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Constructive Characterization of Gorongosa National Park Villages

Michael Santos[1], Ana Ferreira[2], and Dinis Gardete[2]

[1]Zambeze University, Faculty of Sciences and Technologies, Beira, Mozambique
[2]Polytechnic Institute of Castelo Branco, Superior School of Technology, Castelo Branco, Portugal

Abstract

The Gorongosa National Park was created in 1960 and it has 4.067km2 that integrates the Serra da Gorongosa and the local communities that live nearby. This work aims the characterization of the traditional houses and ways of building observed in the natural park. The main objective is the identification and characterization of constructive systems and the organization of villages in the Gorongosa National Park. This characterization is intended to be constructive from the point of view of the materials, geometry and solutions applied on the construction. The present work has many phases, in this sense the following stages were defined: Developing the state of art based on the analysis of constructive characterization methods and bibliographic research on earth systems used in Mozambique and other countries with similar conditions and climates; Definition of the studying cases: identification of the villages that were objects of studies, definition of survey criteria and registration; Visiting the villages and surveying the solutions through photographic register, visual observation, measurements, interviews; Registering identification files to each solution, etc. The work presents the typologies of construction found, namely: constructions with walls made from earth commonly used in the country, being the most usual technology the earth covering over wooden structures with different geometries and pieces of different shapes and dimensions. The study has documented some of the most current solutions in National Park.

Corresponding Author:
Michael Santos
michaelmendessantos@gmail.com

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1. Framing

The globalization of the economy has been responsible for the mobility of services and products globally, with the sharing of knowledge and technologies, but without the necessary adaptation to the characteristics of the regions. This effect is also determinant in the construction, with the mischaracterization of local knowledge, the contempt for endogenous resources and the degradation of the relationship between construction and climate.

The present work was developed in Mozambique, on the southeast coast of Africa, with about 27 million inhabitants, more specifically in Gorongosa National Park (PNG), which was created in 1960 and has 4,067 km2 including the Gorongosa mountain.

This work consists of the characterization of local traditional buildings and the constructive systems existing in the park. It is important to understand the solutions used, understanding how they operate regarding the local climate.

The observation of the Mozambican reality, mainly in the central area of the country, also served to consolidate some aspects of the research, and contributed greatly to the analysis of typologies. Mozambique is a country with major technological and technical limitations: the country does not produce a large part of the materials and construction equipment; does not have a network of roads and railways and is not well equipped in means of transports; does not have a fair distribution of the few production units of basic building materials; and does not have a marketing network of products and construction materials minimally well distributed. On the other hand, and for historical reasons, after national independence, the country had to depart virtually from zero regarding to the technical capacity of its construction companies, which were preferentially located in large urban centers.

2. The Traditional Construction

2.1. Traditional African Architecture

According to Bruschi et al., [1] until the 19^{th} century, the knowledge about the traditional sub-Saharan African architecture was little known by Europeans. Initially in the 16^{th} century the African settlements were described as powerful empires provided by imposing palaces and majestic cities, hidden within the forests or on the shores of the deserts. However, already in the era of colonialism, these settlements began to be described as ”production of wild and miserable sets of pallets” in order to racially diminished the people and culture of Africa, a manifestation contrary to the enthusiastic described initially.

This perception was changing from the second half of the 20^{th} century with the schools of modern cultural anthropology, and with the beginning of the study of the models that refer to the form of dwellings, and in which were identified the metaphors that characterize the production of different African cultures and settlements [1]. However, this knowledge may nevertheless have been limited, since the symbolic interpretation of the formal elements neglecting the contribution of the typological and technological analysis of architecture. Therefore, it must be considered that the transmission of African culture was almost exclusively oral and thus, the symbolic interpretation of the built

space could not be an intention of the builder, but rather a way to ensure the possibility of reproduction and transmission of its compositive and constructive rules.

Usually, the main characteristic that defines a city or village of African architecture are the settlements in the form of ”Kraal”. The ”Kraal” is a land surrounded by several buildings, Currais, spaces dedicated to the work activities and leisure of the family and contiguous outdoor spaces to all buildings and some enjoy shadows from the local vegetation [2].

