técnica da República Federal da Alemanha in Moçambique. The German Cooperators' intention was to use the recently restored ancient church of Inhambane for the exhibition of the project for the town Archaeological Museum and had asked the Faculdade de Arquitectura in Maputo to evaluate the disintegration phenomenon of the plasters on the church walls and give a guidance in the steps needed for a regular progress of the scheduled event.

Figure 3.8.: The Church of Nossa Senhora da Conceição in Inhambane [*M.B., 2004.*].

As to historical knowledge, the dates of the foundation and subsequent transformations of the church could not be determined with due precision, particularly because of poor local documentary sources, scattered around during the recent decade of war and civil unrest. However, we could rely on the studies conducted and published by the Faculdade de Arquitectura; therefore, we can set some dates giving an acceptable historical perspective to the subject[8].

Between 1854 and 1862 Inhambane was subject to a major reorganization after a fire. Not only were civil and military buildings rebuilt but the church and its bell tower as well. As to the church, we should speak of reconstruction or, perhaps, expansion. The 1821 *Planta da Fortificação de Inhambane*, reproduced in the studies quoted above, shows a masonry church occupying the corner on the south of the military square, a fort equipped with a powerful yet simple fence on the four sides, according to the Portuguese custom at the time of their first occupations on the coast of Moçambique.

Before the important 19th century reorganization, in 1779, a previous reconstruction is recorded. There are no news regarding the church between 1779

[8]We are referring in particular to the collection of studies in Sandro BRUSCHI, Benjamin Alfredo SONDEIA, *Inhambane, elementos de hostória urbana*, edições Fapf, Maputo 2003.

and 1821, therefore we can believe that a primitive masonry core of the building already existed in 1779. Moreover, a quite common practice in the history of architecture leads us to guess that the original nucleus could have been somewhat included in the new plan of the church built between 1854 and 1862 and, then, be still visible.

Those buildings belong to a relatively recent time; however, Quirino Pedro de Fonseca's studies on the subject, carried out between 1972 and 1973 in Moçambique, implicitly invite to take into consideration the persistence and the stratifications of historic architecture. In particular, we are referring to his analysis of the construction phases of the present Igreja da Misericórdia in Ilha de Moçambique, which is a widening of the older church of the Espírito Santo; we are referring too to his analysis of the fortress of São Sebastião on the same island, which preserves in its structure elements recalling the original fort built by Dom João de Castro in 1545[9]. In our case, the construction techniques adopted and the materials used, still present in the oldest parts of the church, could justify the deformation in the masonry looking to the southeast and supported by a powerful external buttress.

A 1893 topographic map representing a well-defined urban structure is reproduced in the same study on Inhambane[10]. The small church compound is drawn as to reproduce its present shape, but the other masonry buildings scattered along the roads are reduced to a few dozens. This map is important for two main reasons: first, it gives a precise date of the age of earliest masonry buildings and makes it possible to understand better the disintegration phenomenon, comparing them with the still surviving ones. Second, we can establish a comparison among the few older buildings and the large number made after the completion of the urban layout.

A preliminary short survey leads us to believe that the first group of buildings has adopted poor or emergency construction techniques, with the use of coral stones carved in a non systematic way, coming from the demolition of the coral outcrops of the limestone soil near the buildings or digging the reef at low tide.

It is assumed that in more recent buildings the construction techniques have improved; then, there was a better selection of materials to ensure the durability of the buildings facing the aggressiveness of the marine climate. In a more

[9]Pedro Quirino de FONSECA, *Algumas descubertas de interesse histórico-arquelogico na Ilha de Moçambique*, in *Monumenta. Boletim da Comissão dos monumentos nacionais do Moçambique*, n. 8, ano VIII, Lorenço Marques 1972, pp. 55-71; Pedro Quirino de FONSECA, *A fortaleza construida por D. João de Castro na Ilha de Moçambique*, in *Monumenta. Boletim da Comissão dos monumentos nacionais do Moçambique*, n. 9, ano IX, Lorenço Marques 1973, pp. 65-68.

[10]Bruschi and Sondeia, 2003

Figure 3.9.: The Customs building in Inhambane [*M.B., 2004.*].

advanced social and economic context, compared with the early centuries of the colonial presence, municipal buildings too have been carefully and formally constructed improving their structural stability. Compact and homogeneous limestone quarries have been used as well as river or quarry clean sand and selected mortar.

The Customs building at the port of Inhambane has given an opportunity to see how the construction of the walls was executed during the early stages of the colonial urbanization. The process of transformation of a window in an entrance door revealed the construction typology of the wall, the general state of decohesion of its constituent materials and the static function held by the most recent additions to the plaster.

In 1929, Carlos Freire de Andrade described the geological characteristics of the Mozambican territory and, in particular, of the Chandane quarry: *Em Inhambane, na pedreira de Chandane, situada na baía de Mongue, aparecem uns calcáreos arenosos, contendo dentes de esqualos.*

We were unable to locate the Candane quarry north of Inhambane. Since the extracted material was limestone, we can assume that it was used as an inert material for conglomerates and mortars or as a building stone, once rough-hewn or squared. It seems unlikely that it could be used in lime production as not so convenient as pure coral limestone, still present in local deposits.

Then, the story tells us that at this date sandstone was also used in Inhambane, at least for the general construction industry. As to the supply of coral limestone found in Inhambane, historic data were not found, but coral stone buildings are actually present.

A historic evidence of the exploitation of building materials for Ilha de Moçambique, we reproduce here the photo of the island quarry and its caption: *Na margem esquerda do Zambese, os grés de Sena desaparecem sob as aluviões e areias modernas, que seguem numa faixa mais ou menos estreita até um pouco ao sul da baía de Mocambo, onde os depósitos terciários afloram novamente. No distrito de Moçambique, e em especial na ilha do mesmo nome e na costa adjacente, as rochas terciárias são constituídas por calcáreos pouco arenosos e consistentes (fig. 77), fossilíferos e com freqûência oolíticos. Na ilha de Moçambique, a rocha consiste em calcáreos muito moles, contendo calhaus de quartzo rolado e algumas vezes de feldspato, assim como muitos fósseis. Estas mesmas rochas encontram-se em Conducia e no Lumbo.*[11]

The reference to Ilha de Moçambique in the last two sentences recalls the situation of the Brazilian coasts John Casper Branner studied in 1904, quoted in Chapter One.

In Brazil, the deposits of limestone and coral rocks can be simultaneously present and visible even in very limited perimeters of soil, and rock outcrops can be of either types. In the district of Moçambique, and in particular in Ilha, Freire de Andrade writes of the presence of a not very resistant type of Tertiary sandstone and of an inconsistent limestone rock, but does not specify whether it comes from corals. Indeed during my visits to Ilha de Moçambique the presence of sandstone as well as coral limestone was observed in the soil and in constructions too.

Here is an opportunity to reconsider the not uncommon opinion stating that the construction of the historic masonry buildings should be considered *in toto* coming from coral rocks just because they can be found in a geographical context with a widespread presence of coral sediments in places where this material is traditionally used. There seems to be a diversified source of limestone and we will try to better explore the topic later on, in the third case study concerning Ilha de Moçambique.

3.2.2. Well-known physical and chemical behaviours

Direct observations on the buildings in Inhambane, Ilha de Moçambique and Ilha de Ibo and the current scientific literature as well, have led to the discussion

[11] Carlos FREIRE DE ANDRADE, *Esboço Geológico da Província de Moçambique*, Imprensa Nacional, Lisboa 1929.

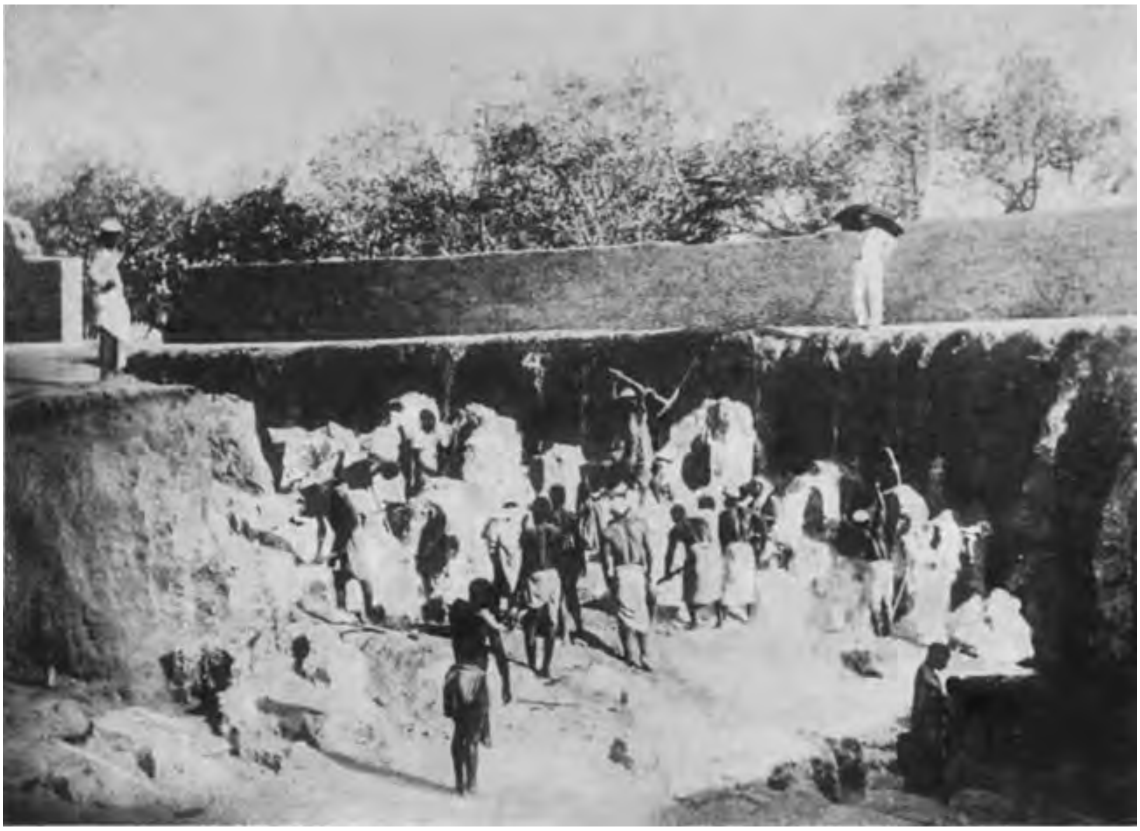


Figure 3.10.: Coral quarry in Ilha de Moçambique, in the late 20's of the 20th century [*Freire de Andrade, 1929, fig. 77.*].

Figure 3.11.: Coral limestone quarry in the area near the town of Inhambane, today's Tofo [*Photo by Mohamad Arif, 2004.*].

of the general and specific aspects of this subject.

I carefully read Donatella Procesi's handwritten paper in the International Centre for the Study of the Preservation of Cultural Property ICCROM library in Rome and found it is a model of scientific analysis on the topic of coral limestone, providing a range of scientific data on the chemical and physical characteristics of limestone and rocks of coral origin. Procesi especially deals with cases and phenomena found on the coasts of Kenya and Tanzania: more precisely, in Lamu (Kenya), Mombasa (Kenya) and Zanzibar (Tanzania). In recent years her paper has become an essential starting point for the scholars of coral limestone used in constructions. The circumstances of my present studies haven't permitted adoption of a linear working method similar to the one Dr. Procesi developed, as it seemed possible at the beginning. However, her work has given a sort of guidance thanks to the her experimental results and a cognitive framework of references already well outlined under the technological aspects of the building materials coming from corals.[12].

In 2005, the interest shown by the Faculdade de Arquitectura e Planeamento Fìsico in Maputo produced the publication, edited by Mohamad Arif and myself, of a booklet entitled *Conservação dos antigos edifícios de pedra coral. Dois casos ao longo da costa moçambicana*, which sold out in a very short time[13].

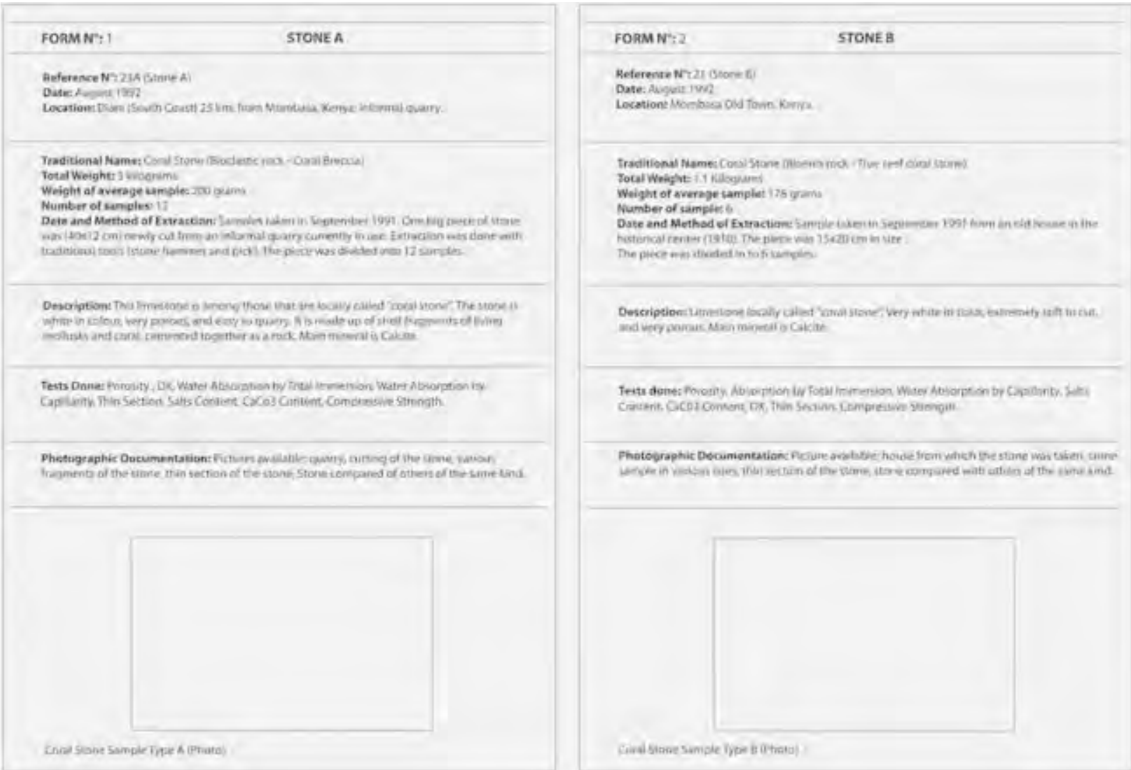
In 2004, the subject of chemical and physical analysis applied to the coral stone walls of the historic buildings on the coast of Moçambique was discussed during an interview with Ernesto Borrelli, at the time the coordinator of the ICCROM laboratory[14].

The discussion derived from an idea expressed in the already quoted publication by the Faculdade de Arquitectura. The issue was the possibility of a

[12]Donatella PROCESI, *Coral Stone and Lime in the East African Coast*, Submitted for the M.A. in Conservation Studies Centre for Conservation Studies, The Institute of Advaced Architectural Studies, University of York 1993, [typescript]. Donatella Procesi is co-author of the technical report for the conservation plan of Mombasa Old Town. On behalf of UNESCO, She worked on the plan from 1987 to 1990. See in: UNESCO (Prepared by J. King and D. Procesi) *Conservation Plan of Mombasa Old Town* - Tecnical Report, Mombasa 1990. And in: George ABUNGU and Lorna ABUNGU, *Old town conservation in Kenya: the case of Mombasa town*, in *African Archaeological Review*, Vol 15, No. 4, 1998, pp. 221-224.

[13]Maurizio BERTI e Mohamad ARIF, *Conservação dos antigos edifícios de pedra coral. Dois casos ao longo da costa moçambicana*, Edições FAPF, Maputo 2005.

[14]Ernesto Borrelli, ICCROM Laboratory Coordinator and Marisa Tabasso Laurenti, manager ICCROM directed the analysis Donatella Procesi performed on samples of coral material, using various laboratories: ICCROM, the Central Institute for Restoration, University of Bari, University of Nairobi , University of Rome. The series of 64 physical and chemical, tests was performed on four groups of samples of coral stone, lime, sand and mortar. The results are of fundamental interest for the studies on the conservation of coral stone buildings, although the author states that further resistance tests should be necessary for a better definition of the mechanical properties of the materials (Procesi, 1993, p. 79.).



FORM N°: 1 STONE A

Reference N°: 23A (Stone A)
Date: August 1992
Location: Diani (South Coast) 25 kms from Mombasa, Kenya: informal quarry.

Traditional Name: Coral Stone (Bioclastic rock - Coral Breccia)
Total Weight: 3 kilograms
Weight of average sample: 200 grams
Number of samples: 12
Date and Method of Extraction: Samples taken in September 1991. One big piece of stone was (40x12 cm) newly cut from an informal quarry currently in use. Extraction was done with traditional tools (stone hammer and pick). The piece was divided into 12 samples.

Description: This limestone is among those that are locally called "coral stone". The stone is white in colour, very porous, and easy to quarry. It is made up of shell fragments of living mollusks and coral, cemented together as a rock. Main mineral is Calcite.

Tests Done: Porosity, DK, Water Absorption by Total Immersion, Water Absorption by Capillarity, Thin Section, Salts Content, CaCo3 Content, Compressive Strength.

Photographic Documentation: Pictures available: quarry, cutting of the stone, various fragments of the stone, thin section of the stone, Stone compared of others of the same kind.

Coral Stone Sample Type A (Photo)

FORM N°: 2 STONE B

Reference N°: 21 (Stone B)
Date: August 1992
Location: Mombasa Old Town, Kenya.

Traditional Name: Coral Stone (Biogenic rock / True reef coral stone)
Total Weight: 1.1 Kilograms
Weight of average sample: 176 grams
Number of sample: 6
Date and Method of Extraction: Sample taken in September 1991 from an old house in the historical center (1910). The piece was 15x20 cm in size.
The piece was divided in to 6 samples.

Description: Limestone locally called "coral stone". Very white in colour, extremely soft to cut, and very porous. Main mineral is Calcite.

Tests done: Porosity, Absorption by Total Immersion, Water Absorption by Capillarity, Salts Content, CaCO3 Content, DK, Thin Section, Compressive Strength.

Photographic Documentation: Picture available: house from which the stone was taken, stone sample in various sizes, thin section of the stone, stone compared with others of the same kind.

Coral Stone Sample Type B (Photo)

Figure 3.12.: The first two sheets of coral samples as analyzed by Donatella Procesi [*Procesi, 1993, p. 84.*].

permanent laboratory supported by the resources and expertise of the Eduardo Mondlane University, for the study and control of the decay of the historic coral buildings and other environmental forms of degradation, to provide the institutions responsible for the architectural heritage in Moçambique with technological devices tested by the scientific community.

The idea is still up-to-date, but the first discussions and surveys made clear that evaluating the involved phenomena only on the basis of material samples could become a problem.

An evident aspect of direct observation of any coral limestone artifact lies in the diversity of the stone blocks of the walls. Frequently, the blocks on the same wall have different volumes, structures, hardness and porosity. Therefore, the lack of uniform characteristics is a kind of obstacle if a curator wishes to keep a regional environment interested in the topic of coral stones. Under this aspect it may be difficult to describe general phenomena relying on the scientific observation of heterogeneous samples. For this main reason, testing of samples was not undertaken; it was preferred to turn to different phenomena and their simultaneous interactions. In the conclusions of her precise work, Procesi states that conservation requires a holistic approach, consisting of the knowledge of the materials provided by the experts, the awareness of the value of that particular heritage by users, the presence of competent craftsmen and professionals, financial aid, a strict control on the historic areas and so on.

If we apply her concepts to our field of enquiry, we may say that in any conservation program a restorer/architect must be open to a contextual and problematic vision of coral heritage.

During the survey in Inhambane in 2004 we were able to recognize that the major problem of deterioration in the church of Nossa Senhora da Conceição was caused by the migration of salts through the walls and that the slight deformation due to the collapse of the wall area facing south-east was to be considered stable. In a simple visual exploration of the oldest buildings in town, referring to the 1893 map, it was noted that the phenomenon of salt recrystallization must always have been present since their construction. In fact, many of the oldest buildings in Inhambane present quite a number of re-plasterings; we can compare the patches of plaster following their time sequence in order to detect the different degrees of skill in execution, strength and effectiveness. Even with no instrumental survey on the samples, the patches' position and mixture showed that, in the past, maintenance workers had realized that the problem to be solved was to inhibit water from penetrating from the outside. They had made different types of mortar in order to get very low porosity plasters. In some patches we believe having recognized dust of *pozzolana* in a relevant proportion as compared with the whole mixture. The idea it was cement mortar didn't hold because the analyzed fragments showed a gray-red colour; furthermore, the gray-red granules were visible at first sight and the fragment, once compressed, lost its shape and became dust; that meant it was made of a ductile material and then it didn't break sharply as it is typical with fragile things.

In the various processes of preservation of the historic heritage, the salt migration phenomenon through the materials is being studied with the tools of chemistry[15]. In literature we can find several cases where the disintegration process of historic masonry caused by the migration of salts and the reformation of salt crystals due to water evaporation have been interrupted. In general, the

[15] Readers will realize the discussion is limited to those aspects of materials knowledge belonging to the responsibility field of an architect/restorer. The texts consulted on the theme of the disintegration process of the wall due to soluble salts are the following: Marisa LAURENZI TABASSO, *Materiali. Umidità di manufatto*, in Luca Zevi editor, *Manuale del restauro architettonico*, Mancosu publisher, Roma 2001, cap. C from CD; Lorenzo LAZZARINI, Marisa LAURENZI TABASSO, *Il restauro della pietra*, Cedam publisher, Padova 1986; ICCROM - UNESCO - WHC, *Conservation of architectural heritage, historic structures and materials, ARC Laboratory Handbook*, Roma 1999 [Scientific Committee: Ernesto Borrelli, Giacomo Chiari, Marisa Laurenzi Tabasso, Jeanne Marie Teutonico, Giorgio Torraca, Andrea Urland.].

disruptive phenomenon can be controlled working on a simple physical level, i.e. washing the walls with water, once the flow of saline solutions has been inhibited.

When materials with open and homogeneous porosity are present, such as high-quality bricks or some types of compact rocks, the widespread moisture phenomenon can be controlled. The procedure is aimed at downsizing the capillary network by the use of lime or silica or various types of resins. These products are forced to flow and deposit themselves in the cavities at different depths, in a more or less predetermined thickness. In this way the pore width is reduced.

In any case these experiences require special skills and a high degree of carefulness. The application of synthetic resins is not recommended; their use may be necessary and sometimes even fit in cases of obvious emergency or provisional works before restoration.

The presence of a certain degree of salinity in the dampness ofr the walls, such as sea salt (NaCl), does not involve serious conservation problems if the various elements can be kept in a state of fixed balance. On the contrary, the combination of elements such as water and temperature usually shows an unbalanced behaviour. If the surrounding temperature varies, the concentration of a given saline solution can vary too. When salt concentration increases with water evaporation, excess salts may again resume their crystalline state.

3.2.3. Capillarity

Donatella Procesi performed some laboratory tests on coral stone samples taken in Mombasa and Mtwana concerning porosity and water capillary absorption[16]. The results confirm the remarkable capacity of water absorption as typical of coral rocks. Similarly, the properties of high water absorption is also a characteristic of mortar and plaster mixed with inert limestone coral. It confirms that most of the buildings of the old centre of Inhambane are extensively affected by the phenomenon of water absorption due to the widespread capillarity of common construction materials; in addition, it should be noted that phenomena of capillary rising dampness were neither observed in Inhambane nor in Ilha de Moçambique.

In the last case we can only make an educated guess, as it was not possible to check directly whether the phenomenon still exists in the houses of concrete

[16] Procesi, 1993, from p. 85.

Figure 3.13.: Houses in Ilha de Moçambique resting directly on coral limestone [*Photo by Mohamad Arif e M.B., 2004 e 2009.*].

blocks in the town of *macuti*. The reason why there is no rising dampness may simply lie in the fact that these houses are located above the sea level. In any case, the delaying effect of capillary rising should be evaluated in the buildings where the walls have large pores and cavities preventing or substantially reducing the tensions required by capillarity.

However, capillary phenomena are not to be excluded *a priori* and, in particular, there may be stagnant or waste rainwater caused by a poor drainage property of the soil when it is sealed by artificial flooring or by the breaking of horizontal and vertical pipes. Moisture or water stagnation, in adherence to the foundation walls of a coral limestone building, may cause the phenomenon of rising dampness when the stone porosity is mostly thin and continuous. The examined buildings do not have these characteristics and then, possibly, the phenomenon of rising dampness would affect more the plasters than the walls.

The coral reef forming Ilha de Moçambique emerges from the highest levels of the surface of the coastal carbonate platform, as in most of the islands in northern Moçambique. Likewise the ground of the old centre of Inhambane lies

Figure 3.14.: Old coral stone house, now abandoned, in Ilha de Moçambique [*Photo by Mohamad Arif e M.B., 2004.*].

more than two meters above the average sea. In some places of Ilha de Moçambique the foundations of the walls were built directly with coral reef stones, cut out in the required thickness, both in civil buildings and in the fortress of São Sebastião.

The disintegration of the walls occurs, both in their inside and outside elevations, because the terrace coverage is missing. The presence of a tank, partially excavated in the coral reef, indicates that the whole construction is at a higher level than the sea and there is no salt rising damp.

3.2.4. From dampness to instability

The construction typology of the ancient walls of Inhambane In 2004 the walls showing the same age as the church main body were examined, keeping in mind the historical maps and, in particular, the aforementioned 1893 topographical map; attention was especially given to the damaged or broken parts to understand the building typologies.

The Customs building, in particular, offered the opportunity to understand how the Portuguese manufacturers proceeded in their constructions during their early experiences of colonial urbanization.

The ongoing work of transforming a window in a public gateway revealed the wall construction typology, the general state of de-cohesion of its materials and the static function held by the most recent additions to the plaster. The construction typology was confirmed by the observation of other decaying buildings in town and can be schematically described as follows:

1. The walls are made of roughly hewn coral limestone blocks of poor hardness. The blocks are orderly placed with the likely purpose of directing the gravity centre of the weights towards the inside walls of the compound. The expedient of foreseeing a likely inside slippage of each block compares with the good building practice of some rural regions in Europe in the case of dry stones and mortar walls. The wall blocks consist of aggregate limestone elements of biological origin with a low degree of diagenesis; among them we can see the skeletons of the most common corals of the region. Tofo, an area east of Inhambane, is among the places expected to supply the material. Another source can be found in the flattening of the sediments of the building in question;

2. The mortar looks disintegrated, especially at the lowest levels where it is often reduced to dust. In similar conditions, the blocks are often in direct contact; the result is a dangerous overloading on individual points. Mortars are composed of many broken fragments of shells, suggesting beach sand was used or that calcined shells were incompletely cooked;

3. The plaster thickness is not always the same because of the irregularities of the block faces, and it has different texture and composition according to the various areas examined, probably because of repeated maintenance works.

Wall dampness and water penetration Water gets inside a wall in a liquid or vapour state. In particular, the walls we examined were affected by rain.

1. The rain hits the exposed face of the perimeter walls. Differently from what happens with rising dampness because of capillary action, the speed of horizontally penetrating water is very rapid if the porosity of the plaster and the walls is large. In the case examined, both the plaster and the walls are very porous.

2. The presence of wind and rain and the marine environment suggest that the walls are soaked by salt water. The salt soaking of the external walls may be caused directly by the spraying of seawater raised and dispersed by the wind or by a mixture of sea and rain aerosol, that is the chemical compound NaCl + H2O. In the last condition the salt concentration is very low, but the penetration of the liquid may be higher than when the liquid is precipitated in an aerosol.

3. Technicians and scholars of historic architecture in Moçambique widely believe that sea salt was present in the oldest walls since their construction. Studies in progress or completed within the Facultade de Arquitectura in Maputo[17] on the building systems in the early periods of colonization indicate that the use of marine materials was a widespread practice in constructions. Beach sand, calcified shells and seawater were used for the mixture of mortar required to bind and protect coral blocks. A more rigorous way to know for sure if salts were present in the initial stage of construction of the walls, is the analysis in scientific laboratories of samples taken from an area adequately protected from the external environment, as the internal partition walls of a building may be.

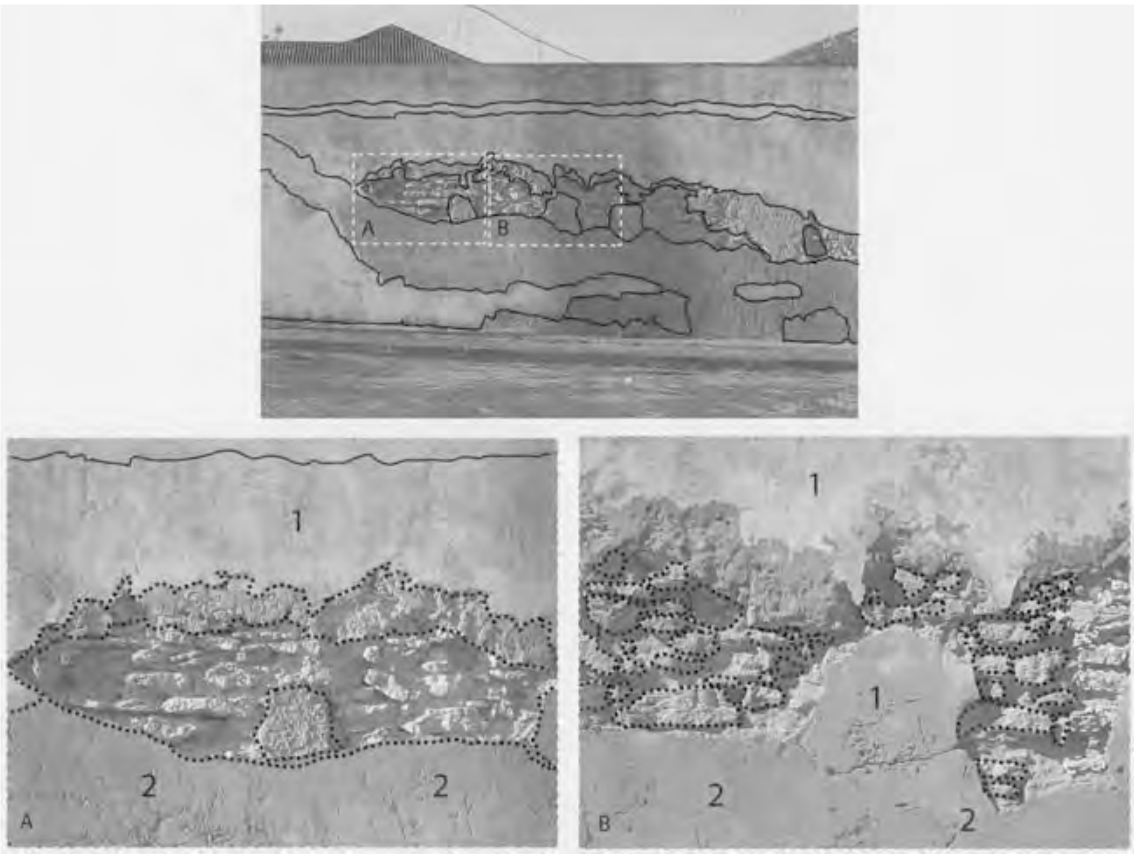
4. The recrystallization of the salts already present in masonry or reintroduced, cyclically, by marine aerosols has a great impact on plasters. The salts in solution propagate through the wall because of the water absorbed from the rain.

The length of the disaggregation cycle in the wall next to the church The perimeter wall of the ancient military square of Nossa Senhora da Conceição was built using the same technique as the church. In it there are some areas where the disaggregation phenomenon is in progress; then we can obtain information on deterioration and also on the length of the phenomenon.

To understand the type of deterioration it was necessary to graphically determine the mapping of the various patches of plaster and imagine a timeline. First, homogeneous areas were identified on the basis of a visual evaluation of the materials. After this first step, it was easy to determine which patches were applied first and which ones later. Each area has its own specific characteristics in relation to the phenomenon of deterioration; then it made it possible to evaluate the vulnerability of the plasters compared to water penetration and salt crystallization. Finally, the mapping allows for a careful and well-defined planning of the additions to implement.

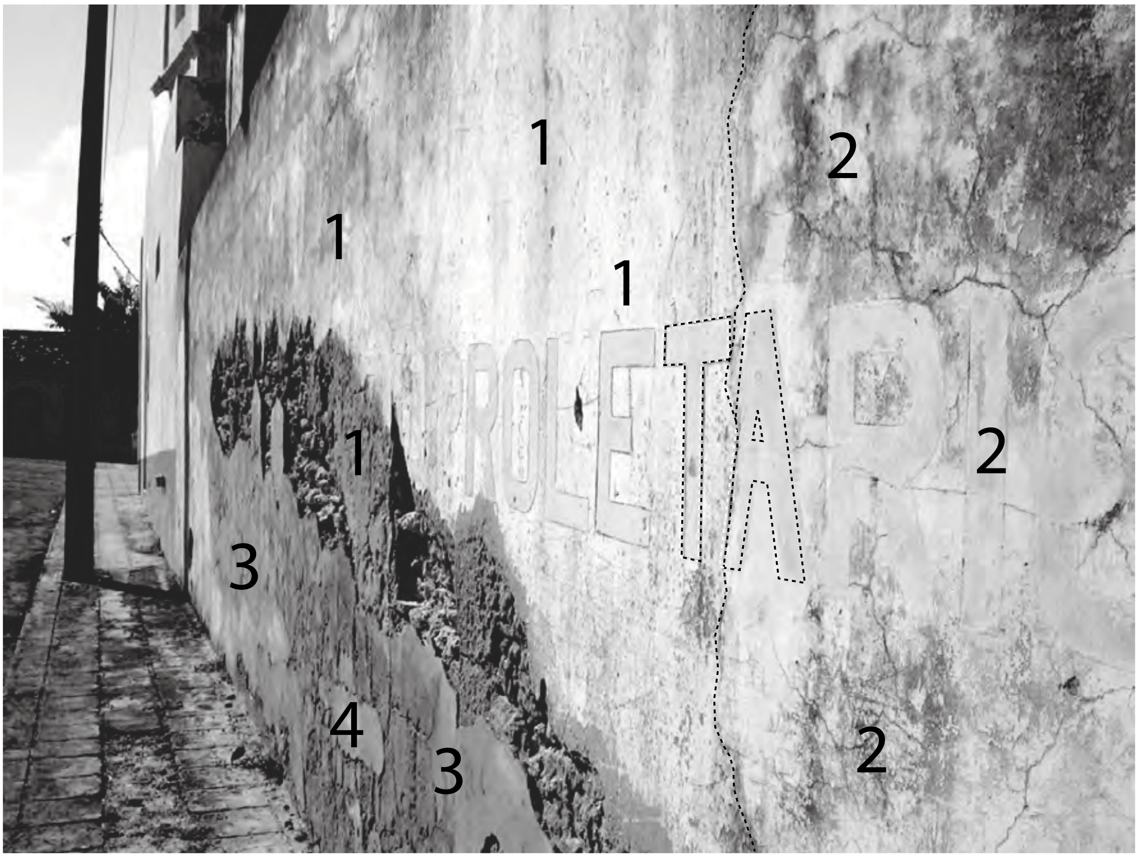
The presence of this graffiti displays some timelines in the patched plaster and, consequently, gives a time dimension to the cycle of disintegration of the plaster

[17] Carrilho, 2005, p. 127.



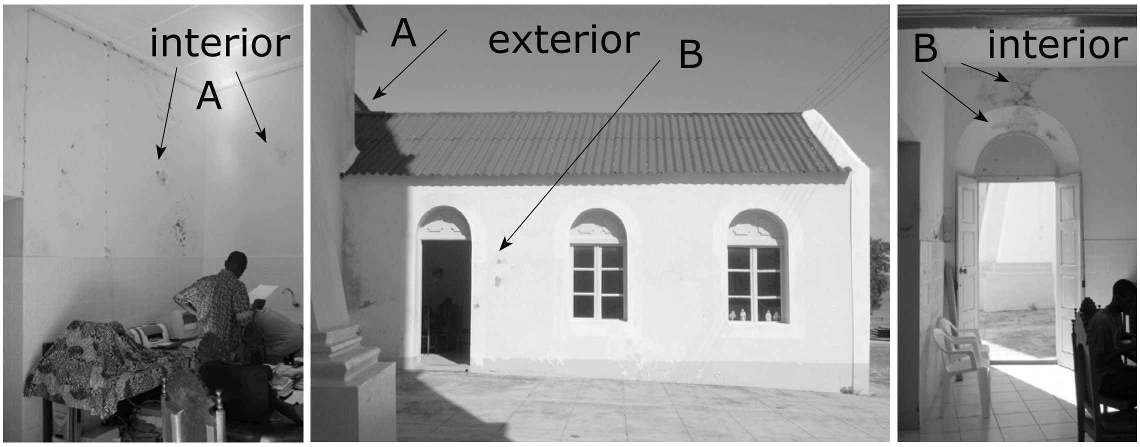
Disruptive effect caused by the cyclic reformation of salts in a wall adjoining the old Catholic church in Inhambane. A survey was performed on this wall which has the same plan as the church. The method and purpose of the survey can be summed up as follows:
1. identification of homogeneous areas considering the visible materials;
2. definition of time consequences among the different applications of plaster;
3. assessment of the current state of decay, examining how the salts phenomenon manifests in the different areas surveyed;
4. proposal of a subsequent integration of the plaster.

Figure 3.15.: A map intended for the study of the disintegration phenomenon of the ancient walls of Inhambane [*M.B., 2004.*].



The presence of graffiti makes clear the sequential order of plaster patching and, consequently, gives a time dimension to the disintegration cycle of the plaster and the wall. We can't make any attempt at determining at least one cycle of the reformation of the salt crystals with a substantial disruptive effect. The maximum length should be of about twenty-five years, the age of the graffiti.

Figure 3.16.: The graffiti makes clear the length of a disruptive cycle until the collapse of the wall [*M.B., 2004.*].



The cause of humidity found in (A) seems to be simply the wrong layout of the fiber-cement sheets used to cover the sacristy, in particular along the join line in the wall of the church. The problem will be solved simply by a maintenance check.
The efflorescence in (B) are caused by the saline phenomenon analysed here.

Figure 3.17.: The cause of moisture in the sacristy [*M.B., 2004.*].

and the wall itself.

The presence of a painted graffiti allows the definition of three different periods. The first one is the one where the graffiti is intact because the plaster has not deteriorated. A patch was laid in a subsequent period; it is the one containing the final part of the graffiti, re-made. The third period is the one of the contemporary degradation still in progress, affecting the initial plaster and the subsequent patches.

When we consider the contents of the graffiti and the fact it was written on fresh plaster, we can say that the plaster of the first period was laid towards the late 70's of the 20th century. It is difficult to imagine the minimum length of a cycle of reformation of the salt crystals of an important disruptive effect. The maximum length should be of about twenty-five years.

3.2.5. After the restoration of church of Nossa Senhora da Conceição, a new disruptive cycle begins

Two years after the ending of the restoration of the church (2004), the effects of a new cycle of salt crystallization in the wall caused by heavy rain and sea spray are already visible.

Outside, due to high temperatures, crystallization affects the wall in its depth. In two years the phenomenon has resulted in the disintegration of the plaster thickness and therefore appears quite evident. Stratigraphic proofs on the side

Three layers of repainting over a plaster; at first sight, it seems a patch but its extension on the entire wall can't be determined.
(B) The same type of plaster found in the previous exploration (A).
At a careful visual inspection the plaster doesn't' look like a mixture of sand and cement, but of sand and pozzolana. If a test with scientific instruments confirms this initial assessment, we would be facing a case of some historical and scientific interest.
(C) From a conservation point of view, the application of a synthetic waterproof painting during the last restoration (2002), hasn't worsened the decay caused by salt moisture in the area of the bell tower.

Figure 3.18.: Identification of the three layers of repainting on the plaster of the bell tower [*M.B., 2004.*].

door of the bell tower were performed to get an idea of the wall conditions before restoration, using a simple lancet. The first and second tests identified three layers of paintings: an exterior synthetic paint and the underlying ones in lime paint. The three layers are laid out on a plaster clearly belonging to a patch, but its extension wasn't determined - a piece of information it would be interesting to get.

At a first glance it seemed that the plaster was made of a combination of lime, cement and fine sand. On a closer inspection, we discovered a mixture of sand, lime and pozzolana. If a laboratory exam confirmed the initial assessment, we would be facing a case of scientific and historic interest too, as the colonial time custom to transport directly from the Portuguese Metropolis, a variety of materials and semi-finished products for buildings and civil constructions would be confirmed once more.

In this part of the bell tower we found a synthetic paint laid out in the recent restoration. From a strict conservation point of view, it has not worsened the degrading salt action in the wall. We can imagine that restorers were aware that the plaster excessive porosity is the problem for the conservation of these walls; then, they deliberately spread an almost completely waterproof final layer.

The church situation can be considered as a complementary aspect of the same phenomenon analysed from the outside with the mapping on the wall adjacent to the church and with scrapes of paint and plaster layers made on the side of the door to the bell tower.

Inside, the temperature being lower than outside, the salts will only be present on the wall surface in a state of efflorescence. Here the more recent synthetic layer is detached from the plaster, because of salts and vapour. The fact that these film lifts are present near the windows suggests that rainwater gets into the wall directly from the windowsill.

The following point is not directly connected to the subject matter but we think interesting to indicate the presence of a wooden ceiling as we strongly oppose its demolition, as suggested in an opinion heard during this study. The same ceiling system (*contre-placar*) on the roof of the religious building hall through a suspended wooden planks vault can also be found in Ilha de Moçambique, e.g. in the Igreja da Saúde. Apart from the stylistic interest of this constructive and architectonic way, this solution gives the environment a comfortable cli-

Figure 3.19.: Igreja de Nossa Senhora da Conceição, the outside and inside of the south-east [*M.B., 2004.*].

Suspended vaults formed of wooden strips are also used in Ilha de Moçambique, as in the Igreja da Saúde. This solution gives the environment a comfortable climate.
Left: even if protected by an adjoining room, this wall is affected by the phenomenon because the rain enters from the roof brim resting on the east wall of the church. Once the sealing of the windows will efficiently protect from rain, the problem of salt efflorescence will be drastically reduced.
Right: the wall of the presbytery is not affected by the phenomenon as its exterior façade is protected from rain by a well-protected adjoining room.

Figure 3.20.: Salt effects on the plaster inside the church [*M.B., 2004.*].

mate. Moreover, this part of the building does not suffer from any problem of conservation.

An analysis of the east wall of the church shows that it is entirely affected by a disruptive phenomenon, even in the part protected by the sacristy. Here the wall is wet because the rain enters through the edges of the roof not well sealed in their junction with the wall.

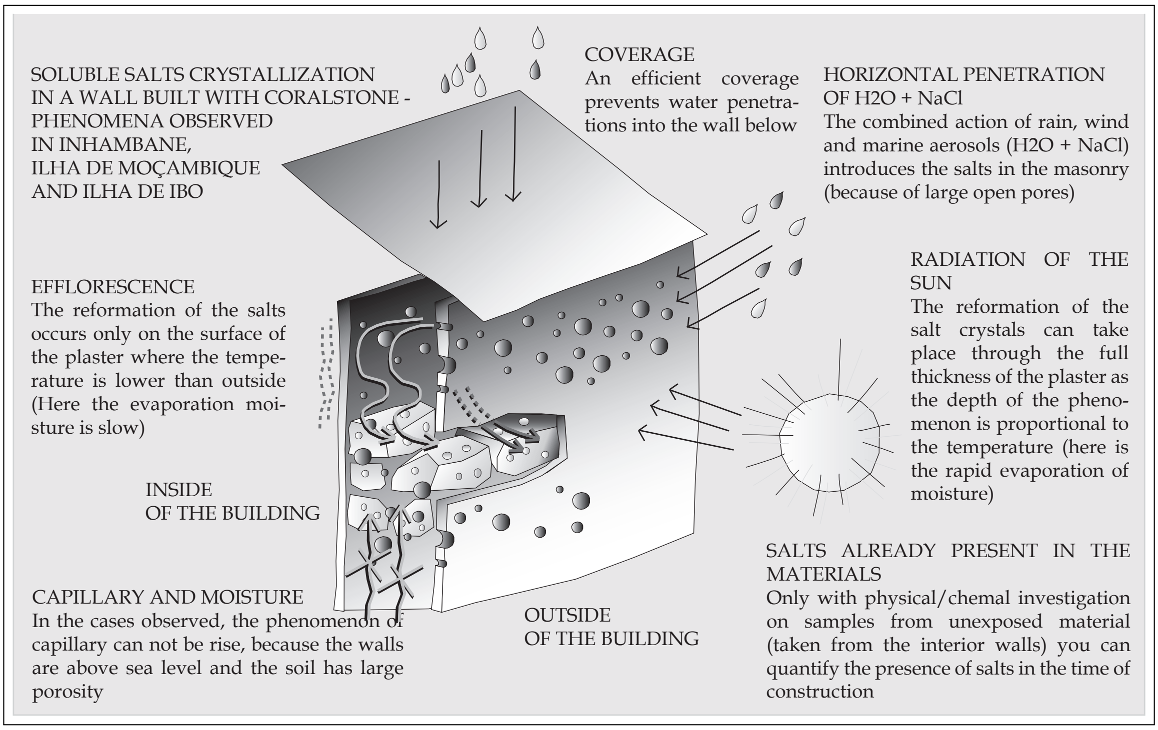
As to the east and west walls, once the closing system of the window will be tested to check its capacity to protect from rain, even if it is now considered unfit, the phenomenon of surface efflorescence will be drastically reduced.

