

## Riverside Population in Amazon: Culture, Environment and Construction Technique

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### ABSTRACT

This article's objective is to study the construction techniques of the riverside dwellers in the Amazon rainforest. The studied communities are located in the banks of the Solimões River, and suffer with the constant floods and physical phenomena related to the region environment. An ecosystem of thunderous natural forces, which makes it harder the importation of approaches from other regions as alternatives to the Amazon rainforest. As a method of research and understanding of the problematics, an assessment of the riverside communities in the city of Manacapuru and in two rural communities was carried out, surveying the cultural, social, and environmental characteristics of each community, and surveying the local constructive characteristics, materials and vernacular techniques. In the conclusion, we observed that: the relevance of a joint action to understand the wood and the housing durability, expanding the life cycle of the river buildings and reducing the impact on the rainforest. Regarding thermic comfort, it is important to redeem the bioclimatic techniques of crossed ventilation and to highlight the relevancy of sustainable techniques that work with local materials, such as natural fibers.

**Keywords**—culture, environment, house, riparian, riverside population.

### I. INTRODUCTION

The main problems highlighted by Bertha Becker [1] researcher that studied the Amazon region confirm that the phenomenon of nature, the floods and river often brings with it challenges for the riverbank populations. These geographic factors are amplified by the lack of basic sanitation and potable water, difficulty to access the healthcare service and the great distances to the urban centers. The majority of houses aren't adapted to the hydrological cycles that occur annually, during the flood period. The riverine population is subjected to the contamination of the water by solid wastes, fungi and bacteria and animals. Cohen et al [2] point out the importance of allying the conditions for a "healthy habitat to the strategy of primary environmental care". These factors determine "the results of a gradual process to improve quality of life". According to the authors, "the habitat is the space that surrounds the physical element, the dwelling. The environmental quality in this built space, and in its surroundings", leads to quality of life.

The Amazon region is rich in geographical elements and natural resources, yet it lacks expansionist actions of religious, social and cultural groups, as well as investments in research. These

actions promote the interaction between researchers and communities. Thus, the exchange of knowledge and experiences favors the social inclusion and improves quality of life. There is a gap related to the dwelling due to the buildings' low durability in the area, lack of comfort and of basic sanitation, with waste thrown in the rivers, among others. It is possible to stress out the lack of technical formation associated to the wood, generating the lack of housing quality, as observed by Schneider et al [3]. A second point is the lack of valorization of the goods associated to the local culture and to the intrinsic nature of the humid tropic regions. The present study was carried out in two distinct Manacapuru zones, in the Amazon State, localized in average at 68 km in straight line from Manaus, and the other at 35 km on the right bank of the Solimões River, with latitude and longitude of 3°17'29,44"S and 60°37'54.62"O.

The first visit was held in conjunction with the Department of Civil Defense of the State of Amazonas, at the Correnteza neighborhood, in the city's urban center, where there are informal occupations. According to the 2010 City Master Plan, the Department of Civil Defense informs that families should be relocated from the risk areas. This Year, three neighborhoods were at risk: São Francisco with 397 families, Liberdade with 377, and the Correnteza neighborhood with 330 families.

The second visit was in the countryside, in a scenario of densification opposite to the one found in urban centers. Two communities were located in Costa Canabuoca, at the right edge of Solimões River, geographic region that houses approximately eight rural communities. At this location, two communities can be highlighted: Canabuoca 1 and 2, which are characterized by their landscapes of a continuous length of floodplain, thus subjected to the process of water-level fluctuation. This oscillation between the terrestrial and aquatic phases [4] promotes environmental changes, allowing different activities in order to optimize the use of available resources in different phases of the year. Lakes, beaches, flood plain and forests are components of this landscape.