In this typology of architecture, it is essential to emphasize that, each building constituent of the ”Kraal” is intended only for one function, so there is a construction with functions only of dormitory, another with function of kitchen, another with function of sanitary and so on.

One of the most widespread and typical types of houses in the Swahili culture are the quadrangular plant houses. This typology of construction still remains until today with its genesis in the Islamic culture, particularly the Mediterranean basin and the Arabian Peninsula, resulting from the Muslim markets of the African coast [3].

By the end of the XIX century, two types of traditional houses existed in Mozambique: the house of rectangular four-sloped plant present in the northern region and the house of cylindrical plant with conical cover existing in the southern region of the country. In both types of buildings, the walls were constructed with a vertical light wooden structure (sticks) usually covered with earth and stone. Palm leaves or grass [4] were used for the coverage. We can affirm that, independently of the ethnic group and its concept of housing, there is a pattern for the existence of an open space formed by several independent buildings, each with a specific function. It is also noteworthy the existence of outer space and its importance in the daily life of the African people. It is in this outdoor area that most of the daily tasks of the family are performed, and the buildings are practically only used at night as a dormitory.

In the area that currently corresponds to Mozambique, this type of house consisted of cylindrical buildings of larger diameter than their height. The roof of the building had a conical shape and there was usually a balcony all around it. The center of the house was destined for the cattle enclosure and the common barns buried. At the entrance of the house was the building destined for the most important person in the family who, in turn, would be the chief or his first wife. The remaining family members, like remaining wives, married children, and guests were distributed across the side houses according to the hierarchical order. The younger elements of the family, the teenagers, were reserved for the buildings near the entrance of the house where they were separated according to their gender. Gradually, the central place of the house

destined for livestock has been replaced by a common meeting space. This adaptation arises following the separation of the cultivation and breeding of livestock in the family economy. However, the families that left livestock breeding continued to perpetuate the type of home construction carried out until then. The houses presented a fence built with palisades or spinous bushes in order to make the house safer and protect against invasions [5].

This author also mentions [5] that, the first type of houses of this group consisted of only one opening, had no interior divisions, the roof had two slopes, the structure was held in palm stakes, the finishing of the walls and the house coverage was of palm leaf mats. At present, this typology of construction continues to persist in the areas of abundant cultivation of palm trees, where these are the only supply of construction material. In the second type of house was highlighted the existence of doors and windows, roof with four slopes, finishes of the walls in 'Matope' (earth from the river) and the existence of a balcony. Result of the incursion of the Swahili markets, this type of house spread on the coast, as well as inside the African continent.

The rectangular house with a four-sloped roof was gradually replacing the pre-existing house types and acquiring some of its particularities, namely the interior where the balcony was integrated all around, according to the cylindrical house. On the coast is not adapted to the balcony being replaced by a roof ledge on the front of the building [5].

It is concluded that, from the merger between the type of pre-existing cylindrical house and the types of houses originating from the Arab culture, namely Swahili, the type of rectangular house arises, but the circular organization of space remain.

2.2. The general characteristics of Mozambique -- country and climate

In Mozambique, self-construction prevails as a factor resulting from socio-cultural conditions, since the construction of housing is mostly carried out by the end user, by the effort of the families and the community itself, possibly are these factors that give the richness of African architecture among other aspects.

The Mozambican architectural heritage encompasses vast ecological regions and various social systems whose knowledge is extremely important for the understanding of constructive processes. In Mozambique, 69% of the inhabitants live in rural areas, according to the projections made in 2011 by the United Nations [6].

In African rural environments where dispersion and relative socio-spatial isolation constitute the most visible characteristics of the habitat, rural communities accumulate experiences in the face of spatial and ecological constraints. At the same time as they discover their potentialities and develop strategies to overcome the conditionings, they benefit from natural resources at their disposal as land for construction and agriculture, forest, water sources, etc., generating their own identity.