The portion of the west wall, corresponding to the presbytery, is not affected by the phenomenon of salts because its outer surface is protected by an adjoining room with its own efficient coverage.

3.2.6. The hypothesis of an ancient disruption: was it caused by salts?

Three elements in the church have been sequentially linked: the irregularity of the pitch of the roof facing east, the upper deformation of the wall dividing the hall from the presbytery, the buttress constructed on the longitudinal wall facing east[18]. It could be, as a hypothesis, a case of disruption caused by the

[18] Even this one could be explored as a study case.



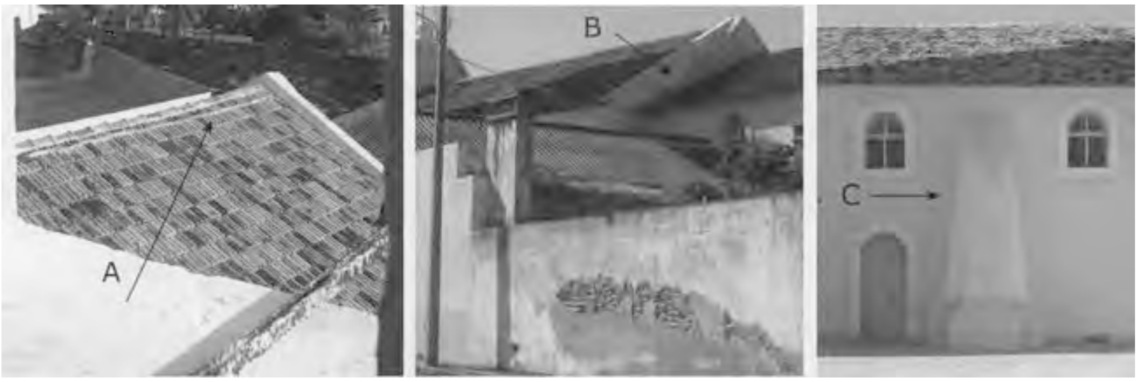
Schematic illustration of the phenomenon of the coral limestone disintegration due to the regeneration of soluble salts. The phenomenon was observed in Inhambane, Ilha de Moçambique and Ilha de Ibo.

Figure 3.21.: Diagram of the phenomenon of regeneration of soluble salts [*M.B., 2004.*].

disintegration of the wall components in an area with a predominantly horizontal distribution, as it can be seen today where the phenomenon of salt action is present.

The irregularity of the perimeter of the roof slope, the deflection of the top of the back wall and the buttress on the longitudinal wall of the church can be reasonably related one to another.

It is an interesting topic that could be studied in many other cases in Moçambique. We observed in Inhambane, at Ilha de Moçambique and in Ibo that a buttress was often used to counterbalance the wall rotation of the artifacts towards the outside of their structures. The rotations can occur as a result of a phenomenon of subsidence and as a result of major gaps in the walls, often in an intermediate zone between the base and the upper end, caused by falling material disrupted by soluble salts. In the church of Inhambane it is probably a disruption caused by a local disruption of the coral walls under the effect of salts.



The irregularity of the perimeter of this roof slope (A), the deformation of the top of the back wall of the church (B) and the buttress placed on the longitudinal wall of the church (C) can reasonably be related to each other.
It is an interesting study case. It is probably a disruption caused by the local disaggregation of the coral walls under the effect of salts.

Figure 3.22.: Observations on an ancient ruin [*M.B., 2004.*].

3.3. Ilha de Moçambique, a third study case

3.3.1. Different hardness in coral rocks

In the present paper, the phenomena of deterioration of the architectural heritage in coral stones have been reduced to a few key cases, with the intent to focus on a few prior directions of preservation: the aim is to make easier a possible practical application, especially if it is intended for an architectural heritage not based on monuments. We believe that Procesi's clear and reasoned simplification based laboratory tests performed on limestone samples could be repeated in our studies.

The field tests and the comparison of the characteristics of the different sites do not allow the same simplification as adopted by that expert. In this case, knowledge is based on data obtained from experimental tests on samples and with appropriate references to the scientific literature related to instrumental diagnostic.

In this case, direct observations were possible together with limited geographical and geological information. However, at least in the identification of two main classes of limestone, a correspondence between Procesi's data and the ones collected during our study may be established.

In the historic settlements at Lamu, Mombasa and Zanzibar two types of coral lime rocks used in the constructions of the past have been identified:

coral breccia or the Pleistocene coral e *true coral reef stone*. *Coral breccia or the Pleisto-*

cene coral, is presently the most common building stone along the coast. It is a bioclastic carbonate rock formed by residues of coral reef, shells, fossils and other eroded fragments. Wave actions transport and redeposit these residues on the shore by natural phenomenon and they are finally cemented together by dissolution and precipitation. Coral breccia is white or yellowish-white in colour, very porous, and soft to cut. Calcite is the main mineral component and responsible for its cementing. Other minerals can be present in the breccia in minor quantities, including quartz, hornblende, garnet, magnetite and feldspar. The stone does not present recognizable planes. Krenkel calls this type of coral stone the Riffrumerkalk. The true coral reef stone (Pic .1.10) is also used in construction although nowadays not as commonly. It is a bioherm stone consisting of a large portion of coral skeletons enclosed in rock. Aragonite is the main mineral component when the rock is still geologically young. When the stone has aged the aragonite becomes calcite. In this type of rock, the growth of the organism toward the top can be recognized. The stone, therefore, looks like a combination of hundreds of microscopic vertical straws tied together. Porous and very soft to cut, the stone varies in colour from white to yellowish ochre. When weathered it becomes grey. Krenkel calls this type of coral stone the Riffkalk.[19]

The four samples (3 from Mombasa and 1 from Mtwana) subjected to various laboratory tests belonged to the second type - true coral reef stone. From the mineralogical point of view the expert divides the A, B, C, D samples into two classes and two sub-classes:

I. Bioclastic rock mainly formed from coral reef remains. The age is quaternary-pleistocenic. The stone originated from solid fragments of organic material carried and deposited by natural phenomenon such as precipitation and dissolution. After deposit, the fragments cemented together (sample A). This type of rock is calcitic in nature. (Picture 8.1 sample A)

II. Bioherm rock formed from coral skeletons with clear signs of the animal growth (samples B, C, D).

Among the three samples of Bioherm stone, there is a second subdivision: coral stone of aragonitic nature (sample D, picture 8.2) and coral stone of calcitic nature (samples B and C, picture 8.1). The second type was probably formed by a transformation of the original aragonite into calcite.[20]

It is important to have an exact knowledge of the lime type the buildings were built with, because the conservation methods or the restoration techniques can change according to the physical and chemical characteristics of the construc-

[19] Procesi, 1993, p. 34.
[20] Procesi, 1993, p. 127.

Figure 3.23.: Ilha de Moçambique. The front of a bastion built in limestone blocks of the Tertiary-Quaternary period (*Bioclastic rock*). Column and wall of the ruins of a small house constructed with limestone blocks in a limited stage of diagenesis (*Bioherm rock*) [*M.B., 2009.*].

tion materials. In Ilha the walls were built with limestone of different physical consistency and porosity with different coefficients resulting in a mechanical strength and different environments of absorption of the moisture. Builders used blocks and stones of different hardness depending on the extent of the volumes where they were to be placed. Thus, blocks of bioclastic limestone were used for the walls of the faces and flanks of the ramparts and the curtains of the fortress, while in most of the one or two floor buildings boulders of bioherm rocks were used.

One of the founders of modern geology helps us to understand why in a site of such a small size (1 sq. km[21]) and at close heights calcareous sediments are present with different physical characteristics, even if they have the same biological origin.

Amadeus W. Grabau clearly describes a model of sedimentation of biogenic marine limestones. He published his model of sedimentation in the 1913 *Principles of stratigraphy* based on a study on coral reef in Alpena near the town of Traverse in the state of Michigan; he reproposes the same model for broader application in *A Textbook of Geology*, 1920.

Structures Common to All Reefs - It is important that we should understand the main structural features which distinguish reefs of corals and other lime-secreting organisms from other types of lime deposits, so that we may have definite means by which we can recognize older limestone deposits as due to reef growth, if such be their origin. In the first place, then, it should be noted that the main mass of the reef-mound is composed of coral or coralline structures in the position of growth. That is, as each new coral head or coral branch developed, it remained attached to the older dead coral mass or to the original rock-floor which served it as a foundation. Thus, in general, such a mound represents a mass of undisturbed coral and coralline structures. As the growth is not uniform, however, in all directions, numerous large and small cavities exist among the coral masses, and these cavities are generally occupied by shell-bearing and other animals whose hard parts remain there on the death of the creature. The lime-sand and lime-mud into which the waves grind the exposed corals is washed into these cavities, which may eventually be filled up by such material. On the margin of the reef, especially on the outer one, many coral heads and branching forms are broken from their anchorage and rolled about by the waves, grinding into sand and mud the coral masses over which they are rolled. When finally they themselves become embedded in the coral sand, they are no longer perfect, but are broken and worn, and they may come to lie in all positions, being

[21] Secretaria de Estado da Cultura - Moçambique, Arkitektskolen i Aarhus - Danmark, I*lha de Moçambique. Relatório 1982-1985*, Phønix A/S, Aarhus, 1985, p. 40.

Figure 3.24.: *Diagram of the reef structure in the Traverse (Middle Devonic) limestones of Alpena, Mich.* [*Grabau, 1913, p. 427; 1920, 304.*].

even completely overturned. The fine coral-mud resulting from the grinding will be carried out to deeper or quieter water, though it may also be caught in protected cavities within the reef. The coral-sand remains in shallow water to form bedded deposits. Along the margins of the reef-mounds the bedded deposits of coral sand will often lie at a steep angle, which is sometimes as high as 45 or even more. Frequently a layer of small corals will grow upon such a bedded deposit, and this in turn may be covered by other lime-sands. Thus an interfingering of the organic lime structures, the corals, etc., with the clastic lime, the coral-sand, will result, and this is one of the most characteristic features of the margins of the reef-mound[22].

A field check of Grabau's diagram has allowed to get elements of knowledge that can effectively guide the practice of restoration of the architectures in Ilha and simple elements of discussion, relevant to the issues of the architectural conservation and environmental heritage. We observed the sedimentation levels of silt and debris-derived structures produced by various reef biota in different places. The most interesting surveys were made at the two ends of the island, in the north and south, and in some parts of the centre. In the south we can find the cemetery surrounded by a road. Beyond the cemetery, at the tip of the island there is small lookout where there are clear traces of excavation leading to the levelling of the soil in this part of the island too.

From the *Planta da ilha e perspectiva da cidade de Moçambique* by J. Faustino, dated about 1835[23], we can see the southern part of the island was levelled in relatively recent times, as indeed are also the recent excavations at the place of

[22] Amadeus W. GRABAU, *A Textbook of Geology. Part 1 General Geology*, C. Heath and Co Publishers, Boston 1920, pp. 304–305.

[23] FAUSTINO, J., ca 1835 Planta da ilha e perspectiva da cidade de Moçambique [Material cartográfico] / J. Faustº inv. et fecit.. - Escala [ca 1:7200], 200 Braças = [6,10 cm]. - Lisboa : [s.n.], 1835 (Lisboa, Rua Nova dos Martyres, 12). - 1 planta : litografia, p&b ; 27,3 x 42,4 cm.

With reference to the *Planta da ilha e perspectiva da cidade de Moçambique* by J. Faustino, around 1835, it is thought that the southern part of the island was levelled in relatively recent times; a considerable amount of rocks was taken away.

Figure 3.25.: The soil profile of Ilha de Moçambique in the first half of the 19th century [*Faustino, ca 1835.*].

the depression where the modern town of *macúti* is now, as documented in the photo of the quarry published by Freire de Andrade in 1929. From an exam of the historical maps of the island in the second half of the 19th century and the first half of the 20th century, it appears that the excavations of the south central part of the island are to be related with the completion of the east area urbanization of the *cidade de pedra*. On the other hand, it seems likely that the excavations on the abutments and around the fortress of São Sebastião are to be connected to the first stages of construction of the fortress itself.

The problem of levelling and excavations of the rocks to put up the buildings and to produce the material necessary for their construction can be of great interest if considered with the resuming of the studies by architect Pedro Quirino da Fonseca during the intense period of restoration in Ilha de Moçambique in the 60's of the past century[24].

As mentioned in the previous section on Inhambane, De Fonseca observed very closely the construction of civil, religious and military buildings in Ilha making unprecedented contributions to the history of Moçambique.

In his reconstruction of the early history of the fortress he reports a 1547 letter from Capitão-Mor Fernando De Sousa to El-Rei D. João III, examining its contents referring, more or less clearly, to the old tower of São Gabriel or the new fort still to be built.

Mainly involved in the projects of the old and new fortifications, De Fonseca only mentions the topic of soil preparation, a topic which can be found in his published letter; there he writes about the use of sixteen diggers especially selected and moved to cut the hard rock, square the stones and manufacture lime, while waiting for architect Miguel De Arruda, at that time busy on the site of another fortress[25].

We can't say how long and how many resources were spent on preparatory work on the soil and building materials. Only in 1558 the proper construction works begins. It will take about sixty years before the fortress takes its first shape. The phrase first shape derives from the fact that the ancient and recent changes are evident, that the geometries of the fortress of São Sebastião took for

[24] Pedro Quirino DE FONSECA, *Algumas descubertas de interesse hostóricoarqueologico na Ilha de Moçambique*, in "Monumenta. Boletim da Comissão dos monumentos nacionais de Moçambique, n. 8", ano VIII, Empresa Moderna, Lorenço Marques 1972, pp. 55-71.

Pedro Quirino DE FONSECA, *A fortaleza construida por D. João de Castro na Ilha de Moçambique*, in "Monumenta. Boletim da Comissão dos monumentos nacionais de Moçambique, n. 9", ano IX, Empresa Moderna, Lorenço Marques 1973, pp. 65-68.

[25] De Fonseca, 1972, pp. 60-62.

updates to the defence techniques and maintenance work.

This topic should be taken into account mainly because it would help in drawing up a conservation program for a long period. The conservation program seems the only advisable way for maintenance practices with a long-lasting beneficial effect on a monument of great size.

The rocks observed on three different areas in Ilha (A, B, C Areas) are different. From a morphological exam the rocks in the three areas appear to have had the same genesis, but the cohesion of the levels is different in the sedimentary limestone outcrops in the centre of the island (B Area) compared with the rocks next to the sea (A and B Areas).

The importance of this aspect in the condition of the coral rocks in different parts recalls the topic of water action on limestone[26]. Here we can't deal with it in a more exhaustive way, but it is useful to give a general formulation to make easier the following studies. The idea is to evaluate the conditions in time of the rocks of coral or madrepore origin; some principles state that, in the presence of fresh water, the dissolution of calcite is favoured, while in the presence of sea water precipitation is more likely to occur[27].

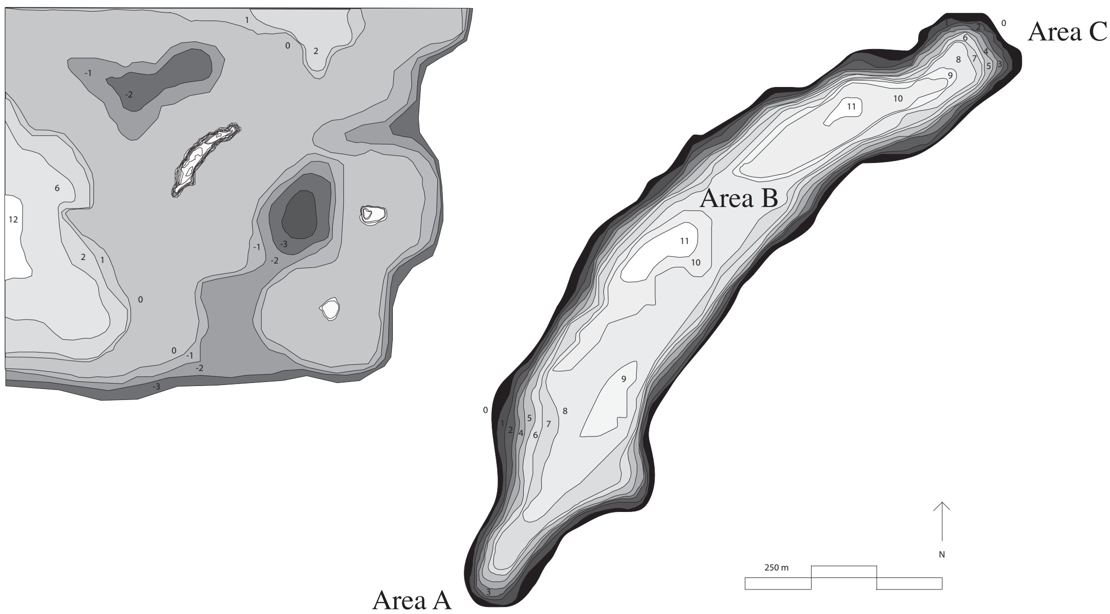
This topic should be handled together with wall disintegration due to the recrystallization of soluble salts, repeatedly dealt with in this text. In a tropical region it is interesting to examine the single action of fresh water in an unprotected wall of porous stone and limestone binder, because of the warm rains.

Water's property to dissolve limestone is known and it is also known that water, at a temperature between 30° and 35° C, precipitates calcite. We made an attempt at evaluating the consistency of the rock outcrop on which some of Ilha's buildings are based, but with no useful results as exams and laboratory tests are necessary. Even the rock ridges, cut according to the thickness of the walls where they were embedded during the levelling of the abutments, should be evaluated for their effective mechanical properties.

The rock ridges embedded in the walls of the fortress of São Sebastião seem

[26] For a better understanding of the geographical and geological phenomena, which are part of this paper, I often ask for help and advice of specialists. In particular, I could benefit from a visit made together with Professor Fernando Ornelas Marques from the Dep. Geologìa – Facultade de Ciências, Universidade de Lisboa, to Xai-Xai beach in January 2010. There we observed the sandstone rocks were following the intertidal coastline and some deposits of mollusc shells embedded in the dunes beyond the beach, about 5 meters above sea level. Reffering the flat sedimentary rock sandstone cliffs, Marques showed the significant dissolution of the rock surfaces caused by fresh water, rain or flowingl. I imagined that the same phenomenon could also be present in Ilha de Ibo and Ilha de Moçambique when the rocks are not in contact with sea water, but under the action of fresh water.

[27] Ward CHESWORTH edited by, *Encyclopedia of Soil Science*, published by Springer, Dordrecht 2008, pp. 77-79.



Area A - Cemitério | Area B - Praça dos Heróis | Area C - Cortina leste da Fortaleza

The rocks observed on three different areas in Ilha (A, B, C) show different hardnesses. From a morphological exam the rocks in the three areas should have had the same genesis, but the cohesion of the sheets of sedimentary limestone is different from the outcrops in the centre of the island (B) compared to the rocks in contact with the sea (A and B).
The importance of this aspect in the state of coral rock in different parts brings back to the subject of salty or sweet water action on limestone.

Figure 3.26.: Contour lines in Ilha de Moçambique and in its coastal environment. The rocks in three different areas of Ilha de Moçambique [*M.B., 2009.*].

Figure 3.27.: The skeleton of coral colonies growing among the calcareous sediments in the southern promontory of Ilha [*M.B., 2009.*].

compact at first sight; the lack of crackings under the significant weight of the fortress above, demonstrates the high degree of mechanical resistance to compression.

The same can't be said for the rock ridges embedded in the buildings of the central area where the thin layers of sediment accumulation have no cohesion; materials penetrated the cavities and the powder coming from limestone, due to dampness and water, is on the soil. Furthermore, for an observer, it would be interesting to evaluate the consistency of the deep ridge to check its compactness and porosity; the primary purpose is an assessment of its carrying capacity and, secondly, to see if hot torrential rains brought to the precipitation of calcite and its regrouping. In the latter condition, a systematic consolidation of the material which might be protected by an ordinary plaster in a possible restoration, wouldn't be necessary.

Figure 3.28.: Checking Grabau's diagram at the Fortaleza de São Sebastião [*M.B., 2009.*].

3.3.2. The Fortaleza de São Sebastião

The approach to the reading of the materials and structures of the fortress of São Sebastião must be accompanied by at least a brief summary of the stages that marked its building. We said that this architecture should be fully examined; the studies, prior to the 80's of the last century, of its transformations should be resumed to understand its history and its current physical structure. At the same time, this example of modern military architecture should be compared with different examples within and outside the influence of the Portuguese military habits in order to highlight their features and similarities.

For example it would be interesting to know what the Portuguese military engineers had in their minds when they built or modified the construction. They employed solid walls, while Italian and European military engineering as a whole believed that defences should be made of easy workable materials, even before the end of the first half of the 16th century; there they were applying advanced theories as a result of numerous experiments. In this way the curtains and faces of the ramparts, when hit by artillery, would have had the ability to absorb bullets rather than breaking into deadly shrapnels or crack and fall into pieces to the floor.

From our survey it seemed that the general idea of designing the fortifications as a set of flexible rather than brittle materials was seriously considered in the 17th century transformations or later ones in the fortress; São Gabriel's ramparts to the southwest and Santa Bárbara to the south-east. This hypothesis, obviously, should be verified by tests and stratigraphic surveys.

The dates of the major phases of the construction of the fortress of São Sebastião can be found below[28].

1498 - Vasco da Gama landed on the island of Moçambique;

1502 - Vasco da Gama completed his second journey from Portugal to India. During his stop at the island of Moçambique the first Portuguese trading post is established;

1507 - The Portuguese built the tower of São Gabriel (according to the studies by Pedro Quirino da Fonseca the remains of São Gabriel's tower were embedded in the construction of the church and convent of the Jesuits since 1619; it was to become the palace of the Governor of Moçambique[29].

[28] For this short survey of dates useful for a general historic perspective of the fortress of Ilha de Moçambique I refer particularly to Lobato, 1962, passim and Newitt, 1997, passim.

[29] Da Fonseca, 1972, pp. 62-68.

Figure 3.29.: Plan of the Fortress São Sebastião in Ilha de Moçambique [*UNESCO, José Forjaz Arquitectos*, *Maputo, 2007.*].

1522 - 1522 - Construction of the chapel of Nossa Senhora do Baluarte in masonry and coral stone with decorations and finishes in *pedra de lioz* [30]).

558 to 1620 - Construction of the first state of the fortress São Sebastão;

1607 - Attacks and siege by the Dutch. The fort, still under construction, resisted;

1610 - The Viceroy gave the Companhia de Jesus the old fortress, including the tower and the house of the king's farmer. The king confirmed the donation, provided that the old fortress was completely demolished, so as not to be a shelter for enemies in case of attack[31].

1626 - Completion of the drinking water tank;

1635 - Reform works of the bulwarks São Gabriel (southwest) and Santa Bárbara (southeast);

1694 - Construction of the fort São Lourenço on the islet south of Moçambique;

1712 - Construction of the portal on the west curtain of the fortress São Sebastião;

1744-1745 - Reform works in the bastion São Gabriel.

1750 to 1840 - The slave trade was flourishing.

1750-1752 - Various reform works. Arrangement of the gun low platforms.

1762 (1775) - Ilha de Moçambique passed from the Viceroy of Goa's administration to the direct dependence from the Portuguese crown.

1793 to 1797 - Attacks on the French fortress.

1820 - Last restoration of the fort Santo António in the south on the seaward side of the island.

1869 - Opening of the Suez Canal; it was now possible to sail from the Mediterranean Sea to India without circumnavigating Africa. The route of India would not have touched Ilha anymore.

1898 - The capital of Moçambique is moved to Lourenço Marques.

1947 - The construction of the port of Nacala in the north of Ilha accelerated its decline.

1975 - On 25th June the independence of Moçambique was proclaimed.

In 1530, the captain of Sofala assumed the title of captain of Moçambique and Sofala; the change stated the primacy of Moçambique over Sofala. The Portuguese captain had his residence in Ilha de Moçambique and Sofala too. Historians consider the construction of the fortress of San Sebastião a kind of strategic investment in the Portuguese expansion policy, for the growing im-

[30]Da Fonseca, 1972, p. 59.
[31]Da Fonseca, 1972, p. 65.

portance of gold and ivory trade coming from African mainland and for being an obligatory stop in the route to India.

During the 16th and 17th centuries the island was an important Portuguese outpost, with two forts, churches, convents and a hospital. Gold, silver and ivory, clothing, liquors and other objects had to pass through Moçambique before being brought to their final markets. Here the ships carrying goods across the endless route between India, Arabia, Africa and Europe, were repaired and food was bought during the long waits for the favourable winds of the Monsoons. The repeated Dutch and French assaults are an example of the strategic interest Ilha took in the trade routes with the East before the opening of the Suez Canal.

In this way we can explain the great English enterprise in the first three decades of the 19th century; Captain William Owen and his fleet performed a detailed survey of the coast on the route to India and, in particular of Ilha and Delagoa. Here's William Wolfe's summary of Owen's observations during the exploratory mission in Ilha de Moçambique.

The anchorage is rendered secure by three islands, on the centre one of which stands the town. They are of coral, and very low. Vasco de Gama touched here on his voyage to the East Indies; and not long after it was taken possession of by the Portuguese, who, in 1508, built Fort San Sebastian, which is quadrangular, very extensive, and containing within its walls a chapel, barracks, prison, tanks, and storehouses, with sufficient space for manreuvring a large body of men. The harbour is farther defended by four other small forts. The garrison consisted of about two hundred black soldiers. The place is fast sinking, into insignificance, and is now reduced from its ancient vice-regal splendour to poverty and desolation: it is still a bishop's see. In 1769, the Arabs were expelled this place, as well as Sofala and the settlements on the river Zambezi. The population at this time amounted to about six thousand-Portuguese, Canareens, Banyans, free coloured people, and slaves; the former the most limited, the latter the most numerous. It is a mart for slaves, and a small quantity of ivory and gold dust. The northern shore of the main is the only part cultivated for the maintenance of its population, the Arabs supplying the rest. The Portuguese jurisdiction does not extend ten miles in any direction; the natives will trade with them, but will not suffer them to enter the country. The governor is elected every three years, and his salary is so small, that he is compelled to enter into mercantile speculation, in which his authority supplants the regular trader. Mozambique is at times very unhealthy; bark is the only remedy employed by the natives-bleeding is never resorted to. There are no beasts of burden, all the work is carried on by slaves[32].

[32] William WOLFE, *Narrative of Voyages to explore the Shores of Africa, Arabia, and Madagascar.*

Figure 3.30.: Firing platform, called *campo de tiro* or *cemetery*. The effects of the cyclone Jokwe, 7-8 March 2008 [*M.B., 2009.*].

When I revisited Ilha in 2009 architect Jens Hougaard went with me inside the fortress, not yet open to the public because of renovation works in progress[33]. The characteristics of the building site clearly revealed that the works planned for the first phase of restoration had been largely implemented.

In 1991 UNESCO included Ilha de Moçambique in the *World Heritage List*, according to the Criteria IV and VI of the procedures. The reasons are summarized as follows:

The fortified city of Mozambique is located on this island, a former Portuguese trading-post on the route to India. Its remarkable architectural unity is due to the consistent use, since the 16th century, of the same building techniques, building materials (stone or macuti*) and decorative principles*[34].

Performed in His Majesty's Ships Leven and Barracouta; under the direction of Captain W. F. W. Owen, R.N. By Lieutenant Wolf, R.N. In: *The Journal of the Royal Geographical Society of London*, Volume the Third, John Murray - Albemarle-Street, London 1834, p. 204.

Wolfe's description is a summary of Owen's, reported here in Appendix: William Fitz William OWEN, *Narrative of Voyages to explore the shores of Africa, Arabia and Madagascar - performed in H. M. ships Leven and Barracouta*, publ. Richard Bentley, vol. I., London 1833, pp. 121-123.

[33] Between 2006 and 2009 I made five trips to Moçambique, arranged with the Corso di Dottorato di ricerca in Riqualificazione e Recupero Insediativo of the University of Rome, La Sapienza and with the Faculadade de Arquìtectura e Planeamento Fìsico in Maputo. The visit to the restoration site of the fortress São Sebastião was prepared with due care. Professor Jose Forjaz, whose Atelier won the International Competition for a proposal of restoration and subsequently was the technical supervisor of the work, kindly let me get a UNESCO special permission to visit the yard. Also, he put me in touch with architect Francisco Monteiro, the technical director of the UNESCO Regional Office in Maputo and architect Jens Hougårt, the technical manager of the Government Office for Conservation of Ilha de Moçambique. In this visit as in all the other ones I had a generous and competent help of the esteemed colleagues Júlio Carrilho, Sandro Bruschi and Luis Lage.

[34] See: http://whc.unesco.org/en/list/599. The UNESCO *World Heritage Committee* enlists the nat-

This date was preceded and followed by numerous activities in the cultural and political fields. The document which best expresses the desire to learn, restore and enhance the heritage of Ilha in a period of neglect and general disinterest, is the *Relatório-Report - Ilha de Moçambique* published in English and Portuguese dated 1982-1985 by the Secretaria de Estado da Cultura of Moçambique and Arkitektskolen i Aarhus in Denmark. The document which best shows the remarkable and complex activity of the recovery of the island from 1991 to 1999 is the *Final Report: Ilha de Moçambique - World Heritage Site. A programme for Sustainable Human Development and Integral Conservation* published by UNESCO and edited by Sylvio Mutal in 1999.

UNESCO's intense institutional activity, the constant generosity of the donor countries, Mozambican political skill and an extensive cultural interest of local and international groups created the conditions for the beginning of the recovery of the most powerful architectural expression in Ilha, that is the Fortaleza de São Sebastião, in 2003.

When we read the call for the rehabilitation works of the UNESCO department in Maputo in 2007, the strategy governing their action is clear; it is a part of a wider program of cultural preservation and social development. In brief, restoration has to become an extraordinary opportunity to improve the conditions of society as a whole; the process is time consuming and takes in the various aspects of a society strongly focused on the economic development, but still keeping its historical and traditional characters. The choice of prolonging the

ural or cultural properties in the World Heritage List in accordance with strict and updated procedures. Here are the criteria under which the properties are enlisted: *i. to represent a masterpiece of human creative genius; ii. to exhibit an important interchange of human values, over a span of time or within a cultural area of the world, on developments in architecture or technology, monumental arts, town-planning or landscape design; iii. to bear a unique or at least exceptional testimony to a cultural tradition or to a civilization which is living or which has disappeared; iv. to be an outstanding example of a type of building, architectural or technological ensemble or landscape which illustrates (a) significant stage(s) in human history; v. to be an outstanding example of a traditional human settlement, land-use, or sea-use which is representative of a culture (or cultures), or human interaction with the environment especially when it has become vulnerable under the impact of irreversible change; vi. to be directly or tangibly associated with events or living traditions, with ideas, or with beliefs, with artistic and literary works of outstanding universal significance. (The Committee considers that this criterion should preferably be used in conjunction with other criteria); vii. to contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance; viii. to be outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features; ix. to be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals; x. to contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.*

process of the heritage conservation is also beneficial to the recovery of the fortress, because of the complexity and the participation of different social elements.

Thanks to the studies and applications of the past three decades we can now say that the recovery of a historical monument of great size requires a programmatic approach distributed along a reasonable period of time. Facing complex historical layers in structures, forms and uses, designers and contractors are generally able to identify the most appropriate technical solutions for a good recovery. But sometimes they are not able to define an updated fruition; in particular, they are often faced with the need for substantial financial resources. In this case an intelligent conservation program may establish a protocol of interventions distributed over a long period of time and hierarchically arranged according to those criteria of necessity and urgency of the monument itself[35]. Quite appropriately, the UNESCO's coordinates, which had already guided the careful restoration project, say in the invitation to bid [36]:

SCOPE OF WORKS.

The proposed works to be contracted concentrate on the urgent structural consolidation and rehabilitation / restoration works to prevent further deterioration of the Saint Sebastian Fortress, and includes the provision of basic services with a minimum of facilities (electricity, water facilities and public toilets). The Works consist, mainly, in the rehabilitation of a part of the Saint Sebastian Fortress comprising:

- Eradication of intrusive vegetation from all surfaces of the building.

- Structural repair of part of the rampart walls, top surfaces of the bastions, terrepleins and vantmures, and part of the external walls, internal walls, ground pavements, suspended pavements and roof slabs.

- Waterproofing of part the roof surfaces.

- Full rehabilitation of the existing rainwater collection system.

- Instalation of a new power supply system to serve initially a discreet number of the fortress facilities.

- Restoration of building designated as HL, with construction of new walls, pavements, doors and windows, sanitary facilities and electrical, water supply, sewage and drainage services.

- Reconstruction of one lookout in the "São João" Bastion.

- Construction of a new community service water cistern, outside of the Fortress enclosure, and respective hydraulic connections to the rehabilitated existing rainwater stor-

[35]Some hints for reflections can be found in Part II Miscellaneous cases, in: Experiences in the city of Padua.

[36]UNESCO Office Maputo, *Invitation to Bid, Ref: [ITB 570 MOZ 4000 – Rehabilitation Project of the San Sebastian Fortress on Mozambique Island – Execution of works]*, 6 November 2007.

age cisterns.

- Construction of new stairs to access the Fortress secondary entrance.

All works will have to be executed in accordance with the working drawings, technical specifications, bills of quantities and scheduling as provided, to the best construction and restoration standards and under the contractual terms and conditions of UNESCO. In line with the Saint Sebastian Fortress architectural and constructive features, the rehabilitation works will require - besides regular construction works - the mastering in traditional construction and restoration techniques to include structural coral lime stone masonry, lime based mortars, renders and paintings, as well as coral stone and lime based mortar slabs supported by structural timber, considering, as much as possible, the use of local materials.

...

Aiming to halt the continuous deterioration of the Saint Sebastian Fortress structures, the rehabilitation / restoration works will include the following:

- Repair, seal and restore water drainage, collection and storage systems to protect structural elements from decay, by preventing water infiltration; dismantling and replacement of seriously degraded masonry and timber structural elements; reconstruction of collapsed structures, etc.;

- Installation of basic infrastructural services and facilities foreseeing expansion for future functions and re-use: basic electrical power supply system and lighting, basic water supply and sewage treatment systems and visitors' toilets, etc. The capacity of the firm to propose a strategy for the execution of the restoration works involving available competencies within the local community to a maximum extent will be an extreme advantage.

Jose Forjaz, the head of a group of engineers and architects who have first drawn the restoration project and subsequently performed the work supervision, wrote the following remarks in a UNESCO report describing their works carried out[37]:

Os estudos e as análises pormenorizadas realizados para a definição e a quantificação das intervenções exigidas para o restauro da fortaleza forneceram a informação necessária à definição da estratégia de intervenção:

[37] Lazare ELOUNDOU e Jana WEYDT editado por, *Fortaleza de São Sebastião. Ilha de Moçambique*, Centro do Património Mundial da UNESCO, Paris 2009, pp. 15-16.

The entrance to the fortress of São Sebastião still retains a traditional structure with a ceiling of wooden beams and slabs of coral conglomerate. The flat roofs of the fortress had been replaced for decades with beams and slabs of concrete. This system has been improved during the most recent works.

Figure 3.31.: Portal and access to the fortress [*M.B., 2009.*].

Figure 3.32.: The system for collecting rainwater in the Fortress São Sebastião [*M.B., 2009.*].

After detailed studies on the particular characteristics of the fortress of São Sebastião and the environmental conditions of its site, the authors of the restoration project appointed by UNESCO decided a rational strategy for intervening.
The undertaking for a general restoration of a monument of such large proportions is rather expensive; then, the authors decided a number of different works according to a hierarchy of priorities. Actually, a series of operations in the form of project may be financed and then implemented in the years.
In this way UNESCO can refine the restoration management with subsequent contracts, the curators of the monument have the time to involve donors, the administrators can raise funds and, at the same time, the population can gradually take possession of the site and, after the first restoration works, avail themselves of primary resources such as water or spiritual and social resources such as tourism and cultural exhibitions.
The work at the top of the hierarchy was the restoration of the high platforms and the terraced roofs, completed in 2009. The work has achieved two important tasks: the drastic reduction in the degradation of the structure, now effectively protected from sea storms and torrential rains, thus eliminating the phenomenon of walls disaggregation due to the reformation of soluble salts; secondly, the restoration of the system of collection and storage of rainwater for domestic use by the islanders and their guests.
From UNESCO photographic documentation, reproduced here, we can see that the structures of the flat roofs, completely renewed, were made by a structure of main beams of reinforced concrete and wooden secondary beams. The substrate consists of prefabricated concrete tiles and finished with a protective special paint. This construction typology is indeed a technological improvement of the existing one.

Figure 3.33.: The restoration of the high platforms and the flat roofs of the fortress of Ilha de Moçambique [*Eloundou e Weydt, 2009.*].

- A fortaleza foi submetida a um número incontável de transformações durante a sua história, em particular entre o início e meados do século XX, como confirma a documentação encontrada nos Arquivos Nacionais e em outras fontes.

- Estas transformações relacionavam-se, na maioria dos casos, com a construção de paredes de subdivisão e com a adaptação de prédios para usos diferentes daqueles originalmente designados.

- A maior parte da laje dos tectos, originalmente construída com vigas de madeira sobre as quais um concreto feito de pedras de coral era aplicado em telhas de cerâmica ou lajes de pedras de coral, foi substituída por lajes de concreto reforçado, seguindo a geometria e os declives originais, presumivelmente utilizando a estrutura de madeira original como cofragem. Em muitos casos, esses elementos estruturais foram deixados no local, sem nenhuma função estrutural.

- A maior parte dessas lajes de concreto reforçado, que à primeira vista pareciam estar seriamente danificadas pela água e pelas intempéries, encontravam-se, na verdade, em condições relativamente boas e puderam ser reparadas sem grande demolição.

- As vigas de madeira deixadas no local não podiam ser utilizadas, em termos estruturais, e inicialmente foram interpretadas como uma tentativa feita pelos engenheiros militares de reterem o efeito de métodos de construção originais. Os arquitectos reviram, desde então, esta opinião e as vigas foram retiradas. O madeiramento estrutural excedente recuperado desta operação foi quase suficiente para a reconstrução de partes dos prédios em que era necessário seguir a tecnologia de construção original.

- A maior parte das patologias encontradas nas lajes de concreto reforçado eram devidas à penetração de água de sistemas defeituosos de colecta de águas. Parte das lajes do tecto tiveram de ser cortadas e fundidas novamente com o devido cuidado, para a continuidade do reforço e adaptação do novo concreto ao antigo.

- A estratégia de salvaguarda da integridade estrutural do monumento, que era o objecto desta fase do projecto, foi condicionada pelas severas limitações impostas no contrato para o primeiro prédio.

Após um amplo estudo das características geométricas, técnicas e arquitectónicas e das condições ambientais do sítio, foi constatado que os seguintes factores condicionavam a reabilitação das várias estruturas e prédios: A fortaleza estava a ponto de tornar-se numa ruína, pelo menos no caso de alguns dos seus componentes, embora os aspectos mais flagrantes da deterioração fossem mais superficiais do que estruturais e medidas remediadoras pudessem fornecer uma solução a um certo número de problemas. A intervenção mais urgente, para impedir quaisquer desmoronamentos estruturais, dependia amplamente da impermeabilização dos tectos. Entre vários factores que contrubuíram para esta situação, o mais importante foi a falta de manutenção no decorrer dos últimos quatro decénios.

Door and window concrete lintels where iron has broken due to oxidation or corrosion in a normally wet environment and subject to marine aerosol.

Figure 3.34.: The row of rooms behind the curtain facing west of the fortress of São Sebastião, Ilha de Moçambique [*M.B., 2009.*].

As condições ambientais extremamente agressivas do sítio, com as muralhas de protecção construídas directamente sobre a rocha de corais que se ergue do mar e agravadas pelo clima tropical, com ciclones, chuvas intensas durante vários meses do ano e altos índices de humidade permanentes, tornando a secagem das paredes e dos tectos num processo muito lento.

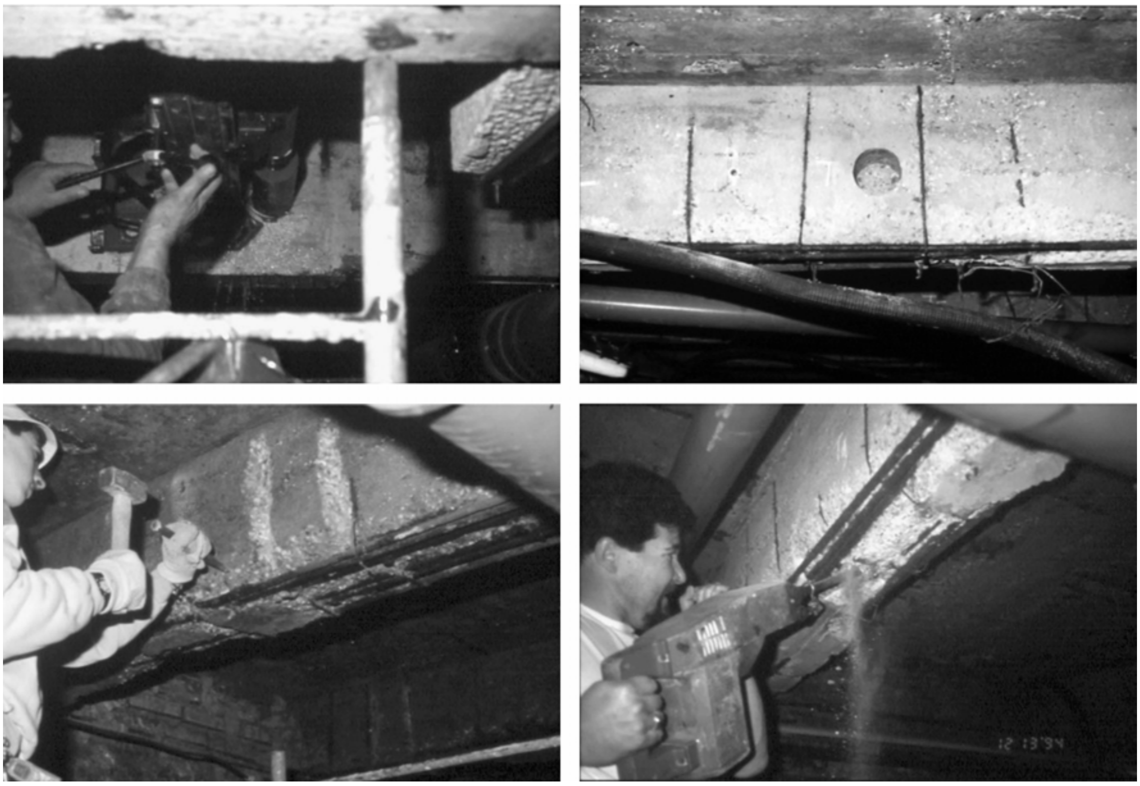
During my visit I could see that the works so far described were listed as already finished. Actually, the fort is no longer a great monument in a state of abandonment and an incipient condition of decay, but now protected and made safer by implemented structural safeguards, can wait for further restoration in a lasting condition and be visited by scholars and tourists.

Each one of the recovery problems faced and solved in the first phase of the extraordinary maintenance programme deserves the attention of the specialists in architectural restoration; the authors or supporters of this great task will, hopefully, provide the data and revelations each building site restoration shows with information and critical writings as well as with the practice of the following-up works of restoration.

We hope that a special appendix will be present in future to program the maintenance schedule for each subsequent building site. The owner can to take care this monument with a modest amount of money, adopting simple maintenance practices and following the guidelines developed by restorers, pending, during and after each restoration yard phase.

View of the underground space with Roman findings and structures of the medieval buildings the Palazzo della Ragione was built on top. The first stage of restoration was the location of the iron of reinforced concrete beam.

Figure 3.35.: A - Procedure for the restoration of a beam or a slab of concrete - Photos 1, 2, 3 clockwise [*M.B., 1994.*].



