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Impacts of the Construction of the Belo Monte Hydroelectric Power Plant on Traditional knowledge of Riverine Communities in Xingu River, Pará, Brazil

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Abstract: *The objective of this study was to investigate the impacts of the construction of the Belo Monte Hydroelectric Power Plant on the traditional knowledge of three riverine communities located in the cities of Altamira and Vitória do Xingu. For that, we interviewed the residents of the communities of Mexicano (Altamira) and Bambu and Belo Monte (Vitória do Xingu), with the help of questionnaires, applied in November 2016. Participated in the interview 70 people, 37 men and 33 women. The results of this research revealed that before the Belo Monte hydroelectric plant, the members of the communities investigated used the fishery as the main subsistence craft. Residents of the Mexican community (single resettled) still cultivated plants and vegetables to supplement their livelihoods. With the completion of the dam works, it is possible to verify that there are already changes in the application of the traditional knowledge of these peoples. This is because most of the riverside communities were forced to change their profession, either because they had been resettled in distant localities, but mainly because of the hydroelectric impacts on the biodiversity of fish on the Xingu River. The results of this research, although preliminary, demonstrate the need to create innovative solutions that combine energy production with economic, environmental and social benefits, based mainly on sustainable practices.*

Keywords: *Artisanal Fishing, Social Impact, Resettled, Cultural Impact.*

1. INTRODUCTION

The dams are used for land management and flood control, irrigation and agriculture, supply water, and provide hydroelectric power [1], all these topics were subject that has given rise to extreme controversy. Hydropower dams were an important part of North American and European energy development until 70´s decade. Since then, many of those dams were removed because their energy benefits did not outweigh the environmental and social costs [2; 3].

Was estimated that 40 to 80 million people have been displaced by dam construction worldwide [4]. Affected peoples should be compensated, however, often is rarely or poorly implemented [1]. In the world the experience for populations who were forced to resettle for dam construction became much poorer than they were previously and worse off than those around them who did not move [5].

The experience in Brazil, particularly in the Amazon basin was disastrous. Different residents' complaints for alternative settlement sites were made in front of the headquarters ELETRONORTE, the electrical authority in northern Brazil and condemned the Brazilian government for the impacts of Tucuruí for International Water Tribunal in 1991 [6]. Additionally, in Brazil, riverine populations living downstream from dams are not considered directly affected by Brazilian government and consequently they are not included in the consultation processes prior to construction or compensated for subsequent negative impacts [7].

When the Xingu River was dammed, several urban and rural families, mainly from the cities of Altamira and Vitória do Xingu, in the state of Pará, were removed from their homes to the urban

resettlement sites (RUC). In the same wake, some riverside residents were relocated from their properties (on the banks of the river) to some resettlements built in the cities mentioned above, losing the livelihood, which was based on fishing and agriculture in the floodplain. Therefore with these reallocations social ties between fishermen were broken and their main livelihoods and food security are often placed at risk, for example, in the Tucuruí dam in the Brazilian Amazon the fish catch declined by 60% almost immediately, and at least 100,000 people living downstream were affected by the loss of fisheries, flood-recession agriculture, and other natural resources [3].

There are two trends in scientific studies on the impacts of dam construction on human societies: 1. that the populations suffering more from large-scale dam construction are those that are displaced, forced to resettle because their livelihoods were destroyed, their homes flooded, and they receive few benefits from the projects [8] and 2. Downstream communities not displaced and not included in consultation processes are also severely impacted by the construction of dams [7].

Independent of location downstream or upstream, the riparians are one of the communities most affected by the social and environmental impacts of building a hydroelectric dam. In addition to losing their homes, the riverbank loses contact with the land, its way of life and the river, which has always been their only means of support [9].

Thus, this study aims to investigate the existence of impacts of the Belo Monte hydroelectric dam in the application of the traditional knowledge of three communities in the cities of Altamira and Vitória do Xingu, Pará.

2. METHODS

2.1. Study Area

This research was carried out in three communities affected by the construction of the Belo Monte hydroelectric power plant, the first one being made up of people relocated to an urban resettlement site, RUC do Mexicano. The other two communities are Bambu and Belo Monte.