## II. METHOD

From an analytical view over the abovementioned aspect of geographical formation, we aim to understand the territory through the concept of cultural environment [5]. Formed by a set of physical and cultural manifestations, this environment reflects the sum of intangible assets, such as traditional practices of, past and present communities, materialized by means of buildings, objects and tools, among others. The culture of dwellers riverside, like many other societies of the national territory, is the result of a long-term occupation process of the Amazon rainforest by a diversity of cultural identities [6]. Therefore, the multidisciplinary involvement of different areas of knowledge, especially the traditional practices transmitted through the participation of social actors and representatives of those communities, independently of its location zone, urban or rural, is considered of paramount importance. Given this premise, the methodological challenge is to give voice to the local community. Considering of challenge, field activities were carried out, as well as surveys of the edified material assets, non-structured interviews, photographs and measurements therein.

Thus being, from a field registration system, tangible and intangible cultural assets, which are still linked to the territory, were surveyed. Territorial aspects were surveyed during the assessment, some of them being:

1. the human relationship with the landscape transformation; social-cultural aspects; lifestyle survey; the traditional knowledge focused on housing construction; the use and management of local raw material;
2. Technical data;
3. Housing dimension and temperature measurement.

Three communities were visited throughout the field research carried out in April 2016.

Meetings were held in each community, totalizing 11 interviews with the residents of the region. The interviewees were representatives of each community. Please note that only their first name is presented in this article, in order to preserve the residents' privacy. The interview transcription and the technical data compilation were performed during the post-field research period. The field measurements were performed with measuring tape and laser thermometer. Therefore, the housing building technique was represented through digital media, in drawings with tools such as AutoCad 3D and SketchUp. After doing so, the critical analysis of the aforementioned aspects was added herein.

## III. THEORETICAL REFERENCE

The first wave of migrants arrived in the region in search of work, during the so-called rubber cycles, between the middle of the nineteenth century and the mid-twentieth. In the second cycle, there was an increase in the population quotas that sought after the promise of wealth [7]. As said by Wille Bolle, in Amazon, there is a search for diversity of natural resources, ever since the colonization until the present days [8]. This idea of extractive exploration is frequent in the history of Brazil's occupation, which indicates an approximation between greed and domination, since its colonization, recurrently in Amazon [6]. The decay of these systems of migration and immigration, due to exploratory factors during the history of the Amazon occupation ended by making relative the absence of urban dynamism. The several and diverse outbreaks of this migration process did not promote the local development [9]. Therefore, the Riverside communities are not natural from the Amazon; along with the environmental conditions, a traditional identity was built, inhabiting the riverbanks and expressing itself not only as an integration with nature, but also as a social adaptation to historic conditions.

The riverside dwellers have a large knowledge of the territory, its riches and natural potential, and they know the importance of its preservation. For this reason, the way he organizes his life does not devastate the environment, he knows that he will need nature for his survival. As described by researcher of the geography area, the Amazon riverbank population developed an adaptive process with local biodiversity, due to the strong relation of dependence with the environment that culminates in a combination of the integrated use of the physical space, along with the multiple uses of the available resources [10]. It is no different when it comes to housing construction; the knowledge about the raw material management, and the building procedures, is passed from generation to generation. Their way of life carries remainders of the past, present, and "future" expressing several

temporalities regarding distant times, to the indigenous legacy, to the colonialism and to migration processes that take place to this day. Ana Carolina Brugnera in your master's dissertation concludes that it is possible to identify that the origin of this population is not constituted only out of the traditional Amazon populations identifying peculiar nuances of the way of living that are reflected in the architecture with its direct link with the landscape in which they are inserted. Their physical aspects, such as hydrological, geological, geographic aspects, added to their history and culture. It can be noted that during the process of occupation the exchange of knowledge between different actors in society occurred [6].

#### IV. DISCUSSIONS AND RESULTS

In order, to analyze the cultural, the environmental characteristics, and the construction techniques, a review on the literature was carried out, complementing the field studies and the visits of the researches to the environment, the observational visits and the interviews.

