RIVERINE COMMUNITIES AND BELO MONTE POWER PLANT: DETERRITORIALIZATION AND INFLUENCE ON THE CULTIVATION OF EDIBLE PLANTS[1]

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Introduction

The expropriation of Amazonian natural environments is often justified by the economic ideology of progress and by the stereotyped propaganda of sustainability. Such theme has been put in a secondary position, but it is also highlighted as an essential environmental matter. According to Florit (2003), the perception of progress substantiated by technological innovations does not take into consideration the complexity and the dynamic profile of living beings composing the ecosystems, as well as destroys the genetic patrimony synthesized by species representative of biodiversity.

The implementation of Hydroelectric Power Plants (HPP) in the Amazon, such as Belo Monte, is a way to use natural resources to generate power depending on the interests of political and economic groups backed up by the development and progress propaganda. However, this model lies on unbalanced basis; economic growth is associated with deep inequalities and with violation of rights. It does not take into account the ways of life of different social groups (FAINGUELERNT, 2013). Based on Sevá Filho (2010), the word "development" corresponds to large-scale capital accumulation, to Market Economy amplification, as well as to the appropriation of land, routes and resources. The word "economic" is used as the symbol of liberation and advancement, but it hides the involution of social rights, community impoverishment and Nation-state setback.

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Studies have pointed out the main consequences of Belo Monte HPP implementation: I. Increased migratory flow – higher costs with housing, food, goods and services (MACEDO, 2016); II. High mortality rates due to homicide, suicide and car crashes, and to the consequent saturation of healthcare services (GRISOTTI, 2016); III. Negative impacts on fishing activities in Xingu River (MAGALHÃES et al., 2016); and IV. Compulsory replacements – the case of Santo Antônio traditional community, which was expropriated due to the power plant construction (MAGALHÃES; SANZ, 2015).

Several sectors of society were affected by impairments caused by the construction of the Dam, which slowly becomes feasible and gains national and international relevance. Some investigations stood out for analyzing the deterritorialization process experienced by families (SILVA et al., 2013; HERRERA; SANTANA 2016; RELATÓRIO MPF, 2017). They aimed at encouraging intense articulation to assure the rights of the affected communities, and the need of regulating land use in Middle Xingu due to huge projects in course in the region (GONÇALVES et al., 2016), rather than just presenting scientific data.

Compulsory displacement of riverine families in Xingu was widespread by a research carried out by *Grupo de Trabalho da Sociedade Brasileira para o Progresso da Ciência (SBPC)* (MAGALHÃES; CUNHA, 2017). Discussions about stopping the use of natural resources addressed in the present document are approached in general lines. Research about agricultural production systems adopted by riverine communities and studies to assess the dependence on the sociocultural reproduction of these individuals within a scenario of territorial loss and change remain scarce. It is worth to simultaneously reverse the damage and encourage the production capacity of these farmers.

The acknowledgement of knowledge on plant uses in the Amazon has been broadly approached (SABLAYROLLES; ANDRADE, 2009; LIMA et al., 2013; SANTOS; COELHO-FERREIRA, 2012; LOBATO et al., 2014; LUCAS et al., 2017). Riverine communities manage several plant species for domestic consumption and trade (DIEGUES; ARRUDA, 2000). The appropriation of these elements through family farming and extractive practices applied to vegetation draws the territory, which is also useful for the great diversity of social actors involved in this process.

Food production is the prevailing practice of agro-extractive societies. According to Lima et al. (2013), it is essential promoting food safety and contributing to family income stability throughout time. Siviero et al. (2011) assessed the presence of edible plants in backyards and highlighted that these plants play a key role in completing nutrition diets. Family crops are an important source of biological components used in the diet of Amazonian *caboclos* (MARTINS et al., 2005). Traditional food production and associated sociocultural practices are acknowledged as immaterial cultural patrimony, since food systems are related to culture, which is understood as memory and identity (SANTILLI, 2015).

The aim of the present study was to assess the importance of edible plant resources in order to maintain the traditional ways of living of riverine communities due to Belo Monte HPP. The idea was to better understand the challenges posed by it and the perspectives focused on assuring these communities' plant use traditions by carrying out an ethnobotanical study, as well as by contextualizing changes caused by its implementation in riverine ecosystems, and their consequences.