The Mexican RUC community is located about three miles from the city of Altamira. The locality is inhabited by river dwellers affected by the work, who lived on the banks of the river around the volta grande do Xingu, and in some islands near the city. It should be noted that the above mentioned area is located upstream of the Belo Monte dams.

The other two communities: Bambu and Belo Monte, are located on the banks of the Xingu river, in a region that is downstream of the dams of Belo Monte, both belonging to the municipality of Vitória do Xingu. The Bambu community is inhabited by riparians of the community known as Santo Antonio. In Belo Monte it is constituted by residents removed from Vila Belo Monte (ferry). As we can see in the figure1.

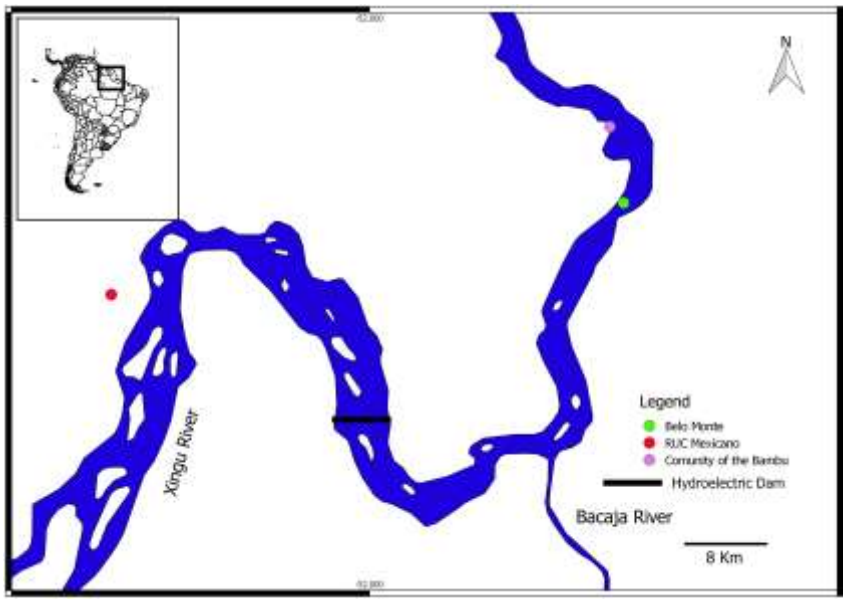

Figure1. *Spatial distribution of the communities Mexicano, Bambu and Belo monte in the Xingu River.*

2.2. Instrument and Data Collection

We used semi-structured questionnaires with open and closed questions as a data collection instrument. In this document, (see appendix I) there were general questions that sought to trace a profile of this riverine, such as age, sex, schooling and profession, as well as specific questions about the traditional knowledge of these peoples. In the questionnaire, still contained questions that sought to extract the main changes in the ways of life of these peoples after the construction of the Hydroelectric Plant.

Data collection occurred in 2016, between November 4 and 30, in the three communities mentioned above. The visits were carried out directly in the residences. Considering that they did not know how to read and write, the questionnaires were filled by the second author.

2.3. Data Analysis

The data were initially tested for their normality using the Levene 95 % confidence test [10] using software R(R Development Core Team). To compare the responses of the groups, we used the non-parametric test of x^2 in PAST software, version 2.17b [11] at 95% confidence level.

3. RESULTS

Seventy people participated in this study, of which 37 were men and 33 were women, distributed in the three localities of Rio Negro (Mexican RUC, Belo Monte Community and Bambu Community), directly affected by the Xingu River.

When analyzing Figure 2 (activities developed before construction of the Belo Monte Hydroelectric dam), we noticed that all the interviewees of the Belo Monte and Bambu communities used fishing as their own means of sustenance. In contrast to Figure 5 and 6 (activities developed after the hydroelectric plant), we conclude that of the 43 people in the Belo Monte community, about 15 individuals still fish and the others were forced to change their profession, with the majority of women becoming are housewives or housewives, while men employ efforts in various activities such as the scouring of private properties. In the Bambu community (Vitoria do Xingu), of the fourteen interviewees, a total of eleven people still practice fishing and two people became traders and one person works with various activities (Figure 6).