Mozambique is characterized by a warm tropical climate, influenced by the monsoon of the Indian Ocean and the hot current of the Mozambique Channel [7], being influenced by local factors such as altitude, latitude and proximity of the coastline. The country can be divided into three climatic zones: North and South zones, characterized by a tropical and subtropical climate, Interior area, with a more arid climate.

2.3. Traditional Construction in Mozambique -- techniques and materials

The common type of construction in rural areas are traditional constructions. Despite the widespread lack of basic infrastructures – sanitation, drinking water supply and electricity – these buildings contain constructive technologies resulting from the knowledge developed over many generations, in order to better adapt to the environment, using local resources. The application of local materials makes construction cheaper, since these are usually transformed and applied by the owner. They are also less costly as they are easily accessible materials. wood and stalk are applied without treatment, which, sometimes reacting to heavy rains, do not have a very long duration, and it is necessary to periodically replace it. According to the concepts of sustainability, we must preserve and promote the knowledge and creativity of the population, improving and framing them with simple rules [7].

The African continent is characterized by great ethnographic heterogeneity, in which each ethnic group or subgroup has different sociocultural characteristics. However, about the constructive characteristics, the differences are very few, since the most used materials are the sticks, rods, 'Macuti', wood, adobe and stone, which are easily found in all regions.

Natural materials generally have less incorporated energy and less toxicity than synthetic materials, becoming more sustainable.

2.3.1. Earth

The construction on earth was and is the art developed in antiquity in a more universal and more accessible way, using it cooked or raw.

In Mozambique the most recurrent construction techniques are earth constructions. It is understood to be any activity that uses earth as a raw material. In concrete, the constructions with earth where the most usual technology is the use of the earth as a coating material are common. As for the covers used, it can be observed that they consist of stems and metal plates. Although the traditional solution consists in the use of stem, at present there has been a tendency to replace the vegetation cover by sheet metal (Fig.1).

Figure 1: Construction of covering land and cover in the stem of the right and cover in metallic sheet in the construction of the Left, in the Wine Community.

Another type of solution usually found (Fig.2) is the use of clay blocks, manufactured in small units on land, in the plastic or dry state, compressed with a small packet in molds and subsequently dried in the sun.

Figure 2: Construction in clay blocks in houses in the Inchope area.

2.3.2. Thatch (reed)

The thatch is a type of stalk, found in grass plants such as wheat, rye or bamboo, with long stems, hollow, and we are well visible. It is a material abundantly available in almost all regions of the world, except in dry climates where vegetation does not grow. There are several types of reed, according to the stem origin. This material is applied to the

constructions after dry so that it does not rot. After the drying process, this material is often called straw.

The stalk is a very visible material in the covering solutions but can also be used on walls (Fig. 3).

These materials are effective in maintaining a comfortable interior temperature for their thermal characteristics, being a material with low thermal conductivity that avoids the occurrence of superficial condensations. However, it gives a humid environment to the housing, reduces the flow and leads to surface temperatures close to the values of the interior environment and is easily traversed by insects or another small animal type. The use of this construction material presupposes regular maintenance due to its degradation by the sun and the detachment of the plant elements.

Figure 3: Construction with covering straw walls and roofing of metal sheet, in the central and southern area of Mozambique respectively.

2.3.3. Wood

Wood is one of the most widely used materials in the construction sector. The material requires a reduced amount of energy for its processing and can be recycled and reused. It can be affirmed that wood has an important, but not decisive, contribution to a more sustainable construction. Trees are indispensable for the survival of the planet, in a broader sense, and for the improvement of the quality of life of the populations, in a stricter sense. They function as the ”factory” of the wood raw material that can, in this context, be regarded as a natural, renewable and with a high rate of reuse.

The wood serves as a structure for fixing the earth’s coating, and/or wall. In the first case, the structure called ”cage” is used for formation. Which has the structural function to subsequently perform the coating with earth. In the second case the wood is used directly for the formation of the walls and assumes the structural function simultaneously.