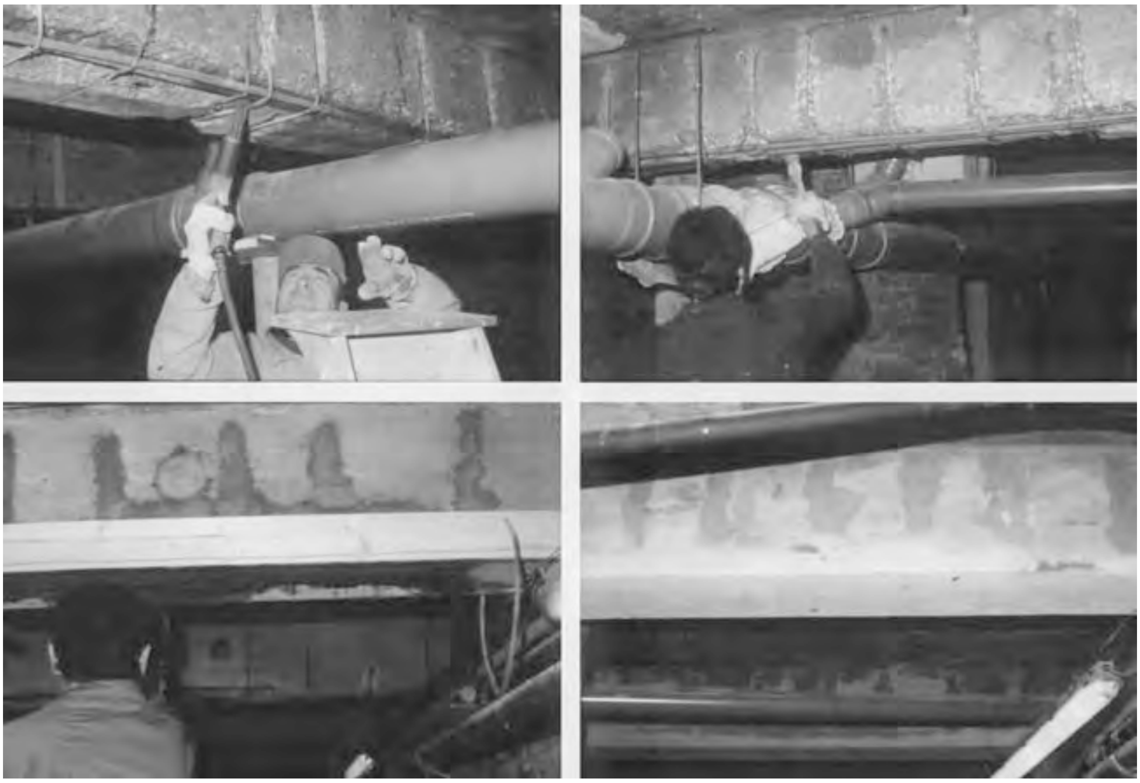
Sampling from the beams to determine the mechanical properties of the concrete cast, cleaning of the oxide layers and stripping of virgin iron, placing and fixing of new pieces of iron or brackets, where deemed necessary by the engineer calculations.

Figure 3.36.: B - Procedures for the restoration of a beam or a slab of concrete - Photos 4, 5, 6.7 clockwise [*M.B., 1994.*].

It was noted that among the works not yet carried out there were some horizontal structures of reinforced concrete. In Ilha as well as in the fortress and the two forts in Ibo there is a pathology typical of these structures with construction defects in an wet and aggressive environment; that pathology manifests in a progressive oxidation of outer iron in the cages arming concrete pillars or beams. Iron expansion cracks the layer of the cover forming chips which peel off exposing iron; in this way the phenomenon reproduces inside the beam or pillar. These disruptions normally can be repaired.

Let's now examine the procedure applied to the restoration of the concrete beams on the ground floor of the most important public building in Padua[38],

[38]The restoration was effected by the Settore Edilizia Pubblica of the City of Padua between 1993 and 1995. Once again I like to thank my colleague Mr Bruno Biaggioni for allowing my numerous visits to the site, for his comments and our long discussions.



Paintings with acrylic resin for iron protection and the improvement of the adjoining between the iron and concrete prepared through cleaning; integration of the concrete gaps with mortar of plastic cement added with acrylic resin. The application is effected in two or three subsequent layers.

Figure 3.37.: C - Procedures for the restoration of a beam or a slab of concrete – Photos 8, 9, 10, 11 clockwise [*M.B., 1994.*].

Palazzo della Ragione..

It was built in two main phases, starting from 1219 and 1304. After the Second World War, a space was excavated in the underground corresponding to the entire plan of the monument, with the aim of improving the functioning of the shops on the ground floor of the Palace. To reposition the trachyte floor, reinforced concrete slabs, resting on reinforced concrete beams, was created.

Over four decades, the high concentration of water vapour in the basement caused such an aggressive action that the iron plates and beams, mostly oxidized and corroded, were dangerously exposed even in the deeper parts of the conglomerate. The restoration work was carried out from the intrados without stopping the commercial activities above and at a very low price.

The main stages of restoration are the following[39]:

- Localization of iron reinforcement of beams;

- Sampling in order to determine the mechanical properties of the concrete cast;

- Cleaning of the oxidized layers to get the clean iron;

- Installation and fixing of new pieces of iron or brackets, where deemed necessary by engineers' calculation;

- Paintings with acrylic resin for protection and improvement of the binding between iron and concrete, as prepared by cleaning;

- Integration of the concrete cracks with mortar added with acrylic resin. The application is effected in two or three successive layers.

3.3.3. Restoration of the walls of an old *casa-feitoria* in Ilha de Moçambique

Let's now examine in a didactic way the photographic documentation, shot with the collaboration of architect Mohamad Arif, of a restoration site of a large house in the central area of the town of Moçambique. This site was observed during a study visit of a group of students and professors of the Faculdade de Arquitectura e Planeamento Físico in Maputo in October 2004 [40].

[39]Photos 1, 2, 3, 4 and 5, 6, 7, 8.

[40]Already published in: Maurizio BERTI e Mohamad ARIF, *Conservação dos antigos edifícios de pedra coral. Dois casos ao longo da costa moçambicana*, Ed. universitarie FAPF, Maputo 2005.

At ICOMOS (International Council on Monuments and Sites) I heard the news of the damages caused by Cyclone Jokwe, on 7-8 March 2008, on some structures of the fortress of São Sebastião, Ilha. I read two technical reports on the consistency of the damage, and during my last study visit, I wanted to inspection it for a better knowledge.
The picture shows one of the places where the damage wasn't so relevant. I found damages only on the outer wall of the low square which had been built directly on the reef. In the same point, however, a collapse had already occurred in the past. An examination of the collapsed material made evident that what had collapsed during the Cyclone Jokwe was a rebuilt, but reinforced wall. The new wall was equipped with a sort of buttress: a second parallel wall had been built in adherence to best oppose the waves. Analysing the underlying rock, that point is clearly much battered by the waves due to its geographical and environmental conditions and the coral rocks are more worn than the ones nearby.

Figure 3.38.: The low platform of the fortress of Ilha to the east, called *campo de tiro* or cemetery. [*M.B., 2009.*]

The reconstruction and integration of the cliff, here and in other nearby points, show that the ancient keepers had already protected and repaired the parts of the reef more eroded by ocean waves, as they are today.

Figure 3.39.: Erosion pots with artificial additions [*M.B., 2009.*].

The coral stone buildings require a constant care of the plasters which, together with the covers, ensure the necessary level of protection of the walls to avoid the phenomenon of disintegration due to salt. The practice of patching may be performed as in the past, using slightly porous plasters to avoid the penetration of marine aerosol and rain.
As it can be seen in the pictures below, the fortress was plastered in the past; that is a restoration issue to be faced with special care for formal, historic and material reasons.

Figure 3.40.: The current practice to supplement the plaster gaps and the restoration works on the faces of the fortress [*M.B., 2009.*].

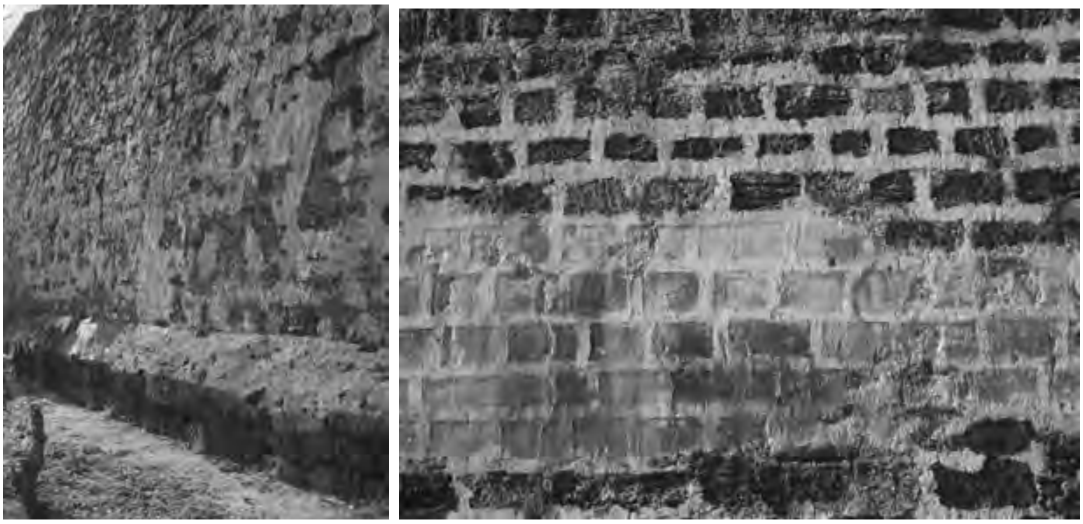


Figure 3.41.: The problem of plasters in the Fortress of São Sebastião [*M.B., 2009.*].

The observation of the site called for some methodological reflections on the general issues of restoration in architecture. As to the integration of portions of the walls, an effective restoration is achieved adopting simple measures such as the compatibility of new materials and, most important, eliminating or, when not possible, multiplying the points of contact among the limestone blocks; that would avoid the concentration of loads undermining the static equilibrium of the whole.

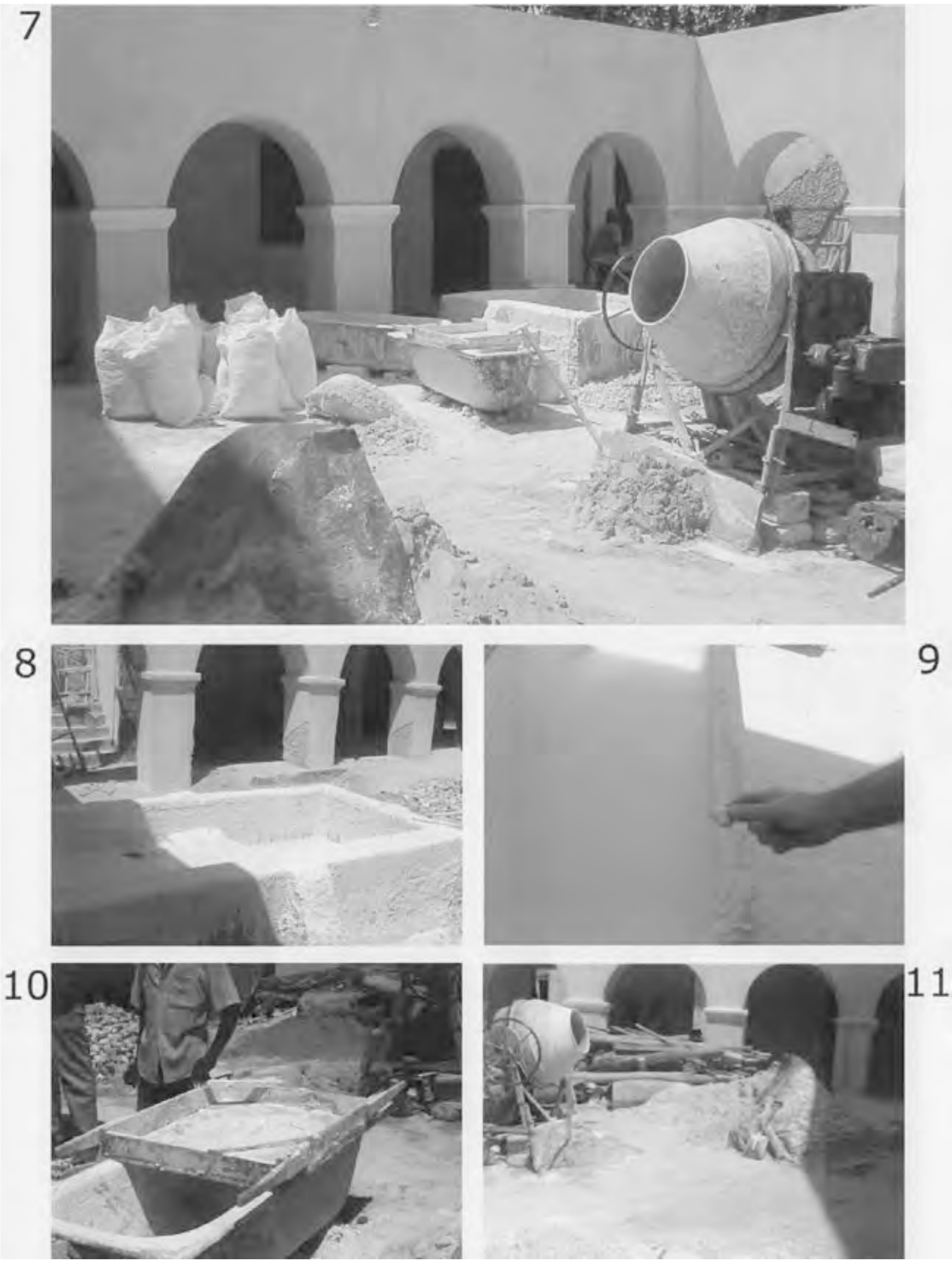
On the contrary, the recovery or re-draft of plaster require a greater skill. First of all, if the firmness solidity of the existing plaster and of the wall can bear - but in these Mozambican buildings it very rarely happens -, a simple wash with fresh water is needed; at the same time, the drainage cannulas should be temporarily placed at the base to make easier the removal of salts. In this type of masonry, the plaster finish is laid in two layers; the ultimate goal is to protect the masonry keeping in mind that it should transpire.

A very thin porous plaster prevents rainwater infiltrations and, at the same time, allows the wall to transpire. Under the plaster finish, the plaster can re-structure the wall. Small pieces of coral limestone can be used to reduce the plaster thickness while a good hydraulic lime should be used to improve the mechanical strength of grouts.

Hydraulic lime wasn't available in our case, but common lime can have the same behaviour as hydraulic lime adding Portland cement. Furthermore, the same effect can be achieved adding a fixed quantity of clay or pozzolana. Special care is required in the final layer of plaster: the mixture should be carefully evaluated and its application checked by slow drying, sprinkling fresh water so

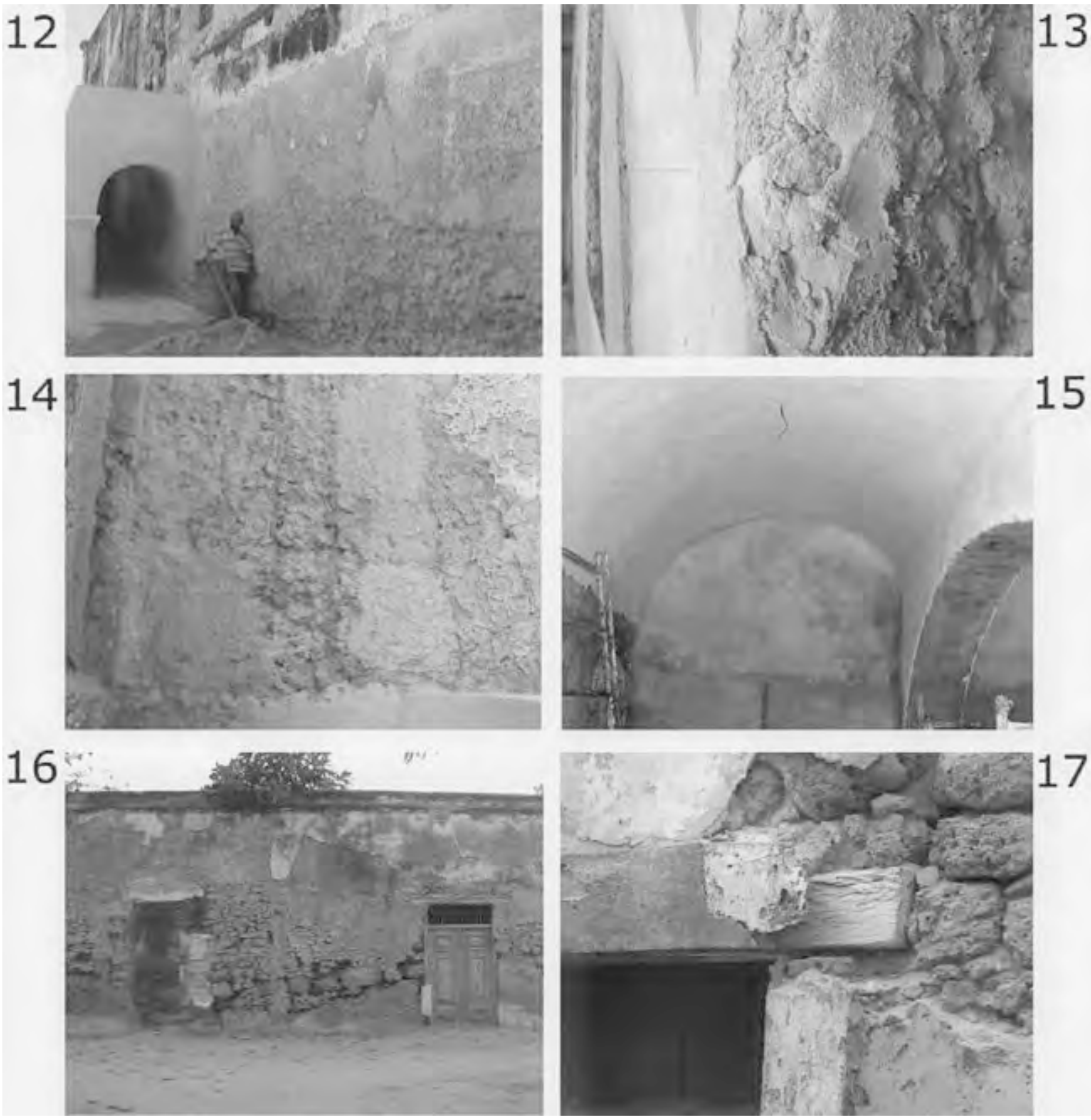
The outside and the passage to the house (Figures. 1 and 2).
Before restoration, many sections of the house walls were in dilapidated conditions and therefore extensive additions were necessary to make up for loss and dispersed material. Stones from an old limestone quarry in an ancient coral reef on the mainland coast were used.
The material was cut into pieces of varying sizes, according to the plan necessities. The larger pieces were used in the missing wall blocks (Figure. 4), while the smaller pieces were used to reduce the small cavities caused by the dissolution of the mortar as a result of the reformation of cyclic salts (Figure 3).
The need for mortar enticements in shooting walls, the deep stucco work and the finishings were made on site using river sand, lime from the national industrial production and fresh water (Figures. 5 and 6).

Figure 3.42.: The restoration site of an old *casa-feitoria* in Ilha de Moçambique [*Photo by Mohamad Arif, 2004.*].



Special care is given to the extinguishing of lime in bags supplied by the factory (Figure.7).
The lime powder is poured into a tank with water and, according to the chemical reaction CaO + H2O = Ca (HO) 2, it becomes slaked lime, or calcium hydroxide.
The employed lime is sieved to prevent lumps once in situ (Figures. 7, 8 and 9).
The sand is sifted to free it from impurities (Figures. 10 and 11) to get a very thin porous plaster. The plaster finish is applied in two layers to prevent crimps.

Figure 3.43.: Lime in the yard [*Photo by Mohamad Arif, 2004.*].



When repairing a wall, the concentration of loads which could damage the whole static balance is carefully avoided (Figure16).
Localized simple washing with fresh water, using drainage cannulas at the base makes easier the removal of salts (Figure 12.)
The plaster finish is laid in two layers according to the type of masonry (Figure 17). The final goal is to protect masonry, keeping in mind that masonry should be allowed to breathe. Under the plaster finish, the first layers of plaster are properly restructuring (Figure 13).
Small pieces of coral limestone can be used to reduce the thickness of the filler. A good hydraulic lime should be used to improve the mechanical strength of grout .
Special care is required in the final layer of plaster (Figures. 14 and 15).

Figure 3.44.: Treatment of the walls of the *casa-feitoria* [*Photo by Mohamad Arif, 2004.*].

that the layers remain uniform and without crimps.

The number of sprinklings are necessarily determined on a case by case basis, depending on exposure and solar temperature.

The observations on this case study were made possible thanks to the interviews given to Mr Arif by the Direcção dos Serviços Urbanos in Ilha de Moçambique, by the Norwegian architect Per Morten Ekerhovd and Mr Momade Assumane.

From the 2004 interviews, we came to know that the restoration of this building, an old Feitor of the 19th century, was carried on with the aim to build a tourist guesthouse. The building is entirely constructed in coral stone of low compactness. The interviews confirmed that the methodology developed for the restoration of masonry and plaster were based on the traditional architecture of the *Cidade de pedra and cal*, not completely disappeared on the island.

Before restoration, the house walls were in a state of decay and an imminent collapse was feared. The widespread disappearance of the external plaster was not an immediate concern but gaps in the surrounding walls, especially in the pillars of the courtyard porch, required immediate action.

The urgency of the works and an insufficient local testing of the most advanced techniques of structural restoration, such as consolidation by injections of binding material, forced the integration of the numerous wall gaps or, in limited cases, the radical reconstruction using the materials and techniques peculiar to this ancient building. Then, after careful discussions with the local environmental protection offices, the necessary quantity of stones was extracted from an old limestone quarry on the coral coast of the mainland.

According to the project, the material was cut into pieces of larger and smaller sizes; the larger pieces were used to supplement the missing blocks of the walls, while the smaller pieces were used to reduce the cavities produced by the dissolution of mortar, due to salts, and also to reduce the thickness of the new grout. The mortar needed for enticements in walls and the deep stucco finish were packaged on site using river sand, common lime of national production and fresh water.

Site restorers scrupulously followed the traditional procedure for a most accurate extinguishing of the mortar. Supplied in bags from the factory, powder lime (CaO or common lime) is poured into an extinguishing tank adding water and, according to the chemical reaction $CaO + H2O = Ca(HO)2$, becomes hydrated calcium, that is slaked lime. According to the the amount of mortar required for the various works in progress, slaked lime is drawn off from the tank. Before mixing it with sand and water, slaked lime is sifted through a sieve so as to intercept any lumps of not yet slaked lime that could cause some damage once the mortar has been applied to the wall. Sand is sieved to get a very fine rendering and to free it from impurities. Coral limestone and lime mortar were used for filling the gaps in the walls; in fact, compatible materials alternatives to coral stones weren't available.

In our case, the gaps are the result of the disruption or loss of coral stone blocks (aggregate in the wall) and of the disintegration of the mortar (connective tissue of the wall). These factors lead to concentrations of loads dangerous for the static balance of the whole, where the limestone blocks are in direct contact. With the use of mortar and coral stones these points of contact can be eliminated; alternatively, the contacts among the blocks are multiplied in order to distribute loads on different parts.

If a new layer of plaster must be put on this type of walls, a more elaborate procedure is required than the one used for the compensation of the gaps of the walls on the whole.

First, a deep wash with simple fresh water is necessary, if the still existing plaster and the wall itself allow the operation. Drainage cannulas can be temporarily placed at the base of the wall in order to facilitate the removal of the salts. Plaster is laid out in two or more layers according to the type of masonry. The final goal is to protect masonry from outside moisture, still maintaining a high degree of transpiration. A very thin plaster porosity prevents rainwater infiltrations and, at the same time, allows transpiration.

The first and deeper layers of plaster can restructure the wall as they should help to re-establish a homogeneous static behaviour of the whole architectural volume. A plastering of reduced thickness allows mortar a smooth and continuous carbonation. Small pieces of limestone can be used to reduce the plastering thickness. For improving the mechanical strength, a good hydraulic lime should be used to combine a chemical reaction among the elements.

In our case, due to the unavailability of hydraulic lime, a small percentage of Portland cement is added to common lime (a volume of concrete and two of lime). The same effect can be achieved by adding a certain amount of clay or pozzolana to lime.

The last layer of plaster - the external one - is treated with special care to get a very fine porosity and homogeneous distribution. The carefully sieved mixture is applied on the underlying layer of plaster and kept wet; its resistence will be increased wetting it with fresh water for a few days. The result is an uniform hardening of the plaster and a surface without cracks. The final paintings helps to further reduce the pore size if lime penetrates deeply into the plaster, after dilution with plenty of water and applied in multiple coats.

In August 2009 I was able to visit the beautiful house now restored and inhabited by friendly owners, Amelia Cumbi and Enrico Parignani.

In my visit I collected some new information; so I must correct what I had published, on the state of the yard in 2004, owing to a personal misinterpretation, in my previous publication on coral stone buildings in Moçambique[41]. The old arches in the building are not ancient vestiges but the result of a successful restoration[42].

[41] Berti and Arif, 2005

[42] I wish to thank the people in the text and Mr Stefano Ferroni who introduced me. The technical director Mr. Antoine Millerioux is now restructuring the house of Mr Ferroni, as well as Mr and Mrs Parignani's. I wish to thank him for showing the *Murrapa* plant I had been lookin for years.

Part II.

Miscellaneous cases

The Red Castle in Tripoli and the site of Sabratha.
The Arab Coasts.
Conservation of 16th century bastions.
The restoration of Defterdar mosque in Pejë/Peć.
A method of strengthening.

4. Miscellaneous cases

4.1. The Red Castle in Tripoli and the site of Sabratha

Why this section?

This paper is a short report of a scientific mission in Libya in 2006. It describes the main themes of restoration and conservation within the project of renovation and development of the Red Castle in Tripoli.

The issues relating to the Red Castle conservation are in close relation with the topics covered in this paper on the development of coral stone constructions.

The paper highlights are the following:

- the porous sandstone used in Tripoli is subject to phenomena of moisture absorption, as it can be seen in many varieties of coral rock used in the constructions along the African and Arab coasts;

- the Red Castle and the African and Arab architectures belong to the coastal regions closer to the equator, and then each construction is affected by the combined actions of marine aerosol and strong sunlight[1].

The Red Castle and its urban context. The Green Square is a large space clearly separating the last century town from its older parts. Probably because

[1] Project name: *Recupero e valorizzazione del Castello Rosso di Tripoli. Studio di fattibilità e formazione del personale. Legge 212/92 - Prima fase*. Group Leader: University of Urbino Carlo Bo; Local Partner: Department of Antiquities of Tripoli; Italian, Partner: Scuola di Specializzazione in Restauro dei Monumenti University of Rome La Sapienza; Italian Partner: DeMine – Ngo of Florence.

Activity 4: *Design and development - introductory topics to a conservation project*.

The topics described here are a rewriting of the report I drew up during a mission with Project Team Leader Laura Baratin, University of Urbino, from 1st to 7th June, 2006.

The same topics were discussed with the Project Scientific Leader Giovanni Carbonara, University of Rome La Sapienza.

Figure 4.1.: The front of the Red Castle facing the sea. On the left the Green Square; on the right the former headquarters of the *Cassa di Risparmio della Tripolitania* [*M.B., 2006.*].

of the width of the square, an observer may find it difficult to make a panoramic comparison between old Tripoli – the Medina and the Red Castle - and the later urban parts stretching to the east and south. The recent development of numerous towers has introduced a sort of dissolution in the compactness and continuity of the urban skyline of the Medina and the castle thus modifying visual quality kept up until a few years ago, according to the cone of perspective from the sea. Anyway, from some viewpoints, the castle is still retaining its architectural and material features giving it a special monumental evidence in its context.

The idea of considering the context problem as fundamental for the setting of the first castle conservation issues was a direct result of the reading of the most recent historical studies showing an interest in the problem. Among the various aspects historians have studied, we consider of prior importance Armando Brasini's architectural and scenic work, designed and put into practice between 1922 and 1935.

During the June 2006 inspection, the most striking aspects of the architectural report submitted by the *Cassa di Risparmio della Tripolitania* and the castle were discussed. We believed that the formal details of the two buildings were designed by Brasini as the symmetric elements of a single monument; in particular, from the north-east point of view, the castle and the bank are perceived as a single architecture despite the obvious differences in style, colour and texture of their wall surfaces. The large high arches on St. James's bastion built where once was the parapet and the whole volume of the bank with its corner towers

Figure 4.2.: The prospect of the Red Castle facing the Green Square [*M.B., 2006.*].

seem elements emerging from the same architectural elevation. The main formal elements of the castle and bank facades seem to be the same as the ones of the castle facing the Green Square.

Together with the problem of the context, but of no secondary importance, is the external surface of constructions. The facade surfaces of the castle and the bank were carefully evaluated and, similarly, the different appearance between the castle and the Medina must receive the same consideration. Their different appearance was introduced in the years from 1922 onwards, removing the many buildings constructed next to the castle wall together with the plaster from the outside facade.

Finally, there was recently placed a new external layer to the South West bastion using a sort of limestone with different characteristics from the stones used mainly on walls of castle; this fact, in particular, has raised some perplexities. The new management of the Department of Antiquities has now blocked the works.

Further information:

Geological and technological investigations have been proposed for the context problem. In particular it is necessary to collect data on the characteristics of the ratio used for the relining of the southwest bastion and the laying out and processing techniques.

We are willing to pay a particular attention to Armando Brasini's indications on the issues of the urban context concerning the historical studies and the collection of file data.

The construction of the new museum. Between 1982 and 1989 the new museum of Tripoli was built, designed by Robert Matthew, Johnson-Marshall and Partners. The previous archaeological museum, built between 1934 and 1939 and designed by Florestano Di Fausto, was partially demolished[2]

A search for the old museum remains integrated into the new one, is at present only of generic interest while it is of greater interest to know exactly which changes and structural reinforcement of the foundation level were made in the construction of the new museum for the purposes of the restoration project. During our inspection we thought that the decays of the curtain overlooking the sea had been stopped with the construction of the museum. We still can see some hints of previous injury. Therefore, the studies and reports on the new museum written in the 80's of the last century must be examined carefully.

Further information:

With reference to the problem of the new museum building, we realized that there were the project documents and part of the preliminary studies carried out by the new archaeological and anthropological museum of Tripoli, which can be found in the Department of Antiquities. During our studies, we considered the idea of making a digital copy in order to provide a most suitable and easy-to-access filing system. Data on consolidation works made during the construction of the new museum must be obtained and evaluated for any future restoration project.

Historical mapping: the castle structures and its urban context. It is useful to consider the relations between the Medina and the castle for developing an appropriate plan of the conservation and restoration techniques. For our purposes it may be more appropriate to look at the construction techniques rather than at formal issues, although they are plenty and of great interest. However that choice wouldn't keep apart the formal and figurative aspects, where necessary.

As a rule, historical cartography and iconography offer the fundamental guidelines to restorers even if their interest is strictly for conservation. The attention to constructive techniques and ancient materials requires an exploring and a direct observation of the object to be preserved. We have to keep an appropriate caution with formal and compositional problems facing to the historical iconography. Meaning that often it is better to keep a cognitive process in progress and therefore we prefer not to use the historical iconography as conclusive for

[2]The Jamahiriya Museum. 1990. In MIMAR 35: Architecture in Development. London: Concept Media Ltd. [*Quotation as recommended by the Editor*]

understanding the object for documentation. In this view, we evaluate two documents collected for our study.

John Seller's map and view[3] have no logical equivalent in the timeline of historical iconography. Probably the purpose of the drawings didn't lie in the topographical or typological recordings of Tripoli, but the thick transcript of levels, presumably with reference to the dock depth, could offer some ideas for improving the knowledge of the castle environmental state in the past.

The second example is an aerial photo of Tripoli, referring to the 30's of the 20th century, where the hypothetical major axes of the Roman city are drawn or, better, outlined; perhaps, they refer to Di Fausto's settling of Marco Aurelio's arc area (1911-12 restoration) by, from 1932 until 1936. This second interesting document should be considered more for its documentary value of an unexplored study hypothesis rather than a collection of data useful to the formulation of our conservation plan.

Further information:

At present, the reconstruction of the castle history, linking files with the current state of the monument, is being performed through a systematic cataloguing of the historic iconography directly referring to the castle and an in situ measurement campaign.

What remains of the rampart: floors for walking, moisture and water - I. The Red Castle was fitted with compressed earth embankments during the war between the Spaniards and the Turks in 1551. But the reconstruction of defenses was not complete. From the time chronicles, the most appropriate technical layout, using compressible soil, was executed behind the curtain wall stretch between St. James's and St. George's bastions. Between St. James's bastion and Saint Barbara's platform, however, the embankment was built with sand, a material not suitable for the ammunitions of the curtains. Thus, thanks to the weakness in the defensive points, the Turks broke into, driven here by the information given by a castle defender.

Today a part of the 1551 embankment could still be present, at least the one reported in journals and referring to the attack efficiency shown by the Turks because of ramparts built. Probably, the roof gardens and the new ramp to the Governor's palace, as Armando Brasini arranged them between 1923 and 1934, are an adaptation of the 1551 rampart. Perhaps a rampart part still exists between St James's bastion and Saint Barbara's platform. The embankment of the rampart is a problem for two important reasons related to the conservation

[3] John SELLER, *A Map of the Citie and Port of the Tripoli in Barbare*, London 1675.

of the monument:

1. the special attention in the survey to preserve the historical data of the terrain and to know the old and new underground ducts;

2. the widespread phenomena of the walls decay, due to the rising dampness or the moisture contained in the ramparts themselves, must be diagnosed.

The presence of compressed soil should be checked after it was detected during the Medina walls demolition in 1920, and its origin should be discovered.

Further information:

The problem of the embankment ramparts is dealt with from a geotechnical perspective through the execution of manual tests and micro coring in order to determine the material composition of the rampart between St. George's bastion and Saint Barbara's platform. As a result, the origin of the material used to fix the mound could be hypothesized. Investigation of the sources on the embankment issues will be effected in the archives.

What remains of the rampart: floors for walking, moisture and water - II. The survey campaign will graphically describe in an accurate way the layers of the horizontal planes at different floors, even the outdoor ones not intended for walking. The work has never been done before and is a necessary priority. The simplified or brief horizontal sections now in existence don't allow to well track the complex network of waste water collection and the disposal of rainwater. Also, the plans related to the project of the archaeological museum by Florestano Di Fausto (1935-40), obtained with five planes of section, are insufficient for the purposes of our study.

During our inspection, the architects supervising the maintenance of the castle, have confirmed that there isn't a map, neither approximate nor incomplete, of the system for collecting surface and disposal water. Certainly we can't exclude that there are phenomena of rising damp, at least at the points close to sea level, but it must be diagnosed with certainty; many of the phenomena of the walls disintegration we've seen in backyards or in the castle closed environments are related with water stagnation when it isn't removed by the drainage networks. A phenomenon with different processes from the ones observed inside the castle is the disintegration of the walls exposed to marine aerosol.

Further information:

Planimetries will probably be drawn with reference to all the plans for use and feedback in vertical sections. A survey on the existing networks and their state of efficiency will be made. A thematic subject of the survey campaign is reserved for a graphic depiction, in plans, prospects and sections, of each area degraded because of moisture. A special *monitoring is needed to understand the real characteristics of rainfalls which can cause serious damages to masonry, despite the low monthly rainfall average of about 50mm between October and February.*

What remains of the rampart: floors for walking, moisture and water - III. After the recent construction of the motorway on the coast between town and port, the action of sea salts on the castle curtains isn't so damaging nowadays as it was in the past. An artificial lake was created between the highway and the castle to remove any storm damages.

Before, the two pedestrian walks along the marina were linked by a road crossing the castle - architect Di Fausto's museum was overlooking it - and outside, at the foot of the curtain walls, by a narrow pedestrian path, unfit to shelter the monument from direct sea action. The wider pedestrian road, recently remade to linking the two walks designed by Armando Brasini, seems to have been projected together with the new museum.

The news about the contact of seawater with the walls of the castle should be well documented and understood, in order to measure time and solidity against erosion and its possible cycles. Under many aspects (salt solutions, open porosity limestone, high temperatures etc.), this type of disaggregation corresponds to the cases we studied in coral limestone buildings along the east coast of Africa.

The preservation of the castle on an urban scale requires a defining of the construction dates of the coast highway along the basin of the artificial lake and the setting of the dates of the next improvements of the pedestrian path at the foot of the castle curtain towards the sea.

Thanks to the studies and statements of geology and chemistry specialists, the processes of disaggregation of plasters, surface and mortars, of the natural stones in the castle curtain walls due to soluble salts will be revised. Furthermore, as far as meteorology is involved in this aspect of urban settlements, the data on the amount of rainfall and on the seasonal behaviour of the sea must be retrieved considering rainfalls and tides.

A comparison on the advantages of the plaster, the resin or the masonry without plaster. From a letter dated May 15, 1936, kept in the archives of the Government of Libya Public Works department, we learn that in Derna a product for consolidation of stone surfaces was widely used. The text states that *for the application of SILEXOR* (a product used by Ferruccio Rossi's company) *I'll always practise the lowest prices, because I'm willing to introduce a very solid, washable, excellent lasting product, widely used for its quality in the conservation of the works of*

Figure 4.3.: The disruptive effect of salt crystals in the buttress on the side of the Archaeological Museum entrance; the unfinished cladding of the Southwest bastion [*M.B., 2006.*].

art of soft stone, concrete, plaster façades.

In my opinion, architect Liliana Mauriello reported some information of great interest for the historical research. In order to check the effectiveness and the results of these materials after such a long time, it would be useful to determine whether the consolidating applications - silicates, resins - have been actually carried out and where. As to the protection of wall surfaces, we can see that the bank and the transformations of the castle made by Brasini are the only one or two of the few buildings in Tripoli old town that do not show a protective plaster.

With the geometric survey the different textures of the castle curtain will have to be carefully represented, as they appear today, without neglecting any more radical interventions executed later between 1920 and 1940, even the latest ones. A detailed mapping of these typologies of the castle curtains could influence the project for the protection of the not yet plastered walls.

The arched wall, Brasini designed and built as *opus incertum* without plaster and with very accurate joints, is in a good state and, at the moment, doesn't require any protective guard. It would be interesting to know whether the stone satisfactory conditions in this added part is due to the different geological characteristics of the stone in relation to the older ones, to its location out of reach of marine aerosol or other causes.

The main thematic maps based on the surveys are related to the knowledge and distribution of the materials, to their conditions, to the identification of construction types and to the historical building phases. The graphic design features will be made on the basis of the thematic maps of the survey.

Plasters of the past - I. Archaeologists know well that Phoenician and Roman town walls on the Libyan coast were generally made using blocks or soft rock slabs with open pores (calcarenites, sandstones, etc.); the exposed surfaces were systematically protected with plaster. This peculiarity can easily be observed in the archaeological town of Sabratha. There, different methods of preserving some of the plaster fragments can be noticed. Various methods of consolidation and protection of the ruins exposed have been adopted during subsequent archaeological campaigns and, in time, they have shown varying degrees of effectiveness.

The technical and scientific literature produced on the subject during the numerous archaeological campaigns on the coastal sites in Libya must be explored in order to know:

1. the actual prevalence of the plaster protective practice in ancient times;
2. the degree of effectiveness, if verified by scholars, of the protective practice in marine areas;
3. the composition of the most efficient plasters.

The problem of the protection of exposed surfaces is defined in a lot of ways - historic, archival and archaeological. A systematic technical and scientific bibliography relevant to the archaeological excavations along the Mediterranean coast of Africa is a priority. In particular, information on the presence in ancient buildings of plaster protecting them from marine environment aggression will be sought.

Plasters of the past - II. Maintenance practices are being developed, so anything recorded and processed for the protection of historical buildings according to traditional methods should be collected.

A state Institute of Studies for the protection of Tripoli Medina has been recently founded. The cooperation partners of the Libyan Department of Antiquities or of the University should be involved for the archaeological data associated with the traditional techniques still in use.

In agreement with the Technical Unit in the Department of Antiquities in Tripoli, it will be contacted the Institute for the Protection of Medina in order to implement what has already been drafted and turn it critically to our study.

Desalinate and whitewashing. As to the case and application studies on coral limestone already mentioned, desalination treatments are suggested only where there is a real need, to be determined during following studies. As a matter of fact, the presence of a moderate amount of salts in masonry can be

Figure 4.4.: Part of the old plaster of a house on a public road in the archaeological site of Sabratha [*M.B., 2006.*].

irrelevant to the state of preservation, provided moisture doesn't transport any saline solutions through the pores.

Indeed, the migration of soluble salts in the castle should be inhibited in both phenomena where it occurs - capillary tension and horizontal penetration.

As to capillary tension transmigration (first phenomenology) with a feeding area from the bottom, a solution should be studied for each case. However, real cases of rising dampness should be limited; the observed ones are mainly due to the stagnation of rain water through the structures and earthworks, from utilization plans higher than the ones below. This type of moisture should be greatly reduced once an effective drainage for rainwater will be set up.

As to salt transmigration due to horizontal moisture penetration (second phenomenology), the surfaces exposed to pouring water or marine aerosol should be protected. If the traditional protections - including the ones on the coast of Africa - indicate micro-porous plaster are an effective solution, in this specific case light applications of whitewash should be studied and yearly renewed. As a matter of fact, some historic buildings in Padua and Fano, Italy, are now protected by only one layer of plaster – a technique devised by the members of the study group, carefully planning the mixture and the particle size of aggregates - as advised by Dr. Stefano Odorizzi, of Tassullo Company. This type of plaster,

Figure 4.5.: Ramp and hanging garden from the entrance of the Department of Antiquities building in Tripoli, on the ancient castle/fortress rampart [*M.B., 2006.*].

especially thanks to its flexibility and easy fitting to deformed surfaces, can be regarded as a whitewashing. The purpose for preferring a whitewashing rather than a thin plaster lies in its ability to not completely hide the ancient surface or its irregularities, altering as little as possible the material substance and also the image the monument has gained during its history, all without compromising any of the protective capacities of the plaster itself.

Using the tools of chemistry and science of the materials, a program of applications of the various types of whitewash or thin plaster should immediately start, checking the stability of its effects.

Drainage as a priority. During our visit to Tripoli, the idea of giving priority to the creation of an effective network for rainwater disposal, the same as the so-called white water, was discussed with the Department partners, who confirmed that there wasn't a network connected for inspection and maintenance. Such a work is preliminary to a more complex conservation program. Indeed, its immediate effect could result in a general reorganization of the disruptive phenomena now widely affecting masonry, plastering, decorations and wall paintings.

It will be rather expensive and the planning of a network of canals and pipes will not be an easy task. The surveyor must know that the study group decided to work according to said priority, in order to properly orient the surveys and their graphical representations. The project coordinator will personally follow the survey and to a better achievement, she will use some special tests of the equipment - radar, electromagnetic surveys, and direct visual and manual samples).

This procedure should also ascertain the rainproof and mechanical efficiency of all areas of use and of the covers which are generally flat.

Detection and special investigations will give the site full morphology in order to devise a complete removal of surface water. The critical points will be detected especially where moisture degradation is evident and there is a drainage network, even if not working. As a first step in an overall restoration project, the definition of the complete network for the removal of rain and of technological systems water is a priority.

4.2. The Arab Coasts

Why this section?

The various themes of the architectural heritage conservation need to be carried out on a historic perspective. For the study cases discussed here, it is useful to refer to a relatively wide region corresponding to the north-west coastal area of the Indian Ocean. Archaeologists and historians have described a coherent historical environment able to explain the nature and evolution of coral stone buildings. At least until the 16th century, the name Arabia Felix was given to the Arabian Peninsula and the south western shore of the Red Sea. The knowledge of the Arabian Peninsula and the African coast heritage may help to better understand some aspects of the Swahili presence on the analysed African coasts.

Historic buildings of stones and coral limestone mortar can be found on the east and west coasts of the Red Sea. As it happened with Swahili societies on the coast of Africa in different periods from the 17th century on, also on the Arab coast the evolution of economics and the changing social habits have resulted in a state of neglect for the buildings for several decades. The lack of maintenance and the adverse natural environment quickly deteriorated an architectural heritage of historical interest that can still be recovered for use.

In recent decades we have witnessed the importance of actual and intended utilizations in the policies of the architectural heritage conservation. Utilization can often solve various issues in restoration. Sometimes, a new suitable use for an historical artifact which has lost its original function, is a more difficult task than the effort required for the application of modern techniques compatible with a proper rehabilitation of ancient long forgotten building techniques.