##### IV.I. Environment and culture:

On a field trip, in one of the Costa do Canabuoca communities, the Canabuoca 3 community was visited, and an interview was carried out with its representative, Mr. Raimundo. There is a variety of communities along Solimões' River channel. The interviewee states that just within Costa do Canabuoca-Manacapuru/AM, there are 8: Pesqueiro, Marrecão, Canabuoca 1, Canabuoca 2, Canabuoca 3, Vila do Jacaré, Nova Canaã and São Geraldo. The last one being next to the border with Anamá city (see figure 1). Mr. Raimundo, born and raised within the community, is Napoleão's son, as he reports in the interview: "I was born and raised here and I worked during my entire youth.... When I was 30 years old, I moved to Manacapuru. In the city, I built my house and raised my children, but I myself was not able to adapt, so I decided to go back to the countryside. My father lived in this little house next to mine on his own; God and him. It took me a while to get used to the countryside again, to crop, to fishing... Then, I slowly started to bring my family back. There were still some family members that stayed in Manacapuru. Nowadays, I am 59 years old and I am healthy enough to work, thank God".

Just as the Family of Raimundo and Napoleão, whose grandfather, father, son, grandchildren and great-grand children live in the area, according to the community representative, there are other 130 families registered in this place. The daily life of these families is directly linked to the nature of the forest, to the water cycle and to the management of their natural resources that guarantee the subsistence of these people that live there. There

is time to fish, to produce the flour, time to harvest, of the guava and açaí.



**Figure1** – MMap with the localization of the communities of Costa do Canabuoca, quoted by Raimundo. Source: Adapted by Ana Carolina Brugnera from Google Earth, April 2016.

In the community of floating houses Rosa Mística, located near the city of Manacapuru, the strength of this culture can be highlighted. An eight-year-old boy navigates along the Solimões River on top of a three-meter-long canoe. He speeds up the stern-drive engine, and goes towards the dry land, approaching Canabuoca's Coast, where his houseboat, fixed upon the açacu logs, is located. When he is almost reaching his destination, he turns off the engine, retracts it and within seconds, he grabs the paddles. Aided by the ripples, he rows towards his home. Amazon pulsates; men live there in harmony with nature. His father is Mr. Renato, a fisherman, who decided to live "on the water" due to his profession. As he says "the closer to the river, the better" At the time of moving, some friends from the local community helped him build his house. They gathered the floating açacu logs and raised the basis over the water, the structure of the floor (wood), the mainstay, poles and roof structure. Under the cover, the floor was built, the walls gasket and the inner divisions, all made out of wood. It is a job that demands a lot of effort. As Mr. Renato says: "as you can see here, it is a house made of wood that floats over the water. It moves wherever you want it to. It adapts to nature and to the river."

The profiles of this Riverside population described above are a constituting part of the long-term process of occupation of the Amazon territory, according to interview with the secretary of environment of Manacapuru, "they are called Riverside populations because they originated by the river side, and the occupation starts on the river side." The occupations that characterizes the rural areas had gone through modifications, in the territorial space, small urban nuclei were created, classified today as Amazonian municipalities and their districts, where the population that lived far from public services, like schools, health and urban infrastructure, come back to the urban centers

searching better quality of life. This rural exodus causes, many times, social problems. Cities that receive a great amount of migrants, that many times are not prepared to such phenomenon. The Jobs are not sufficient and many migrants start working in the informal Market and come live in housings with no good conditions, like “favelas” and “human beehives”.

In the urban areas, the agglomeration of people creates social vulnerability and risky conditions to the population that lives there. These conditions are intensified by physical factors, like flood areas, earth sliding and anthropic factors, resulting from human activities, like construction of housing on unstable ground, leading to informal occupations, using rudimentary techniques. The neighborhood of Correnteza in Manacapuru is an example of this phenomenon that was identified during the visit. The riverside people brought their customs from the rural zone and they used their customs in the city, creating hygiene and security problems, since they were placed at risk areas. The families that lived many kilometers away from each other now are living very close, within a five to ten meters’ range.