Materials and Methods

Study site

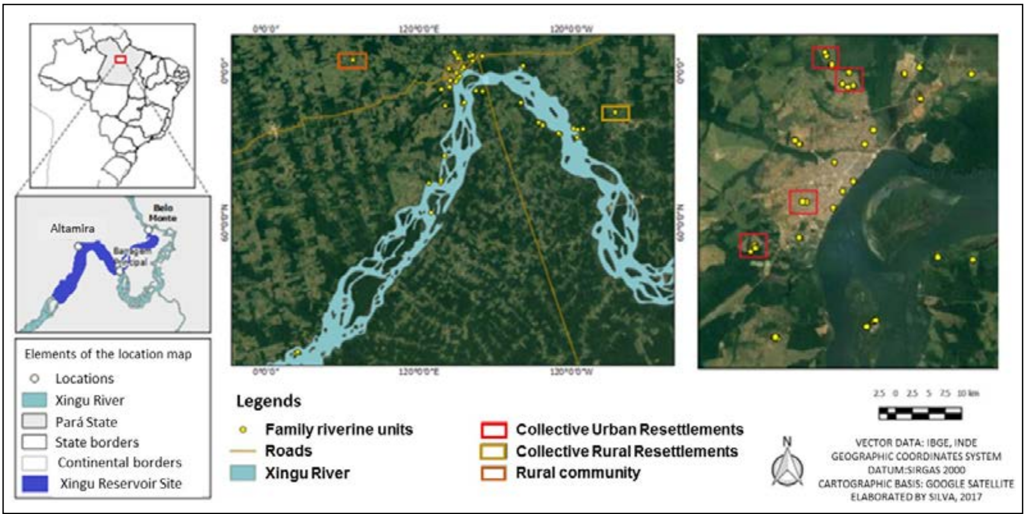
The research was carried out in Altamira County, Southwestern Pará State. It is the biggest Brazilian county (159,533.255 km^2 of territorial unit); its estimated population was approximately 109,938 inhabitants in 2016 (IBGE, 2016). The county lies on the Xingu riversides; it is located in a sloped area known as *Volta Grande do Xingu,* which counts on sites ideal for the implementation of hydropower plant facilities given its geological aspects, which form natural falls on the riverbed (FEARNSIDE, 2015).

Belo Monte HPP construction site was launched in 2011 in *Volta Grande do Xingu* by the company Norte Energia S.A. The construction project was approved through the Installation License issued by the Brazilian Environment and Renewable Natural Resources Institute (IBAMA, 2011). The project was seen as a priority of the Growth Acceleration Program (Programa de Aceleração do Crescimento - PAC) launched during President Dilma Rousseff's administration. It resulted from the propaganda about the need of fulfilling the growing demand for power in the country and of boosting local sustainable development (FAINGUELERNT, 2016).

According to the Environmental Impact Report (EIA RIMA), this power plant has the capacity to produce 11,233.1 MW. The plant has two powerhouses: one in Belo Monte Site (11,000 MW); and the other in Pimental Site, which was projected to generate 233.1 MW (EIA RIMA/LEME, 2009). This site is located 40Km downstream Altamira, where one finds the main dam, whose installation stopped the normal river flow and significantly changed its bed. The dam formed a lake approximately 380 km^2 long known as Xingu Reservoir (EIA/RIMA, LEME, 2009).

Reservoir formation has affected urban and rural sites close to streams in Ambé, Altamira and Panelas counties. It also affected riverine communities living in the region. Given the described situation, research scope encompassed Altamira City and the whole coverage area of Xingu Reservoir (Figure 1), with emphasis on areas visited for data collection.

Figure 1 - Study site location: Altamira, Pará State, Brazil.



Source: Elaborated by the authors.

Research participants and sampling procedures

The target population of the study comprised riverine families affected by Belo Monte HPP, who lived in Xingu Reservoir area. These families lived in lands by the river, but they were displaced from their territory through a dramatic process set to take these families from their houses. They were forced to search for new locations to live in, consequently, their social organizations were disrupted. It was necessary making an intentional search for community leaders in social movements, for healthcare agents, and for riverine and fishermen communities in order to find these families; these actors became key-informants during the research.

Each conversation the research group had with these actors allowed the inclusion of a new participant. This process featured the so-called "snowball" technique. Non-probabilistic sampling (when it is not extrapolated to all members of the sampling universe) and rational selection (ALBUQUERQUE et al., 2008) were the approaches adopted to select interviewees, i.e., only riverine individuals affected by the HPP were included in the research.

The current research was indexed at Plataforma Brasil, under protocol n. CAAE 68990017.1.0000.5174 and approved based on Opinion n. 2.270.475. Participants had to sign the Free Informed Consent Form. The study was also registered in The National System for Genetic Patrimony and Associated Traditional Knowledge System (*Sistema Nacional de Gestão do Patrimônio Genético e do Conhecimento Tradicional Associado - SisGen*) under n. A476196.

Data collection and analysis

Field visitations took place between April/2016 and March/2017. Interviews with 60 family units (FU) were based on semi-structured forms applied to each FU, or with more family members who accepted to participate in the research. Field notes and pictures from different environmental scenarios and social groups, such as Altamira City, rural zones in the county and riverine houses by Xingu River were recorded (Figure 1). These new housing centers resulted from socioeconomic reorganization. Norte Energia was in charge of this re-organization, it planed the family displacements to rural and urban resettlements, and for land plots in different reservoir islands and sides.