One of the latest studies on coral stone architectures - *The Conservation of Coral Buildings on Saudi Arabia's Northern Red Sea Coast* by Aylin Orbasli (2009)[4]- deals with the problems of knowledge while keeping a constant attention on the reuse issue. In the article there are the results of a whole year of studies (2006-07) on coral stone buildings in the towns of Duba, Al Wejh, Umluj and Yanbu Al Bahr on the northern coast of Saudi Arabia on the Red Sea. The task was to find new uses for historic buildings and find appropriate methodologies for their conservation. At the beginning of her article, Orbasli states there are substantial differences in the degradation of the four centres. The recovery of the historical districts in Duba and Umluj appears difficult for the strong impact impressed by the overall urban development, while the historical centres of Yanbu and Al Waj are reasonably intact and have a chance to be restored thanks to proper maintenance practices. The observation of the overall cohesion of historic buildings is a must in this type of architecture where efficient protective components, such as plasters and roofs, play a more important role than structural components, such as walls and intermediate floors. Suakin, on the west coast of the Red Sea, is a well known example of the decay progress of one or more coral stone architectures in the same historical area.

The theme of preserving the coral limestone architectural heritage must be developed according to the history of the region.

Until the 16th century at least, the name of *Arabia Felix* was given to the Arabian Peninsula and the southwestern shore of the Red Sea as well. So the coastal heritage of the Arabian Peninsula and of the African coast are both considered.

Perhaps we can usefully speculate on the conditioning the continent had on the Swahili coastal settlements going beyond Mark Horton's results[5], and then locate

[4]Aylin ORBASLI, *The Conservation of Coral Buildings on Saudi Arabia's Northern Red Sea Coast*, in *Journal of Architectural Conservation*, n.3, Donhead Publishing Ltd, Shaftesbury 2009, pp. 49-64. I wish to thank Aylin Orbasli for sending me the two pictures of hers published in the text.

[5]Horton, 1996; Horton, 1991.

According to the Aylin Orbasli observations, Arab houses along the Red Sea coast are structured with wooden chains arranged in the thickness of the wall. The bearing walls are built of coral stone courses by placing allurements of lime mortar. Each cm of meter twenty rising, they settle down a rail of wood, which are called in Saudi Arabia *taglilat*. It is believed that the use of this wooden structure can increase the elasticity of whole masonry.
Orbasli gives an interesting interpretation about the local custom of keeping rail of beams without the protective plaster. This solution would allow easy identification of any local failure of the masonry because of the disintegration of coral stone and thus allows a rapid and easy restoration with new elements.

Figure 4.6.: A house in Al Wajh on the west coast of the Red Sea [*Photo by Aylin Orbasli, before 2008*].

After Port Sudan was created in 1922, Suakin began its slow decline. Today, however, Suakin is the most valuable place of memory for reconsidering restoration and preservation of the historic centres on the Red Sea, the Arabian Peninsula and African coasts, facing the Indian Ocean, in terms of mere physical preservation.

Figure 4.7.: The government palace of Suakin [*Photo by Mauro Serafini, 2005 in Google Earth - ID: 18679947*].

an ancient matrix created by the Egyptian architectonic civilization, attributing it to the traditional buildings now existing on both sides of the Red Sea.

This idea was inspired by the 19th century French archaeological reconstructions around the topic of houses in the Pharaoh era where, as it has been suggested, the technique of a masonry structure with wooden beams was used. But the major difference between the hypothetical building models on the River Nile compared to the ones of the banks of the Red Sea lies in the fact that wood is used with two types of very different wall materials: adobe and the coral stone. The practice of combining wood with masonry has some historical precedents in Europe. The comparison between architectures built with mixed wood and brick structures in the Arab and European regions, shows aspects which could provide opportunities for a deeper understanding, at least from the point of view of the history of technology. In many regions of the Roman world the building practice using wood as a temporary or permanent structural masonry support was common.

Both *muri formacei*[6] in compacted earth, where the use of wood is mainly limited to a temporary housing function, and half-timbered walls, where wood is

[6] VITRUVIO, *De Architectura*, lib. II. cap. VIII. PLINIO, *De Historia Naturalis*, lib. XXXVI, cap. XXII.

Restoration of Defterdar mosque. Left: a phase of partial replacement of the chestnut chain in the outer perimeter wall of the mosque, in the rail on the fourth level. Right: the same wooden chain already repaired, but on the main prospect. The description of project and works can be found later under the title: The restoration of Defterdar mosque in Pejë/Peć.

Figure 4.8.: Chestnut chains of Defterdar Mosque [*M.B., 2009.*].

the final element of the building[7], are the products of primitive construction techniques evolved in time, producing samples of historical architecture of the West. Large concrete buildings were made using the same *formacea* technique, while the timber-framed building technique was used for later concrete and iron buildings. In the West, this construction system was widespread in Germany where whole towns were built, especially between 15th and 17th centuries. It was used in England, France, northern Spain and northern Italy.

The Arab habit of building walls using wooden elements can be described as follows:

The walls are built putting coral rubble courses on lime mortar beds. Every four/ feet inches of elevation, horizontal timber reinforcements are put; in Saudi Arabia they are called *taglilat*. The use of wooden parallel structure increases the elasticity of the overall masonry. Timber boards or beams have the function of architrave to minimize the effect of load concentration at the walls doors and windows holes. It's interesting to know that in the homes of wealthier owners not only the local palm wood was used, but also wood imported from other regions. The amount of wood used in this technique was big, so the cost of a home for the rich should have been really considerable.

I found the same technique in Defterdar mosque in Pejë/Peć, as in the *kulla*[8]

[7]The construction of a skeleton of wooden lattice beams, with brick infill panels, mixtures of straw and clay or stone or less tied with Malta. It is sometimes applied a plaster of chalk. It is an ancient technique, used especially to construct ordinary buildings.

[8]The Albanian word *kulla* means tower. It is a very common type of dwelling in the Dukagjini valley, the

Restoration and reconstruction of Mushkolaj Kulla in Decan/Decani. Left: The final phase of the work conservation of ruins survived the fire of 1999 and ten years of total abandon. Right: reconstruction of the destroyed parts with the traditional use of wood as a structural element. The system allows the thick walls of river stones and lime mortar to take moderate deformation when stressed mechanically. In our case, the traditional use of wood has been reinterpreted in a critical way, following Professor Predrag Gavrilovic design. Now the building can resist the most severe earthquake.

Figure 4.9.: Fir chains in Mushkolaj Kulla, Decan/Decani [*M.B., 2009.*].

and in earthen houses in Kosovo. There, a track of fir or chestnut rafters covers the whole horizontal section of the wall. The beams are held in place by nailed wooden elements at intervals of about one meter, with the purpose of increasing the elastic capacity of the masonry.

It is difficult to recognize the existence of a historical connection among examples coming from far away regions, but a study hypothesis may be made, justified even by the Ottoman centuries-old cultural and administrative presence in the Balkans.

However, it sometimes seems that architectural techniques possess an intrinsic universality of such an inner nature that it isn't easy to identify their sources and contaminations, differently from what happens with the forms of historical architecture that often express explicit regional values easier to be identified.

ancient west lake in Kosovo. This house is the most ambitious symbol of the Kosovar and Albanian populations of Islamic culture. Kullas strongly express a peculiar family and social conception. In my 2008 to 2009 stay in Kosovo I have often felt the cultural orientation to give those monuments a special ethnic and cultural meaning. However, I believe that the cultural and regional origin of Kullas may be a promising field of studies and discussions. In Azerbaijan we can find the same type of historic buildings of the same name, in particular along the coast of the Caspian Sea. See in: *Joumal of a Tour through Azerdbijan and the Shores of the Caspian*, Communicated by Colonel Monteith. E. I. C. Read 13th February, 1832, in *The Journal of the Royal Geographical Society of London*, Vol. 3th, 1933, Johon Murray, Albemarle-Street, London 1834, pp. 1-56.

In Ilha de Moçambique monumental hospital, vaguely neoclassical in style, a systematic use of wood for structuring the walls of the three front volumes was adopted in the last quarter of 19th century. Most likely, it is a diligent application of a Portuguese system, bravely recalling the late Enlightenment, in 17th/19th century reconstruction of Lisbon Baixa which took the name of Baixa Pombalina, rather than a late Arabic contamination[9].

Indeed, some doubts remained observing the frequent cases of masonry structured with wooden poles. This widespread technique is known as pau a pique and can be found in most parts of Moçambique, with some variations. It is not easy to tell whether the more traditional type, that is the construction of a trellis where small pieces of dry rock or clay are embedded with an rough final finish, may be regarded as a native technique of the region, as we know it is also widespread in southern Brazil.

In Ibo we observed a change to the *pau a pique* technique, perhaps to be considered unique. It is the practice of building the walls assembling a coral conglomerate on both sides of a wooden palisade, stuck or not in the ground; but the cases observed in Ibo are above the ground level.

The operation takes place without the need for housing as the pieces of rock, for their sizes, can be stuck with a thick paste one onto the other. This construction technique was adopted in the formal and informal areas, which suggests it is unlikely to be a replica of the Pombalina model, preferably intended for the later learned architectures. Not be ruled out, however, that it may be a late corruption of the Portuguese model once in contact with the local traditional *pau a pique* practice. The issue is just mentioned, like we did for other themes, waiting for deeper studies.

Let's now come back to Orbasli's study: her attention is focused on the conservation of the coral stone buildings in the historic centres of Duba, Al Wejh, Umluj and Yanbu Al Bahr in Saudi Arabia on the coast overlooking the Red Sea. The scholar identifies the aspects that constitute the heart of these centres conservation problems.

From a purely mechanistic point of view, the main cause of the more or less serious decay of those buildings is found in the lack of maintenance. But from the sociological point of view, the causes are to be found in the transformation of the economic models and the voracious pressure exerted by new local structures on weak ancient buildings. Then, a proper maintenance and opposition to

[9]The earthquake-proof system adopted in the walls of the wonderful monument Baixa Pombalina is called *gaiola pombalina*.

In Ibo, a variant of the construction technique *pau a pique* can be found. The construction of walls is made by putting together a conglomerate of coral on both sides of a trellis of wood stuck in the ground. In this work is not need for formworks because the pieces of rock can be placed one by one in mortar, according to their size. In the past, this technique has been adopted in both formal and informal areas of the town. It is believed that is not the construction a replica of the model imported during the colonial period. Not be excluded, however, that it is a corruption of the late Portuguese model adopted in Lisbon in Baixa Pombalina, once in contact with the local traditional practice of *pau a pique*.

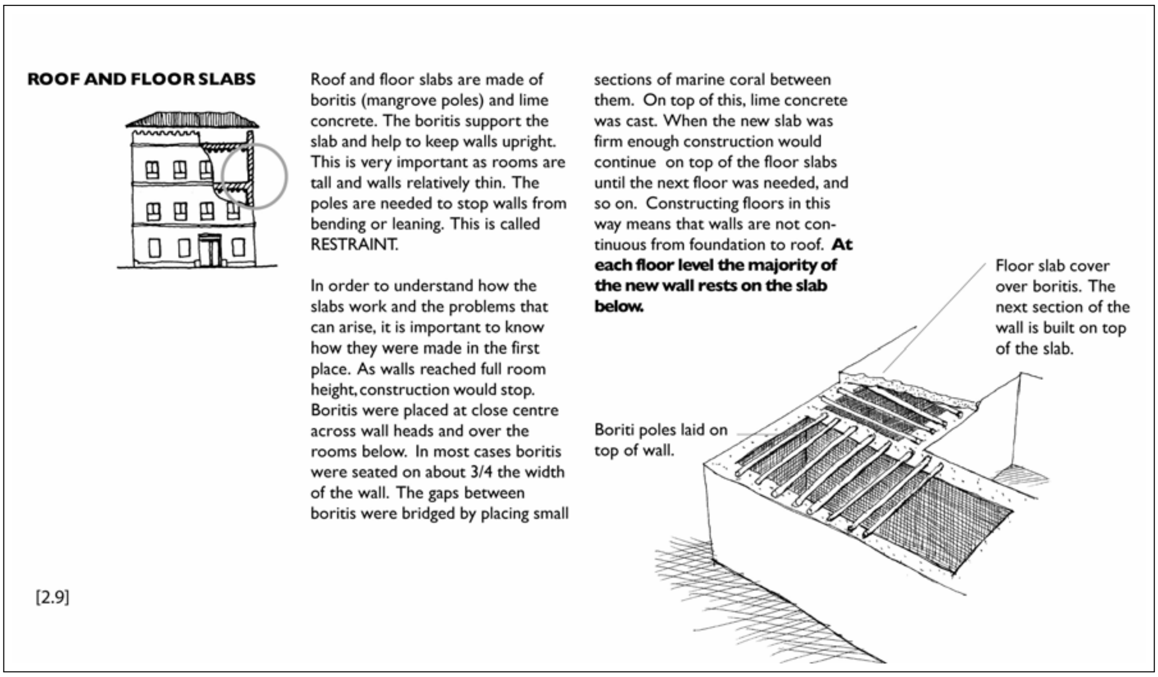
Figure 4.10.: Structuring the coral stone walls of with wooden poles in Ibo [*M.B., 2009.*].

the rapid changes in social patterns will only be determined by a reuse project. The reuse of past societies sites was a cultural and political issue deeply committing west areas administrators and architects during the 60's and 70's of the last century. Under this process the major Western centres were really renewed according to their social uses, in the presence of an overbearing interference of speculative dynamics that have also left clear imprints in their architectural conservation procedures.

The combination of expressions such as restoration and recovery focuses on two aspects that, today, allow reuse. Upgrading implies an improving process which is often an unusual addition to the historical characters of a heritage object. Sometimes, the additions aimed at a value improvement of an old object are operations jeopardizing any chance to recognize the unique historical characters which are the real value of the object to be preserved. Therefore, trying to recreate the *former glory* has no logical meaning, while the enhancement of a historic building may be the result of a series of minimal manipulations of what already exists, using updated technological systems aimed at improving the material conservation of the historical object and its use, with the result of increasing the overall quality of human lives.

This ruined house in Al Wajh, on the east coast of the Red Sea, shows the same construction type of the floors and terraces as found in the houses on the west coast of Zanzibar. In the handbook *Conservation and Design Guidelines for Zanzibar Stone Town*, some specific technical features are examined in order to identify the most suitable methods for restoration and maintenance practices. For instance, we noticed that in the constructions on both sides the floor is usually completed - both the wood structure and the bed of coral limestone with its finish - before proceeding with the construction of the wall upstairs.

Figure 4.11.: Revealed sections of a house in Al Wajh: floor and wall [*Photo by Aylin Orbasli, before 2008*].


ROOF AND FLOOR SLABS

Roof and floor slabs are made of boritis (mangrove poles) and lime concrete. The boritis support the slab and help to keep walls upright. This is very important as rooms are tall and walls relatively thin. The poles are needed to stop walls from bending or leaning. This is called RESTRAINT.

In order to understand how the slabs work and the problems that can arise, it is important to know how they were made in the first place. As walls reached full room height, construction would stop. Boritis were placed at close centre across wall heads and over the rooms below. In most cases boritis were seated on about 3/4 the width of the wall. The gaps between boritis were bridged by placing small sections of marine coral between them. On top of this, lime concrete was cast. When the new slab was firm enough construction would continue on top of the floor slabs until the next floor was needed, and so on. Constructing floors in this way means that walls are not continuous from foundation to roof. **At each floor level the majority of the new wall rests on the slab below.**

[2.9]

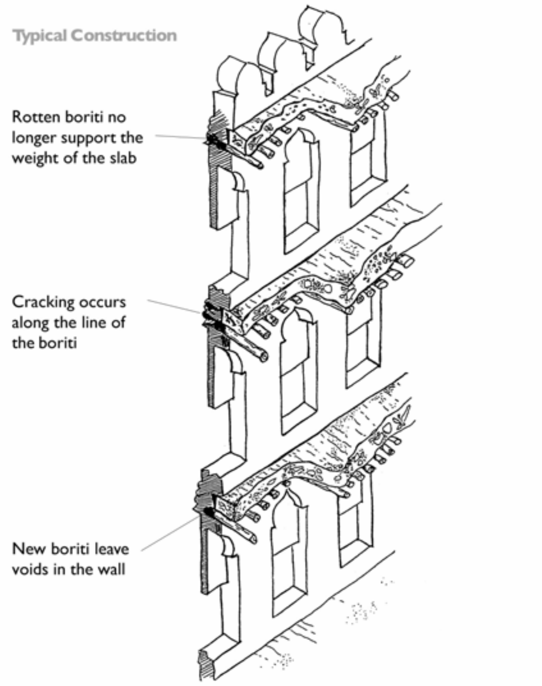
Figure 4.12.: Conservation and Design Guidelines for Zanzibar Stone Town. Roof and floor slabs. Tab 2.9. [*Battle and Steel, 2001.*]

From this point of view, the competence of a careful curator free from any cultural bias may indicate the road to recovery, critically assessing the peculiar characters of historic sites and architectures. First of all, there is the need for a rehabilitation of the historical technologies as Orbasli has shown in her approach to the conservation of the four sites on the Red Sea east coast.

This approach seems to be very useful when a program of heritage conservation has been studied. Indeed, the reading of the historical technologies reveals truthful data in a greater extent than the reading of forms or symbols. However Orbasli appropriately prefers the study of the actual possibility of traditional materials supply, with special reference to coral limestone, rather than the discovery and the teaching of the traditional techniques, a position we have already supported above.

Assessing a balance between man's and nature's spheres is a difficult practice requiring a number of scientific skills. The studies and activities compensating the memories of traditional construction can go side by side with that practice, in a slow progress mainly because of the complexity of the discipline factors at stake.

Despite the condition of long-lasting decline after the creation of Port Sudan in 1922, Suakin is the most valuable place of memory suitable to reconsider the restoration and preservation of the historic centres on the Red Sea coasts, the



Boritis bend under the weight of the slab. As the slab bends it may crack down the centre of its underside, parallel to the wall. When this happens, the walls may be pushed slightly apart and, if pushed far enough, they will tear along the holes left by decayed boritis.

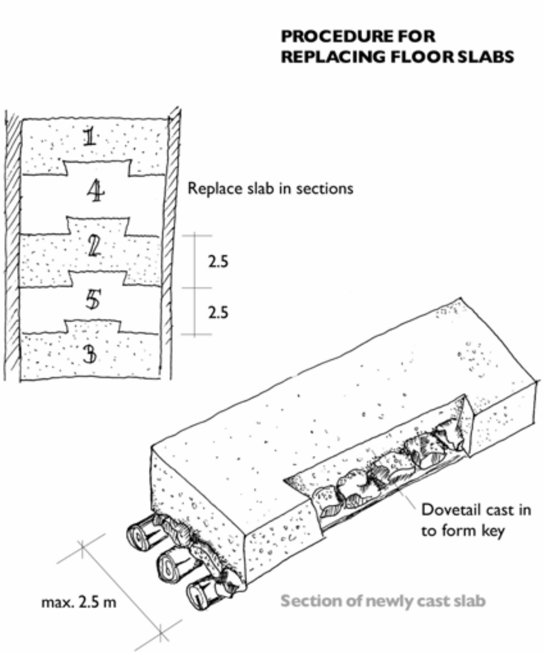
All the old houses in the Stone Town suffer to some extent from the defects mentioned above. Most of them have twisted out of shape, with bent walls, sagging floor slabs, and big holes eaten into outside render. They have deformed because weaker parts of the buildings have given way to the forces described, and other parts have been required to do more work than intended. In due course, it may be that they too will break or at least bend and crack until they have distributed the extra load.

Equilibriam

When buildings DEFORM in this way and adjust to changed LOADINGS, it is said that they have found EQUILIBRIUM. Equilibrium, once established, will remain until another change in loading imposes new stress in other parts of the building and stability is lost. It is possible that the extra stress will cause these parts to break or deform also. When this happens, equilibrium has been lost and damage will continue until the load is again shared and equilibrium returns. Dependent on the quality of the building and the materials used, there may come a time when there are not enough strong parts left to do the work required. That is when part of the building will fall down.

[2.11]

Figure 4.13.: Conservation and Design Guidelines for Zanzibar Stone Town. Roof and floor slabs. Tab 2.11. [*Battle and Steel, 2001.*]



PROCEDURE FOR REPLACING FLOOR SLABS

It is not safe to remove a complete slab at one time. If an entire slab is removed, the walls in that area will lose significant restraint and may begin to bend or bulge under the weight.

Slabs must be removed in short sections of about 2.5m. Each new section should have a male or female dovetailed key cast into it so that it locks into the next section when it is cast. It is best if sections are not removed and replaced one after another all along the floor, instead replace them on a rotational basis. This will allow freshly cast sections to cure slightly before the one next to it is removed. This approach will avoid areas of weakness developing.

It is a good idea to replace all of the boriti along with the slab, since removing the slab makes it possible to fit much longer poles. If this is too expensive, at least one long pole should be inserted into each section of repair. This will improve restraint.

[6.4]

Figure 4.14.: Conservation and Design Guidelines for Zanzibar Stone Town. Procedure for replacing floor slabs. Tab 6.4. [*Battle and Steel, 2001.*]

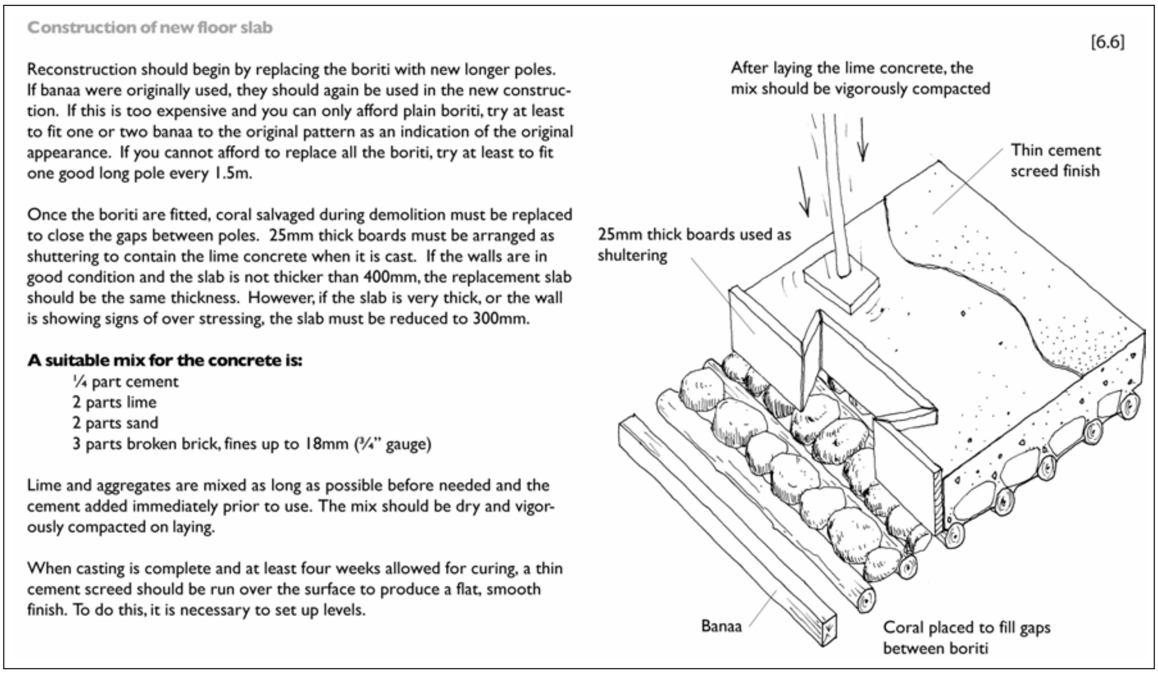


Figure 4.15.: Conservation and Design Guidelines for Zanzibar Stone Town. Procedure for replacing floor slabs. Tab 6.6. [*Battle and Steel, 2001.*]

Arabian Peninsula and the African coast facing the Indian Ocean, in terms of sheer physical preservation.

The interest for the place lies not only in the architectures in a state of abandonment – their structures have collapsed and now are a poignant palimpsest for architects, archaeologists or young artisans; the interest in Suakin lies also in the role it played in the history of the region and in the literary or figurative materials where it was represented and which is now scattered in various state and private collections, far from home.

The processes of treatment and use of the different types of coral on the Red Sea east coast Orbasli described, are very similar to the ones on the opposite coast and along the east coast of Africa. The processes are the same as some cases previously reported and correspond to the archaeological reconstructions of the sites and of the architectures of Arab and Swahili societies starting from 8th century.

The differentiation in the structural and formal use of calcareous materials is made according to its strength, compactness and workability, using both biologically active corals and, above all, the mineralized coral deposits above the intertidal current level. As we have already seen for the Swahili and Arabic architectures on the African coast, the most geometrically precise blocks were cut from porites species and used for the wall corners, the windows edges or doors and thresholds. But, as in Ilha de Moçambique, also mineralized beds have storage areas with excellent compactness, homogeneity and mechanical strength.

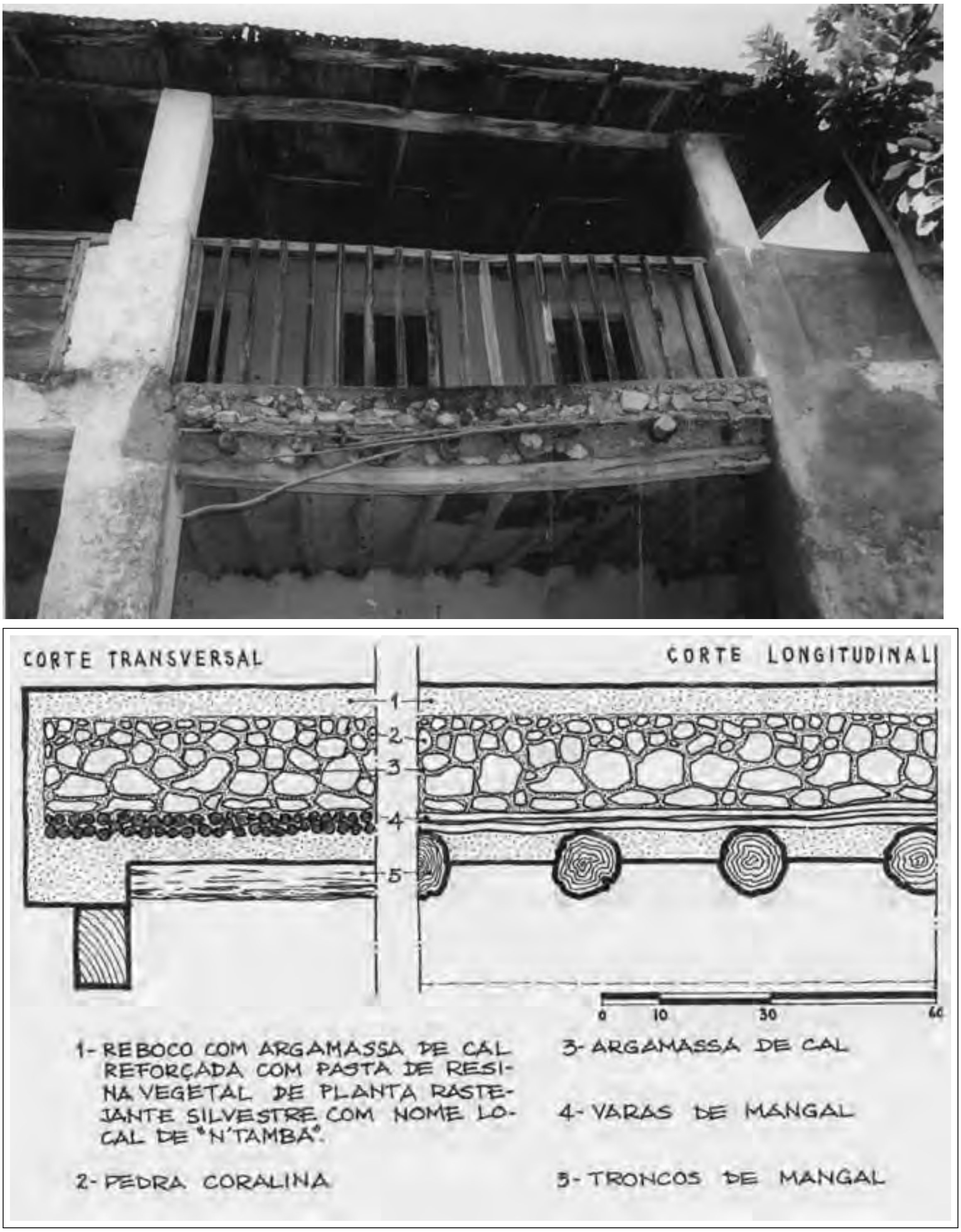
Orbasli deals also with floors and flat roofs, a theme which has a direct link with the issues raised here. As to the horizontal elements, the walls of the houses become thinner at each subsequent elevation of the floor of about 15 centimetres, a building process to be found in Venice too. At their feet, the Arab houses walls are very thick, about 80 cm. Perhaps a technological link could exist between the placement of the wooden horizontal chains and the remarkable thickness of a coral rock wall often characterized with poor cohesion because of the mortars used. Even in the two cases tested in Kosovo, the wooden structure walls are very thick – the walls of the mosque are often 110 cm thick and only 6m high, while in a Kulla is about 60 cm thick.

The Arab floors Orbasli describes are similar to the traditional ones of the African coast here studied. The supporting structure is made of *rafters* (of *Mangal* in Ibo), stripped of their barks and often with no geometric shape, in the obvious aim of keeping their loading capacity. The secondary wooden structure is formed with branches lined up side by side and secured with ropes to the rafters of the main structure, at right angles. On the Arabian Coast, the floors sometimes have a secondary structure consisting of wooden planks or a floor formed by two layers of rods aligned at an intersection of 45 degrees. A mat of leaves or, as in the restoration sites observed in Ibo, of spathe palm is interposed between the wooden structure and the coral stone and lime screed.

In 2001 Stephen Battle and Tony Steel published a handbook for routine and extraordinary household maintenance for Zanzibar houses which can help to understand the components of the traditional Arab floors and roofs[10]. Its usefulness lies in its clearest indications on maintenance or restoration, while its cultural value lies in the remarkable wealth of the traditional techniques there collected, which are the result of a research lasted for long years, and of the promotion and application AKCT has played in the region[11].

There[12] and in Silvia Carbonetti's accurate report on *Nyumba ya Moshi (House of Smoke)* in Malindi[13], we can read that the slabs surface is being refinished with a thin slurry of Portland cement in traditional Arab houses. To judge its actual

[10] Conservation and Design Guidelines, published by the Aga Khan Trust for Culture (AKTC) in collaboration with UNESCO.
[11] Battle, Stephen and Tony Steel, 2001. Conservation and Design Guidelines for Zanzibar Stone Town. Geneva: Aga Khan Trust for Culture. [*Quotation as recommended by the Editor*]
[12] Battle and Steel, 2001, Sheet 6.6.
[13] Carbonetti, Silvia. 2004. Baseline Survey of 836 Nyumba Ya Moshi House Rehabilitation. Zanzibar: Aga Khan Cultural Services. [*Quotation as recommended by the Editor*]



Restoration of a floor or a flat roof, using traditional techniques swahili.
The two images are taken from a holistic study on the unique and complex environments of the island of Ibo (Carrilho, 2005.).
With regard to mortar, the same study reports the use of another product of plant origin, such as *n'tamba* or *murrapa* juice, as mentioned above. For hardening and waterproofing screeds made of lime and coral, in Ibo they use a plant extract called *n'tundanga*, this extract when mixed with the fibers of cotton was used for caulking boats (Carrilho, 2005, p. 103.).

Figure 4.16.: Photo and graphic reconstruction of the section of the floor of a house in Ibo [*Carrilho, Ibo a casa e o tempo, 2005, p. 95.*].

Restoration of a floor or a flat roof, according to traditional Swahili techniques.
The image on the left describes the roof conditions of a veranda facing the courtyard of a house in the *Cidade de Pedra* in Ilha de Moçambique.
The image on the right records the traces of a traditional roof and another made of reinforced concrete in Fortim de Santo António in Ibo.
The traditional plates and the most recent, when built for function as flat roofs are highly perishable, since they are exposed to the elements, thus they need yearly maintenance, as opposed to the ones with a sloping roof with vegetation cover, or brick or fiber cement, where routine maintenance can be done with multi-year cycles. Without maintenance, the time required for the almost complete disappearance of the traditional flat roof and concrete slabs in marine environments, it is almost the same, that is approximately thirty years.

Figure 4.17.: Fallen flat roofs. A house in Ilha de Moçambique and Fortim de Santo António in Ibo [*Photo by Simone Vicini, 2004; M.B., 2007.*].

Restoration of a floor or a flat roof, according to traditional Swahili techniques.
The picture above shows the provisional buttresses which allowed a partial reconstruction of the east wall of the fort and the construction of the new roof in the traditional construction system.
Below left, in the room on the north-east of the fort, the top of the rebuilt wall and the flat roof reconstructed according to the traditional procedure of construction; on the floor there are the fibrous spathes of the coconut palm inflorescences used to isolate the slab of coral conglomerate from the wooden structure of the flat roof.
Below right, in the room on the south-east of the fort, the flat roof reconstructed according to the traditional procedure of construction.
The restoration site is part of the activities related to Ibo Island Restoration Programme of the United States Agency for International Development - USAID. I wish to thank the staff of the Agency in charge of the program, Dr Yakubu Seidu Goodman and Arq. Sérgio Uate for the visits and discussions at the yards.

Figure 4.18.: Restoration of the Fortim de Santo António in Ibo [*M.B., 2009.*].

usefulness in a long period, it would be necessary to know how it behaves in the presence of vapour. It would also be interesting to know if the same system is being adopted on flat roofs. Most likely, the use of concrete for waterproofing and reducing the over-wearing of coral conglomerates improves the condition of a dwelling when there aren't water leaks or significant moisture contents. But we know that the cement used in outside and inside plasters of a very porous stone, such as coral limestone, opposes the evaporation of moisture accumulated in the wall itself, if evaporation is increased by the environment temperature; this phenomenon produces a degradation of the wall it should protect[14].

The analysis of the walls in Inhambane showed the likely presence of pozzolana dust in the plaster patching. Again, this is a very compact finishing. But pozzolana plasters differ at least in two physical aspects from cement plasters: first, for the presence of an open porosity in their hardening states, even though very thin and, second, for the flexibility character kept in the aggregation of the compounds.

These conditions allow perspiration, preventing the absorption of dripping or strong rainwater and minimize the phenomena causing a loss of materials.

In any case, the cyclical practice of painting the surfaces exposed to air in the covering terraces or in walls not only provides an efficient protection of the building as a whole but, once absorbed the lime in depth, regenerates the connective material plaster and, in the case of terraces, the limestone conglomerate or screed too[15].

4.3. Conservation of 16th century bastions. The surface protection.

...alla presenza di mia madre mi for date cinque ferite mortale, cioè tre su la testa (che in cadauna la panna del cervello si vedeva) & due su la faccia che se la barba non me le occultasse, io pareria un mostro (Niccolò Tartaglia)

Why this section?

[14] See also: Battle and Steel, 2001, Sheets 4.11 and 4.12.
[15] Battle and Steel, 2001

The following is a very simplified rewriting of some essays published between 1995 and 2000. Here can be found three areas in a direct relation with the conservation of the coral stone architectural heritage:

1. the lime plaster or other traditional protection on a very porous or inconsistent stone;

2. modern military architectures as in the Fortaleza de São Sebastião;

3. scheduled maintenance as a form of approach to buildings of great size when the financial funds for heritage conservation are poor.

4.3.1. Experiences in the city of Padua.

The following considerations raise from restoration experiences on the 16th century bastions of Padua[16]. The hypothesis held here relies on the possibility of a conservation of wall surfaces taking into consideration the conditions of the deeper layers of the construction, even if it isn't made of building materials, at least in the modern fortification systems. Bricks or quarry stones were used in a manner more and more consistent with the transformation of the military defence systems which were gradually perfected as a system of earthworks. The remark means that the preservation of the brick surface of a modern fortification may be solved with tools and methods applicable to the ordinary external surface of a brick building, where the materials to be conserved could be reduced to a few more internal millimetres.

Two important examples show the general Italian context where the experience of the defence system of Padua may be placed, a system which at the time was considered illustrious – Francesco di Giorgio Martini fortifications in Mondavio (1501) and Giulio Savorgnan's royal fortress in Palmanova (1593).

In the first two cases we have a defensive model, widespread in central Italy, of geometric design, built with construction materials and structure; in the second

[16] The working group the City of Padua appointed in 1982 to study and restore the Santa Croce bastion, first experience of a systematic recovery of the walls of Padua, was formed as follows: Management and interdisciplinary coordination: Romeo Ballardini; Design: Alberto Guizzardi; Staff and experts: a) Architectural Design: A. Nalin, L. Tietto, M. Fontecha, W. Sandri, N. Marini, G. Tonello, P. Cappello, G. Pinton, P.f. Nicolini; b) Computer graphics: L. Rigoni, A. Brotto; Surveys and research: M. Oliviero, E. Rossi, A. Ricci; Historical Research: Giuliana Mazzi with B. Bertin, M. Vindigni, M. Frank A. By Mas, P. Valgimigli, ME Perissinotto, F. Cosmai, M. Zanazzo, S. Moretti, G. Meneghel; Studies on vegetation: Patrick A. Giulini Varotto, E. Venier; Static analysis: Lamberto Briseghella; Archaeological research: Giampaolo Brogiolo with A. Favaro, G. Cinelli; Analyses: Guido Biscontin; Directors of Works: Gianfranco Martinoni and Maurizio Berti; Contractors: Consortium for the monumental restoration of Padua.

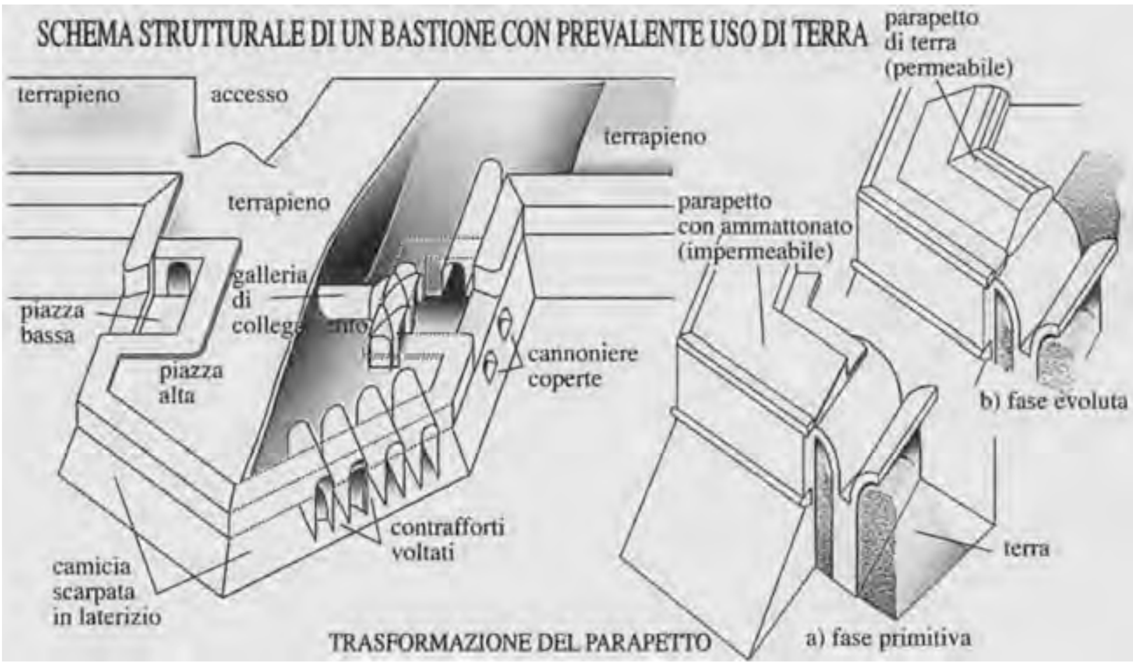


Figure 4.19.: A schematic reconstruction of a bastion according to the concepts of military engineering in the 3rd/4th decades of the 16th century [*M. B., 1995*.].

case the model is planned using technology topics, and its realization comes with prevailing earth operations.

The valuable 16th century military treatises show how a technological change was expressed mainly on the subject of defensive systems, because the criteria and the offensive power had been unchanged for a long time. A challenge for military engineers, who had an equally good knowledge of defensive and offensive techniques, was therefore to improve the capacity of artillery absorption of the defensive curtains, of course retaining all the old and tested devices necessary to prevent direct hand conquests with ladders and digging mines.

Probably, Giacomo Lanteri da Paratico is the one who best can make us understand the planning consciousness of developed ramparts systems manufacturers. In 1559 Lanteri published in Venice a treatise on earth fortifications. Historians have long speculated on the significance of the information contained in the introduction, that is Lanteri himself was preparing a treatise on masonry fortifications which wasn't published. The assumption that he could bear in his mind one of two distinct defence systems – the earth ones mostly as temporary shelters or stable external ramifications of the walls and the masonry ones with lasting and definite characters - may be a theoretical matter the arguments in his treatise on earth defences overcame. Lanteri writes a whole chapter on the structural cooperation between masonry and the earth of a bastion: *Che ordine si*

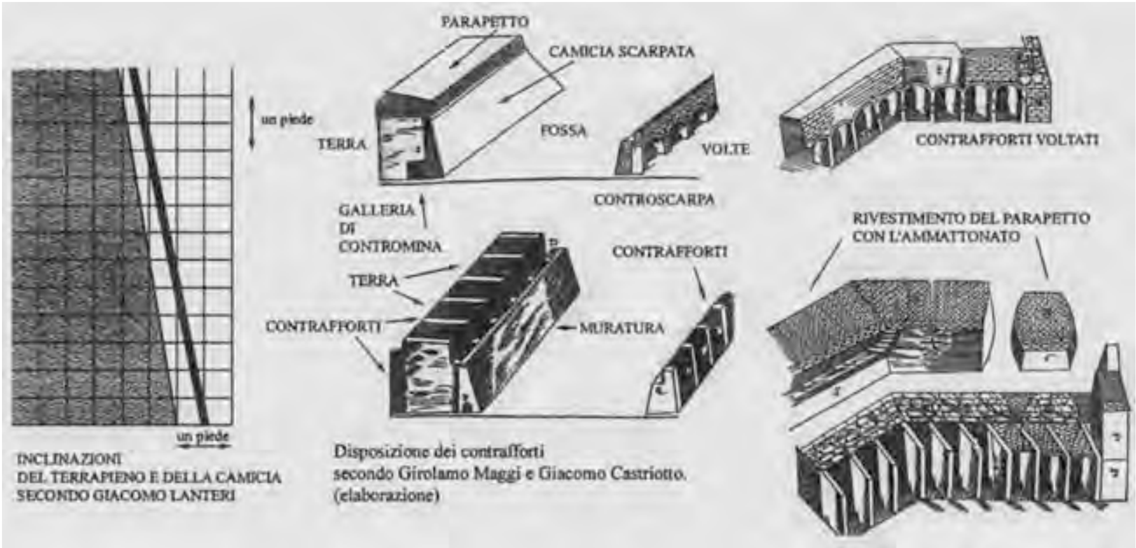


Figure 4.20.: Arrangement of the buttresses according to Girolamo Maggi and Giacomo Castriotto. G. MAGGI, J.CASTRIOTTO, *Della fortificatione delle città*, Venezia 1564 [*M.B., 1993.*].

dee tenere havendo da fare un riparo à canto à qualche muro etc.

He notes that a wall next to the rampart is in a dangerous position. Rain and more generally liquids, in time, inevitably bring a compaction in the vertical direction of the embankment with a corresponding horizontal expansion which will push the wall in touch the rampart. That should be prevented. He suggests to disconnect the bank from the wall at least of four inches and to build the embankment with layers reinforced with timber placed vertically and horizontally to reduce the deformations to the vertical ones. Lanteri thinks that the embankment slope goes on one foot every six in height while the wall slope is in a ratio of one to five. When the two profiles overlap, the bigger angle of the light coating in masonry would leave space towards the bottom for the enlarging of the base of the embankment.