In Manacapuru, these migrants are in peripheral regions, by informal occupations, in places like the Correnteza, Liberdade, São Francisco and Biribiri neighborhoods. Differently from the city center (downtown), which is located in higher lands, these neighborhoods are in areas that are easily flooded. Manacapuru is located between different sources of water, with the main access through the channel of Solimões River, which is surrounded by lakes, like the Miriti Lake and further on the Manacapuru Lake and the Cabaliana one. In the Waters period, the floods cover these lower land neighborhoods. Houses are abandoned by their residents, wooden walkways are built for the mobility of families, one raised floor is built inside the buildings and houses, to escape the waters. Amidst the problems brought about by the flood, which occurs every year, it is clear the lack of planning for the expansion of the city and its infrastructure.

The population that escaped from the rural hinterland finds new problems, now due to the untidy occupation in urban centers. The issue is no longer regarding neglecting public services, but the distance up to these services as a lack of urban infrastructure, mainly those related to a lacking public health and lack of basic sanitation.



**Figure 2-** Buildings in risk location, in the Correnteza neighborhood. April 2016. Source: registered by Autor's



**Figure 3-** Buildings in risk location, in the Correnteza neighborhood. April 2016. Source: registered by registered by Autor's

In the city's periphery, in the Correnteza neighborhood, there are houses in situation of structural collapse, in special, in areas where the wood foundation the large majority of time remain in a flooded area. In addition to the problems mentioned, many riverside dwellers throw the sewage under the house, aggravating the problems of foundation. Due to the Strong movement of the floods, there were houses where the pillars were not aligned, getting distant from the floor structure in wood. The population requires that the governors and the civil defense find ways to move these dwellers somewhere else. The two Fig. 2 and 3 show the houses of Street of Afonso Pena, considering the situation of structural risk.

#### IV.II. Constructive techniques:

The visited houses in the rural communities, differently to urban zones, find a constructive richness in terms of finishing, with gables and guardrail, each house with one color and details that represent its dweller's identity. As one can observe in Fig.4 and 5. Fig.4 shows the floating log houses and Fig.5 shows stilt house, built on lowland areas.



**Figure 4 –** Buildings from Canabuoca 3 region. April 2016. Source: registered by Ana Carolina Brugnera.



**Figure 5** – Buildings of Canabuoca 3 region: stilt house. April 2016. Source: registered by Ana Carolina Brugnera

In Costa Canabuoca, the communities take the raw material out of the Amazon forest and during the rains (June-August), the water level rises and facilitates the access to areas on land, where there are durable woods, for instance the Maçaranduba – Manilkara. Another fact is that in this region there are no sawmills nearby, and thus the own community enters the forest and through management they determine which trees will be cut. Amid the forest, they collect the wood and craft pieces for construction. Note that this is not commercial exploitation, as they extract the wood for their own housing, public and community buildings only. Mr. Napoleão lives in the Canabuoca coast, and the distance from his house to the permanent course of the Solimões River is short. During the floods, this distance is closed. During this time, the house remains over the stilt under the river. In his country house, there are three buildings drawing the attention, since they date back to different times: a small wooden house, very rustic with no balcony, gables or any ornamentations, that belonged to his grandfather. The second, somewhat larger, and somewhat taller, belonged to his father. The third building, which we visited, the family's current residence, is taller in relation to the old constructions, well structured, with a balcony at the front portion of the house, directed towards the river. These houses display how the constructing technique has evolved throughout the years.

As it is identifiable in field researches, the housing in Canabuoca coast harmonizes itself not only with the oscillation of the water level, but also with the transformation of the landscape resulting from the forces of nature, in different periods of the year. It is identifiable in the location that the riverside people of this region have been elevating each time more their houses due to the climate changes occurred during the last decades, generating a larger volume of water in the river floods in Amazon. Another factor that can be held responsible for the difference in the heights of the stilt of the three houses above analyzed is the accumulation of

sediments left in the river channels due to the waters running down the Andes [10]. Therefore, these landscapes are extremely dynamic, according to Mr. Bernardino: "...in Canabuoca Coast, the floods happen every year and they are violent, destroying everything... Still, people start all over again every year, since everything is ended here [...]. Down the river, a house fell due to the big waves of the ships; here, nothing happened since the ship passes by the other side of the river".