The most drastic results can be seen in the community of Mexicano (Altamira), since of the 13 interviewees who used fishing, hunting and agriculture as a means of subsistence before the dam (Figure 2), none of them currently have the same forms of production. Many became traders, boat pilots, maids, and private property brokers (figure 4).

Based on the comparison of figure 2 with figures 4, 5 and 6, there was a high rate of changes in the means of production, consumption and work of the riverside users after the dam construction, since of the 70 interviewees only 38% (26 people) still practice fishing.

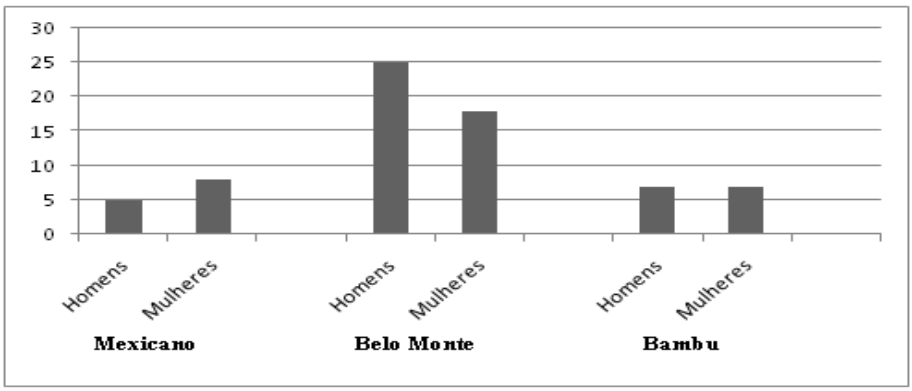

Figure2. *Distribution of residents from three sites analyzed to verify the change in resource use after the construction of the Belo Monte Hydroelectric Plant.*

The age of the interviewees ranged from 24 to 73 years, with most of them not having finished elementary school a total of 50 people, and only five people graduated from high school. The others, about 15 people, are illiterate.

Prior to the construction of the hydroelectric plant, they used artisanal fishing as a means of production and support for their families, a total of 69 people, and only one person was a shipper. In addition to fishing, some riverside farmers grew fruit and vegetable crops and practiced hunting for wild animals, both for their own consumption and for sale in the community trade.

Fishing prevailed as the main source of income in these riverside communities. The main species caught were: Pacu (*Myleus* spp.) Piraíba (*Brachyplastystoma filamentosum*), Acari (Loricariidae) Curimatá (*Prochilodus nigricans*) Pescada (*Plagioscion squamosissimus*) and Tucunaré (*Cicla* spp.).

Regarding the cultivation of plantations: Macaxeira (*Manihot sculenta*), Murici (*Byrsonima crassifolia*), Cacau (*Theobroma cacao*), Abacaxi (*Ananas comosus*), limão *(Citrus limon*), feijão (*Phaseolus vulgaris), arroz* (*Orisa sativa*), Banana (Musa sp.).

In the hunting of wild animals, the most hunted species were: paca (*Cuniculus paca*), cutia (*Dasciprocta* sp.), tatu *Dascipus* spp.

It should be noted that the riverside communities located in the Mexican community were not part of any association of fishermen, whereas in the community of Bambu, of the 14 fishermen, eight people were part of the Z-12 colony, belonging to the municipality of Vitoria do Xingu and an individual was an associate of the Z-57 colony, located in the Municipality of Altamira. In the community of Belo Monte, 30 individuals were members of Z-12 and 07 of Z-57.

We question the subjects of the research as to the origin of their knowledge of fishing, farming and hunting. In figure 3, we present a brief synthesis of the origin of these knowledges.