Curtain pieces matching these requirements can be observed in Lucca, Jesi, Ferrara, and are located at the peak of technical and formal maturity of the protection of ramparts. The soil is settled in its best shape and the thin brick wall has a regularization and protection function. According to Carlo Promis's research and definitions, during the years when the definition of the system in Padua was being worked upon - from 1509 to 1556 – a differentiation between bastions and bulwarks was detectable; that difference tended to disappear until it became indifferent in the military designation of the building, even before the mid-16th century. As a matter of fact, Lucca is a curious case where the prim-

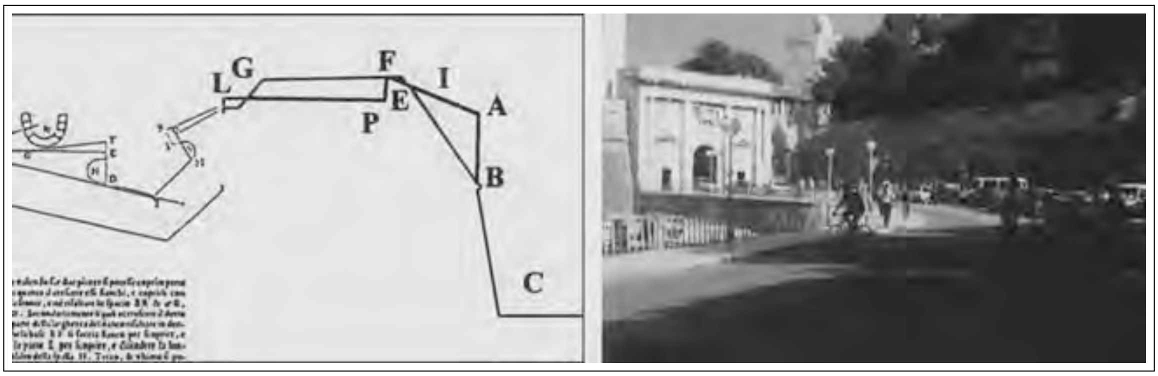


Figure 4.21.: Bonaiuto LORINI, *Delle fortificationi*, Venezia 1596. Bulwark *Grimani* and gate *Terraferma* in Zadar [*M.B., 1999.*].

ordial round bastions were embedded within the larger and lower pentagonal shouldered bulwark, according to a more modern defensive way; the old ramparts, emerging at the centre of the top square of the new bastion, could assume the new function of *cavalier*.

During the War of Cambrai, the setting of the original defence system in Padua was very fast and the construction of shelters and ramparts was probably lacking those structural devices Lanteri would later settle.

Promis: *La città fu ripresa dai Veneziani il 17 luglio dell'anno 1509: gli alleati di Cambrai vi posero il campo nei primi giorni di settembre; ebbero dunque i Veneziani un mese e mezzo appena per compiere le infinite opere di difesa che vi scorsero necessarie.*

Francesco Guicciardini left a memorable description of the assault the defences had to endure. On September 17, 1509 Maximilian began his attack against Padua. *Non haveva mai né in quella età, ne forse in molte superiori veduto Italia tentarsi oppugnazione, che fusse di maggiore aspettatione ... tirava il dì seguente per tutto ferocemente l'artiglieria, la maggior parte della quale per la grossezza sua, e per la quantità grande della polvere, che se gli dava, passati i ripari, rovinava le case prossime alle mura, e già in molte parti era gittato in terra spatio grandissimo di muraglia, e quasi spianato un bastione fatto alla parte d'Ognissanti.*

Girolamo Maggi adds: *Per l'assedio di Padova il bastione della Gatta fatto fare dal Zitolo da Perugia per buono avvertimento di Marco Manini, fuori della porta di Coalunga, per rivellino, e coperta di quella, col fondamento nel fosso sopra pali, & assoni su quelli conficcati, per non essere ben calcato per la troppa fretta, benché fusse grosso braccia 12 fu passato da un grossissimo pezzo d'artiglieria del campo dello Imperadore; dal qual colpo venne rotta una gamba al sudetto Zitolo.*

A note in Marin Sanudo's journals confirms Fra Giocondo's view on this bastion Caesar would have later assaulted. *A dì 18 (febbraio 1509). Vene fra' Jocondo* *inzegner stato a Treviso, Padoa, et Monzeleze, et disse quanto havìa visto, et l'opinion sua zercha il fortifichar Padoa maxime alla Porta di Coalonga. Vorìa far li muri a cantoni, per più sicurtà etc. Et tamen, era stà terminato prima farli dreti.*

On this brief account Raffaello Brenzoni and Giuseppe Fiocco saw an unmistakable sign of the change of the soil ramparts in a pentagonal brick structure with the use of a significant amount of bricks, as Michele Sanmicheli did later.

The information is too elusive if compared to the prevailing general experiences the friar had on soil works, water works on the Brenta and Adige and the defensive works in Treviso, a wonderful mixture between land and water. From 1495 to 1506 Fra Giovanni Giocondo was in France, after serving the Republic on architectural, hydraulic and military matters. How did the French experience help him in terms of current knowledge of military engineering?

We can read in Julia Vivenza's study that, up to the early 16th century, military defenses were different in vocation and tradition between between northern and southern Europe - defenses with earth structured in the north, wall defences in the south. This scheme is however contradicted in Albert Durer's military Treatise where he opposes huge and thick walls to the enemy artillery fire.

Promis says the rampart term and the configuration derive from the north; it spreads all over Italy when pentagonal defences with the *piazza alta* and the *piazza bassa* are adopted. It must be said, however, that on the geometric if not physical configuration, of the pentagonal bastion Promis promotes Francesco di Giorgio's paternity, that is, the maker of masonry defence shape with a slope.

Certainly in Padua, during the years of the final curtain layout, engineers and captains involved in the design or construction of the prevailing masonry defences were present, at least all those who came from the military schools in central Italy. Probably, the primitive earth defence constructions had been kept for logistic and economic reasons. Only now historians are systematically exploring the archives and will show which parts of the curtain were jacketed in masonry after their complete and efficient solution using only earth.

Let's now focus on a particular place of Padua walls where for many months there has been a restoration yard. Santa Croce bulwark is divided into three parts, interesting for issues of stratigraphic and structural reading[17] and for the development of appropriate conservation methods. They are the parapet of the *piazza alta*, the buttresses and the parapet of the *piazza bassa*.

In 1989 the Municipality of Padua promoted and financed a restoration work of the city walls vegetation had hidden and broken up; the prevailing images of the

[17] A possible perspective has been mentioned above.

Figure 4.22.: Surveys on the final form of the parapet of the bastion of Santa Croce; traces of bricks in the initial condition of the parapet of the bastion.[*M.B., 1989*].

walls were charmingly recreated in the minds of lovers, admirers and historians who had passionately examined the old maps and ancient representations.

The first significant experience of recovery was conducted on Santa Croce bastion. Briefly, the scheduled works involved a broad research which could lead to an executive project of restoration and development of appropriate intervention methods. The place was called *le montagnole* - the mounds - from the thick bush it was covered with; anyway most of the original characters of the ramparts were recognizable. Quite reliably, historians attributed the bulwark to Michele Sanmicheli: the inscription on the south west side says 1548, two 19th century detailed surveys were known and had a mutual correspondence - the thought of a restoration of the original designs could be understandable and the architects could be led by objective evidence and not by suggestive signs.

Now the studies and field surveys are over, a road trying to approach the supposed original conditions would be the most difficult to be undertaken. First of all, a restoration limited to the clearing of the weeds would be difficult. The external condition of the three places or area of Santa Croce bastion can therefore be considered just looking at their surface conditions. But we'll see later how difficult it is a work of preservation caring only for the surface.

The parapet of the *piazza alta*.

The clearing of the dense vegetation thriving on the top covered with a thick layer of soil was one of the first works undertaken for the recognition of the real bastion. But only the part where roots interfered with the walls and penetrated the soil blanket was treated, after a survey on its extension. The presence of a parapet walk at the edge of the faces and flanks, and some traces of the two watchtowers were a problem considering their formal and functional characteristics. The plants with a root system undermining the walls had to be eliminated, but a soiled or unsoiled profile effective for future preservation remained to be defined.

An extensive research on archival and press sources did not give the specific subject any support. But before a final decision, it is to be ascertained whether the layer of soil over a parapet without herringbone bricks, with a clear Sanmicheli's typology, is a solution designed to conform to the defensive systems of the second half of the 16th century.

At the end of the 16th century the Florentine nobleman Buonaiuto Lorini wrote a chapter in his treatise on military architecture to propose some remedies to fortresses recurring faults; among other arguments, he was proposing an updating to the ancient defences defects, those with round bastions being the oldest defensive fortifications. The Earl, who is an interlocutor in the dialogue with the author, says: *E per discorrere alquanto d'intorno alle difese usate in queste così fatte Fortificazioni, le addimando la causa per la quale fu fabricata quella parte di muraglia posta sopra al cordone senza scarpa, e così rovinosa per essere scoperta, & esposta a manifesta rovina, dove al parer mio questa opera fa contrario effetto di quello, che doveria fare*.

Lorini replies that probably the interruption of the slope at the top of the shoe was due to the need to retain a generous space for manoeuvring the pieces of defensive artillery for the sake of the high square. But he rightly noted that this system, applied to the primary bulwarks, involved a significant deployment of building materials, especially in setting the faces, *la qual grossezza soleva essere fatta tutta di muraglia sopra a' volti, che si sostentavano nelle larghezze de' contraforti, overo speroni* (and this is the case of the Santa Croce bastion), *la quale era opera delle più deboli, e di maggior spesa, che si potesse fare; nondimeno il suo rimedio sarà facilissimo, perche tagliando sopra il cordone la scarpa BF* (ie eliminate the verticality of the upper portion of the curtain) *si avrà assicurato l'alzato di fuori BA dalle rovine* (...) *e per il parapetto si deve tirare la grossezza FG fatta con la semplice terra*.

In Santa Croce bastion a part of the vertical wall above the *cordon* wasn't demolished, but the conformation of the upper slope of the parapet would still have been adequate, stripping it of its herringbone brick lining and covering it with a thick layer of erth capable of absorbing the enemy artillery strokes. This solution was usually recommended by the military engineers of 16th century and in this bastion of Padua has been experienced a partial renovation. The clearest engineering transformation of primitive modern bastions is of Bonaiuto Lorini and his method seems to have been literally applied to the bulwark *Grimani* on the side of town gate *Terraferma* in Zadar.

The buttresses of the faces.

In his treatise on fortifications, Girolamo Maggi writes about buttresses and recalls Vitruvius, San Marino, Tartaglia - who approved only of the ones 8 foot thick - Captain Frate da Modena and Leon Battista Alberti.

Vuole lo Alberti che da un contrafforte a' l'altro si tirino archi, ò volte che le vogliam chiamare, & che gli spatij si riempino di creta mescolata con paglia (...) *M. Michel San Michele Veronese voleva che si facessero le volte à contra forti, che venissero fino al piano della piazza di sopra di quelle, e si tirasse il parapetto congiunto con quello della muraglia in tutto grosso* (the thickness) *piedi 18. e che restasse il corridoio* (the banquette) *di piedi 10.*

In Santa Croce bastion three arches of the buttresses of a flank and an adjacent face have been now partially explored clearing the embankment. The construction structure is very similar to Sanmicheli's, as quoted by Maggi, including the special compartments splayed inwards to encourage the soil control. There, any restoration solution can only be added to the previous issue of the parapet transformed in relation to its original condition, either the transformation took place in the late 16th century or in a period towards 19th century.

After more than four hundred years from the rampart construction we can see that the behaviours Lantieri provided in soil defences have occurred. The embankment next to the walls of the faces has substantially lowered due to its natural settling in the ratio of at least one-tenth of the height of the embankment itself. In this condition, the bank holds no more the vaults were originally set linking a spur to another. It may result in a static instability. The transformation at the top of the parapet is more worrying for stability, as the herringbone bricks were removed and was covered with pervious earth creating in this way a process of decay of the underlying vaults resulting in chemical reactions activated by water dissolving the mortar and the grouting between brick and brick. Some bricks have already fallen having marched from the intrados. Unfortunately this is one of only two cases resulting in the collapse of a vaulted system, as we learned in school.

The parapet of the *piazza bassa*.

Lorini is an easy way to start with, even if most military treatises deal with the subject. The flanks, especially the portion including gunports for cannons, were considered the first target of enemy artillery; to solve the problem a particularly absorbing screen was opposed. Lorini agrees with other treatises on the use of mud bricks, badly cooked, or of earth to form the wall separating and surrounding the casemated gun emplacement. A particular invention consists in putting crumbled bricks in the merlon and nearby: *benché la muraglia fatta co' mattoni* *pesti non si deve mettere nel numero delle altre muraglie nocive; perché se con questa si fabricasse non solo tutta l'altezza della cortina, ma la grossezza del suo parapetto, si farebbe opera perfetta.*

In the inner part of the walls near the gun-ports of Santa Croce bastion some mud-bricks were discovered. The falling in the ancient times of the outer layer in the wall made that observation possible. It was a relevant phenomenon on the walls of Padua which had already received attention and care in the early 19th century when, for taxation reasons, an extensive work of relining the outer layer of the walls devastated by the exfoliation phenomenon of bricks was undertaken.

4.3.2. Weed control and minimal intervention works in a big size ruin.

The indifference of the community.

Most of the deterioration phenomena affecting the walls of Padua rises from the disappearance of their functions and citizens' cultural neglect. The abandonment of the architecture resulted in the decay of the parts more vulnerable to environmental effects because of their material or structural conditions.

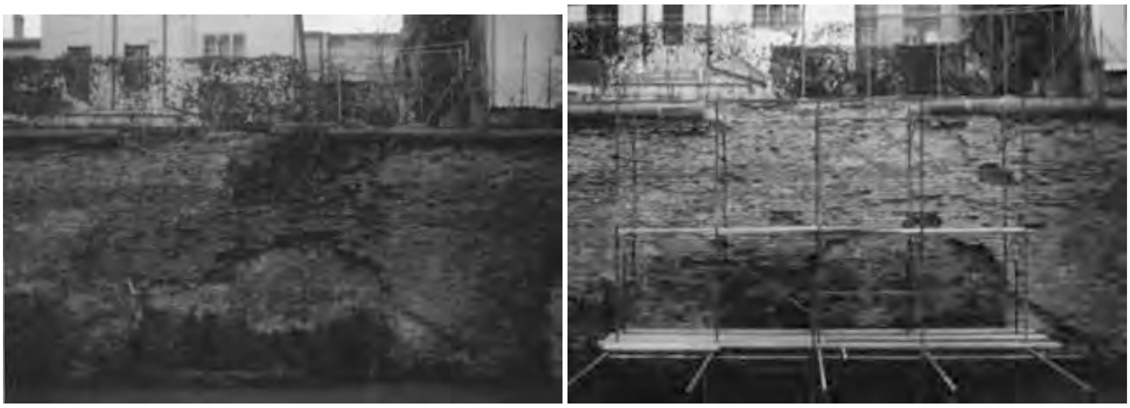
The vegetation roots make the walls move and hide their natural decay. In order to periodically assess the monument state of conservation, the natural vegetation must be removed. In big size ruins, as modern fortifications, the natural vegetation control must be strictly separated from environmental or landscaping concerns.

In Padua, the environment was favourable to vegetation, with embankments and drainage water; therefore, after a long lasting neglect, citizens began to believe that the vegetation on the ruins was to be considered as *a public park*.

The maintenance of the walls of Padua, effected between 1989 and 1997, was preceded by two projects: "Extraordinary maintenance work, weeding and provisional masonry works. Activities preceding the restoration project".

The activities undertaken on the walls had the primary purpose of stopping or significantly slowing the degradation processes and were designed as a condition preliminary to any subsequent restoration. As a matter of fact, some simple maintenance procedures made useless a more accurate subsequent restoration, since the material conditions were fully restored.

Trees and shrubs were mechanically and manually cut down to the roots where they had crept into the walls. A devitalizing product was carefully injected not to disperse it around; in this way, the roots of larger diameter were elimin-



Identification, cleaning and re-adhesion of the surface layers is the bastion San Giovanni. The cycle of decay that causes the vertical fracture of the bricks of the curtain has not yet been established. The photographs show that an unstable condition may last for several decades. This phenomenon was not considered serious until it was carried out the disinfection of the weeds.

Figure 4.23.: Weeds and exfoliation of brick curtain [*M.B., 1994.*].

Some steps of the techniques used to make surface layers adhere to masonry; they generally are about 12-15 cms thick. During the works, it was preferred the use of simple bricks. Steel bolts were used where the detachment had overpassed the length of a brick. Cavities were filled with natural hydraulic lime mixed with inert expanded clay, starting from the bottom.

Figure 4.24.: Re-adhesion of the surface layers of the curtain [*M.B., 1994.*].

ated because their mechanical removal may have involved risks for the walls themselves. The consequent drying out of the roots made repairing easier. The elimination of plants and herbaceous weeds was obtained spraying the leaves with a devitalizing non-polluting product, in weak solutions. The removal of accumulated deposits wind had brought was subsequently performed, with a surface hand-work, and finally, a thorough cleaning with low pressure water.

Provisional and local pre-consolidation.

These works are temporary but necessary to shoot photos and measurements; they must be easily recognizable in photographic and photogrammetric surveys. In cases of superficial disruption, various and simple removable systems have been used without causing any damage to the monument. Parts of curtain walls and filling surface were contained with specially formulated compatible mixtures. Fillings were applied both on the concrete core surface and on brick parts. The filling mixture was tested and experimented on the field and in laboratory. The City Walls Office had the responsibility of the planning and project management – a condition to be wished in restorations; in this way the development of more appropriate mixtures had already been postponed from the project to the yard site. In the first experiments the work directors gave a generic indication to use hydraulic lime, aerial lime, big grain sand and *cocciopesto*. The proportions were appropriate to the mixture workability and to a careful observation of its effects. The scientific advice of the "Centro Gino Bozza", Politecnico di Milano was asked for in order to check working methods and results.

Restoration.

During extraordinary maintenance, some minor restoration work may be required if there are specific degradation phenomena in progress, detectable only after weeding; and that happened. Here is an overview of the main methods:

1. total conservation or preservation of the artifacts condition according to documents;

2. restoration of some aesthetically relevant parts for the sole purpose of maintaining parts of the old building in a state of advanced or impending decay;

3. masonry restoration relocating the damaged materials found on the site but still recoverable (for example, segments of the trachyte cordon);

4. reintegration of the wall gaps causing static instability using the ancient techniques but with contemporary materials;

5. improvement of the ancient techniques where they are inefficient. For example, the top of the bastions of the ramparts must be waterproof. Rainwater flows through the embankments and has impoverished, if not dissolved, the net-

work of the vaults mortar, of the bastions of environments or of the buttresses connection, resulting in a slippage of the bricks;

6. a functional adjustment respecting compatibility between the monument value and its use[18].

4.4. The restoration of the Defterdar mosque in Pejë/Peć

Why this section?

The restoration and reconstruction of Defterdar mosque is a project of UNESCO's I looked after following an agreement between the PhD - Corso di Dottorato di Ricerca in Riqualificazione e Recupero insediativo and the Italian non-governmental organization Intersos. There are two main motives for writing this section: the use of wood in the masonry structure and the use of porous limestone blocks.

As to the first motive, it was found that the framework of horizontal wooden beams in the walls of Defterdar mosque is similar to the one used in Arab buildings, as Aylin Orbasli described above. This technology increases the elasticity coefficient of stone masonry and, in Kosovo, it may be due to the spreading of Arab culture during the long Ottoman administration.

The second reason is the use of a very porous not solid sandstone only for decorative and sculpted pieces; to be preserved, that stone requires the same treatments used with coral stone[19].

Pejë/Peć is the capital of the western region of Kosovo. The town is located on the valley of the Lumbar river, at the mouth of the narrow gorge called

[18] See: Maurizio BERTI, *La conservazione dei sistemi bastionati moderni: il caso di Padova. Interventi su un tratto di mura fra la barriera Saracinesca e il bastione Codalunga*, in Giovanni Carbonara ed., Trattato di Restauro architettonico, Ed. UTET, vol. VIII, Torino 2004, pp. 992-996; M. BERTI, *Spunti bibliografici sul tema delle volte. Il contributo della scuola padovana fra il Cinquecento e l'Ottocento*, in *Le volte in muratura fra tecnologia antica e tecnologia moderna*, Padova 1989, pp. 15-18; M. BERTI, *L'intonacatura delle murature nei sistemi bastionati cinquecenteschi*, in "Scienze e Beni Culturali", Padova 1990, pp. 127-137; M. BERTI, *Conservazione dei sistemi bastionati cinquecenteschi. Conservazione delle loro superfici in laterizio. Esperienze della città di Padova*, in "Scienza e Beni Culturali", Padova 1992, pp. 677-689. G. CARBONARA, M. BERTI, *La manutenzione programmata come forma di restauro: il caso delle mura di Padova*, in "Materiali e Strutture", IV, n° 3, Roma 1995.

[19] This is a summary of the report from the first part of the restoration plan of Defterdar mosque of Pejë/Peć in 2008.

Rugova valley; it is surrounded by the Albanian Alps in the west and by a mountain range which is a part of the western Balkans in the north. Under the geomorphological aspect, it has some interesting distinctive features which can be seen simply looking at the landscape. From a socio-cultural point of view, its inhabitants are in a strong cohesion and their customs come from the Albanian tradition. Pejë/Peć is connected to Pristina, Mitrovica, Gjakova, Rozhaja and Plava. The Municipality is divided into 28 communities and amounts to 95 villages. It's 602 square km wide and the total population is approximately of 170.000 inhabitants.

Pejë/Peć is first recorded in the Roman period; it seems as *Siparantum* and so historians and archaeologists still refer to Pejë/PećPejë/Peć with that name.

The population belongs to the Albanian ethnical group and Islam is their main religion; only a small part is Catholic. Other groups belong to Serbian, Bosnian, Turkish and Rom ethnic groups. The most relevant architectonic monuments are in the orthodox Serb tradition.

In the past Pejë/Peć was famous for its Patriarchate and its mosques, its simple urban settlements with some sparse *kullas* and adobe houses with chestnut beams - constructions inherited from the past and forgotten during the reconstruction following the terrible 1999 war. Pejë/Peć has always been a local market for the surrounding region agricultural produce.

Defterdar mosque is one of the oldest buildings in town. The few historical notes date it back to between 1570 and 1577. The river stones and limestone travertine walls are about 1.10m thick and 6.10 high. A sophisticated system of wood chains set on the whole horizontal section on four levels can be seen in the completely inelastic masonry.

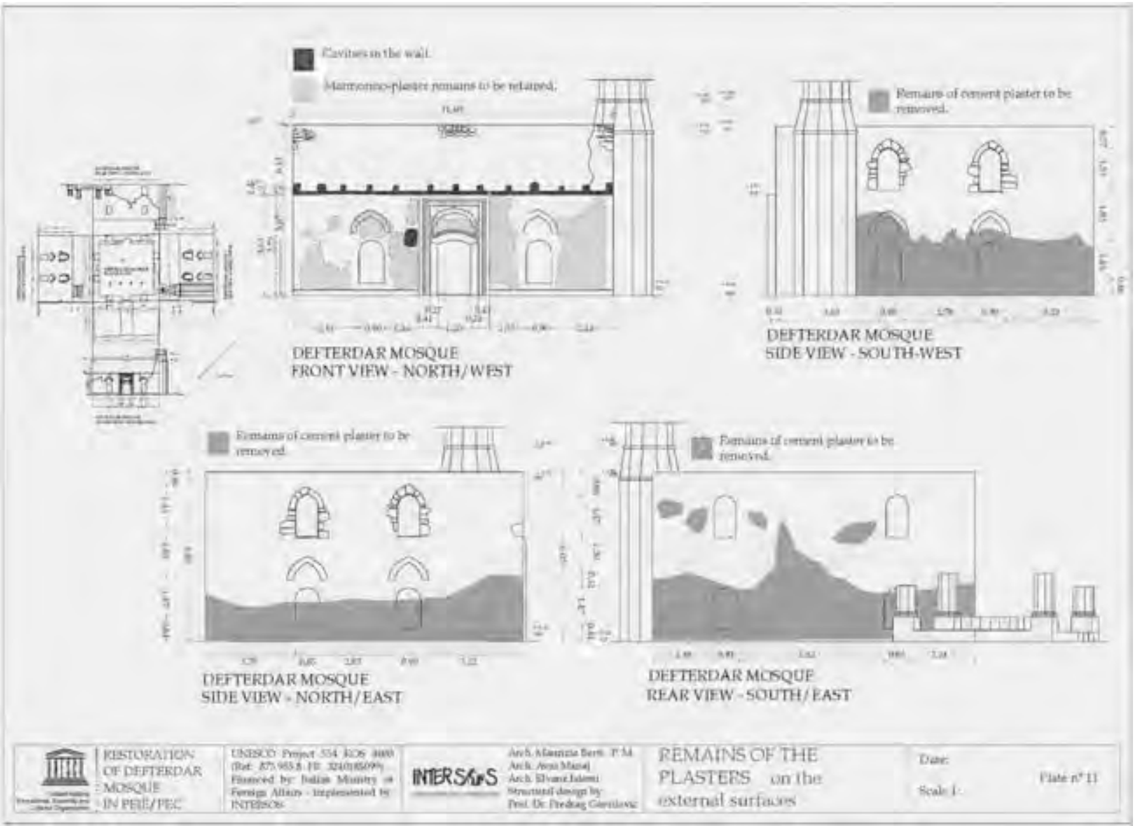
Before the fire, the cover consisted in a four-pitch roof with a brick mantle and a wooden octagonal ceiling. The windows of the second level are arched in the Arab way. A porch is leaning against the main façade. Inside, the usual prayer furniture: *mimber, mihrab, mahvil*, and the minaret entrance. The garden is the old Muslim cemetery with graves dating from 1545. The mosque was burnt several times and it is a significant monument also in the broader regional context.

I. Preparing for intervention[20].

[20] The project data are: *Project Title: "Safeguard of the Cultural Heritage in Kosovo"; Country/Region: Kosovo – Pejë/Peć region; Executive Agency: United Nations Educational Scientific and Cultural Organization - UNESCO; Donor: MAE – Ministry for Foreign Affairs, Italy; Implementer of the project: Humanitarian Aid Organization - INTERSOS; Duration: July 2008 – December 2009; Restoration and rehabilitation works in Pejë/Peć and Decan/Decani: dialogue through the protection and valorization of Cultural Heritage; Contract for Works - Ref: 875.955.8 FR 3240185099 (ONE SITE - Defterdar Mosque of Pejë/Peć).*

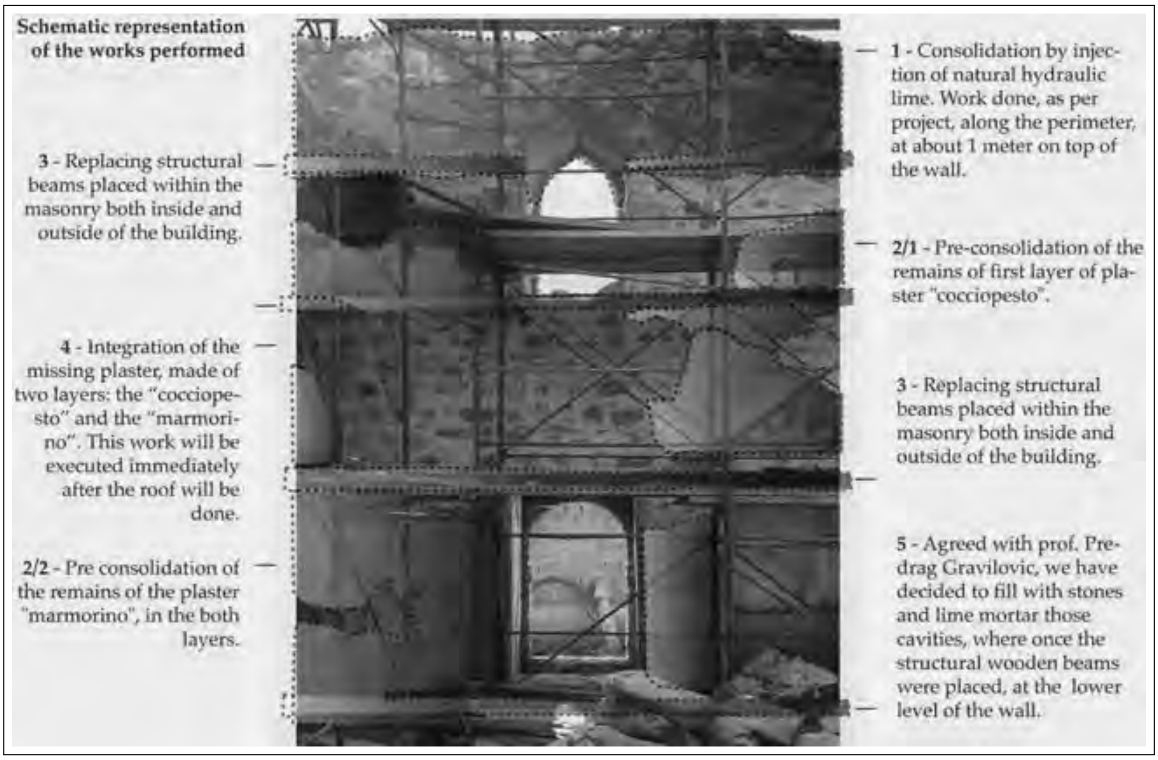
Location of the monument in the urban context and conditions of the artefacts. Aerial view and map of the city. Photos have been compared in the period from 2006 to 2008.

Figure 4.25.: Restoration of Defterdar Mosque. A - Past and present. The place today and historic documentation. Plate n. 4 [*M.B., 2008.*].



Mapping of marble and cement plaster remains. The decision to remove the remaining cement plaster from the outer surfaces and to keep the remains marble plaster of the interior and on the main facade was discussed and taken while preparing the detailed design.

Figure 4.26.: Restoration of Defterdar Mosque. A - Remains of the plasters on the external surfaces. Plate n. 11 [*M.B., 2008.*].



These actions were discussed with Professor Predrag Gavrilovic during many visits to the site and approved by UNESCO.

Figure 4.27.: Schedule of work phases for structural strengthening [*M.B., 2008.*].

The restoration and reconstruction program financing of Defterdar mosque was decided on a restoration final draft, where the part concerning structural consolidation was to be soon executed. After UNESCO and Intersos signed the contract, the preparations for the first part of the executive project started immediately to obtain UNESCO's approval on the subsequent stages of construction and some operational changes of method. There was an invasive presence of vegetation, especially robinias; the first step was to get the Regional Institute for the Protection of Cultural Monuments of Pejë/Peć authorization to proceed with a general hygiene treatment, cleaning the site and organizing the yard. The weed uprooting was carried out mechanically as it was late fall and then the plants had reduced their biological activities, with the intention to postpone to the spring season the most suitable chemical treatments. The waste accumulated on the site during the long years of neglect was collected and deposited in authorized landfills. A scaffolding was set up behind the inside and outside external prospects up to the next level. Then, plastic tissue sheets were fixed to protect the top part of the walls during the long winter and prevent water, snow and ice from further degrading the walls.

II. Program for the construction steps.

The first part of the project was performed according to the themes and circumstances described here below.

During the preparatory steps in September and October, Intersos engineering team carried out a number of on site surveys. New photos were shot using the same visual angle as 2006 photos'; when they were compared, it was detected where and how the deterioration had worsened. The comparison clearly showed that the exposure of the bare walls to weathering, after two winters only, had resulted in a significant further deterioration of the ruins neglected for about eight years; then, it was decided to protect them against the impending winter without delay.

A special analysis session on the cracks passing through the walls was performed to understand their genesis and history. A scaffolding installation allowed a closer observation of the walls crowning; in this way, the areas to be consolidated with injections were set out with a better understanding. Some cracks of greater extension had already been repaired in old times, while the less extended ones could be considered more recent; others were caused by the 1999 fire and by the subsequent abandonment.

During this special on site test Professor Predrag Gavrilovic was also present and took part in the discussion and approved of several actions to be taken in the following steps:

1. strengthening of the crowning of the walls, with the technologies already adopted in the previous restorations at Bayrakli and Kurshunli mosques in Pejë/Peć;

2. systematic replacement of the burnt wooden beams;

3. integration of some parts of the wall collapsed after the wood fire, particularly the windows lintels of the first order;

4. preparation of technical pipes on the ground and vertically;

5. pouring of the plate and the internal perimetric concrete beam at the ground floor of the mosque;

6- cleaning from inappropriate and inconsistent materials, prospect investigation and cognitive exploration of some limited excavations in the area where the porch was to guide the proposed construction of a new porch – whether to build it in wood or brick was to be decided at the end of a specific study.

Intersos's and Istituto Superiore per la Conservazione e il Restauro's in Rome documentation on the previous works on Bayrakli and Kurshunli mosques were an essential help for Defterdar yard. Defterdar mosque showed some specific characteristics requiring operations different from the ones made in the other two mosques, such as the roof to be built in a different way from Kurshunli mosque, or remnants of marble plaster (*marmorino*) to be possibly preserved.

III. Preparatory work and first step.

Along with the project first steps, the following works were proposed to UNESCO Regional Department for advice and approval:

1. pre-consolidation and adhesion of the marble plaster remains on the internal and external walls of the main façade, before the winter season;

2. restoration of the four chains in chestnut beams embedded in the walls; replacing of the windows wooden lintels and integration of the missing parts in the chains;

3. cleaning of loose materials and dust on the walls;

4. excavations for a better knowledge of foundations and soil;

5. first part of consolidation works, as in Predrag Gavrilovic's technical project attached to the restoration project.

The pre-consolidation works were carried out by Kosovar restorers, trained by the Istituto Centrale del Restauro/Intersos in previous restoration works and already known by UNESCO Regional Office. Three of them had already worked in the major restoration of Hadum mosque in Gjakova.

The interventions followed this procedure:

1. pre-consolidation of the raised plaster;

2. systematic removal of the remains of cement plaster, without damaging the lime plaster, if adjacent or below;

3. washing with a solution of biocide-based ammonium salts to remove mosses, lichens and fungi;

4. cleaning of the existing marble plaster using soft bristles brushes with an aqueous solution of ammonium carbonate;

5. consolidation of deep fissures and cracks with lime mortar;

6. application of marble plaster in two layers: a *cocciopesto* substrate based on hydraulic lime mixed with crushed bricks and a final layer based on aerial lime mixed with marble dust, in the areas needing an immediate integration of plaster;

7. reintegration of the gaps with a similar mixture of existing plaster - proportion of aggregates and binder; size and colour of the existing elements - based on two layers as described above;

8. application on the surfaces of ancient marble plaster remains of a solution of calcium hydroxide with repeated strokes for a deeper consolidation.

For the operations of ancient marble consolidation Primal AC33 (an acrylic emulsion) at 10% diluted with de-mineralized water and ammonium caseinate diluted of 5% were used.

The operations of surface pre-consolidation were performed using ammonium caseinate, since its removal is more simple and complete after a provisional consolidation. Before applying casein, the area to be treated was sprayed with deionized water. A solution of calcium caseinate was injected with a syringe into the raised parts of the plaster. In order to make adhesion to the wall easier, the already treated marble plaster parts on the outside surface were gently pressed with a jute buffer. In the parts with powder, pre-consolidation was performed interposing a sheet of Japanese paper between the surface and the applied casein. The Japanese paper was kept moist until the end and then removed.

As to cleaning, ammonium carbonate in a saturated solution was applied with a brush, several times if necessary, after covering the surface with Japanese paper.

As to the deep consolidations of plaster, injections of an acrylic emulsion (Primal AC33) in the required concentrations were made through the cracks; in the case of more extended cavities a mixture of calcium caseinate was used.

Provisional plaster frames were applied to protect the old plaster in the open during the winter season, to prevent infiltrations of moisture or water. These gypsum sealings were easily removed after the winter or after the consolidation therapy.

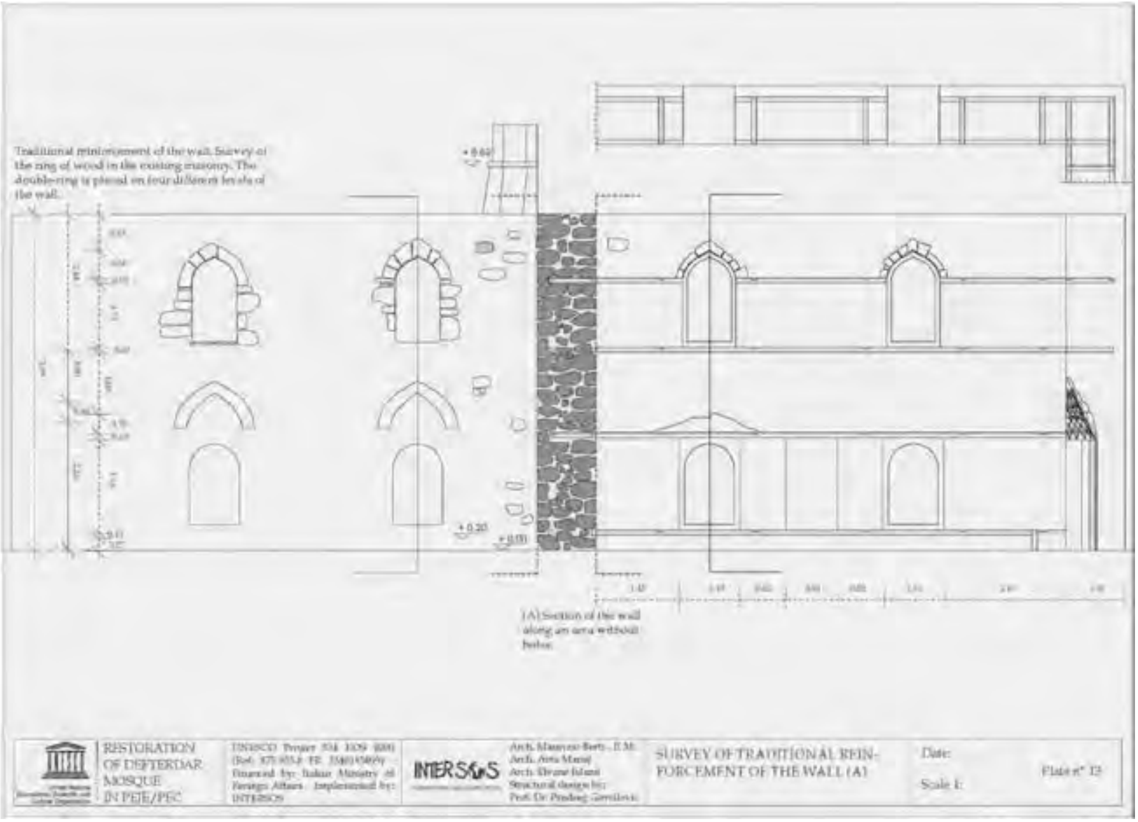
Two types of work were performed for the final integration of the missing parts. If the gap was only on the marmoreal final layer, the integration was performed with a mixture of calcium hydroxide, marble powder and hemp fibres. When integration affected the *cocciopesto* substrate too, the plaster was laid in two successive steps. The *cocciopesto* was performed with a mixture of brick dust and lime. The integration of a double layer plaster involved more than 80% of the wall area and was preceded by the application of a network of made with the same mixture in order to better control the thickness of the rough coat.

IV. After winter works.

Winter forced a break in the yard activities from 15th December 2008 until 15th March 2009. Here is a list of the works performed, from March 16, 2006. Among them the the restoration of the wooden wall strings in four different levels. Some project drawings are shown here.

Here's the list:

1. completion of pre-consolidation and adhesion of the ancient crumbling



Traditional reinforcement of the wall. Survey of wooden rings in the existing masonry. The double-ring is placed on four different levels of the wall. (A) Section of the wall along an area without holes.

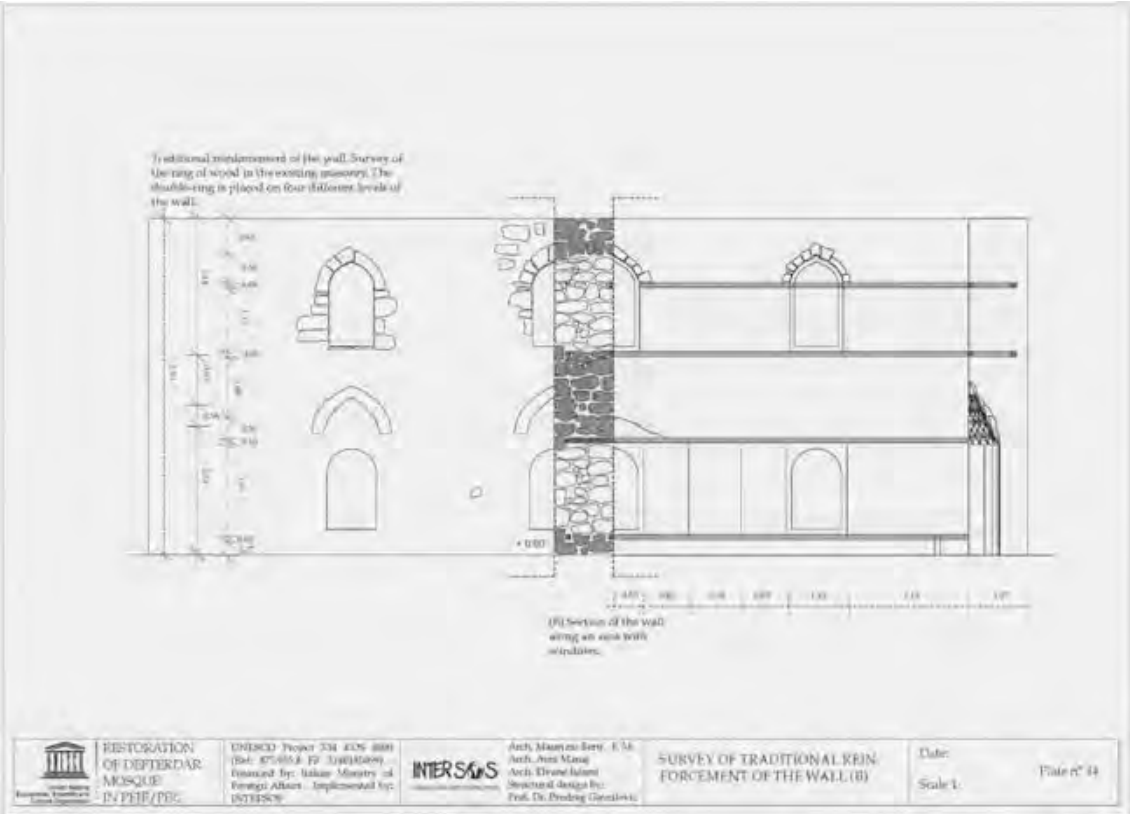
Figure 4.28.: Restoration of Defterdar Mosque. Survey of traditional reinforcement of the wall (A). Plate n. 13 [*M.B., 2008.*].

plaster;

2. preparation and execution of structural consolidation with injections and reinforcements on the upper level wall by one meter and in other parts, where are the wall cracks, using the method described in the project approved by UNESCO and listed below;

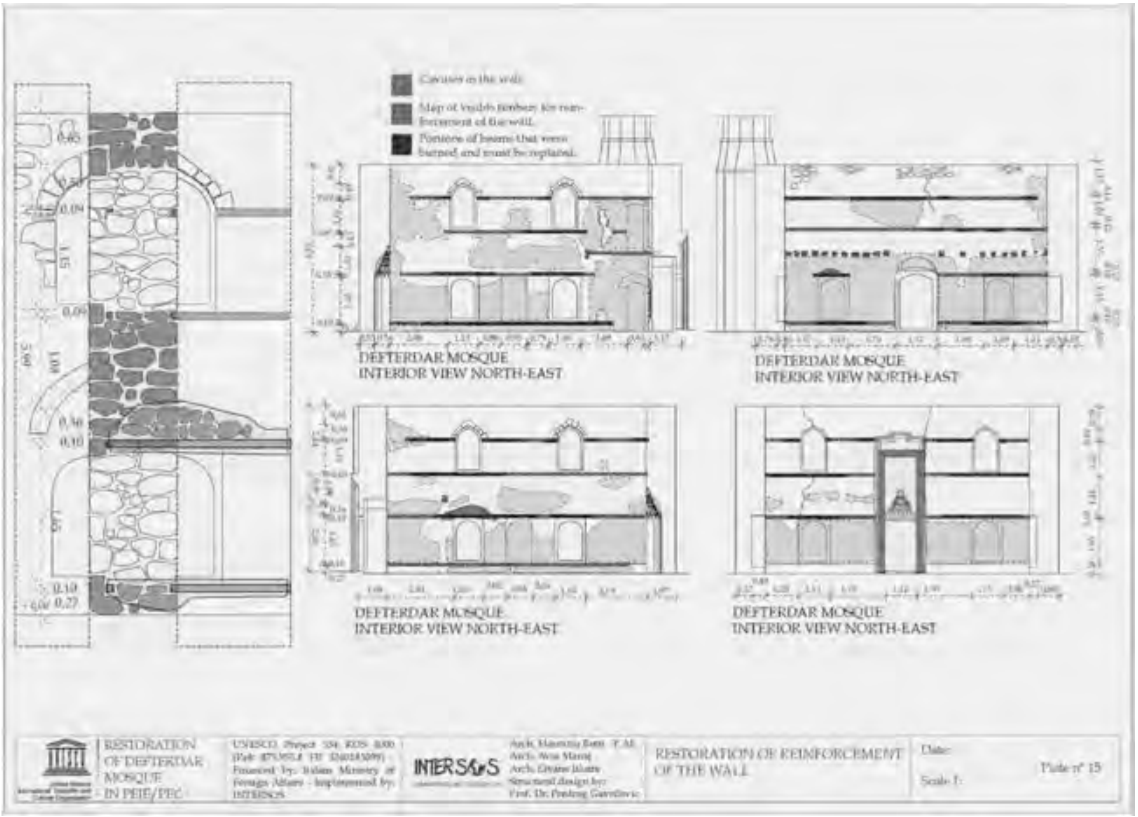
3. set up of a fir beams track, reinforced with steel plates, which will work as a wall reinforcement belt and as a base of the roof structure;

4. consolidation operations with lime injections and degraded chestnut beams replacement - the replacement of the four wood beams tracks in the walls was evaluated for more than 80% of its extension; replacement of windows wooden lintels and integration of wood and stone elements at the top of the wall. The type and static condition of the walls forced to combine a traditional wooden track system with a mechanism of two coaxial iron elements specifically designed to replace the wooden ties mostly missing because of ten years exposure to weathering;



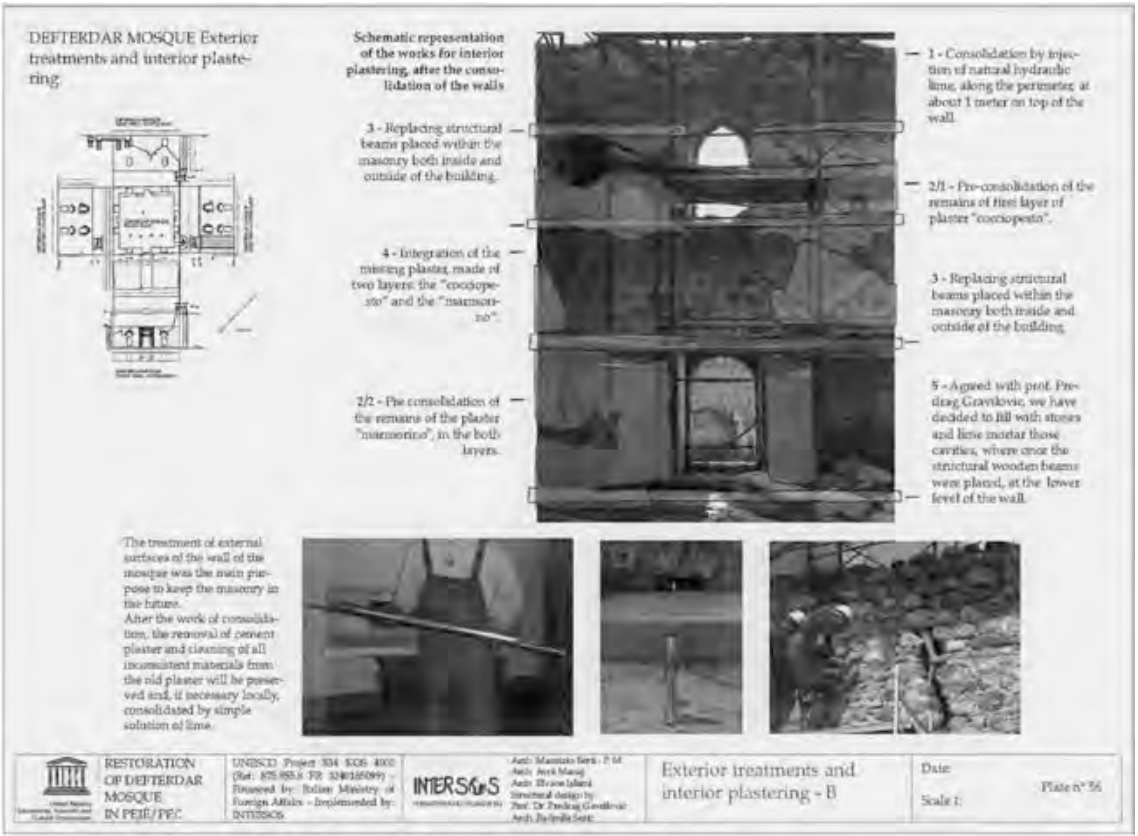
Traditional reinforcement of the wall. (B) Section of the wall along an area with windows.