The houses of the riverside people have few internal divisions in general that divide rooms, living room, and kitchen. The buildings in general have wooden structures and gaskets, their cover today is predominantly out of aluminum, due to the easy access to constructing elements manufactured especially on regions close to urban centers. In the more isolated regions, there are buildings covered with straw roofs, a material used in the beginning, for example as a hut under construction registered in the community of Canabuoca 1, see Fig.6.



**Figure 6** - Hut in construction with roof of straw, registered in the community of Canabuoca 1. April 2016. Source: registered by Ana Carolina Brugnera.

House building is a men's work, and a collective work. The riverside people build their houses or buildings like a church with the aid of their children, friends and neighbors. In a field trip, we had the experience to witness a family building their house on high pillars, and children reproducing the knowledge through child games, working with what was left from the wooden construction, small houses in the inferior gap between houses, miniatures of high pillars, as shown on Fig. 7.



**Figura 7**-Miniature house done by children during construction done by their fathers of Family. Source: registered by Autor's

The foundation, of the building in stilt house wood in general is made with the pillar directly on the soil. Regarding the structure of the construction, stilt house or floating over water, it presents the same components assembled in sequence: the pillars and wooden by compression, that are the supporting structures; once the vertical structures are fixed, the longitudinal and transversal poles are the support for the floor and roof wooden pieces, stabilizing the building structure. With the main structure of the building done, the riverside people place its cover. This may be of straw, asbestos, zinc, fibro-cement or aluminum, allowing them to work, the floor, gaskets and placing window frames in the shadow cast. As Mr. Napoleão says: "Here, the roof is done first, and then we work on the floor coating, so that it does not receive the heat of the sun. In such case, the floor covering spikes up, due to the insufficient drying period." The treatment that is applied to the wood in this region is rudimentary, distinct from the professional industries of wood commercialization in Brazil, where the wood is considered dry with a humidity rate of 12% to 15%. Mr. Bernardino reports that in Riverside buildings, the drying time is practically null. The wood is used green with a 33% humidity rate, the same humidity rate of wood when it is removed from the forest. This fact causes several problems in the building, among them the rotting and the retraction. He notes that to prevent the cracks, "[he] nails the wood boards as close as possible to one another". One of the cultural beliefs of this population is that when the wood is removed under the moonlight, it will be spoiled. They emphasize that woods such as Itaúba (*MezilaurusItaúba*), Louro (*Bastardiopsisdensiflora*), Andiroba and Maçaranduba are strong, and even though they are still wet, they are resistant to pests and bugs.

The field work indicated that the distance from the floors in the stilt houses to the environment is of about 1,5 meters, because the Riverside people have been raising their houses each time more, due to the influent climatic changes occurred over the last decades that directly interfered in the volume of water and in the floods of the rivers of the Amazon region. Another factor that is less influent, but also acting upon the housing, is the accrued sediments (sand) left in the rivers' channels due to the Waters coming down (ebb tide); therefore, these landscapes are extremely dynamic [10].

The sandy soil is a soil with little cohesion, that is, its grains are easily separable from one another when dried and with a temporary cohesion when humid. This fact accelerates the problems of global stability of the buildings in stilt houses, once their foundations is superficial, and the houses are subjected to the movement that happens in the soil due to the annual floods. Another point taken during

the field trip was the lack of stability of the buildings that in general do not have cross bracing. These two factors result in the observed problems like the houses with inclined pillars, or that lack any support to the beam whatsoever, see Fig.8.