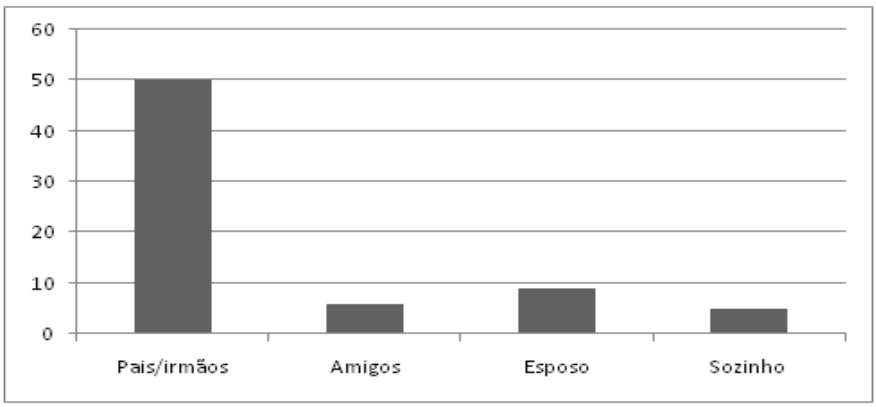

Figure3. *Origin of the knowledge of the residents interviewed in three analyzed sites to verify the change in resource use after the construction of the Belo Monte Hydroelectric Plant*

Considering that many of the interviewees were removed from their homes, and consequently changed their job, we questioned the riverside people about their new means of producing. In the Figures 4 and 5, we will present, by locality (Mexican, Belo Monte and Bambu) since each region was differently affected by the work, a brief overview of the present means of subsistence of the subjects.

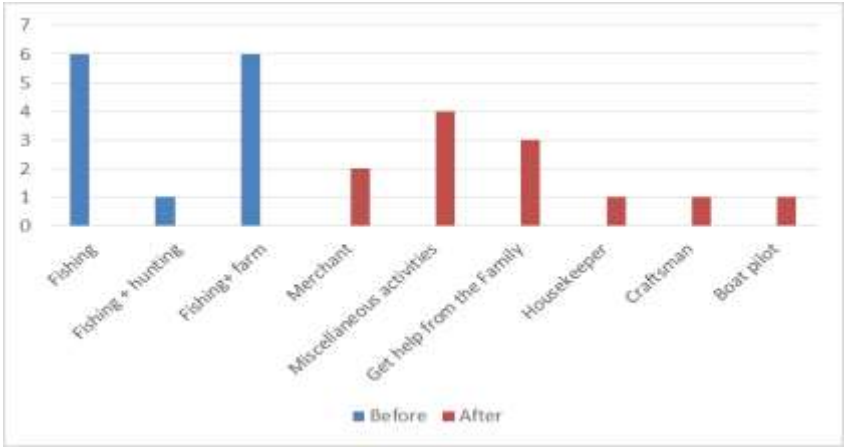

Figure4. *Occupation of the riparians of the Mexicano community before and after the construction of the Belo Monte Hydroelectric Plant, in Altamira / PA.*

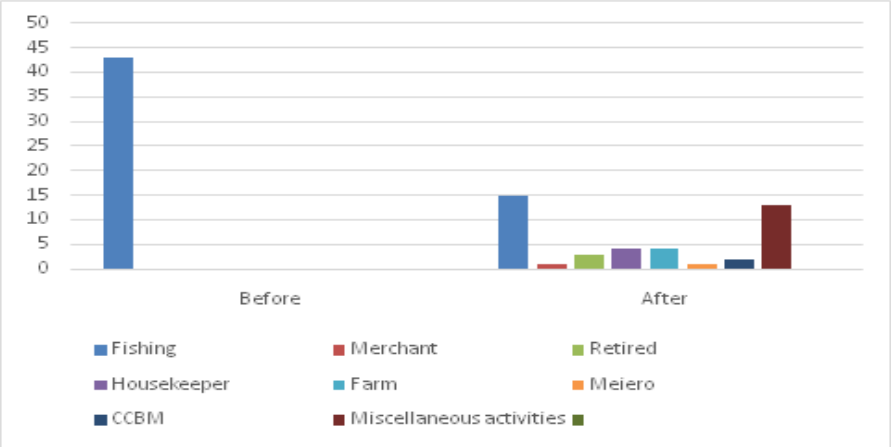

Figure5. *Occupation of riparians of the Belo Monte community, before and after the construction of Belo Monte Hydroelectric Plant, in Vitória do Xingu / PA.*