2.3.4. Stone

Natural stones, such as wood, constitute some of the oldest building materials. This is because it is used without altering its natural state. It is undeniable the aesthetic value of the stones in the construction, as well as its efficiency in applications with structural and ornamental functions. It is a material with high thermal inertia, making it suitable for regions of warm climate, while conferring a cool environment during the day, and warm at night. However, its high self-weight makes it vulnerable to seismic demands.

Although natural stone is often regarded as a material of eternal resistance, it is liable to suffer deterioration under some circumstances. The damage depends on the aggressor agent, as well as the composition and structure of the stone itself. Damage can be manifested in two phases: loss of aesthetic value and loss of resistant and/or filling function. To avoid deterioration of the stones can be applied some preservation treatments [8]. In Mozambique concrete stones are essentially use as an element of filling the walls, replacing the earth or in conjunction with it.

In addition to the materials referenced above, we can refer to other materials, such as the use of metal plates currently used in the roofs or in the wall cladding (Fig. 4). It is undeniable the aesthetic value, however, it is a material with great conductivity, becoming discouraged to regions of warm climate, by conferring a warm environment to the interior of the dwelling.

Figure 4: Construction with walls consisting of stones in the area of Dondo, on the left and construction with walls consisting of sheet metal cladding in the southern area of Mozambique, on the right.

The soils and wood are undoubtedly the predominant materials in the constructions analyzed (also called ”ground construction”) in the structure and vertical parings. In the covers, straw is the predominantly used material, however, the increasing use of metal plates is also observed.

In the general scope of this work are notable the variations of the constructive solutions applied according to their geographic position, which can be justified by local knowledge and tradition, as well as the availability of material.

3. Characterization of the PNG Villages

Taking into consideration the need to characterize and record the constructive solutions in PNG villages, in areas with difficult access, three villages were chosen located in the park: community of Wines, Casa Banana and Nhamacola, located in the province of Sofala in Mozambique (Fig. 5).

Figure 5: Location of Gorongosa National Park.

In this way, a survey of constructive and material solutions was carried out for the different elements of the various buildings.

This characterization was intended to be constructive, from the point of view of the materials and solutions applied. For this preliminary work, three withdrawal forms were created (Fig. 6). The surveys have the following structure:

Factsheet 01 – Identification and characterization of the building: survey of data related to the location, use, relationship with the village, main materials and observations.

Factsheet 02 – Definition of materials and techniques of vertical surroundings, as well as existing anomalies.

Factsheet 03 – Analysis of materials, solutions and anomalies in the pavement and coverage.

In the visits to the communities, the survey was carried out through the aid of pre-defined withdrawal forms, through photographic registration, visual observation, measurements and interviews.

The communities of Nhamacola and Casa Banana are characterized by small scattered villages, where the inhabitants dedicate themselves essentially to subsistence farming, which have characteristics of spatial organization very similar to what is Conducted a survey of one of the villages.

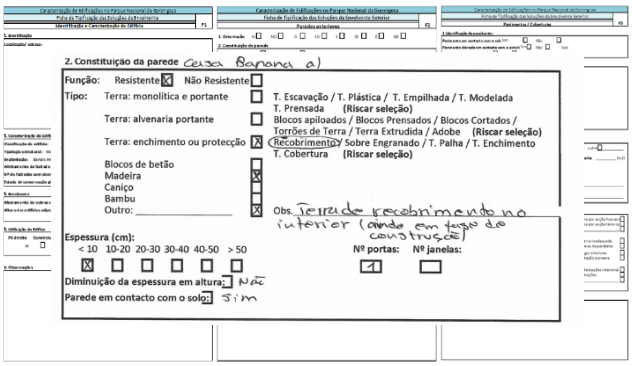


Figure 6: One section of the survey applied (constitution of walls).

On the contrary, the wine community is characterized by relatively close constructions and where there is already the organization in plots distributed along a main street, where the inhabitants essentially dedicate themselves to agriculture and some Develop activities in the PNG itself. Unlike Nhamacola and Casa Banana, in this community the constructions have characteristics of spatial organization and differentiated constructive methods.

In terms of construction techniques predominates the ”stick to Pike” in the three communities under analysis, with the Earth as the main component together with the wood and/or bamboo that is used to create the plot that sustains the construction.