**Figure 8** - shows the dislocated pillars and flooded level of water. Source: Picture by Ana Carolina Brugnera.

Current researches highlight the importance of the Housing Project in considering sustainable parameters for the comfort of the residents, aiming at a more durable building, so that to increase the life time of a building, among other factors integrating bioclimatic concepts, like cross ventilation [11]. As of the durability of the Riverside houses, some points observed therein can be highlighted, such as: the wooden pillars in general are directly dug in the soil, which speeds up the rotting process over the course of time. In this case, some communities cut the pillars and elevate the building, in new wooden pillars. In general, the wet areas, like the bathroom and the kitchen sink are located outside the houses.

Another related point, which directly affects the durability of the riverside housing, is the fact that most houses present small eaves. It is known that the farther the wood is from the water, the longer the building may last. Another important aspect is the shape and composition of the gasket. In Manacapuru, the majority of the houses present wooden boards nailed upwards. During the floods and the period of rains, these boards get rotten in their foundation, demanding the removal of the whole board for maintenance. These factors accelerate the wooden houses degrading process and directly impact the forest cycle of life.

For some decades, when in this Amazon region, the access to industrialized constructive elements was restricted, the cover of the houses was made of straw, material that provided them with a fresher environment to the building's interior. Over the last years, new elements made it to the region, the riverside population adopted the aluminum and zinc to build its cover. According to Oliveira Junior [12] this roof tile when curled fits in a small boat called fast boat for local transportation, and so, this element easily arrives at the more isolated locations.

However, according to measurements done in site, the aluminum roof provides a big thermal discomfort inside the buildings, at several times with an internal temperature being higher than the external. For instance, according to readings performed by our thermometers in site, at Mr. Napoleão's residence, the temperature in the internal environment registered 34°C and on the aluminum roof it was 50°C, while the external temperature in the environment was 29°C. Mr. Napoleão's house presented a porch turned towards the River and eaves a little bit larger than those normally found in the region. It can be noted that the higher temperatures directly affect the quality of life of those who live there.

The majority of the houses in the region needs to go through a process of recovery, on an average of a 15-year basis. This is considered a very short period for a housing cycle of life. This is a distinct reality from that in the Brazilian Southeast cities, where housing is designed to last more than one generation or century. At the same time, this reality is impacting on the life of the riverside people, since many times due to the nature phenomena, they need to rebuild a new house. As the study of Association "Wood for Good" points out, the durability of a wooden building when well designed may compete with brick, concrete and steel buildings [13].

## V. FINAL CONSIDERATIONS

The research demonstrates the importance of field trips and the participation of the Riverside community for the understanding of the cultural characteristics and the problems the population copes with [14]. The importance of the involvement of different researches, with the communities, with the valorization of the concept of housing and an adequate knowledge of the architecture design. Therefore, elements that enhance comfort, building durability and technical development of the wood are sought, instructing community officials to understand how to work with the wood in the building. We observed the importance of a joint action, for the understanding of the wood and with an adequate and durable housing design, thus extending the cycle of life of the Riverside buildings, and decreasing the impact on the florets. As an example, we can highlight a few points to a longer durability of the building: a concrete foundation; pillars with variable heights, sensible to the water level, use of porches and larger eaves, board gaskets nailed upwards. To amplify the global stability of the Riverside people, they should recover the elements of cross bracing that over the course of time have been lost.

In thermal comfort, the importance of tracing back the bioclimatic techniques with cross

ventilation and chimney effect to minimize the heat near the aluminum tile, or working with a double-aired roof. It is highlighted the relevance of techniques that work with the development of local materials, such as natural fibers for the improvement of the housing, so it is not needed to import industrialized materials that are not adequate to the weather. The importance of joint actions among the universities, governments, communities and associations that enable the implementation of technical courses on wood and industries in the region, with the production of wooden components, seeking to determine the durability and the quality needed to tend to the riverside people's needs. As an example, we highlight the laminated glued wood, laser cut wood, closing panel factories, with humidity control.

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