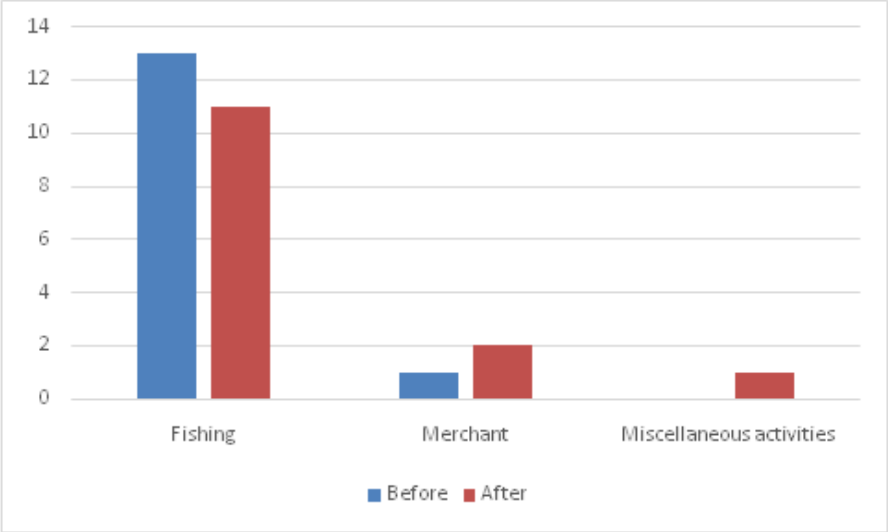

Figure6. *Occupation of riparians of the Bambu community, before and after the construction of Belo Monte Hydroelectric Plant, in the municipality of Vitória do Xingu / PA.*

We also question the riparians as to the main changes that occurred on the Xingu River after the construction of the Belo Monte hydroelectric plant. In this sense the riverside people informed that before the dam the river was beautiful, very stuffed with fish, clean and bulky. After the installation of the hydroelectric plant the level of the river has dropped a lot, the fish are scarce, the bottom of the river is full of mud and the waters with a high temperature.

From the data of the interviews of the different residents, it was possible to perform a statistic test of x^2 which indicated significant differences in the activities developed before and after the construction of the Belo Monte hydroelectric plant (Table 1). The Mexican RUC was mainly made up of fishermen who after the settlement changed their activities. The communities of Bambu and Belo Monte were the ones that retained the largest number of inhabitants in the fishing activities.

The x^2 tests of data from the Belo Monte and Bambu communities (Vitória do Xingu) indicated statistical differences in resource utilization between before and after the construction of the Belo Monte dam.

Table1. *X^2 tests comparing some traditional knowledge before and after the construction of the Belo Monte Hydroelectric Power Plant for three communities of fishermen.*

Community	X^2	P	Deegres of fredom
RUC Mexicano	26,0	< 0,01	7
Community Bambu	18,2	< 0,01	5
Community Belo Monte	64,9	< 0,01	12

4. DISCUSSION

It is noticed that there was a considerable decrease in the number of fishermen in these three locations affected by the construction of the Belo Monte dam. Similar data have been found in several studies carried out in riparian communities affected by hydroelectric construction in the Brazilian river basins, such as: [12] at Tucurui dam in the Tocantins river (Pará), [13] at the Porto Primavera Hydroelectric dam in the Tocantins River (Pará), [14] at the Santo Antonio dam in the Madeira River (Rondônia), and [15] at the Estreito dam in the Tocantins River (Maranhão).

The riparians are one of the communities most affected by the social and environmental impacts of building a hydroelectric power plant. In addition to losing their homes, the riverbank loses contact with the land, its way of life and the river, which has always been their only means of support [9].

According to a study by the World Commission on Dams (WCD) about 80 million people have already been evacuated from their homes due to the development of hydroelectric plants across the globe [16]. In the Xingu region, it is estimated that, with the construction of the Belo Monte hydroelectric plant, some 20,000 people were resettled, losing their link with the environment they were involved in, thus implying an abrupt change in their modes, customs and production [16].

The resettlement of these communities causes changes in the ways of life of these peoples, thus threatening the traditional knowledge of these historically constituted peoples. The knowledge they have about the ecosystems they are part of and about the diversity of species that inhabit them constitute a true patrimony that modernity can not do without for the continuity of life on the planet [17].

In this sense [18] affirms that the displacements of these communities influence in the change of the perception and the knowledge, since the rivers are submitted to the experience of loss of its habitat.

There is, therefore, a rupture in the transmission of this rich culture, given that such knowledge is passed on from generation to generation by the family members themselves, as we can see in figure 6 (Origin of the knowledge of research subjects).