Regarding the ordering of villages in the community of Nhamacola and Casa Banana, isolated and dispersed villages were identified, organized in a circular way, in the wine community the organization of buildings is carried out around a main street with some perpendicular secondary arteries.

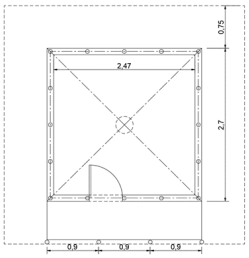
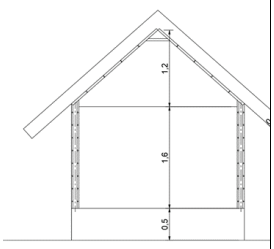
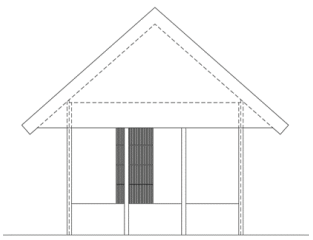
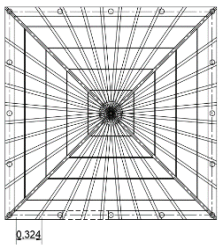
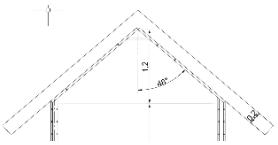
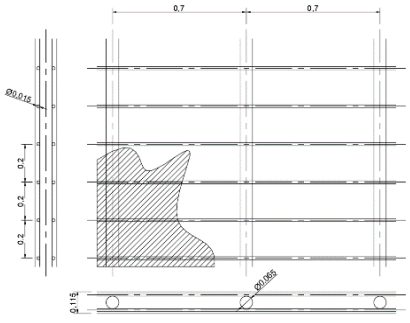
4. Collected Data Organized By Buildings Typology

After collecting data in the communities, from a total of 12 buildings, three typologies of buildings were identified. The following Tables, from 1 to 3, presents the main characteristics of each type.

5. Conclusion

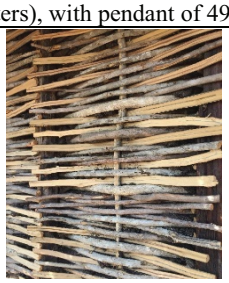
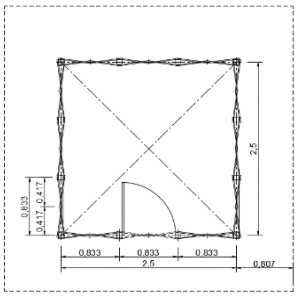
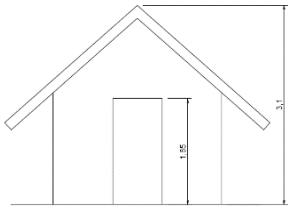
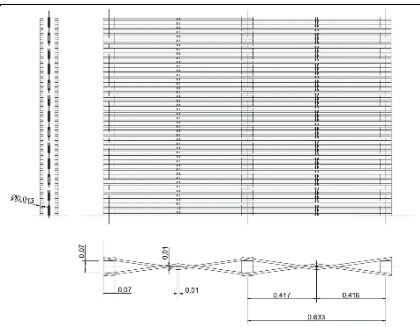
The accomplishment of this work was made possible from a survey carried out in three villages of PNG (Nhamacola, Banana House and community of Wines) where the constructive characterization of the buildings was carried out.

TABLE 1: Building type A – Geometry (Nhamacola).

Geometry:	Square
Materials:	Wood (Muzimbiti); Earth (clayey sand); Straw (reed).
Structure:	Wood structure ("Pau a Pique")
Constructive Techniques:	Soil covering in vertical parings; Cover in Culm (four waters), with pendant of 48 º.
 General Photography	 Plan view
 Section	 Elevation
Constructive Solutions:	
 Roof structure	 Roof section
 a) Wooden wall structure	
Observations: Walls with total thickness of 17.5 cm; Cover with total thickness: 20.0 cm.	