Figure 4.29.: Restoration of Defterdar Mosque. Survey of traditional reinforcement of the wall (B). Plate n. 14 [*M.B., 2008.*].



Cavities in the wall. Map of visible timbers for reinforcement of the wall. Portions of beams that were burned and must be replaced. Section and four interior prospects of the mosque before works.

Figure 4.30.: Restoration of Defterdar Mosque. Restoration of reinforcement of walls. Plate n. 15 [*M.B., 2008.*].



Replacement of the four rings of chestnut beams - internal and external - lying inside the wall. The condition of the walls forced to combine a traditional wooden track system with a mechanism of two coaxial iron elements specifically designed to replace the wooden ties mostly missing because of ten years exposure to weathering.

Figure 4.31.: Restoration of Defterdar Mosque. Exterior treatments and interior plastering - B. Plate n. 56 [*M.B., 2008.*].

5. preparation of the wooden elements for the roof structure. There we decided to use fir wooden beams. This type of wood was suggested by burnt wood traces found on the top of the wall and by the building tradition of the region. The use of fir in the roof and of chestnut wood in the wall structural parts was discussed and agreed upon during the various inspections on site of a UNESCO delegation;

6. removal of exterior cement plaster;

7. processing of the green area. The external area around the mosque was often cleared, disinfected and reorganized. It is the old Muslim cemetery with interesting archaeological aspects;

8. roof assembly, according to Gavrilovic's structural design, already approved of;

9. excavation of six surveys with the aim of obtaining information about the foundations and soil nature;

10. completion of the consolidation and restoration of the marble remains;

11. integration of the missing parts in the second order windows, recovery of the ancient decoration elements, restoration of the damaged stone elements;

12. removal of the recent brick structure on the ground floor and restoration of the eight windows with the rebuilding of their frames with traditional materials and technology;

13. external walls cleaning and lime mortar application of the missing sealings around each stone in the same way as the existing antique pieces;

14. application of a new internal *marmorino* plaster to supplement the missing parts of the ancient plaster;

15. study of the archaeological excavations, in collaboration with the National Institute of Archaeology of Kosovo.

4.5. A method of consolidation

Why this section?

The brief description of a method of consolidation refined by Professor Predrag Gavrilovic, international expert on seismic safeguards for historical buildings, is justified because this same method is suitable for many aspects of the coral walls in a serious state of deterioration and decohesion. With the project and the frequent visits to the site of Gavrilovic were consolidated the walls

of the Defterdar mosque in Pejë/Peć and of the traditional Albanian Kulla in Decan/Decani, both restoration projects of UNESCO.

The main steps of the procedure for consolidation of a masonry built with river stones or stones that is unstable due to the decohesion of composite materials. The descriptions refer to the project for structural reinforcement of the mosque Defterdar[21].

The structural and material conditions of the mosque.

At the time of the composition of the consolidation plan, the mosque is in a state of severe structural destruction. The structural engineer highlights three main factors that caused the disorder and partial structural collapse.

First, the fire that burned almost all the wooden components: roof, windows, fittings rituals and structural elements such as lintels and chains that look for the masonry in four overlapping orders.

Second, the existing cracks of varying size and severity, are a manifestation of a state of structural disorder which causes, however, will be revealed more completely during the work of restoration.

Finally, a cause of further serious damage to the monument was the decade of exposure to atmospheric agents of the masonry. When starting the work the condition of the mosque could be described as ruinous.

(...)

2. PRESENT CONDITIONS AND DAMAGE STATE OF DEFTERDAR MOSQUE.

2.1. Present Conditions and Damage State.

The present conditions of the structure are the following:

The central hall of the mosque consists of massive walls without a roof, without windows and door (see attach Photos and drawings). The structure has long been without any protection, which was the reason for occurrence of additional damage to the upper parts of the walls and the roof parapet. Vertical cracks in the walls, cracks around the openings are also observed along the entire height of the walls. The "mirab" (a balcony inside the hall constructed as a timber structure resting on the wall mass of the massive walls and timber columns in the hall is also demolished. (see attach Photos and drawings). Interior wooden tied beams distributed over the height of walls are detonated and damage, lintel beams over the windows are damage detonated and have damage too.

[21] Predrag GAVRILOVIC and Radmila SARIC, *Structural Design of Reconstructions, Repair and Strengthening of Defterdar Mosque in Pejë/Peć*, in UNESCO Project 534 KOS 4000, Financed by: Italian Ministry of Foreign Affairs, Implemented by: INTERSOS, *Restoration of Defterdar Mosque in Pejë/Peć*, Pejë/Peć - Skopje, November, 2008.

INTERSOS
HUMANITARIEN AID ORGANISATION
ORGANIZZACIONE UMANITARIA PER L'EMERGENCA

INTERSOS Kosovo- Office Peje/Pec, kosovo@intersos.org

DRAFT

STRUCTURAL DESIGN OF RECONSTRUCTIONS, REPAIR AND STRENGTHENING OF DEFTERDAR MOSQUE IN PEJE/PEC, KOSOVO

Vol.I

Structural design by
Dr. Predrag GAVRILOVIC, St. Eng
Professor Emeritus
Msc. Radmila SARIC, St. eng

Principal designers of reconstructions
Dr. Arch. Maurizio Berti
Arch. Avni Manaj
Arch. Elvane Islami
From INTERSOS Kosovo, Office Peje/Pec

Peje/Pec, Skopje, November, 2008

PREFACE
This report is a result of the Contract signed between Intersos Kosovo Office Peje/Pec and Consultant Prof. Dr Predrag GAVRILOVIC, from Skopje, Republic of Macedonia, for elaboration Project " Structural Design for Reconstruction, Repair and Consolidation of Defterdar Mosque- in Peje/Pec – Kosovo. The above monument was damaged during the war and it has been left to the ravages of time, without any protection.
This Project has been elaborated on the base of Architectural and Conservations Project for Defterdar Mosque issued by Intersos Kosovo Office in Peje/Pec. This report contains structural design, analysis for gravity and seismic load, plans and details for construction of work presented in two Volumes. Volume 1, contents analysis and descriptions, Volume 2 contents structural drawings and details for constructions and field work instructions.

ACKNOLWEDGEMENT
As a Principal Designer of Structural Reconstruction I am extending my gratitude to the INTERSOS Office in Peja/Pecc, Kosovo for the entrusted task and engaging me as a consultant and classe cooperation during performance of the work. I am also indebted to architect Dr. Arch. Maurizio Berti, Arch. Avni Manaj and Elvane Islami, for their personal assistance and cooperation during the realization of the mission.
Peje/Pec, Skopje November, 2008 — Dr Predrag GAVRILOVIC, Emeritus Professor

RESTORATION OF DEFTERDAR MOSQUE IN PEJE/PEC
INTERSOS
D - PROJECT AND DETAILS FOR STRUCTURAL WORKS
Date
Scale 1

Figure 4.32.: The report for the consolidation of the Defterdar Mosque, 2008.

The entrance of the mosque that was additionally built will be treated separately.

The mosque minaret has been preserved.

Generally, the structure can be evaluated as damaged and partially collapsed. Detail presentation of present conditions as well as damage with appropriated survey and recording has been presented in the Architectural Project and Project for Conservations.

The identification of the structural system and knowledge of the materials used give us the possibility of evaluating the load capacity of a wall in ordinary conditions and the capacity of resistance to seismic forces. The repair of lesions and the consolidation according to the procedures in the structural design will make the structure adequate to support loads of ordinary exercise and respond safely to any seismic force.

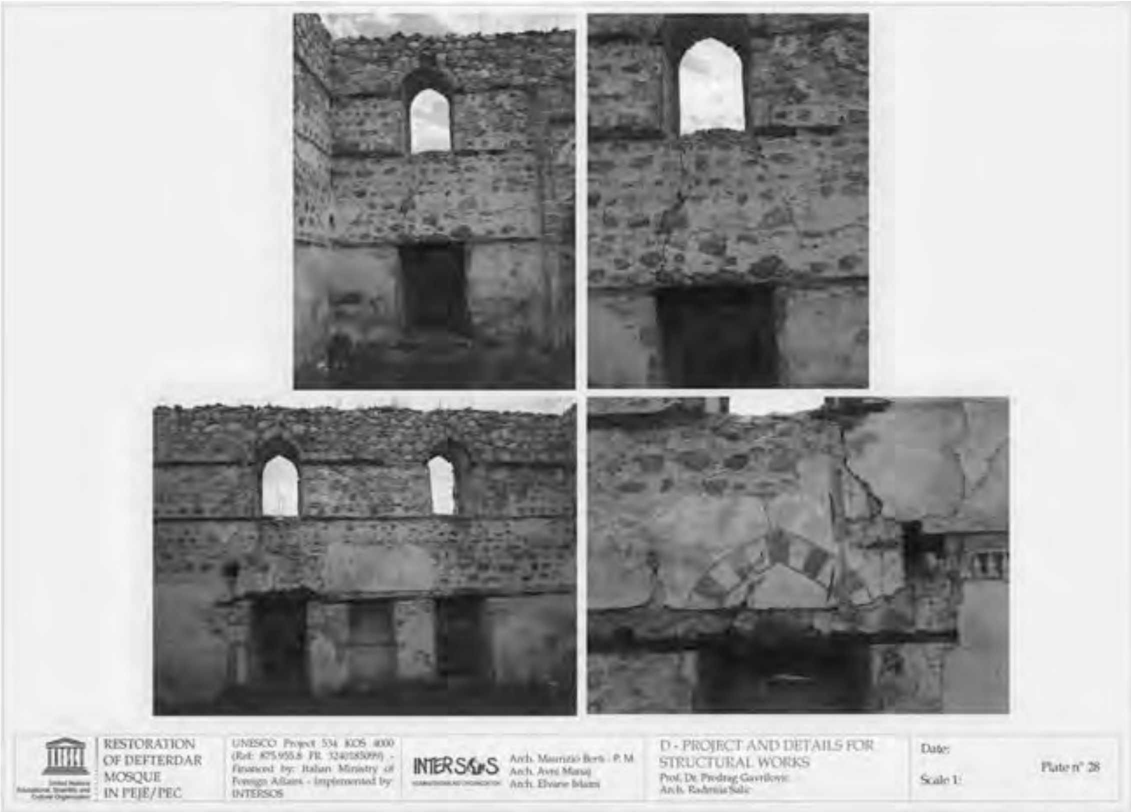
2.2. Identification of Structural System, Built-in Materials and Assessment of Bearing Capacity.

The principal structural system of the mosque consists of massive bearing walls constructed of stone masonry in lime mortar with a thickness of 1.06 m and a height of 6.05 m and a foundation into sandy-clayey soil. The walls are plastered from the inside and pointed on the façade. Since the structure has long been left unprotected, it has suffered damage and cracks (see attach Photos and drawings). As to the opening of the cracks, it is clear that the cracks are not only upon the surface but extend through the entire thickness of the walls which indicates damage to the structural system. It is necessary to pointed out that existing structure is not seismic resistant and it will be necessary to introduced elements in the forms for strengthening for seismic safety considerations. For gravity load, after repaired cracks and consolidations, capacity of existing masonry will satisfied this criterions.

On the basis of checks of the structure, the structural engineer can be concluded that there are conditions to perform the complete reconstruction of the monument, so that it can have its main function, namely to celebrate religious ceremonies. However, being a religious monument that will have a daily public use, and being this region interested of seismic phenomena of the eighth grade of the MCS scale, the structure of the building should not only be consolidated for a stable routine, but reinforced in order to have the seismic safety policy.

2.3. Conclusion and Recommendation for Reconstruction, Repair And Strengthening.

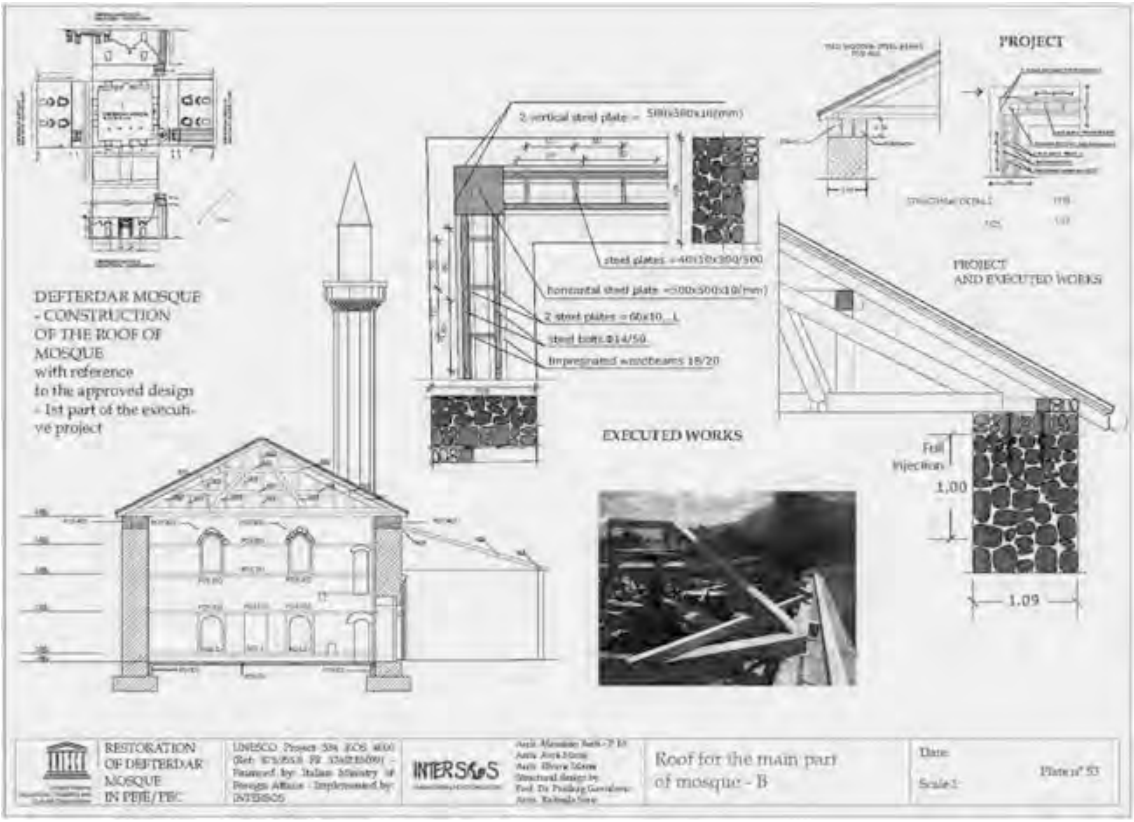
Based on the existing conditions and performed identification of the structure as well as the concept about its conservation given by the Institute for Protection of Cultural Monuments in Peja/Pec, it is proposed that the timber hipped roof structure with the central timber dome resting on the existing massive walls be reconstructed. In the process of reconstruction, it is necessary to perform appropriate consolidation, repair and/or



Structural Design of Reconstructions, Repair and Strengthening of Defterdar Mosque in Pejë/Peć, Kosovo - Vol.1. Structural design by: Predrag GAVRILOVIC, Radmila SARIC from Skopje. Principal designers of reconstructions: Maurizio Berti, Avni Manaj, Elvane Islami from INTERSOS Kosovo, Office Pejë/Peć. November, 2008. Views of the interior prospects of the mosque before the works.

Figure 4.33.: Restoration of Defterdar Mosque. D - Project and details for structural works. Plate n. 28 [*Photo by Predrag Gavrilovic, 2007.*].

strengthening of the bearing walls and the integral structure. Based on the performed inspection and preliminary analysis of the structure, it can be concluded that there are conditions to perform complete reconstruction of the monument in order that it might be operational regarding its main purpose, namely as a religious structure. Structural reconstruction, consolidation, repair and strengthening are necessary and should be performed based on a detailed analysis and design, presented in the next chapter of this Report. According to existing criterions as monument as well as religious building, having in mind seismicity of the regions- VIII degree MCS Scale, reconstructed and strengthen structure should satisfied safety criterion having in mind also important factor and to a proof seismic safety.



Project of the roof for the main part of mosque and illustration of the executed works for repair and strengthening the Defterdar Mosque walls.

Figure 4.34.: Restoration of Defterdar Mosque. Roof for the main part of mosque - B. Plate n. 53 [*Gavrilovic and M.B., 2008.*].

Methodology.

Since even the roof is an integral part of the structure of a building, the structural engineer does not separate the construction of new roof from static and dynamic characteristics of the walls of the mosque. In summary, the entire structural reform involves the following steps:

(i) the structural consolidation, repair and reinforcement of current massive bearing walls;

(ii) the application of a framework of wooden beams in the crown of masonry;

(iii) the replacement or integration of wooden strings inside the wall with their four levels (during the work we have been determined not to restore the wooden strings at ground level and so the wall cavities were filled.);

(iv) the reconstruction of the roof structure of wood with a central dome;

(v) the reconstruction of the entrance porch;

(vi) the strengthening of the load-bearing walls;

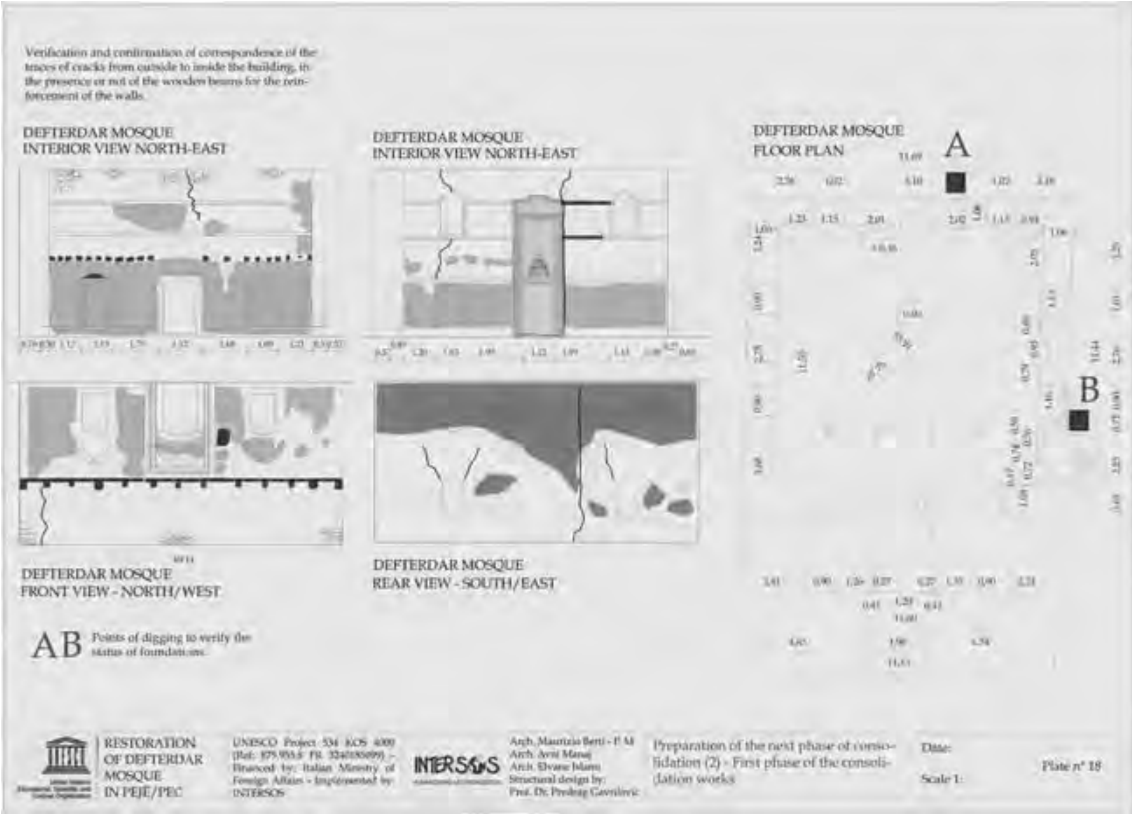
(vii) the construction of a reinforced concrete plate at the foundation level.

3. RECONSTRUCTION, REPAIR AND STRENGTHENING OF DEFTERDAR MOSQUE.

3.1. General Concept of Reconstruction The complete reconstruction of the structure should involve the following phases: Structural consolidation, repair and strengthening of the existing massive bearing walls with introducing tied ring beams on the top of the walls, replaced wooden belts on originally places and lintel beams over openings Reconstruction of the timber roof structure with the central dome, Reconstruction of the entrance part, with roof and strengthening of bearing walls /next phases of reconstructions/ , Reconstruction of the "mirab" (the inner balcony) with appropriate wooden structures Works on the interior (plastering, floors, etc.) according to conservators requirements. Strengthening of Foundation and construct R/C floor slab.

3.2. Proposed Methods, Techniques and Materials for Reconstruction, Repair and Strengthening.

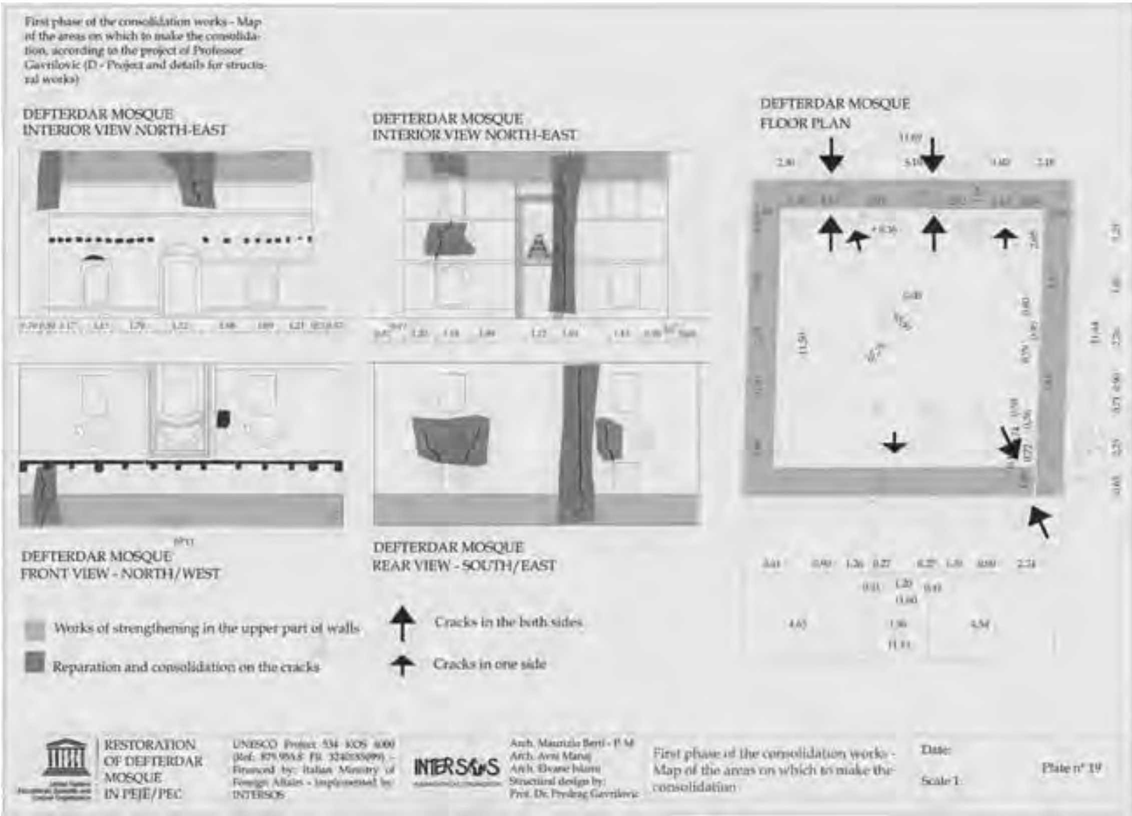
The reconstructed structure should satisfy all the stability requirements in accordance with the valid regulations, which also includes seismic stability in accordance with the present criteria. To provide complete stability with the necessary level of safety, it is necessary to design the roof structure with the dome from engineering – structural aspect considering existing spans. The massive walls must be repaired and consolidated such that they will at least have the bearing capacity that they had prior to the collapse. To provide seismic stability, it was necessary to perform detailed analysis in compliance with the regulations and design appropriate strengthening of the existing bearing system. Considering the existing conditions, consolidation of the walls by injection and



Verification and confirmation of correspondence of the traces of cracks from outside to inside the building, in the presence or not of the wooden beams for the reinforcement.

Figure 4.35.: Restoration of Defterdar Mosque. Preparation of the next phase of consolidation (2) - First phase of the consolidation works. Plate n. 18 [*M.B., 2008.*].

introducing of a final belt course along the roof perimeter, could be sufficient measures of strengthening. It was elaborate a project for structural repair with computation and analysis of seismic stability – safety of the structure that represents a structure of the first category (a structure in which people are gathered), meaning that although the structure is in the VIII seismicity zone, it should be treated as if it is in a zone designated by important factor Ip=1.5 witch is meaning to increase seismic forces for design of structural elements and evaluated safety of structures and Building as a Monument and religions Building as well. Based on the performed inspection of the structure, it can be concluded that there are conditions to perform complete reconstruction of the monument in order that it might be operational regarding its main purpose, namely as a religious structure. Structural reconstruction, consolidation, repair and strengthening are necessary and should be performed based on a detailed project and corresponding analyses. In the next chapter and volume 2 are presented designed structural reconstructions and repaired.



First phase of the consolidation works - Map of the areas on which to make the consolidation (D - Project and details for structural works).

Figure 4.36.: Restoration of Defterdar Mosque. First phase of the consolidation works - Map of the areas on which to make the consolidation. Plate n. 19 [*M.B., 2008.*].

The increase in potential structural seismic response.

As said, the building is located in an area of considerable degree of seismic activity. More specifically, under the Charter of the seismicity of the Balkan region are expected here earthquakes VIII degree of the scale of MSC. Considering the category to which the building belongs, ie religious building frequented by people, the structure will increase the security level to respond in terms of stability and security to seismic forces 50% higher than those provided in conformity with the legislation regional and Euro code 8.

4. ANALYSIS OF STRUCTURAL SYSTEM AND STRUCTURAL ELEMENTS OF DEFTERDAR MOSQUE IN PEJË/PEĆ.

Based on the previously presented existing state of the structure and the designed concept for reconstruction, repair and strengthening of the structure and the structural elements, the analysis of the structure to be reconstructed will be done in compliance with the technical regulations, rules and standards for the corresponding location and type of structures to which this structure belongs. The structure is situated in a zone of expected seismicity of VIII degree of MSC scale./ According to existing Map of seismicity of the Balkan region./ Considering the category to which it belongs, namely a religious structure serving for gathering of people, the structure should be treated considering an increased level of protection, i.e., the analysis of its seismic stability and safety will be performed for seismicity of increasing seismic forces for 50 % in accordance with the valid regional regulations and Euro code 8. The fact that the structure also represents a historic monument makes even more justified the increase of the category of the structure from the safety aspect. The analysis of the structure will be carried out by using corresponding software packages while the proportioning will be performed according to the standards for the corresponding materials.

Consolidation by injection of pozzolana ash.

(...)

5.5. Repair and Strengthening of Masonry.

Walls Masonry walls should be repaired with injections with non-cement basis. Injections of cracks and partially of "systematical foul injections" of some parts as a Tied rings beams, above windows should be don by special equipment, materials and procedures. These methods will be presented as an Annex of this Report- project after details inspections, survey and specifications.

(...)

III. - 1.1 Injecting the stone wall by joint pointing with lime mortar. Then the injectors shall be fitted, 3/4" in diameter, about 4 pieces to m2 of the wall. The injectors shall be well connected to the 4 injecting device. The drills shall be minimum 2/3 of the wall *deep. The injecting device shall be constructed for continuous mixing and pressurization of the mass, without halting or stopping the process. The walls shall be injected with mixture consisting of 50% of lime slurry, 40% of filler and 10% of microsilica*[22]*. The injection mass shall be prepared with lime mortar. In the lowest parts of the wall, a hydrophobic additive shall be added. Injecting shall be performed after washing and soaking the wall with clean water which is entered into the wall through injectors. The injecting shall be started at the lowest point to enable driving air and water out of the wall. It shall be performed under 1 atm pressure, to be increased to 2 atm when the wall stops taking any more injection mixture, which pressure shall be maintained for 10 minutes (defiltration time). After this, new injector shall be filled, always the lowest one. During the defiltration period, the surplus water is evacuated from mortar and mortar therefore reaches greater strength. Expansion of injection mass shall be monitored at the neighboring injectors. Those that leak shall be plugged to prevent the mass to leak. The mixture shall be cleaned from walls immediately since they shall be pointed and visible. After injecting, injectors shall be removed from the wall and mortar used for fixing them at the wall shall be cleaned. After this, the wall shall be pointed again and harmonized with the surrounding walls. Injecting shall be performed by a company specialized for this kind of works.*[23]

[22] 1. INFORMATIONS FOR PUCOLAN

Technological treatment for pucolan production

The pucolan that our company uses is good mixture of "eruptive" compounded with the emplacement located in the eastern Macedonia. The appliance is in cement industry.

Technological production process includes following operations:

- creating the emplacement - perforation - mining - transportation of comminute material till the mills for the grinding - rudely grinding - desiccation of the grinding with the humidity of 1 % -fine grinding and separation of the grindings on the fractions according to the requests of the customers -packing -modulating in the warehouse

1.2 Characteristics

Pucolan is fine grinding of eruptive cliff with the contents above the 90% silicon dioxide. Precisely for the improving of the calcareous mortar, the pucolan find adaptation in Italy. The production of the pucolan in Macedonia is established in the base of the eruptive cliff named TUF. Granulometriski structure of grinding is from 0-10 microns. Same through the reaction based on the midst of hydrous lime enables obtaining bigger beginning and endmost strength characteristics of calcareous mortar.

Majority participation/involvement of components in the compositive ligament is hydraulic lime and tuff and other parts are additive for the decreasing of water involvement, the raised compounded of mortar and resistance versus atmospheric conditions. Each component of composite has own role also in the extreme quality of calcareous mortar.

[23] Without wishing to load special meaning it is transcribed a step of Universal Scamozzi Architecture, a real encyclopaedic modern man. The pozzolana that we used in Kosovo had been extracted in the eastern region of Macedonia, but we found that there are also deposits in eastern Kosovo.

CAPITOLO XXI. Delle pozzolane, grappilli ed altre materie da murare e di alcune sabbie. particolari usate in varj paesi di là dai monti. (. . .) Ma la migliore veramente è quella che si trova nel territorio di Pozzolo, come ottima è quella di Cuma, la quale mescolata con la calce fa presa in sessanta giorni. La pozzolana di Roma e là d'intorno, è di color rossiccio, forte e gagliarda, della quale selciano le strade e fanno fondamenti massicci e mura, servendosi poi della scura o nera per l'intonacatura delle mura. Queste pozzolane sono alquanto più grosse e magre, che non quelle in terra di Lavoro (denominazione antica di parte della Campania). Quasi una simil sorta di terra e non polve, come la pozzolana, trovasi nella regione de' Ciziceni (dall'antica città di Cizico), isola del mar maggiore (Mar di

Physicallymechanically characteristics of the pucolan are presented in the chart 1.(scanned attachment)

	0-10 microni
Specific weight	2320
Specific surface m^2/kg	$41.2*10^3$
Whiteness EIR	75.5
pH to 10% suspension	7
Volumetric weight kg/m^3	
-in solid condition	410
-in disolved condition	310
Abrasiveness(mg)	
-in Einlehner	32
-in Valley	55
Apsorption of linseed oil (ml/100g)	86.8
Apsorption of water (ml/100g)	113.4
Apsorption %	8.70
Apsorption of resin (ml/g)	
-pH 8	1.33
-pH 5	1.01
Zeta potential	
Humidity	1.5
Percentage retained on sieve(%)	1.10
Grain size distribution:	
D max mic.	
D min mic	3.9
SSD	

Chemical structure of pucolan is presented in the chart 2.(scanned attachment)

	0-10 micron
	%
SiO_2	93.75
Al_2O_3	2.93
Fe_2O_3	0.57
CaO	0.93
MgO	Trace
Na_2O	0.04
K_2O	0.06
Heating loss	1.79

In the consolidation of both walls of the Defterdar mosque in Pejë/Peć and of the Kulla of Decan/Decani, the procedure for injections of the connective-based pozzolana and lime is as follows. Pre-consolidation and local re-adhesion to the wall of all the remains of plaster marble to retain. All the cracks, passing the wall or not, are carefully cleaned and plastered both inside and outside of the wall to contain the fluid injected into the cavity. The material for plastering consists of a preparation of lime and gypsum with low mechanical strength, that it can be easily removed after hardening of the mixtures injected. Definition of drainage network, adapted according to the distribution of degraded areas and textural characteristics of walls. Application of drainage cannulas. Apart from special cases of cracks, for example linked to doors and windows, the consolidation with the consolidating fluid injection is performed starting from the bottom of the wall, continuing to work the second successive sections of five feet high. Pre-washing of the cavities wall with very dilute hydrated lime in order to wet the powdered material, possibly facilitating the escape from the wall, and thus have an environment more suitable to receive the consolidating fluid. At this stage it is possible to improve the arrangement and change the number of knock-outs and improve the dilution necessary for optimal penetration of the mixtures to be injected. The mixture of hydrated lime and pozzolana is established according to the proportions of the project and is regulated in accordance with the dilution of the treated area. The recommended pressure for the injection is between 1 and 2 atm at the level of the work plan. The mixture from the mixer to the compressor is sieved with a fine mesh sieve size determined to ensure uniformity of the fluid.

Figure 4.37.: Pozzolana from Macedonia for Defterdar mosque [*Gavrilovic, 2008.*].

Marmara, l'antico Propontide), la quale, per grandissima quantità che fosse, tuffandosi nel mare diventava pietra, ed il medesimo faceva il terreno nella Macedonia e nel fonte di Guido nella Caria, ed altrove.

See: TICOZZI Stefano editor, *L'idea dell'architettura universale di Vincenzo Scamozzi*, Vol. I., Borroni e Scotti, Milano 1935, p. 267.

Part III.

Appendix

Different sources:
- João Dos Santos;
- Gaspar Correa;
- Charles Darwin;
- William Fitz William Owen;
- Andrew Petersen.

Different experiences:
- Plano de Urbanização da Vila do Ibo;
- Restoration of the Defterdar mosque in Pejë/Péc (Kosovo);
- Preliminary report for six restoration works in Ilha de Moçambique (2002) - Rewriting (2009).

Abbreviations.

A. Different sources

A.1. João Dos Santos

In 1505 Pero de Anhaya built the fortress on the island at the mouth of the Rio de Sofala. Thus the description of the fortress and the region in the account of Friar João Dos Santos, who lived from 1586 to 1590 in Sofala:

Da fortaleza de Sofala e suas povoações. A fortaleza de Sofala está em vinte grãos e meio da banda do Sul, situada na costa da Ethiopia Oriental, perto do mar, e junto a um rio que tem de boca uma legoa, pouco mais ou menos, e nasce pela terra dentro obra de cem legoas, nas terras a que chamam Mocarangua, e passa por uma cidade que chamam Zimbaoé, onde vive sempre o Quiteve, que é rei de muita parte d'estas terras, e de todo o rio de Sofala. Por este rio acima navegam os moradores da fortaleza de Sofala, e levam suas mercadoria até Manica, que é terra de muito ouro, situada pelo sertão dentro mais de sessenta legoas, onde vendem suas fazendas, e trazem muito ouro em pastas, lascas e em po. É a fortaleza de Sofala quadrada e cercada de muro de vinte e cinco palmos de altura. Tem quatro baluartes redondos nos quatro cantos, guarnecidos de artilheria grossa e miuda. Em uma quadra da banda do mar, tem uma larga e formosa torre de dois sobrados, e ao pê d'ella uma sala formosissima, as quaes casas são aposentos do capitão da fortaleza. Nos baixos d'esta sala tem o capitão suas despensas, e no vão da torre do chão até o primeiro sobrado, uma mui formosa e boa cisterna de agua da chuva, de que bebe ordinariamente a mais da gente de SofaIa, por ser muito melhor que a dos poços, e não bebem do rio, porque ali é toda sua agua muito salgada. Dentro d'esta fortaleza está a egreja matriz, que é a freguezia de toda a gente da terra. Na quadra do muro que vae para a banda da povoação, está uma formosa casa, que serve de feitoria, onde se recolhem todas as fazendas, assim roupas e contas, que vem de Moçambique, como marfim, que se compra junta por toda estas terras. Junto a esta fortaleza de Sofala está a povoacão dos moradores christãos, na qual havia no tempo que eu lá estava mais de 600 almas de confissão, em que entravam portuguezes, mestiços e gente da terra. N'esta povoação esta uma ermida da invocação do Espirito Santo. Nos fizemos outra da invocação de Nossa Senhora do Rosario nas casas em que moravamos e fóra da povoacão fizemos outra da invocacão da Madre de Deus em um palmar nosso que é o melhor posto *e sahida que tem Sofala; a qual é de muita romagem e devoção da gente da terra. E ambas esta ermidas deixámos bem ornadas de peças e ornamentos, quando nos fomos de Sofala. O moradores d'esta fortaleza ordinariamente são mercadores, uns se occupam em ir a Manica ao resgate do ouro, com roupas e contas assim do capitão, como suas, e outros ao rio da Sabia e ás ilha das Bocicas, e a outros rios que estão perto de Sofala, ao resgate do marfim, âmbar, gergelim e outros legumes, e muitos escravos. As mulheres desta terra toda se occupam em semear arroz, em o que andam a maior parte do anno, ora cavando a terra, ora semeando, despondo e mondando; o que tudo fazem a poder da enxada, e nada e semea com arado. Outra povoação ha em Sofala de mouros, afasada da fortaleza obra de dois tiros de espingarda, na qual haveria no tempo que eu lá estava cem vizinhos, os quaes são vassalos da nossa fortaleza, e muito sujeitos ao capitão, e aos mais christãos. Todos são pobres e miseráveis, e ordinariamente vivem de servir aos portugueses em seus caminhos e mercancia e de marinheiros. As mouras tambem se occupam na sementeira, como fazem as cristãs , e de tudo o que colhem pagam o dizimo á nossa egreja* (Dos Santos, 1609, p. 42-44).

Esta fortaleza foi feita por Pedro da Nhaya no anno do Senhor de 1505, o qual foi a esta costa por mandado d'El-Rei D. Manuel, de gloriosa memoria, com uma armada de seis náos: e depois de passar na viagem muitos trabalhos chegou ao rio de Sofala, onde entrou com quatro náos mais pequenas, deixando a duas grandes no mar por não poderem entrar a barra, que é muito baixa. E depois que desembarcou foi fazendo esta fortaleza por consentimento do rei da terra, que era mouro, chamado Zufe, o qual era cego de ambos os olhos, de uma doença que teve. Mas depois que Pero da Nhaya teve a fortaleza quasi feita, o rei Zufe se arrepéndeu de ter dado consentimento para se fazer a tal fortaleza nas suas terras e por conselho dos principaes mouros seus vassalos, determinou matar aos portugueses, e tomar-lhe a fortaleza. Esta traição foi logo descoberta por um mouro abexim que morava na mesma terra, chamado Açotes, grande amigo de Pero da Nhaya: e com este aviso se fizeram logo prestes todos os portugueses dentro na fortaleza, para resistir aos mouros, os quaes vieram no mesmo dia que para isso tinham determinado, cuidando que nao sabiam os portugueses de sua traição, nem estavam apercebidos: no que se acharam muito enganados, por que começando de abalroar a fortaleza com muita furia, acharam tanta resistência, e esforço nos portuguezes, que não podendo esperar seu impeto, voltaram as cotas, fugindo para o aposentos onde estava o rei fortalecido, e os portuguezes lhe foram dando nas costas, até entrarem as casas do proprio rei: o qual, ainda que cego, pretendeu vender sua vida a troco de tirar a dos inimigos: pelo que fez alguns tiros com azagaia, que tinha junto de si, e feriu alguns portugueses, entre os quaes um foi Pero da Nhaya: mas durou-lhe pouco esta resistencia por que logo foi morto pelos portugueses, com muitos de seus vassalos, e o demais vencidos e desbaratados. No *principio d'esta briga acudiu Açotes, com cem homens da sua obrigação e família e se poz logo da parte de Pero da Nhaya seu amigo, e pelejou com toda sua gente em defensão dos portugueses, como leal e fiel amigo. Pelo qual respeito Pero da Nhaya o fez rei dos mouros de Sofala, e reinou n'ella toda a sua vida pacificamente, assim com os mouros como com os portuguezes. E Pero da Nhaya acabou a dita fortaleza em paz e faleceu n'ella depois de a ter feita, ficando em seu logar por capitão Manuel Fernandes, que n'esta costa andava por feitor d'El-Rei. No anno de 1586, em que eu fui a esta fortaleza, achei ainda n'ella alguns mouros velhos, e algumas mulheres cristãs, que haviam sido mouras, naturaes da mesma terra, que se lembravam mui bem d'esta guerra, e de quando se fez a fortaleza, que n'este tempo havia mais de oitenta anos que era feita. Já que falei n'este reino de SofaIa, é de saber que antigamente em muitas fraldas do mar d'esta costa, e particularmente nas bocas dos rios, e nas ilhas, havia povoaçoes mui grandes, habitadas de mouros, com seus termos cheios de muito palmares, e fazendas, e cada uma d'estas cidades tinha seu rei como era este Zufe de Sofala; os quaes tinham paz e comercio com os reis cafre senhores do sertão, mas já hoje ha muito poucos reis d'estes mouros, por que os mais d'elles se acabaram com a entrada dos portugueses n'estas terra, como foram os de Sofala, onde já não ha reis mouros, nem castas d'elles; e no logar d'estes reis ficaram o capitães de Sofala, que tem agora o mesmo comercio, e amizade, que eles tinham com o Quiteve rei de todas estas terras do sertão* (Dos Santos, 1609, p. 46-48)[1].