To understand this phenomenon it is necessary to understand that the territory has an intrinsic relation with the cultural identity of certain people. In order for this culture to survive and, especially, to reproduce, it is necessary to assure to the riverside part of its immemorial environment, where its roots, its memories are, where it can apply its traditional knowledge of hunting, fishing and agriculture [19].

We can infer that the displacement of riparians to other communities may hinder the application of traditional knowledge. However, it is important to emphasize that other factors are related to the extinction of these knowledge, such as the environmental impacts of hydroelectric plants on rivers, since they affect the flow of water, influencing the ecology and biodiversity of fish species [20].

Richter et al. (2010), points out that initial results in the Belo Monte hydroelectric region already indicate fish death by interrupting the migratory cycle of many species. Although the venture has built ladders as a means of transposition, many fish have not been able to climb these ladders, resulting in a high mortality rate.

With the shortage of fish, fishermen are forced to seek sustenance from other sources. In this sense fishermen reported that after the construction of the hydroelectric plant fishing has become difficult, as the amount of fish has decreased considerably. Other factors found in the discourse of the subjects of this research refer to the decrease of the volume of the waters, the mud that settled in the bottom of the rivers, and the high temperatures of the water.

It is a consensus that large hydroelectric projects constitute a major environmental problem. However, in underdeveloped countries the practice is seen as a form of economic development, which is why dams are still built in a way that disrupts the ecology of rivers and forests that need to be deforested to make way for the reservoir [21].

We agree with [22] when asserting that this development model is unsustainable, since the energy benefits do not overcome environmental and social disasters. It is necessary to seek more and more sources of energy that do not harm the environment, aiming at a sustainable development of a nation that respects natural resources and uses them consciously. It is worth noting that the way of life of the riverside, its relationship with nature and its means of production is an excellent example of sustainable development.

The riverine community is a reference, both nationally and internationally, of a sustainable development model, due to the means used as a mechanism for fish appropriation, hunting and agricultural production, which is directly related to its relation of the riverbank to the land and the [23].

In this sense the fishermen apply their knowledge in obtaining the fish. For this, it is necessary to know the flow of the river, the migratory movement of the fish and, especially, to respect the spawning period of the species, considering the importance of preserving today to fish tomorrow. It is also worth noting that fishery resources (mahindra, tarrafa and hook) do not harm the environment. In the same vein of thought the productions on agriculture and hunting are applied.

The riverside production model is also notable for the use and management of natural resources always guided by respect for the environment, after all, it is their home. Respectfulness is a phenomenon shared by the community, which according to [22] "increases the chances of fostering the simultaneous attainment of a more equitable distribution of the wealth generated and of increasing the margins of sustainability of community resources."

Oliveira (2012) clarifies that the riverside people seek to maintain their culture, even with capital, which is a latent reality, responsible for the destruction of many communities, as happened and happens in several regions of Brazil. The change in cultural patterns and their replacement by "modern" social organizations is involuntary, and imposed by the mediation of the state along with capital.

5. CONCLUSION

The land, the river and the streams is a house of the riverside people, the fortress from which their livelihood and their families are taken away. The place of construction of his identity, where his memories, his stories and, above all, his knowledge, historically built, are kept through his relationship with nature. Thus, a compulsory compulsion of the environment is what is its importance in the way of life, and the social forms, values, identity and its culture.

Large hydroelectric projects, not only those located near rivers, are threatening the communities' way of life, such as the process of urban rehabilitation for the distant regions of the river, as is the case of the Mexican community, as well as the impacts of the forest and the river, and consequently on the diversity of fish, so that the rivers are obliged to look for diverse alternatives of sustenance.

In the face of the environmental disasters of a hydroelectric plant on the environment, they emphasize the need to design other forms of development that reduce environmental and social issues.

In order to do so, it is necessary to create innovative solutions that combine energy production with economic, environmental and social benefits, based mainly on sustainable practices that do not endanger nature, as is the case of riparians who withdraw from nature only what is necessary for their subsistence using mainly resources that do not pollute the environment.

The data collected here diagnose the real effects of the Belo Monte hydroelectric dam on the Xingu River and its sociobiodiversity.

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