This study leads us to the realization that to understand the forms of life, it is unfeasible to begin by understanding the living conditions and the sociocultural conceptions of the African matrix. The African population has developed its own characteristics to relate

TABLE 2: Building type B - Geometry (Casa Banana).

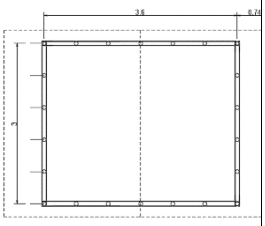
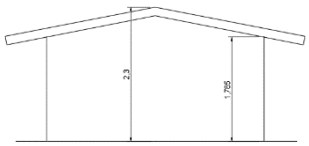
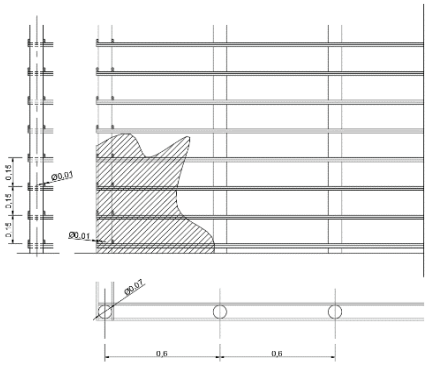
Geometry:	Square.
Materials:	Wood; Earth (clayey sand); Straw (reed).
Structure:	Wood structure ("Pau a Pique")
Techniques:	Soil covering in vertical parings; Cover in Culm (four waters), with pendant of 49 º.
 General photography	 Lattice walls
 Plan view	 Elevation
Constructive Solutions:	
 Wooden wall scheme	
Observations: Walls with total thickness of 10.0 cm; Cover with total thickness: 15.0 cm.	

to each other and to the habitat, being characterized by the high relationship with its environment.

In Mozambique are current the constructions with earth. The most usual technology is the earth of coverage, however, there is a prejudice of society in relation to this type of constructions that are associated with poverty.

It is important to mention that the earth is the oldest building material in the world, an example is the Great Wall of China, which was built 4,000 years ago. As advantages we can highlight, the availability of material worldwide, and its excellent thermal and

TABLE 3: Building type C - Geometry (Casa Banana).

Geometry:	Rectangular
Materials:	Wood; Bamboo; Earth (clayey sand); Straw (reed); Plastic.
Structure:	Wood structure ("Pau a Pique")
Techniques	Soil covering in vertical parings; Cover in Culm (two waters), with pendant of 19 º.
 General photography	 Lattice walls
 Plan view	 Elevation
Constructive Solutions:	
 Wooden Wall scheme	
Observations: Walls with total thickness of 12.0 cm; Cover with total thickness of 12.0 cm, with plastic in the interior part.	

acoustic behavior. More than an ecological solution, it is a construction that does not necessarily require skilled labor.

Doing this work, in places like this, implied overcoming several obstacles such as: the need for the presence of an interpreter and to respect the local customs.

In view of the work done, some specific conclusions are presented that result from the experience gained through the various phases developed:

- In developing countries, such as Mozambique, with constraints in relation to the materials available for construction, it is important to value local techniques and the use of endogenous resources with traditional techniques;
- The communities in studies are characterized by a tropical climate with two seasons, rainy season and drought;
- The houses have circular and square shapes and are organized in a circular manner according to their respective functions;
- Self-construction is carried out according to the use of traditional techniques where knowledge is transmitted from generation to generation, thus preserving the acquired and maintaining the original characteristics of the villages;
- Climate constraints are clear in the constructive solutions adopted, namely the overtaking of the floors due to the risk of rising water, such as the protection of the walls due to the action of the and winds;
- Within the most used constructive solutions in the villages, a catalog was defined, where the so-called ”Pau a pique” is the predominant, with wood and/or bamboo structure, the earth is used as a material for covering the walls and roofs in stalk;
- Soils are undoubtedly the predominant material.

This work intends to collaborate to overcome some obstacles related to the valuation of traditional construction, through knowledge of techniques and solutions and the demonstration that the valuation of existing resources can be an asset for the economy, society and the environment.

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