A.2. Gaspar Correa

*CAPITULO V. (p. 570) DE COMO EM MAYO, DEPOIS DA PARTIDA DO VISOREI DOM FRANCISCO, ELREY MANDOU PERO DA NHAYA PERA CAPITÃO DE ÇOFALA COM SEIS NAUIOS, E O QUE PASSOU NA VIAGEM, E FEZ EM ÇOFALA ATE' FAZER A FORTALEZA COMO PARECE. Partido Dom Francisco pera a India, EL REY mandou muyto trabalhar por se tirar do fundo a nao de Pero da Nhaya, o qual trabalho e déspeza * foy* (*fez*) em vão. Então se ordenou outra nao, que logo em todo foy prouida com as outras da companhia, que erão per todas seis, de que fez Capitães Pero da Nhaya Capitão mor, e seu filho Francisco da Nhaya pera com dois nauios andar de Çofala pera a costa de Melinde no trato das roupas pera Çofala, e os outros quatro nauios mandar pera a India acabada a fortaleza; de que erão Capitães Pero Barreto de Magalhães, Pero Cão pera feitor, João Leite, João de Queiroz, que todos juntos nauegarão, e sem contraste passarão o Cabo; e depois dahy a hum mez partirão Pero Quaresma, Cide Barbudo, e nom passarão, e enuernarão em Quiloa. Pero da Nhaya,*

[1] João DOS SANTOS, *Ethiopia Oriental e varia historia da covsas no taueis do Oriente*, Manoel De Lira Impressor, Eura 1609 [Reprint as: *Ethiopia Oriental*, Lisboa 1891 - from: http://books.google.com].

*seguindo sua viagem pera Çofala, fáleceo de sua doença Pero Cão feitor, e foy logo *feito* (...) capitão do seu nauio e pera feitor Manuel Fernandez de Meireles bom cauaIleiro, e ficando em Çofala com seu cargo, foy pera a India no seu nauio Jorge Mendez Çacoto. João Leite, fisgando hum pexe, da proa cayo ao mar e morreo, e foy feito Capitão do seu nauio João Vaz d'Almada, e vendose já perto de Çofala, ficando atrás João de Queiroz, sayo em huma Ilha a matar vaccas, *e* (...) o matarão com doze ou desaseis homens, e o mestre, e piloto; e chegou a Çofala e foy feito Capitão do seu nauio Gonçalo Aluarez, que depois foy piloto mór da lndia; e no nauio de Pero da Nhaya, que auia de andar no trato era Capitão João da Nhaya seu parente; e correndo seu caminho Jorge Mendez, topou com o batel da nao de Lopo Sanchez, que se perdeo, com doze Portuguezes já quasi pera morrer, porque nom comião senão caranguejos crus. Chegarão todos a Çofala, e entrarão os nauios *dentro* (*de Mitro*) e a nao de Pero Barreto e de João Vaz d'Almada ficarão fóra porque erão grandes. Onde assy entrados, o Capitão mór mandou recado a ElRey, que estaua hy perto, pedindolhe licença pera lhe, hir falar, a qual licença lhe ElRey deu com boa vontade, e então elle vestido de festa com os Capitães, sómente Pero Barreto que ficou nos nauios, e com cincoenta homens armados, e com suas trombetas diante, foy onde estaua o Rey, ao que se ajuntou muyta gente. As casas tinhão grande cerqua de sebe de espinhos muy fortes, com porta fechada. Entrarão em huma *casa grande de terra,* (*grande terra*) e todas as casas de palha, e nesta casa grande estauão muytos Mouros mercadores bem vestidos, e o Rey estaua em huma casinha pequena álem desta, armada de panos de Cambaya pintados de seda, e elle jazia deitado em hum esquife; muiyto velho e cego, que mostrou muyto prazer com a chegada dos nossos, e mandou assentar o Capitão mór, junto do esquife, em esteiras que erão muy fermosas, e a outra gente ficou em pé na casa dianteira. * (...) Então lhe disse o Capitão mór que ElRey de Portugal, pola amizade que já com elle tinha assentada com os seus Capitães que ahy vierão, por tanto, que por assy desejar de pera sempre com elle e com seus filhos e naturaes ter boa paz e amizade, e aly em sua terra ter feitoria com grande trato ambos muyto proueito sem lhe fazer ninguem mal nem escandalo a seus mercadores e naturaes, assy em Moçambique como por toda a India: e pera esta verdade e assento de boa paz se lhe a elIe prouesse darlhe licença pera fazer casa de feitoria e casas em que elle morasse *com* (*e*) sua gente, de que elle auia de ser Capitão, pera que tudo estiuesse bem guardado, porque em tudo nom faria senão o que elle mandasse. * (...) O que ouvido polo Rey disse que muyto folgaua com sua vinda e que estiuesse em sua terra, e nella fizesse quanto quisesse, porque nom seria menos do que fazião nas outras, que lhe contauão e tinha sabido que faziamos mal aos Reys máos; e bem aos bons; e porque em sua terra ninguem lhe auia de fazer mal nem nojo, com que estaria em paz sua terra e gente, elle tomasse lugar onde lhe bem parecesse, e fizesse feitoria e casas muyto á sua vontade; com que o despedio, e com elle mandou hum* *seu Regedor que lhe fosse dar tudo quanto lhe pedisse, com que assy sayndo das casas acompanhado com o Regedor, que lhe fez grandes honras, se tornou aos nauios, donde logo mandou a ElRey grande presente, que lhe trazia, de peças de seda de cores, espelhos, continhas, coraes, facas, barretes vermelhos, e outro presente ao Regedor. O que leuou Francisco de Nhaya com suas trombetas diante, e tudo descoberto que o visse a gente. O que o Rey recebeo com *grandes* (*muytos*) contentamentos, e assy o Regedor, offerecendose a lhe fazer muytos seruiços; com que se tornarão aos nauios, onde logo lhe o Rey mandou galinhas, e inhames, e cabras, e cousas de comer que auia na terra, e lhe mandou vinte Portuguezes que estauão em outra pouoação muyto bem tratados e curados, que hy chegarão por terra da nao de Diogo Sanches, que se perdêra dahy a dozentas legoas; com que o Capitão mór e todos ouverão muyto prazer, e lhe contarão que todo o bem que tinhão o Regedor lho *fazia.* (*fizera*) O Capitão mór, olhando a desposição da terra, com o conselho de todos tomou o lugar pera fazer a fortaleza perto do rio, junto de hum palmar, em que estauão humas casinhas de palha, que bem pagou a seus donos, e logo fez casa grande pera a feitoria e outras casas pera a gente, ao que se fez grande cerqua, em que logo se puserão no trabalho de abrir grande caua; e repartio a gente com os Capitães ao trabalho com cauouqueiros, e pedreiros, e mestres, que trazia com muytas monições pera a obra; pera o que já trazia pedras lauradas e portas feitas pera porta grande, e janellas e portas; ao que o Regedor sempre era presente, dandolhe gente de trabalho e quanto podia, que tudo era bem pago. E muytas vezes hia estar com ElRey, e muyto folgaua de falar com os nossos, que lhe contauão as cousas da India que os nossos passauão. Sendo a caua aberta, e querendo abrir os aliceces [aliçerces] pera a fortaleza, em que auia mester muyto tempo pera a obra, ouverão por melhor conselho nom começar a fortaleza, porque nom seria feita, nem estauão fortes, e que os nauios auião de hir pera a Jndia, e mórmente as duas naos que estauão na barra, que corrião muyto risco dos grandes temporaes que sempre aly auia; e porque pareceo bem a todos fazer a obra que se *pudesse* (*pusesse*) acabar, com que a gente estiuesse segura d'algum mal que succedesse, fizerão de dentro da càua huma forte tranqueira de grossos paos mettidos na terra, e por dentro outra, e *contra* (*antre*) ambas muy forte antulho, mais que hum muro, em que assentarão artelharia, e fizerão muytas casas, em que recolherão as monições, fazendas e mantimentos. Do qual trabalho, por a terra ser doentia, começou a gente adoecer e morrer; pelo que ouverão por bem acertado conselho no que tinhão feito em nom ter começado fortaleza; e a tranqueira e toda a mais obra foy acabada em fim d'Outubro, sendo muyta gente doente de grandes febres dos maos ares da terra. Então o Capitão mór despedio Pero Barreto por Capitão mór das outras tres naos, que se fossem á Jndia, escreuendo ao Visorey que o escreuesse a ElRey, que parecia escusado aly fortaleza e gasto de gente, que nom senhoreaua nada, porque se com paz e amizade se nom fizesse o resgate, ninguem lho podia* *fazer por força, por a terra ser má de doença. Abastaua vir aly resgatar e tornar pera Moçambique, onde estaria melhor a fortaleza e feitoria do trato de Çofala, que dahy hiria e viria, sem nenhum impedimento. Com que partidos os nauios, os nossos ficarão assy trabalhados com as doenças, mas passando alguns mezes que nom morrião, tornauão a conualecer ficando em boa saude, sendo senhores da terra com muyto fauor que tinhão do Rey, e do Regedor que mandáua como Rey; mas como os Porluguezes de sua propria *constellação* (*constolação*) são soberbos e altiuos onde nom tem sogeição, com o muyto fauor do Rey que era muyto nosso amigo, que se chamaua Maná Matapá, que era filho do outro Rey chamado Vnhamuda, tanto os nossos se soberbearão em males, que tratauão a gente da terra pior que catiuos, de que se muyto queixauão ao Regedor e a ElRey, que sobre isso mandou recado ao Capitão mór, que posto que por isso os castigasse como o parece razão, os males nom cessarão, e forão em tanto crecimento com todos, os da terra se muyto queixando com ElRey por assy dar tanta possança aos nossos, bradandolhe que os deitasse fóra da terra primeyro que o matassem, e toda sua gente, segundo leuauão caminho em tantos males que fazião, *que* (...) então o Rey mandou polo Regedor dizer ao Capitão mór que tinha grande paixão dos males que fazião a sua gente, o que elle nom queria castigar, nem emmendar, senão cada vez pior; que por tanto nom queria que estiuessem em sua terra, e logo se fossem, e embarcassem em seus nauios. Deste recado mandou o Capitão mór muytas desculpas a ElRey, dizendo que sua doença era a causa da sua gente andar desmandada, mas que elle tudo castigaria como se emmendasse; a qual reposta o Rey nom aceytou por estar já muy, danado com os conselhos dos Mouros; que erão os principaes senhores da terra, que erão Cafres naturaes que se tornarão Mouros: per conuersação e amizade que tomarão com os Mouros tratantes estrangeiros, que vinhão tratar a Çofala, que lhe fazião grandes amizades; e tornou a mandar dizer ao Capitão que nom queria que estiuesse em sua terra, que se fosse a Moçambique, ou onde quisesse, e de lá mandasse as mercadorias, e lhe faria dellas resgate, como se fazia aos outros mercadores; e que se isto nom fizesse, e per força, contra sua vontade, quisesse estar em sua terra, então entenderia que nom viera a sua terra pera lhe fazer bem, senom mal; e por tanto cresse que em sua terra nom auia de estar contra sua vontade. Do que o Capitão nom feza estima que deuera, e respondeo ao Rey, que os Portuguezes nom erão homens que ninguem os deitasse fora da terra onde estauão assentados, e que elle viera aly por mandado d'ElRey seu senhor, e que portanto daly se nom auia de hir, senão quando lho mandasse EIRey seu senhor, porque nom auia de fazer o mandado d'outrem, e sobre isto aly donde estaua auia de morrer com quantos com elle estauão. O que ouvido polo Rey e os seus, fizerão grandes aluoroços, dizendo que assy era nosso costume, entrar na terra com boas palauras e mansidão e despois as tomar por força com males e roubos; que tal nom consentisse, pois tinha tanta gente em sua terra pera ninguem lhe fazer força, que* *era cousa que tanto compria a sua honra nom consentir. Ao que logo mandou ajuntar muyta gente, que erão Cafres nús, com fundas, e paos tostados como meas lanças, assy agudos e fortes, com que tirauão d'arremesso, que nom auia cousa que nom passassem, mas com fundas era a mór sua guerra porque são homens de muyta força e muy certeiros. Vendo os nossos tanta multidão de Cafres ouverão muyto medo, que como gente bestial, viessem abalroar a tranqueira por todas as partes, onde por muytos que elles matassem, os entrarião e matarião a todos, que erão até cento e trinta homens que podião pelejar. Diante da tranqueira hauia hum grande recío, que era mato, que os nossos cortarão e alimparão, que ficou campo raso, mas derredor do campo do recío auia grandes matos de grandes aruoredos, onde a multidão dos Cafres estauão, donde sayão ao campo com muytos atabaques e bozinas, com grandes gritas e souios, esgremindo com seus paos e arquos com frechas grandes, mas arquos erão poucos; e vinhão de corrida como que querião abalroar a tranqueira, e sem fazer obra se tornauão a recolher ao mato. Os nossos estauão prestes com suas armas, postos em ordem pola tranqueira com toda a artelharia prestes, e nunqua tirarão nem sayrão fóra ás arremetidas dos Cafres; e de dia, e de noite tinhão grande vigia do fogo, de que era o principal medo que tinhão, e nom ousauão de bolir comsiguo, somente se defenderem, se os Cafres os cometessem, de muytas arremetidas que cada dia fazião, sem nunqua cometer abalroar, no que assy estiuerão passante de hum mês, esperando que tornassem assentar paz, pois os Cafres nom rompião com elles com os cometimentos que fazião, sem nunqua neste tempo poderem auer nenhuma falla com elles. Entã o Capitão, auendo seu conselho que estando assy ençarrados tinhão gastado muyto mantimento, e que podião acabar de o gastar antes que assentassem paz, e que postoque os mantimentos lhe nom faltassem nom convinha estarem assy aleuantados, com que o resgate era perdido se nom asseritassem paz, a qual os Cafres nom querião ouvir, e inda que o rio tinha tomado lhe nom tiraua seu trato, que lhe vinhão muytas roupas por terra d'outros rios onde se desembarcauão; por conselho assentou de romper a guerra, e sempre assentaria a paz cada vez que elles quisessem, e se a nom quisessem assentar, então se recolherião aos nauios, e se hirião a Moçambique, onde estarião até o Visorey mandar o que lhe aprouvesse. E com este acordo auido ordenarão sua artelharia, e sayndo os Cafres ao campo fazer suas corridas, como só sayão muy seguros porque os nossos nunqua lhe fazião mal, o Capitão mandou dar fogo em outo peças grossas que tinha pera o campo, carregadas com pelouros, e rocas de pedra, que os Cafres inda nom tinhão visto tirar artelharia, com que o campo ficou coberto delles mortos e feridos, caydos no chão das pedras. Os pelouros fazendo pulos, dando polas aruores, que quebrauão e espedaçauão com grande terramoto, e passando alem do mato, forão dar em hum campo em que andauão alifantes brauos, que com os Cafres são misticos, como a nossa caça, que anda á nossa vista, e nom lhe fazem mal senão quando os assanhão. Dando os pelouros* *antre elles, e os alifantes ouvindo o zonido dos pelouros, e tremor do chão e o estourar d'artelharia, com grande medo forão fogindo com seus grandes urros e bramidos, matando os Cafres que alcançauão. Vendo os Cafres o grande mal que lhe fizera a arlelharia assy de supito com tamanho terramoto, assentarão que os nossos o fizerão por arte do diabo, e vendo o medo tamanho dos alifantes, que elles tinhão que nom auia cousa no mundo de que fogissem, *mais* (*muy*) espantados os Cafres de tanto fogo e fumo logo morto, e os pelouros que com tanta força corriâo tão longe, com que nelles entrou muy grande medo, os que erão vindos a chamado d'ElRey se queixarão muyto *contra* (*com*) elle, dizendo que os mandaua chamar pera pelejarem com diabos, e, se forão pera suas terras os Cafres, ficando com muyto medo e espanto de tão supito e tamanho mal, que os nossos lhe fizerão assy supito, e logo se calarão. Porque os nossos nom tirarão mais que esta çurriada, crerão verdadeiramenle que os nossos por arte dos diabos lhe fizerão tamanho mal, com que o Rey com toda a gente fogião, e se meteo pera dentro pola terra. O Regedor lhe foy á mão, dizendo que os nossos, de se verem affrontados dos Cafres, que lhe querião entrar a tranqueira, lhe fizerão a elles o mal, e nom deitarão nenhum tiro pera suas casas; que por tanto tornasse á assentar com os nossos paz como estaua de primeyro, e se tornassem a fazer malo mandaria dizer ao Capitão de Quiloa, que mandaria outro Capitão, ou quando as naos chegassem a Moçambique. Este conselho do Regedor *aceitou* (*assentou *) ElRey, e os seus disserão que era *bom* (*bom*) e estiuerão assy alguns dias, que os nossos nom ousauão sayr fora. Mas vendo o Capitão que já tudo estaua *calado,* (*acabado*) e nom parecião Cafres de dia nem de noite, mandou tirar hum tiro sem pelouro. Os Cafres estiuerão esperando quando o pelouro daria, e nom o vendo, nem lhe fazendo mal, então o Regedor mandou recado ao Capitão porque assy matára tanta gente sem lhe fazerem mal *a elle.* (...) Elle mandou dizer que elle nom viera aly pera fazer mal, e por isso, vendo que os Cafres lho querião fazer, se recolhera com a sua gente pera dentro da tranqueira, e muytas vezes lhe mandara recado pera nom auer mal, e que lho nom quiserão ouvir, e aguardára hum mês pera tornarem a ser amigos, o que elles nom quiserão, e então mandauão os Cafres, que os hião ameaçar e affrontar com gritas e souios, do que a gente se auendo por injuriada fizerão o que era feito, de que lhe muyto pesaua; e que tornassem a ser amigos e nom se faria mais mal. Do que o Regedor, e o Rey, e todos forão contentes, e foy assentada a paz, e então o Capitão, com conselho de todos, que já nom auia homens doentes, abrirão logo os aliceces, e começarão a fazer a fortaleza que lhe era mandado que fizesse, de que EIRey lhe dera a traç.a do tamanho que auia de ser: ao que o Rey, nem os seus *nom* (...) lhe ousarão hir á mão, antes lhe mandou dar trabalhadores que lhe mandára pedir, porque a gente nom bastaua, que era muyta morta de doença. Começada assy a fortaleza foy acabada no anno de 1506, assy da feição que na pintura parece. Mas despois, em tempo de Antonio de Saldanha, que foy Capitão, elle* *fez derredor da fortaleza huma barbacan, e antre ella e a fortaleza se fezerão as casas pera a gente, e se tirarão de dentro da fortaleza, porque dentro se fez huma cisterna, cortada em huma pedra que se achou, em que se recolhião mil pipas d'agoa da chuiua, que parece *por* (...) que na pedra se concertaua, e clarificaua, era fria e tão excellente, que era apropria saude da gente, e ainda oje em dia he. Pero Barreto, partido de Çofala, correo a costa com seus quatro nauios, e foy a Quiloa, onde deixou degradados que trazia pera ahy deixar, e apontamentos e cartas d'ElRey. Pero Ferreira lhe deu o que ouve mester, e se partio, e sayndo pola barra a sua nao tocou, e se perdeo, *de que tudo* (...) se saluou, somente o casco se perdeo, e Pero Barreto se metteo na nao de Gonçalo Aluares, e com Jorge Mendes Çacoto, e João Vaz d'Almada seguio caminho pera a India; onde sendo na linha acharão tanta calmaria, que forão em ponto de se perderem á sede. Acodiolhe o vento, com que assy chegarão a Angediua, como já disse, e Pero Barreto deu ao Visorey muytas cartas que trasia, e lhe deu conta de como assy ficaua Pero da Nhaya em Çofala mettido na tranqueira, com tanto mando e poder na terra, que ficaua em proposito de nom fazer fortaleza de pedra, por ser escusada, pois o trato se nom faria por força, senom com boa paz, polas razões, que já dixe, de lhe nom poder tolher as roupas que lhe, vinhão pola terra, e a terra assy ser doentia, e mataria muyta gente, o que todo se escusaria, pois bastaua vir aly hum nauio com a roupa quanta quisesse, e a resgatar, e *se* (*so*) tornar sem nenhum inconuenieute mais que o do mar; o que todo assy pareceo bem ao Visorey com tenção de assy o escreuer a EIRey, que escusasse o gasto de ter fortaleza em Çofala por ser tão desnecessario.*

(Gaspar CORREIA, *Lendas da India por Gaspar Correa publicadas de ordem da Classe de Sciencias Moraes, Politicas e Bellas Lettras da Academia Real das Sciencias de Lisboa sob a direcção de Rodrigo José de Lima Felner, Livro primeiro. Contendo as acçoens de Vasco da Gama, Pedralvares Cabral, João da Noya, Francisco de Alboquerque, Vicente Sodre', Duarte Pacheco, Lopo Soares, Manuel Telles, D. Francisco d'Almeida. Lenda de 13 annos, desde o primeiro descobrimento da India até o anno de 1510*, Tomo I, Parte II, Typographia da Academia Real das Sciencias, Lisboa 1858, pp. 570-578).

A.3. Charles Darwin

Costa orientale dell'Africa. — Le parti nord appariscono per uno spazio considerevole sprovvedute di banchi. Le mie notizie sono tratte dagli studi e dai viaggi del capitano Owen e da quelli del luogotenente Boteler. Presso Mukdees ha (2°1′ N.) trovasi un banco di corallo che percorre la costa sopra una lunghezza di quattro o cinque miglia (Narrat. di Owen , vol. I, p. 357). È rappresentato sulla costa ad una distanza di un quarto di miglio dalla costa ed è separato da 6 a 10 piedi d'acqua: è dunque una scogliera frangente, *e l'ho colorata in rosso. Da Juba, un po' al sud dell'equatore, fino a Lamoo (2°20' S.) «la costa e le isole sono formate di madrepore» (Narrat. di Owen, vol. I, p. 363). La carta di questa parte (chiamata isole Dundas) presenta un aspetto straordinario; la costa del continente è affatto dritta ed è protetta alla distanza media di due miglia da isolotti dritti, assai stretti, frangiati di banchi. Nell'interno di questa catena d'isolotti si trovano delle superficie piane e pantanose, e delle baie di fango nelle quali si versano parecchi fiumi; la profondità di questi spazi varia da una a quattro tese. Quest'ultima profondità non è comune, e la media è di circa 12 piedi. Al di fuori della catena di isolotti, la profondità del mare, alla distanza di un miglio varia fra 8 e 15 tese. Il luogotenente Boteler (Narrat., vol. I, p. 369) descrive la baia pantanosa di Palla, che sembra somigliare alle altre parti della costa, siccome ha davanti a sè dei piccoli isolotti di corallo regolari e stretti, il cui orlo ha raramente più di 12 piedi di altezza e sovrasta la superficie rocciosa, sul davanti della quale si elevano gli isolotti. Sapendo che gli isolotti sono formati di roccia corallina io credo sia appena possibile esaminare questa costa senza concludere che qui esiste una scogliera frangente che è stata sollevata di alcuni piedi: la profondità non comune di 2 a 4 tese all'interno di alcuni di questi isolotti è probabilmente dovuta al fango dei fiumi, che ha impedito l'accrescimento del corallo presso alla costa. Siccome parecchie regioni di questa linea di costa sono indubbiamente frangiate di banchi viventi, così l'ho colorata in rosso. — Maleenda (3°20' S.): nel piano del porto il capo sud sembra frangiato; e nella carta su grande scala del capitano Owen i banchi si estendono a quasi trenta miglia verso sud; colorata in rosso. Mombas (4°5' S.): l'isola che forma il porto «è circondata di scogli di madrepore capaci di rendersi affatto impregnabili»(167) (Narrat. di Owen, vol. I, p. 412). La costa del continente al nord ed al sud di Mombas è regolarmente frangiata da un banco di corallo che si trova ad una distanza di mezzo miglio ad un miglio ed un quarto dalla riva; la profondità interna del banco è di 9 a 15 piedi. Al di fuori del banco la profondità è di 30 tese ad una distanza di meno di mezzo miglio. Dalle carte apparisce che uno spazio di circa 36 miglia è qui frangiato; colorata in rosso. — Pemba (5° S.) è un'isola di formazione corallina, orizzontale e di un'altezza di circa 200 piedi (Narrat. di Owen, vol. I, p. 425); essa ha 35 miglia di lunghezza ed è separata dal continente da un mare profondo. La costa esterna è rappresentata nelle carte come regolarmente frangiata; colorata in rosso. Il continente di faccia a Pemba è pure frangiato. — Zanzibar somiglia a Pemba sotto molti rapporti, la metà sud della sua costa ovest ed anche quella in prossimità degli isolotti vicini sono frangiate; colorata in rosso. Sul continente, un po' al sud dello Zanzibar, si trovano alcuni banchi paralleli alla costa che avrei creduto formati di corallo, se Boteler (Narrat., vol. II, p. 39) non avesse detto che sono composti di sabbia; senza colore. — Il banco di Latham è una piccola isola frangiata da banchi di corallo; ma siccome non vi sono che 10 piedi di altezza, non è stato colorato. — Monfeea* *è un'isola del medesimo carattere di Pemba; la sua costa esterna è frangiata, e la sua estremità sud è unita a Keelwa sul continente da una catena d'isole frangiate da banchi; colorata in rosso. Le quattro isole ricordate ultimamente somigliano sotto molti rapporti ad alcune delle isole del mar Rosso, che fra breve descrivo. — Keelwa: in un piano della costa, uno spazio di 20 miglia al nord ed al sud di queste località è frangiato da banchi di corallo; nella carta generale del capitano Owen questi banchi sono prolungati ancora più verso il sud. Sui piani dei fiumi Lindy e Monghow (9°59′ e 10°7′ S.) la costa sembra avere la medesima struttura; colorata in rosso. — Isole Querimba (da 10°40′ a 13° S.): intorno a queste isole esiste una carta su grande scala; esse sono basse e di formazione corallina (Narrat. di Boteler, vol. II, p. 54); possedono generalmente dei banchi estesi, che sono a secco durante la bassa marea e si elevano bruscamente dalla profondità del mare; all'interno questi banchi sono separati dal continente da un canale o piuttosto da una serie di baie di una profondità media di 10 tese. Anche i piccoli capi del continente hanno dei banchi di corallo che vi sono attaccati; le isole e banchi Querimba sono posti sulla linea di prolungamento di questi capi e ne sono separati da canali assai poco profondi. È evidente che la causa che produsse i capi, sia essa l'ammasso di sedimento od i movimenti sotterranei, produsse pure, come si poteva aspettarsi, i prolungamenti sottomarini dei medesimi; e le loro estremità hanno fornito di più una base favorevole per l'accrescimento dei banchi di corallo e susseguentemente per la formazione d'isolotti. Siccome questi banchi appartengono chiaramente alla classe dei frangenti, le isole Querimba sono state colorate in rosso. — Monabila (13°32′ S.): in un piano di questo porto i promontori sono frangiati di banchi che si compongono visibilmente di corallo; colorata in rosso. — Mozambico (15° S.): La parte esterna dell'isola sulla quale è fabbricata la città, e le isole vicine sono frangiate di banchi di corallo; colorata in rosso. Dalla descrizione data da Owen (Narrat., vol. I, p. 162), la riva, che si estende da Mozambico alla baia Delagoa, sembra essere bassa e sabbiosa; parecchi dei banchi ed isolotti che stanno attorno a questa linea di costa sono di formazione corallina; ma la loro poca elevazione ed estensione impediscono di vedere, sulle carte, se sieno veramente frangiati. Per questa ragione, tale porzione di costa è lasciata senza colore, come lo sono pure quelle parti più al nord, di cui, per mancanza di nozioni precise, non è stata fatta alcuna menzione nelle pagine precedenti.*

(Carlo DARWIN, *Sulla struttura e distribuzione dei banchidi corallo e delle isole madreporiche*, Ed. italiana a cura di Giovanni e Riccardo Canestrini, Unione Tipografico-Editrice, Torino 1888, pp. 156-158.)

A.4. William Fitz William Owen

Mozambique was taken possession of not long after, and its fort of St. Sebastian, which yet remains a proud monument of ancient Portuguese enterprise, was begun in 1508, and finished in three years from its commencement. It is of a quadrangular form, and mounts upwards of eighty cannon, of various calibre, ages and nations, some brass, others iron, many honey-combed, and a few in respectable condition; still it is a strong fortification, and capable of a formidable resistance. In the interior are a chapel, the oldest in the place, extensive barracks and quarters for the officers, together with a prison, tanks, and storehouses. In the centre is a flat and extensive space, in which a large body of forces might be exercised and manoeuvred. The garrison at this time consisted of about two hundred black soldiers, habited in the Sepoy costume; a guard of these are always stationed at the outer entrance of the fort, and as soon as anyone, having answered the usual interrogatories at the door, is permitted to enter, they advance with bayonets fixed and surround him. This ceremony at first strikes a stranger as very uncourteous and disagreeable, but custom makes it familiar, and he soon sees its necessity, to guard against treachery and surprise. There are two other forts, one on a projecting point, west of the islands, and another on a small insulated rock off the sourthern extremity, to which at low water, it is joined by a coral flat, covered with shells: there are also two semicircular batteries with a few guns on each, and in front of the governor's palace some small pieces of artillery. This palace is an extensive stone building, apparently of great age, with a flat leaden roof, and a large square court in the centre. The grand entrance is through an archway in this court, whence the principal staircase, composed of a double flight of stone steps meeting at the top, ascends to the first story, and to the rooms used for public public purposes, which are both lofty and large; at the entrance of the archway an officer and guard are constantly on duty. Fronting the palace is a large unpaved square; the custom-house, a fine building, forms one side of it, and the main-guard another; while at the extremity is a long and commodious stone warf built on arches, stretching out from the shore almost to low-water mark, and affording at all times an excellent landing for boats. The streets in the city are narrow, although the houses are generally lofty and well constructed, but as the place itself is fast sinking into insignificance, so the finest of its buildings are falling rapidly into decay. Mozambique, like many other cities of the world, is now reduced from its ancient wealth and vice-regal splendour to the almost forgotten seat of desolation and poverty. It is still a bishop's see, subordinate to Goa, but the churches, like the rest of its edifices, denote the decline of power and grandeur. With the place devoted to religion has ceased the principle itself; and even superstition can hardly now be said to exist, every feeling being lost in the love of gain, to which the inhabitants sacrifice every other consideration. The city takes *up about one half of the island, the remainder being divided into two parts, one devoid of buildings, save ruins, and the other the residence of the free coloured people, whose small bamboo huts, placed in the most irregular order, form a striking contrast to the lofty stone buildings of the Portuguese and their well-defined line of streets. In the city are two pretty markets, where vegetables and grain can be procured throughout the day; but, as the sun is intensely hot, those articles that are liable to spoil, such as fish, meat, and milk, can only be obtained early in the morning, except in the Black Town, which appears to be the grand mart for all the necessaries of life on a minor scale. Bullocks are scarce and dear, but they have abundance of goats and pigs, the latter generally black and of a lean appearance, occasioned by the uncommon length of their legs and heads; they are excessively ferocious, and in many instances desperately attack those persons who are desirous of indulging in sucking-pig at the expence of maternal affection. In 1769 the Arabs, who formed a part of the population of Mozambique, were expelled from that city, from Sofala, and the settlements on the River Zambizi, and even now are not permitted to appear armed. The population at this time amounted to about six thousand, divided into five classes; the first of which was very limited, consisting of native Portuguese; the second of Canareens, an appellation given to the Creole Portuguese of Goa and their other Indian settlements; Banyans from India formed the third, free coloured people the fourth, and the resident slaves, the most numerous of all, the last. The commerce of Mozambique has much decreased, and at present it is little more than a mart for slaves, together with a small quantity of ivory, gold dust, and a few articles of minor value.*

(William Fitz William OWEN, *Narrative of Voyages to explore the shores of Africa, Arabia and Madagascar - performed in H. M. ships Leven and Barracouta*, publ. Richard Bentley, vol. I., London 1833, pp. 121-123.)

A.5. Andrew Petersen

Coral

Coral is used as a building material for coastal settlements throughout the Indian Ocean, Arabian/Persian Gulf and the Red Sea. Two main types of coral stone are used for construction: fossil coral quarried from the coastal foreshore, and reef coral which is cut live from the sea bed. Fossil corals are more suitable for loadbearing walls whilst reef corals such as porites are more suitable for architectural features such as doorjambs or mihrab niches. Fossil corals are mostly from an order of coral known as Rugosa which is now extinct. When quarried this coral forms rough uneven blocks known as coral rag. Although this can be cut into rough blocks it cannot be dressed to a smooth finish and therefore has to be used in conjunction with another material to produce an even surface.

Living coral from the reef is easier to cut and dress to a smooth finish although it does require hardening by exposure to the air. The preferred type of reef coral for building is porites because of its compact vascular structure which means it is both strong and easy to carve. However, this is not the only type used and, at the eleventh-century site of Ras al-Hadd in Oman, at least seven different types were noted. In the Maldives and Bahrain platy corals such as oxypora and montipora are used for partitions. The origins of coral-building are not well understood although it is generally believed that the technique originated on the coasts of the Red Sea. The earliest example was discovered at the site of al-Rih in the Sudan where a Hellenistic cornice made of coral was found re-used in an Islamic tomb. From the Red Sea the technique spread to the East African coast of the Indian Ocean where its was established as the primary building material for monumental buildings. In the Arabian/Persian Gulf there is another tradition of coral stone construction although the antiquity of this tradition is in doubt as suitable coral has only grown in the area within the last 1,000 years. At the present time the use of coral stone extends over large areas of the Indian Ocean and includes the coastline of India (Gujarat), the Maldives and Sri Lanka. The origins of coral-building in these areas has not been investigated although it generally seems to be associated with Islamic traders.

(Andrew PETERSEN, *Dictionary of Islamic Architecture*, Routledge Publisher, New York 2002, pp. 54-55. [I ed. 1996].)

B. Different experiences

B.1. Plano de Urbanização da Vila do Ibo

5.1. Enquadramento histórico

A Vila do Ibo foi fundada, como tal, pela coroa portuguesa em 1761. A partir de 1764 e durante mais de 160 anos ela foi a capital dos governos subalternos e de distrito e só em 1929 é que a actual cidade de Pemba assume formalmente esta qualidade, passando a ser a capital da Província de Cabo Delgado, em substituição da Vila do Ibo. Como entreposto comercial, as Quirimbas ganham alguma importância pela procura de marfim, arroz, milho, carapaças de tartaruga, maná, urzela, caurim e âmbar na ilha do Ibo. Tendo os portugueses reconhecido que as ilhas se tinham transformado em importantes centros de comércio independente conduzido pelos muçulmanos, uma enorme expedição atacou Quirimba em 1522, tendo reduzido a cinzas a cidade existente na ilha Em 1570 dá-se a primeira abolição da escravatura, mas esta pratica é re-decretada em 1645 (nota 1: Na sua monografia sobre a ilha do Ibo (pág. 15), o Administrador de circunscrição António Baptista de Oliveira refere que no período entre 1645 a 1671 o comércio de escravos é a actividade dominante nas Quirimbas.). Só em 1836 é que se proíbe exportação de escravos, mas o fim da escravatura só é decretada em 1858, devendo os escravos ser declarados livres a partir de 1878 (nota 2: Oliveira, António Baptista de, Monografia da ilha do Ibo (relatório), Arquivo Histórico de Moçambique, Maputo, pág.28.). Este factor afectou grandemente o desenvolvimento da Ilha do Ibo. Uma imagem da importância da Vila do Ibo nos fins do século XIX e mesmo durante a primeira metade do século XX transparece, por exemplo, no seguinte: • Funcionava frequentemente como ponto intermédio de partida e de chegada das expedições para o reconhecimento do interior; • Possuía um sistema relativamente importante de defesa da ilha constituída por três fortificações; • Possuía uma administração relativamente consolidada, albergando a sede do Governo do Distrito de Cabo Delgado (embora dependesse em muito da iniciativa dos colonos locais e de donativos privados para levar a cabo iniciativas de interesse para a ilha); • Possuía serviços públicos e privados e equipamentos sociais fundamentais nomeadamente a Administração do Conselho, a sede da Comarca de Cabo Delgado, a Direcção de saúde, serviços alfandegários, a Fazenda, a sede dos Correios e Telégrafos do Distrito, a Delegação

Marítima, os serviços meteorológicos, a sede do Banco Nacional Ultramarino (BNU), agências de seguros e estabelecimentos de exportação e importação, bem como uma rede significativa de instalações comerciais, mercado e matadouro público; • Possuía um porto balizado e uma casa do farol em Mujaca; • Era um significativo centro religioso cristão e muçulmano; • Possuía alguma indústria, ainda de reduzidas dimensões, nomeadamente de óleos e sabões, de processamento de castanha de caju, de descasque de arroz, de tabaco; e a comunidade chinesa, que fora autorizada a emigrar para a ilha em 1895, introduziu a pesca e a secagem de holotúria, que era concentrada e exportada a partir do Ibo; • Possuía iluminação pública, um sistema bem identificado de ruas e travessas (nota 3: Os nomes das ruas da época eram dedicados ao rei, rainha e príncipes portugueses, havendo outras com a designação de Rua Formosa, rua da Bela Vista, Rua Nova, rua da Alegria, rua das Delícias, Rua Verde, rua do Teatro, rua da Escola e até a rua do Contrabando, como nos diz António Baptista de Oliveira no Relatório citado, pág. 46.), e o assentamento urbano era gerido através de um Código de Posturas que, entre outros aspectos, definia os limites da vila do Ibo e regulava a construção e o tipo de intervenções sobre o edificado; • Possuía uma intensa vida cultural, não só no que respeita às práticas culturais populares, como no que respeita a manifestações mais modernas da cultura de tipo ocidental como o teatro e outras. Até ao primeiro quinquénio do século XX o Ibo chegou a albergar cinco agências consulares ou vice-consulados, sendo quatro delas: a da França, a da Alemanha, a da Espanha e a da Bélgica. O porto do Ibo era demandado por embarcações costeiras e navios de longo curso numa frequência significativa, mesmo depois de ter entrado em processo decadência por deslocalização das autoridades administrativas para a cidade de Pemba, no continente. Em 1933, o porto do Ibo recebeu 41 navios de cabotagem; em 1943, recebeu 20; em 1944, recebeu 17; em 1953 recebeu 36 navios de cabotagem e 4 de longo curso e em 1962 recebeu 52 navios de cabotagem e 8 de longo curso. Neste ano o porto movimentou cerca de 4 mil toneladas de carga de exportação e cerca de 2 mil toneladas de carga de cabotagem. É interessante registar este processo cíclico e persistente de recuperação, mesmo trinta e três anos depois de perder o estatuto de capital de distrito a favor de Pemba. É como se na alma das Quirimbas, nomeadamente no Ibo, houvesse duas tensões em constante contradição: de um lado a tensão das potencialidades criativas e de desenvolvimento que a geografia e a história lhe confere e, do outro lado, a tensão do retrocesso, que a distância e o isolamento por vezes engendram.

(da: Governo da Província de Cabo Delgado, Direcção Provincial para a Coordenação da Acção Ambiental, Universidade Eduardo Mondlane, Centro de Estudos para o Desenvolvimento do Habitat, *Plano de Urbanização da Vila do Ibo, Vol. 1 - Inventário e Diagnóstico, Vol. 2 - O Plano e seu Regulamento*, Maputo Maio 2008. Qui: *Plano de Urbanização da Vila do Ibo, Vol. 1*, pp. 9-11.)

6.3.2. Habitação

A vila do Ibo é um conjunto urbano fortemente dicotómico constituído por dois sistemas claros: o sistema formal ou planificado de que faz parte o Bairro Cimento, e o sistema informal ou não planificado que circunda o primeiro. Mas esta divisão geral clássica estava também claramente repercutida no interior dos dois principais sistemas referidos, o formal e o informal, através de sub estratificações expressas por áreas com ocupação homogénea, quer de população de determinada origem (europeia, asiática, e autóctone – assimilada ou não), quer de estratos populacionais de poder económico diferente. Na generalidade e do ponto de vista urbanístico a Habitação distribui-se por três grandes zonas habitacionais com características próprias, designadamente: (i) a zona formal; (ii) a zona informal e (iii) a zona de transição.

(i) A ZONA FORMAL, de cerca de 23.3 ha, com construções de pedra e cal, resultante de uma intenção de desenho, que estaria submetida a normas específicas de regulação (Nota 14 - Veja-se por exemplo o Código de Posturas da Câmara Municipal do Concelho de Cabo Delgado, aprovado por Acórdão do Conselho de província, nº 1, de 19 de Janeiro de 1894 e publicado pela Imprensa Nacional de Moçambique, em 1894.) e na qual vive uma parte relativamente pequena da população da vila (cerca de 20%). A Zona formal possui uma estrutura identificável e o desenho do edificado é relativamente homogéneo, apresentando uma clara unidade geral. Como já foi referido, esta zona continua a apresentar uma situação de abandono generalizado não obstante, desde o final da década de 90, se terem recomeçado a verificar operações de transferência de propriedade e de reabilitação do edificado.

(ii) A ZONA INFORMAL, de cerca de 68.4 ha, com construções de pedra e cal ou de pau a pique maioritariamente cobertas com macúti, resultante de um processo espontâneo de ocupação populacional e na qual viviam, em 2002, 2538 habitantes, o equivalente a cerca de 75% da população da ilha. A designação para este tipo de zona urbana é discutível, não sendo fácil de caracterizar com precisão não contestável. Assentamento informal é, na maioria dos casos, a consequência de um processo complexo de ajustamento das famílias, e dos indivíduos, a condições adversas onde os seus interesses, muitas vezes opostos e conflituosos, encontram formas de coexistência num equilíbrio precário do ponto de vista legal, mas, apesar de tudo, reconhecido por todos dentro de tal assentamento, ainda que tal nem sempre pressuponha o reconhecimento oficial pelas autoridades. Dir-se-ia que se trata de uma zona marcada por aquilo que se poderia definir pela contraditória expressão de zona de Insegurança estável. No caso do Ibo a análise do processo de evolução do seu edificado e as entrevistas realizadas mostraram claramente que, apesar do grande sentido de propriedade que impedia ocupações dos vazios ou de edifícios não ocupados, trata-se de uma zona com um grande dinamismo de transformação (Nota 15

- *Cani, Anselmo,* A arquitectura popular na ilha do Ibo, *in Carrilho, Júlio,* Ibo. A casa e o tempo, *op. cit., pág. 140.).*

(iii) A ZONA DE TRANSIÇÃO, de cerca de 13.6 ha, que hoje constitui parte do Bairro Cimento e estabelece o interface entre a Zona Formal e a Zona Informal, com construções geralmente de pedra e cal, resultante de antiga expansão da Zona Formal, mas sem uma estrutura clara ou reconhecível de organização espacial. A cada uma destas zonas corresponde uma caracterização específica da situação do edificado. 6.3.3. Uso e estado de conservação do Edificado Quando nas décadas de oitenta e noventa do séc. XX se falava de um certo abandono da ilha do Ibo, nem sempre se referia à desocupação das casas habitáveis. Muitas delas tinham sido nacionalizadas e foram arrendadas a quem se candidatou a tal, em particular a funcionários e técnicos das organizações que tinham actividades na ilha. As que não foram atingidas por aquela disposição legal e cujos proprietários estavam ausentes permaneceram fechadas durante anos, sendo as que mais sofreram com a ausência de cuidados de rotina e periódicos de conservação e manutenção, tendo atingido níveis de degradação assinaláveis. Acresce a isto que, quanto aos edifícios arrendados, os problemas que se colocavam e ainda se colocam parece terem que ver não só com a aparente incapacidade técnica e financeira da administração que as tutela, como também, nalguma medida, com o deficit de capacidade de intervenção atempada, de tradição e pratica rotineira de conservação e manutenção das habitações por parte dos seus arrendatários e ou novos proprietários. Do levantamento e análise realizados, e de referências a estudos feitos em 2001 e 2003 constata-se o seguinte:

• cerca de 33% dos edifícios apresentavam-se em avançado estado de ruína, sem cobertura, com muitas das paredes derrubadas até quase ao nível do chão, sem os aros e caixilharias e com os pavimentos destruídos;

• cerca de 37% dos edifícios têm todos os elementos de construção presentes, mas estes evidenciam grandes sinais de rotura, envelhecimento, infiltração de águas e fissuras de diversos tipos;

• cerca de 30% dos edifícios continuam a ser utilizados, embora apresentem visíveis sinais de degradação grave;

• cerca de 8% dos edifícios foram reabilitados;

• menos de 3% (6) do total de edifícios observados possuem ligação funcional à rede eléctrica.

A situação geral de degradação, para além do abandono dos edifícios, parece ser o resultado de dois factores principais: elevado teor de sal nas paredes e a acção agressiva da água das chuvas. Relativamente à questão da salinidade nas paredes vale a pena referir Maurizio Berti que, observa que em alvenarias com elevado teor de sal marinho resultante do tipo de materiais usados, os processos de degradação surgem quando um dos três *elementos do ambiente onde se inserem as paredes – a temperatura, a água e o sal – se altera, criando-se um desequilíbrio no conjunto (Nota 16 - Berti, Maurizio,* Muros de cal e pedra de coral. Manutenção e restauro. O caso da Igreja de Nossa Senhora da Conceição na cidade de Inhambane, relatório para a Cooperação Técnica Alemã em Moçambique, *Maputo, 2004.). De facto, das nossas observações na vila do Ibo ressaltou que as paredes dos edifícios que ainda se encontravam protegidas por cobertura, ou os paramentos bem lavados pela água das chuvas, mantinham em grande medida, as suas características iniciais, tanto ao nível da caiação e pintura, no 1º caso, como no bom estado do paramento no 2º caso. A observação empírica do edificado indica que as principais causas da rotura das coberturas parecem ser: o envelhecimento natural dos materiais delas constituintes; a total falta de trabalhos de manutenção, nomeadamente por ausência prolongada dos proprietários; remoção de telhas da cobertura para reutilização. Quanto a outros elementos da construção as principais causas de degradação parecem ser:*

• nos tectos:

– envelhecimento dos materiais que os constituem,

– acção das águas chuvas (com o consequente ataque de xilófagos, principalmente fungos, mas também de térmitas),

– ausência de manutenção;

• nas paredes:

– ausência de manutenção,

– elevado teor de sal,

– acção da água das chuvas,

– actividade sísmica;

• nos pavimentos:

– ausência de manutenção,

– acção das águas chuvas;

• nas portas e janelas:

– ausência de manutenção,

– acção das águas da chuva,

– envelhecimento e desgaste dos materiais que as constituem (principalmente no que respeita às ferragens),

– remoção para reutilização tanto em casas do Bairro Cimento, em reabilitação, como em casas dos bairros periféricos.

(Júlio CARRILHO (Team Leader), *Plano de Urbanização da Vila do Ibo, Vol. 1*, pp. 31-34)

B.2. Restoration of the Defterdar mosque in Pejë/Peć (Kosovo)

INTERSOS
HUMANITARIAN AID ORGANIZATION

Dr. Siniša Šešum
Programme / Project Officer
Section for Culture
UNESCO Venice Office - BRESCE
Antenna Office in Sarajevo

Project Title: "Safeguard of the Cultural Heritage in Kosovo"
Country/Region: Kosovo – Pejë/Peć region
Executive Agency: UNESCO
Donor: MAE – Ministry for Foreign Affairs, Italy
Implementer of the project: INTERSOS
Duration: July 2008 - December 2009
Restoration and rehabilitation works in Pejë/Peć and Decan/i: dialogue through the protection and valorization of Cultural Heritage

Contract for Works - Ref:
875.955.8 FR 3240185099 ***(ONE SITE)***

875.955.8 FR 3240185099 - SUBJECT: FINAL TECHNICAL REPORT ON THE WORK OF THE MOSQUE DEFTERDAR (TO 100% OF AMOUNT) – "The project 534 KOS 4000 - Safeguard of Cultural Heritage in Kosovo/Restoration of Defterdar Mosque in the town of Peje/Pec" (Contracted by Intersos from UNESCO and financed by the funds provided by the Italian Government – Contract for Works - Ref: 875.955.8 FR 3240185099)

1) THE RESTORATION OF DEFTERDAR MOSQUE IN PEJË/PEĆ.
Preparatory studies, drafting the final/executive plan, detailed designs and restoration - strictly conservative - works of present ruins, integration of the missing parts, consolidation and strengthening of the structure, reconstruction of the roof and of the portico at the mosque in Defterdar (17th century), now almost in a state of ruin.

The intervention includes the following phases:
- Preparatory studies, plan, designs, cleaning of the site, preparatory works and restoration of the ruins;
- integration of the missing parts, consolidation and strengthening of the structure;
- reconstruction of the roof of the main structure and reconstruction of the porch;
- installation of the furnitures and of the technological and functional networks;
- design and construction of the ritual furnitures.

I) WORKS PERFORMED BEFORE WINTER
The design and initial work. The first group of developed project (final draft and executive) has been submitted for approval to UNESCO on 16 November 2008. On 26 November 2008 was

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announced the approval of the project by UNESCO Venice Office - BRESCE, Antenna Office in Sarajevo. Consequently we have been requested from the Directorate of the Regional Commission for the Conservation of Monuments of Pejë/Peć the authorization to proceed with the works.
After approval of the project and before the weather conditions oblige us to suspend the works in the yard, were performed the following work:
- maintenance of the yard, instalment of the scaffolding, placing of the structure and cover to protect the walls in the winter period;
- (From 20/12 to 23/12) emergent pre-consolidation of the remains of marble plaster in most danger condition, using casein (caseinate calcium - Ca [OH2]) and Primal (acrylic resin in water dispersion);
- In this works were employed a local restorer specialist and an assistent on training stage. Other local restorers have been engaged for the reintegration of the marble plaster and other decorative parts.

Setting of the scaffolding and cover to protect the walls. A pre-consolidation phase of the ancient marble-plaster, before the winter break.

Winter Break
- During the visit on 09/09/2008, performed in the second week of September, together with Prof. Gavrilovic were discussed and agreed some actions as follows:

a) Intervention of consolidation on the crowning of the walls, using the technology already adopted in previous restoration of mosques Bayrakli and Kurshunli;
b) systematic replacement of lintels of wood burned;
c) the integration of parts of the wall collapsed after the burning of the wooden lintels of the windows;
d) establishment of the channels at the ground level for the infrastructures;
e) preparation of the construction of the slab and concrete beam at floor level, as per project and establishment and the construction of the reinforced concrete slab and beam at floor level, as per project;floor of the mosque;
f) cleaning improper and inconsistent materials, surveys and any deeper exploration on the porch to knowledge and to prepare the final proposal for reconstruction of the porch (of wood or masonry);
g) pre-consolidation and sistematic consolidation of existing ancient plaster.

Given the prolonged season with temperatures under zero, the Project Manager, in accordance with the direction of INTERSOS and, as previewed in the project, assumed to suspend physical works at the site until 15th March (of course, there is conditioned by the metereological conditions). The main reason for this choice is that the yard is in open air and in this condition it is impossible to do any manual and logistic works, in addition, is not possible the process of the lime carbonation.
- In this period the technical and the entire INTERSOS-Kosovo office were maintained normal operations related to the completion of the particular executive drawings of the details and the collection of technical documentation.

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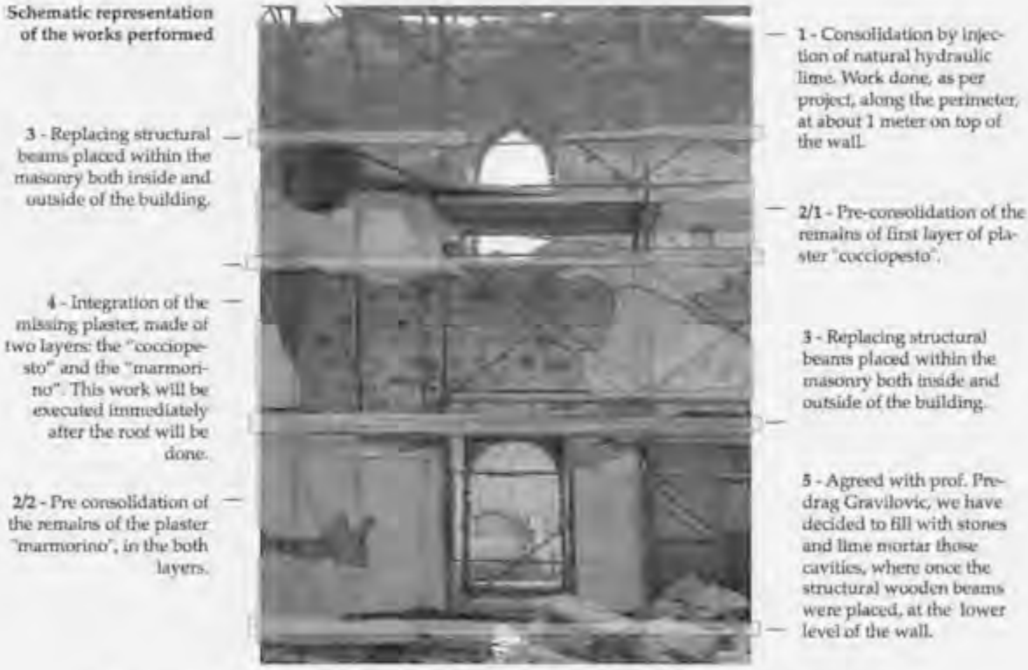
- Ongoing preparatory phase, logistic and the administrative parts.
- Have been drawn detailed drawings and documents for the execution of the carpentry and the mantle of roof, which is considered as a peculiar and special work. The structural model was designed by Prof. Predrag Gavrilovic and corresponds to the technology adopted in the restoration of the other previous two mosques in Peje/Pec, Bayrakli and Kurshunli. The contract for the roof and replacement of the wooden structural rings/replacement of lintels of wood burned or rotten has been signed on 01/04/2009.
- On November 14 there was a visit to the yard of the mosque with Prof. Gavrilovic, in order to assess specific attention to the dynamics of historical craks (which in the past have had a subsequent repair) and the most recent ones. With the installation of scaffolding, a closer observation of the crowning of the walls has allowed the definition of the masses and areas that will be subject of the structural reinforcement and injection. Based on this mission we continued and prepared the documents for the structural consolidation. The methodology has been agreed with Professor Predrag Gavrilovic, wich has already been used in the restoration of the other previous two mosques in Peja, Bayrakli and Kurshunli, and other monuments restored by INTERSOS. The contract for the structural consolidation has been signed on 01/04/2009.

II) WORKS EXECUTED AFTER WINTER



Schematic representation of the works performed, starting effectively on 16th March 2006, after the winter break.

a) Completion of pre-consolidation and re-adhesive of existin ancient plaster walls and stucco works both internal and external.
b) Preparation and execution of the structural consolidation through reinforcements and injections, at the top level of the masonry, to a height of one meter and to the other parts in presence of cracks, according to the methodology described in the project approved by UNESCO: *III - 1.1 Injecting the stone wall by joint pointing with lime mortar. Then the injectors shall be fitted, 3/4" in diameter, about 4 pieces to m2 of the wall. The injectors shall be well connected to the*

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injecting device. The drills shall be minimum 2/3 of the wall deep. The injecting device shall be constructed for continuous mixing and pressurization of the mass, without halting or stopping the process. The walls shall be injected with mixture consisting of 50% of lime slurry, 40% of filler and 10% of microsilica. The injection mass shall be prepared with lime mortar. In the lowest parts of the wall, a hydrophobic additive shall be added. Injecting shall be performed after washing and soaking the wall with clean water which is entered into the wall through injectors. The injecting shall be started at the lowest point to enable driving air and water out of the wall. It shall be performed under 1 atm pressure, to be increased to 2 atm when the wall stops taking any more injection mixture, which pressure shall be maintained for 10 minutes (defiltration time). After this, new injector shall be filled, always the lowest one. During the defiltration period, the surplus water is evacuated from mortar and mortar therefore reaches greater strength. Expansion of injection mass shall be monitored at the neighboring injectors. Those that leak shall be plugged to prevent the mass to leak. The mixture shall be cleaned from walls immediately since they shall be pointed and visible. After injecting, injectors shall be removed from the wall and mortar used for fixing them at the wall shall be cleaned. After this, the wall shall be pointed again and harmonized with the surrounding walls. Injecting shall be performed by a company specialized for this kind of works.

c) Preparation of the track beams that held the both function of a ring reinforcement of the wall and of the base of the structure of the roof and completion of the roof.

The consolidation operations by injection of lime and replacement of chestnut beams in the walls.

d) Replacement of the, internal and external, four rings of chestnut beams sunk into the masonry. Replacement of wooden lintels of the windows and integration both elements in wood and in stones in above part of masonry. The type and the static condition of the wall forced us to combine parallel beams with a mechanism of iron designed ad hoc in place of traditional wood stringers, in most cases, missing.

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The mechanism of iron designed ad hoc in place of traditional wood stringers, because of conditions of the walls.

The final fase of the construction of roof, inside and outside.

e) Preparation of the elements of wood for the roof structure. Regarding the structure of the roof, we decided to use beams (for the primary and secondary structures) of the first category of fir wood. The use of this type of wood has been suggested both by traces of burnt wood that we found on the top of the wall and by the constructive tradition of this region. The use of the fir for the roof, as well as the chestnut wood for the structural parts of the wall, was discussed and agreed upon during the visits to the site of the Unesco Delegation.
f) Assembly and nexuses of the roof, according to the structural project of the Professor Predrag Gravilovic.
g) Removal of exterior cement plaster.
h) About the arrangement of external green areas. On many occasions, the external area around the mosque was cleaned, disinfected and reorganized. This is an old cemetery with interesting archaeological aspects.

Surveys for historical and basement knowledge

i) Excavation of hole-sondes with the aim to get informations for the nature of the foundations and the soil.
o) Archaeological excavations for historical knowledge, in collaboration with the National Institute of Archeology of Kosovo.

j) Consolidation and restoration of the remains of the ancient marble-plaster.

Integration of the missing parts of the "marmorino" plaster in the interior surface of the wall and around the windows at the second order.

k) Integration of the missing parts around the windows at the second order, recovery of original decoration elements, restoration of damaged stone elements.
l) Cleaning of the external walls and making the "fuga" re-pointing of the joints with the lime mortar made of burned lime around the each stone of the walls, in the same way as the existing ancient parts.
m) Making new internal plaster "marmorino" (marble-plaster) for the integrations of the missing parts and the integration of the remains of ancient marble plaster. In this works were employed four local restoration specialists, an assistant on training stage and three students. The other local reconstruction workers were engaged in supporting the plaster works.
n) Preparation and drafting of the second part of the project executive. This project was approved by UNESCO.

Making new internal plaster "marmorino" (marble-plaster).

Remaking of the frames of the windows in the same way of the traditional practice.

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o) In accordance with the project (second phase of works) as proposed and approved by UNESCO, at the ground floor level, were removed from the windows the recent brick arches and were finalized the restoration works of eight windows remaking the frames with traditional material and technology.

Phases of the porch construction.

p) Construction of the porch of mosque. The new porch was built in accordance with the project, over the foundations of the existing one in the past and with same materials. We used stones for paving the entrance through the porch and for the application of the new wall base. The roof, ceiling and the floor of the new porch were completed as per project..

The final phases of the ceiling construction.

q) Construction of the ceiling of the mosque. The construction of the wooden ceiling has been completed in accordance with the approved design details.

The portal of the new porch; the window of the lower level; the gate in the wall of the mosque area.

r) Construction of the doors and the windows. The construction of the 18 wooden windows and the door was executed by the company contracted in accordance with the approved design details.

Reconstruction of the Mimber, Cyrsa and Mahvili.

s) Reconstruction of inner elements in wood (Mimber, Cyrsa and Mahvili). The Mahvili of the mosque Defterdar has been copied from the model used in the reconstruction of the mosque Kurshumli, also in Peja / Pec. The timbers, the boards and decorative elements are composed of oak wood. The Mimber and the Cyrsa of the mosque Defterdar, also, have been copied from the model used in the mosque Kurshumli. The timbers, the boards and decorative elements are also composed using oak wood.

Exterior and interior treatments of the plasters. Integrations of decorative works.

t) Exterior and interior treatments of the plasters. After cleaning the interior surfaces, was applied first layer of plaster "cocciopesto". We used a mixture of lime, crushed brick and water. The second layer of plaster ("marmorino") was made by applying a mixture of lime, marble dust, water and hemp fibers. The decorations with the Arabs arches engravings were performed during the drying of the second layer of plaster.
The remains of ancient plaster was treated in this way: a) washing with a solution of biocide based on ammonium salts to remove the sediments; b) cleaning with soft bristles brushes, after wetting using an aqueous solution of ammonium carbonate; c) consolidation of deep fissures and cracks with mortar made of lime; d) application on the surfaces of a clear solution of calcium hydroxide, through repeated brushstrokes for consolidating "marmorino"- plaster surface.
The reintegration of the lacks has been performed with mortar made as similar composition (proportion between inert and binder; size of elements) and colors to existing ones.
u) Setting up the electrical system and installation of the heating system.

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III) WORKS EXECUTED AFTER OCTOBER 2009

Paving of the concrete slab to reinforce the structure.

v) Paving of the concrete slab, over a thickness of gravel, to reinforce the structure and prepare the floor. Execution of the nivelisation and isolation slab as a base for the wooden floor for the main space of the mosque and for the two side spaces of the porch.

Replacement of wooden elements and installation of new slabs of lead on the cusp of the minaret.

w) Protective coatings and protective various works of the minaret.
x) External pavings. Cleaning of external walls, remove irreversibly damaged plaster on cement base of the joints. And re-pointing of the joints with the lime mortar made of burned lime.
y) Drainage system.
z) Producing, fixing and painting of the external metal fences of the windows at the first level of the monument and the external metal door of the perimeter external wall..

IV) WORKS EXECUTED ALTHOUGH NOT FORESEEN IN THE PROJECT
Although not explicitly foreseen in the project, some works have been carried out on instructions from the project manager. These little works have been considered essential to the use of the monument and useful to the preservation of work done. Note that these works do not involve any increase in expenditure.
The works carried out:
- the arrangement of external green areas and the stones of the cemetery;
- the installation of the heating system;

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- the re-grouting, plastering and painting works of the perimeter walls;
- a sidewalk along the wall of the mosque.

The installation of lightning system; the sidewalk; the external green areas.

Note:
For the systematization and restoration of the area of the cemetery (which is not included in the current project) it is necessary to make another detailed project.

To undertake the above described works, the expenditures undertaken by INTERSOS corresponds t[redacted]USD (100%).

Dr. Arch. Maurizio Berti
Project Manager - Intersos

Peja/Pec - Padova, 14. 01. 2010

B.3. Preliminary report for six restoration works in Ilha de Moçambique (2002) - Rewriting (2009)

Premissa relativa à escolha dos edifícios a restaurar e à sua utilização futura

Os edifícios descritos foram individualizados por funcionários do ministério da cultura.

Os seis inicialmente propostos eram: o Hospital, a Igreja da Saúde, o Matadouro Municipal, a Capela de S. Francisco Xavier, o Convento de São Domingo e o Antigo Liceu.

Após o levantamento chegou-se à conclusão que a Igreja da Saúde e a Capela S. Francisco Xavier já se encontravam restauradas e que o antigo Matadouro Municipal está actualmente parcialmente reparado e utilizado como discoteca, o que torna o restauro pelo menos improvável. Em sua substituição o Director Distrital da Cultura propôs para intervenção: a Biblioteca Municipal, a própria residência e os locais onde se encontra hospedada a Direcção Distrital da Cultura.

Considerada a escassa informação disponível e a delicadeza das intervenções, será necessária a aquisição de ulteriores elementos (sob suporte informático e cartográfico) para poder proceder a um projecto preliminar. Estes elementos podem ser assim resumidos:

1. documentação histórica e dados de arquivo;

2. documentação fotográfica analítica;

3. levantamentos e análise do estado de conservação (é indispensável um levantamento de precisão da análise da degradação material);

4. análise das condicionantes devido ao contexto (na formulação do projecto preliminar são também necessários os seguintes dados:

(i) as condicionantes de ordem ambiental e a sua incidência no estado de conservação dos edifícios, baseados em estudos já existentes (geológicos e climáticos);

(ii) representação do contexto urbano, baseado na documentação existente no Escritório Técnico do Município da Ilha (rede de distribuição e viabilidade);

5. Análise dos preços unitários, dos fornecimentos das obras completas e condições ambientais.

Será depois necessário avaliar atentamente a incidência no custo final dos elementos arquitectónicos, estruturais e especiais de importação.

Finalmente, o sucesso da intervenção dependerá da avaliação dos materiais a empregar para a integração (alvenarias, estruturas, acabamentos), da sua compatibilidade físico-químicas (rocha coralina, madeira, cal tradicional de conchas), e da necessidade de tornar o seu uso compatível com as exigências de conservação ambiental.

O custo paramétrico do restauro vai de 200USD a 300USD o metro quadrado de superfície útil, segundo o estado de conservação, e não inclui as despesas de projecto.

Os parâmetros de custos indicados possuem portanto um valor absolutamente indicativo. Os preços poderão oscilar muito dependendo da prática corrente das obras de reabilitação em curso em Moçambique no momento dos trabalhos, em consequência dos necessários aprofundamentos das peculiaridades geográficas e logísticas da ilha, e dependendo também da escolha efectuada sobre a proveniência de mestres e operários da futura obra de reabilitação.

Existem bastantes outros edifícios (públicos) igualmente interessantes do ponto de vista histórico, igualmente inutilizados e todos necessitando de intervenção. O problema chave para chegar a uma escolha significativa seria o da utilização futura. Existem casos nos quais os edifícios restaurados se deterioraram uma vez mais por ausência de utilização e consequente falta de manutenção. O facto de que a Municipalidade efectue essa escolha, não é particularmente significativo pois não seria capaz de assegurar a utilização pública por crónica falta de fundos. Torna-se necessário enfim, reconhecer, sem falsas demagogias, que a Ilha já superou amplamente os níveis de carga antropica admissíveis e que um eventual renascimento económico, que torne possível a manutenção das estruturas edificadas, ultrapassa as capacidades de investimento locais e deve fazer necessariamente referência a intervenções externas.

A única opção para o restauro e para a conservação do património edificado colonial deve fazer referência a uma utilização apropriada a definir com muita exactidão antes do projecto de restauro das estruturas edificadas.

Tendo em conta a dificuldade de chegar a uma escolha de edifícios que seja realmente significativa e eficaz, não podendo no estado actual garantir um uso compatível com os elevados custos de manutenção dos edifícios restaurados, considerando ainda as incertezas sobre os técnicos e as modalidades de restauro a utilizar, se seria oportuno atribuir às obras um carácter de experiência técnica e formação de operários, deixando a um projecto de investigação, documentação e formação em lugar de técnicos e mestres.

O dossier que se segue baseia-se num breve levantamento, os poucos dados disponíveis na publicação dinamarquesa e outras existentes na Faculdade. Numa primeira tentativa pareceria que os levantamentos efectuados pelos dinamarqueses e sucessivamente pelo escritório instituído pela UNESCO seriam perdidos, ou pelo menos, não facilmente recuperáveis.

A situação mais delicada diz respeito ao estado das infra-estruturas gerais da cidade que condicionam, se não o restauro, a reutilização dos edifícios.

HOSPITAL

NOTA HISTÓRICA

O Hospital foi terminado de construir em 1877 no local onde precedentemente era o Convento de S. João (sem data) onde tambem se desenvolvia uma actividade de hospitalar. Os trabalhos iniciados em 1880 mostraram-se necessários para adaptá-lo ao estabelecimento de controle de doenças contagiosas adoptando um tipo de blocos edificados separados.

OBSERVAÇÕES

Actualmente o complexo consiste de 15 pavilhões de medidas variáveis entre 12x38, 12x20, 12x16 metros de largura e comprimento variável entre 14 e 20 metros e um corpo de ingresso para a administração em dois andares.

Trata-se de uma arquitectura de carácter monumental em estilo clássico correcto na sintaxe, mas com alguns elementos da tradicional cultura portuguesa. Também se reconhecem referencias a Schinkel.

De interesse documental é o sistema construtivo adoptado no corpo de ingresso. Trata-se do emprego de madeira nas paredes com funções estruturais. Um sistema construtivo, de resto, muito utilizado nas construções da Ilha.

Num primeiro exame reconhece-se uma distinção entre a arquitectura do corpo de ingresso e a dos restantes pavilhões pelo que diz respeito às suas características estilísticas assim como ao sistema construtivo.

ESTADO DE CONSERVAÇÃO

Tanto os edifícios do corpo de ingresso quanto os pavilhões foram objecto de obra de manutenção em 1995, após um forte ciclone que provocou a destruição da maior parte das coberturas (1994). A obra constituiu sobretudo na reconstrução de toda a cobertura. Os pavilhões estão cobertos de chapa de ferro zincado sobre nova estrutura de madeira. Os edifícios do corpo de ingresso são igualmente cobertos de chapa de ferro zincado, mas sobre estrutura metálica com seguimento em arco rebaixado.

Em termos de pura conservação física destes edifícios, pode-se dizer que o restauro de todas as coberturas reduziu drasticamente a degradação. Todavia, suspeita-se que esteja em curso um ataque de insectos xilófagos nos componentes de madeira, em particular nas estruturas do corpo de ingresso. Seria aconselhável vedar, por motivos de segurança, o uso das escadas de madeira que conduzem ao segundo piso do corpo de ingresso, pois já se encontram atacadas pelos insectos.

No âmbito do complexo hospitalar há três grandes cisternas com os relativos vasos de recolha de águas pluviais. As obras são em cimento armado. Este sistema, mediante o emprego de bombas e condutas, apropriado às necessidades do hospital no tempo da sua plena eficiência, está neste momento completamente for a de uso.

ESTADO DE USO

Corpo de ingresso

O corpo de ingresso do complexo hospitalar é formado por três edifícios adiantados e por dois edifícios mais recuados que lhe são ligados. Só a sala no primeiro piso no volume da direita é utilizada (secretaria e direcção), em condições minimamente funcionais. O resto do espaço é inadequado a qualquer função. Os elementos eléctricos faltam ou estão degradados em 90%. Os ambientes do corpo adiantado da direita, por vezes são utilizados por pacientes ou acompanhantes para as necessidades fisiológicas.

Pavilhões

Alguns pavilhõesc são em uso. Em particular foi-nos permitido visitar os pavilhões que são adaptados à recuperação de bebés, de senhoras e dos homens, o pavilhão adaptado a laboratório de análise, à farmácia, ao ambulatório, à cozinha e ao alojamento de pessoal.

Cisterna e rede hídrica

O sistema está for a de uso. Todavia, a água que ainda é recolectada nas cisternas é utilizada para usos não potáveis pela população da zona circundante ao hospital.

ELEMENTOS NECESSÁRIOS AO PROJECTO PRELIMINAR

(sobre suporte informático e cartográfico)

- Documentação história e dados de arquivo 1.000 USD

- Documentação fotográfica analítica 1.500 USD

- Levantamentos e análises da degradação 30.000 USD

- Análise das condicionantes devidas ao contexto 1.500 USD

- Análises dos preços unitários, dos fornecimentos para completamento das obras e condições ambientais 4.000 USD

TOTAL 38.000 USD

ESTIMATIVA DE CUSTOS DE REABILITAÇÃO

(muito aproximado para infra-estruturas técnicas)

Superfície: 6.000 m2

Custo estimado: 1.800.000 USD

COMENTÁRIOS

Neste caso o significado social é evidente. É no entanto discutível se não é mais oportuno pensar numa nova localização em terra firme. Isto para evitar a concentração na Ilha de serviços à escala territorial dificilmente compatíveis com a delicadeza do contexto. Convem salientar que o Ministério da Saude não prevê nos seus planos de expansão da rede hospitalar a localização de uma estrutura desta dimensão na Ilha.

IGREJA DA SAÚDE

NOTA GERAL

A primeira implantação desta igreja é da metade do século XVII. O estilo arquitectónico aparente é muito mais recente. Provavelmente esta igreja foi sujeita a mais transformações no tempo. Está conservado um altar com um implante decorativo interessante, provavelmente seiscentesco. Em qualquer caso é interessante o êxito arquitectónico alcançado no tempo. Estão presentes elementos da arquitectura histórica culta portuguesa.

Superfície: 480 m2

O monumento encontra-se já restaurado.

MATADOURO MUNICIPAL

NOTA GERAL

Complexo datável, numa primeira avaliação, aos anos trinta do século XX. Edificação funcional, com algumas características da arquitectura regional portuguesa, o complexo consiste de cinco pavilhões de um só piso de 6 metros de largura e de comprimento variável entre os 14 e os 20 metros, cobertos a telha.

Superfície: 408 m2

Actualmente é utilizado como discoteca.

CAPELA SÃO FRANCISCO XAVIER

NOTA GERAL

Esta Capela devocional, frente ao mar, foi construída em 1922 no lugar que a tradição indica ter sido frequentado por São Francisco Xavier (Saverio). Uma pequena Capela com características de composição modestas. Em 1939 foi-lhe acrescentado o pórtico anterior.

O monumento encontra-se já restaurado.

CONVENTO DE SÃO DOMINGO (actual Tribunal)

NOTA HISTÓRICA

Um primitivo convento de S.Domingos foi construído em 1578, mas foi demolido pelos Holandeses em 1607. O edifício actual é prevalecentemente, colocado sobre a estrutura do convento reconstruído em 1662. Em 1799 foi ali instituída a primeira escola primária de Moçambique. Em 1826 metade do edifício foi utilizado para quartel militar. Em 1984 foi sede da Associação dos agricultores de algodão. Em 1874 foi lá instalado o Departamento das Obras Públicas. Desde 1935 é sede do tribunal.

OBSERVAÇÕES

Trata-se de um edifício em patio com um perímetro externo de 28x30 e largura de 8 metros que apresenta um notável carácter monumental. As escadas monumentais da fachada principal e da lateral, que possuem uma varanda colunada, parecem ser de época recente (anos trinta do XX sec.) De estilo genericamente clássico, estas soluções arquitectónicas adaptam-se bem ao volume seiscentesco que se crê seja ainda grande parte existente. De facto o claustro ou pátio no seu interior significa o permanecer da arquitectura seiscentesca. Ao lado direito do Tribunal, ainda existe a ruina da igreja anexa ao Convento. Estima-se que esta parte possa ser do século XVI. Estes muros são escorados por esporões em cimento armado de consolidamento provisório, provavelmente, dos anos cinquenta/sessenta do século XX.

ESTADO DE CONSERVAÇÃO Dadas as numerosas transformações que o edifício suportou durante a sua existência é, provavelmente impróprio continuar a chamar-lhe Convento. Indubitável o seu interesse do ponto de vista do restauro. Interessante o tema da refuncionalização da ruina da igreja.

Apresenta oxidação dos ferros que estruturam os elementos em betão armado (balaústres) das duas escalas e uma patina difusa biológica sobre as superfícies externas do monumento (líquenes). Estado de conservação física geral satisfatória e decididamente acima da média.

ESTADO DE USO Foi possível constatar que o edifício é em uso.

ELEMENTOS NECESSÁRIOS AO PROJECTO PRELIMINAR

(com suporte informático e cartográfico)

- Documentação história e dados de arquivo 1.000 USD
- Documentação fotográfica analítica 1.000 USD
- Levantamentos e análises da degradação 20.000 USD
- Análise das condicionantes devidas ao contexto 1.500 USD
- Análises dos preços unitários, dos fornecimentos para completamento das obras e condições ambientais 4.000 USD

TOTAL 27.500 USD

ESTIMATIVA DE CUSTOS DE REABILITAÇÃO (muito aproximado)

Superfície: 2.000 m2

Custo estimado: 500.000 USD

ANTIGO LICEU (actual Lar dos Professores)

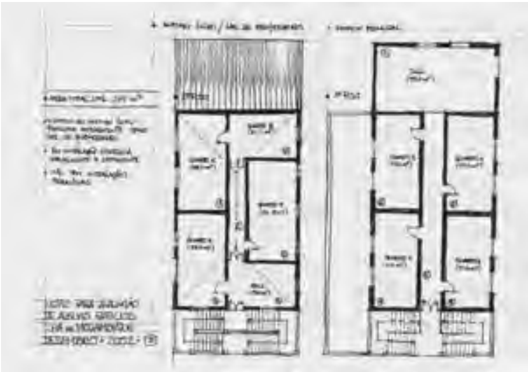
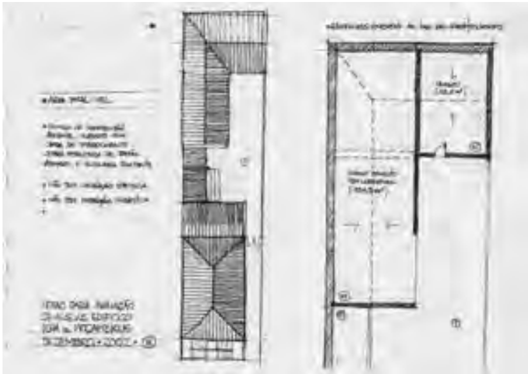
NOTA HISTÓRICA

O edifício consta de volumes pertencentes a pelo menos três épocas diferentes. O volume principal é constituído por uma série de compartimentos, no primeiro e segundo pisos, divididos simetricamente por um corredor central. A cobertura deste edifício, em chapa de ferro zincado, apresenta uma estrutura com asnas em ferro datado do primeiro vinténio de novecentos, de importação e interesse histórico.

A escada monumental de acesso da via pública foi, provavelmente reconstruída nos anos cinquenta do século XX, sobre uma escada preexistente. De facto, parte do elemento apresenta características construtivas de época precedente. Nos anos cinquenta foi anexado o volume posterior num só piso.

O volume anexo compreende dois espaços (provavelmente aulas colectivas do liceu) datado aos anos sessenta/setenta do século XX. Trata-se de uma estrutura de pilares e vigas em betão armado com muros de blocos e cimento, sem reboco.



OBSERVAÇÕES

O edifício apresenta um modesto carácter monumental. São de interesse tanto o sistema da cobertura do corpo edificado mais antigo como a alvenaria deste mesmo corpo constituído ainda por uma alvenaria de madeira e argamassa de pedra e cal. Interessante, do ponto de vista histórico, a porção da escada de acesso em pedra coralina.

ESTADO DE CONSERVAÇÃO

Do ponto de vista estrutural o edifício não apresenta problemas particulares em conexão com as fundações dos vários segmentos construtivos que se sucederam com o tempo.

Assinala-se todavia o preocupante estado de segurança do soalho da construção mais antiga. Trata-se de um soalho construído com traves e tabuado em madeira dura com componentes em defeciente estado e se aconselha vivamente que o piso superior não seja utilizado.

No piso superior a alvenaria do edifício mais antigo esta melhor conservada, no exterior, o primitivo estado de reboco é ainda bem aderente à alvenaria.

Pelo contrário, as integrações e as ampliações dos vãos no primeiro piso comportaram um recente reboco (em argamassa de cimento) que em muitos pedaços caiu.

Toda a caixilharia deverá ser substituida, a aparelhagem eléctrica é para reinstalar. Alguns restos de aparelhagem eléctrica podem constituir o modelo para a reabilitação.

Não existem serviços higiénicos, nem colectivos. Provavelmente até os Professores seguem o costume local de utilizar a praia.

A practica da cozinha no interior do edificio, sobre o soalho, com fogareiro a carvão põe em perigo a construção.

ESTADO DE USO

O edificio não é apropriado para o uso actual.

Propoem-se a destruição das construções mais recentes e em mau estado de conservação, trazendo o edificio a sua traça original.

ELEMENTOS NECESSÁRIOS AO PROJECTO PRELIMINAR

(com suporte informático e cartográfico)

- Documentação história e dados de arquivo 750 USD
- Documentação fotográfica analítica 750 USD
- Levantamentos e análises da degradação 10.000 USD
- Análise das condicionantes devidas ao contexto 1.500 USD
- Análises dos preços unitários, dos fornecimentos para completamento das obras e condições ambientais 2.000 USD

TOTAL 15.500 USD

ESTIMATIVA DE CUSTOS DE REABILITAÇÃO

(ver anexo)

BIBLIOTECA MUNICIPAL

NOTA HISTÓRICA

O edificio foi restruturado nos finais do sec XIX inicio do secXX, utilizando a estrutura preexistente.

OBSERVAÇÕES

A biblioteca e parte do piso terreo edificio do Concelho Municipal, é constituida por dois compartimentos, um dos quais integrando dois espaços num unico.

ESTADO DE CONSERVAÇÃO

O seu estado de conservação é bom, necessitando de uma intervenção de manutenção geral, e reforço do sistema de iluminação. Será igualmente recomendável a renovação de bibliografia e a introduçnao de uma secção de audiovisuias.

ESTADO DE USO

O edificio esta em uso corrente. Foi apresentada a possibilidade de uma posiivel expansão, anexando uma espaço contiguo, pertencente ao Concelho Municipal.

ELEMENTOS NECESSÁRIOS AO PROJECTO PRELIMINAR

(com suporte informático e cartográfico)

- Documentação história e dados de arquivo 750 USD
- Documentação fotográfica analítica 250 USD
- Levantamentos e análises da degradação 1.000 USD
- Análise das condicionantes devidas ao contexto 1.000 USD

TOTAL 3.000 USD

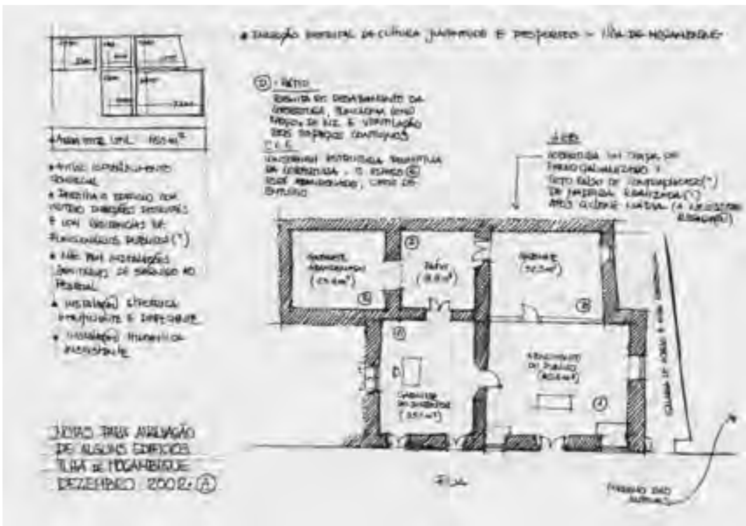
ESTIMATIVA DE CUSTOS DE REABILITAÇÃO

(ver anexo)

DIRECÇÃO DISTRITAL DE CULTURA

NOTA HISTÓRICA

O edificio foi restruturado nos anos 50 do secXX, utilizando uma estrutura preexistente.



OBSERVAÇÕES

Este edificio é parte de um edificio de uso diferenciado (residencial e administrativo), com diferentes estados de conservação.

Dois dos seus compartimentos estão cobertos em chapa de ferro galvanizada que deixa passar chuva, outro encontra-se descoberto por colapso da cobertura, e os restantes dois mantem a sua cobertura original.

ESTADO DE CONSERVAÇÃO

O seu estado de conservação é mediocre sendo de fácil recuperação. Consideramos não ser correcto fazer uma intervenção parcial, limitada aos espaços ocupados por esta direcção.

ESTADO DE USO

O edificio esta em parte em uso.

ELEMENTOS NECESSÁRIOS AO PROJECTO PRELIMINAR

(com suporte informático e cartográfico)

- Documentação história e dados de arquivo 750 USD
- Documentação fotográfica analítica 250 USD
- Levantamentos e análises da degradação 1.000 USD
- Análise das condicionantes devidas ao contexto 1.000 USD

TOTAL 3.000 USD

ESTIMATIVA DE CUSTOS DE REABILITAÇÃO

(ver anexo)

RESIDÊNCIA DO DIRECTOR DISTRITAL DE CULTURA

NOTA HISTÓRICA

O edificio foi restruturado nos anos 50 do secXX, utilizando uma estrutura preexistente.

OBSERVAÇÕES

O edificio na sua estrutura original alberga três quartos e uma casa de banho, que é obviamente uma alteração a sua estrutura. No jardim posterior foi muito recentemente construido um pequeno edificio para albergar a cozinha e uma outra casa de banho.

ESTADO DE CONSERVAÇÃO O seu estado de conservação é mediocre sendo de fácil recuperação. Consideramos ser necessário uma intervenção que recupere as formas tradicionais de construção, especialmente da cobertura, e a recuperação da sua escala para a rua.

ESTADO DE USO

O edificio esta em uso.

ELEMENTOS NECESSÁRIOS AO PROJECTO PRELIMINAR

(com suporte informático e cartográfico)

- Documentação história e dados de arquivo 750 USD
- Documentação fotográfica analítica 250 USD
- Levantamentos e análises da degradação 1.000 USD
- Análise das condicionantes devidas ao contexto 1.000 USD

TOTAL 3.000 USD

ESTIMATIVA DE CUSTOS DE REABILITAÇÃO

(ver anexo).

(NOTE: This report, transcribed here in 2009, was written by me in collaboration with Vitor Tomás between 20 and 30 November 2002. For field surveys and data collection helped us the Faculdade de Arquitectura e planeamento Físico di Maputo and the Studio José Forjaz Arquitectos of Maputo, with the coordination of Sandro Bruschi - Cicupe Italian Cooperation Project. The initiative was prompted to Faculdade de Arquitectura by the Italian Embassy in Maputo with the aim of considering the possibility of restoration in Ilha de Moçambique.)

C. Abbreviations

AD Anno Domini

AP Arboreal Pollen

BC Before Christ

BP Before Present (1950 AD is the "Present" in measurements based on the C14)

ESR Electron Spin Resonance

FT Fission Tracks

Gl Glacial

Igl Interglacial

Ist Interstadial

Ka kilo annum (1000 years)

Ma Mega Annum (1 million years)

OIS Oxygen Isotopic Stage

TL Thermoluminescence

M.B. Maurizio Berti

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Object found by Alice Costa during a biological test of coral reefs in the north of Mozambique. This is the skeleton of a coral colony, aged in about twenty five years in growth and fixed to the neck of a glass bottle [*M.B., 2009*].

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This book deals with five main themes.

The first one describes the organization method of the subjects concerning the natural and historical contexts. Nature and art form an important part of our cultural heritage and, as such, they can be critically interpreted.

The second theme develops the issue of how coral reefs have been studied and the interest they have raised, using the fundamental works of the naturalists, geologists and travellers of the 19th and early 20th centuries.

In the third theme previous studies on the use of coral limestone buildings are examined.

The fourth theme considers the methodologies aimed at conserving the historical settlements on the tropical coasts, giving special attention to the environmental aspects.

Then, in the fifth topic the author analyzes different experiences related to field studies. Particular attention is given to coastal settlements in East Africa: Zanzibar, Lamu, Somaná, Ilha do Ibo, Ilha de Mozambique, Inhambane, discussing the technology and methodology used in traditional buildings of these sites, a field still relatively unexplored.

Finally, in the second part of this book are annexed various case studies that are related to the main study for different reasons, but especially for the methods of approach that the author has adopted.

Maurizio Berti is an architect specialised in restoration works at the University of Venice and University of Padua. He obtained his PhD in Rome at the University "Sapienza". For thirty years he was an architect restorer in the municipality of Padua. As an adjunct professor, he taught at the University "Eduardo Mondlane" in Maputo, at the University "Sapienza" of Rome and at the University of Urbino. Now, as associate professor, he is dean in the Faculty of Architecture at the University "Lúrio", Mozambique. His publications concern the preservation of cast-iron architectures, historic fortifications and coral stone buildings.

Some titles of various publications of Maurizio Berti: *Conservation of coral stone architectural heritage on the coast of East Africa* (2015); *Conservação do património arquitectónico de pedra coral na costa moçambicana, reelaborando as relações com a natureza e com o hábitat* (2014); *Conservation of the Fortress of São Sebastião, Ilha de Mozambique* (2014); *Il Restauro-riedificazione della kulla Muskholaj a Deçan/Decani in Kosovo* (2012); *Il Restauro della Moschea Defterdar a Pejë/Pec in Kosovo* (2012); *Studi propedeutici al restauro del Castello Rosso di Tripoli, Libia* (2007); *L'architettura del Castelnuovo di Padova. Una rilettura critica dei documenti, delle misure e dei luoghi* (2006); *Conservazione del Patrimonio storico e ambientale nell'Africa Sub-Sahariana* (2005); *Restauri africani. La conservazione della città di Maputo* (2004); *Opere di restauro sul porto fluviale di Padova - il Portello* (2004); *La conservazione dei sistemi bastionati moderni: il caso di Padova. Interventi su un tratto di mura fra la barriera Saracinesca e il bastione Codalunga* (2004); *La conservazione delle strutture continue nei sistemi bastionati moderni* (2003); *La gestione del patrimonio ambientale. Sulla via della conservazione africana* (2003); *O restauro na historia e o restauro corrente* (1998); *Architettura e tecnologia nella Corte Cornaro* (1995); *Ponti in ferro a Padova. La fonderia Benech-Rocchetti di Padova 1851-1881* (1994).

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