Family units in Altamira were found in 18 neighborhoods and in 4 Urban Collective Resettlements (UCR), which consisted in planed neighborhoods built during HPP implementation for families that had their real estates affected by this venture. Some families were found in the rural area, at Princesa do Xingu community – which is 23Km far from Northern Altamira City -, and in the Rural Collective Resettlement (RCR) – which stays 27Km West in the county. The Rural Collective Resettlement was selected for owners of small lands and for squatters who did not have the right over the affected rural property, for instance, land keepers, sharecroppers and riverine families (EIA/RIMA, LEME, 2009).

In total, 10 visitations were carried out throughout the river extension, the research team went to 11 locations on the right and left riversides, namely: Arapujá, Furo do Trindade, Paratizão, Paratizinho, Palhal, Cotovelo, Poção, Ilha do Pedão, Largo do Bacabal, Costa Júnior and Boa Esperança. Riverine individuals joined the field visitations as guides, since they knew all the chosen routes, houses, the vegetation and the deforestation and flooded areas (artificial lakes). The participation of these individuals made it possible to understand the life stories of the ones who live by the river *in situ*.

Vegetation diversity was inventoried based on questions in the forms, which addressed plants' popular name, recommendation of use, recipes and traditional repertoires. The "free lost" technique was used in the data collection procedure. Interviewees selected the most important plants for their Family Unit, based on their own judgement – these plants were conserved before and after Belo Monte HPP. The technique was followed by the specific non-induction method, which consists in questioning interviewees after they have declared to no-longer recall more elements (ALBUQUERQUE et al., 2008). Four guided visitations were made after the interview, when interviewees were available to accompany the research group; i.e., guided visitations to the areas where the plant species were found (ALBUQUERQUE et al., 2008).

Botanical samples were collected (MARTINS-DA-SILVA, 2002) and identified through consultation to taxonomists and para-taxonomists of Paraense Emílio Goeldi Museum, Belém City, Pará State. The scientific nomenclature was used based on the virtual basis of List of Brazilian Flora Species (2016) (www.floradobrasil.jbrj.gov.br/), *Missouri Botanical Garden* – MOBOT (www.tropicos.org/), *The Plant List* (www.theplantlist.org/), *New York Botanical Garden* (www.nybg.org/) and *SpeciesLink* (splink.cria.org.br). Images of the specimens recorded in the field and the collected material were added to Herbarium MFS Prof. Dr. Marlene Freitas da Silva, of Pará State University.

Data analysis happened through the interpretation of information in the forms, interview transcriptions, field notes and photographs (ALBUQUERQUE et al., 2008). The statistical test Wilcoxon (*BioEstat* software), which compared results of plants before and after Belo Monte HPP, was applied after data normality was assessed through *Shapiro Wilk test* for quantitative measurements. This is a non-parametric test that compares data related to samples collected at different occasions (AYRES, 2007) – at significance level $\alpha = 5\%$. Other information was treated through descriptive statistics.

Salience Index in Cultural domain (SIC) (SMITH, 1993) was calculated in the Anthropac software, version 1.0.2.60. This index ranges from 0 to 1 and weighs absolute frequency values and the citation order of elements in the free list (BORGATTI, 1992), a fact that allows visualizing the position of species within a cultural domain (QUINLAN, 2005). SIC was applied to plants conserved by riverine families after Belo Monte HPP. The importance values (IVs) of species were determined by the expression IVs = n_{is}/n; wherein, n_{is} is equal to the number of people who have classified a taxon as more important, and n is the total of interviewees (BYG; BALSLEV, 2001).

A sketch representing these groups was elaborated to depict the composition of plants conserved in backyards, family crops and woods. The sketch respected the organization observed *in loco*. The choice for these graphic elements followed the largest number of citations made for each cultivation space, frequency and Salience Index in cultural domain of the assessed species.

Results

Of the 60 interviewees, 29 were men and 31 were women, in the age group 25 – 76 years. Most of them were born in Pará State (91%), 81% of the sample was born in Altamira County. The other interviewees migrated from Abaetetuba (2%), Porto de Moz (3%), Santarém (2%) and Vitória do Xingu (2%). Others have come from Maranhão (5%), Ceará (2%) and Paraíba (2%) states. The ones who were born in riverine communities, between Xingu River and its subsidiaries in Iriri, accounted for 68% of the population in Altamira and Vitória do Xingu.

Interviewees came from 20 communities, also called locations upstream Altamira, which were influenced by Belo Monte HPP, namely: Arapujá, Padeiro, Furo das Lanchas, Babaquara, Barriguda, Bom Jardim, Costa Júnior, Largo do Bacabal, Meranda, Pedão, Poção, Praia Alta and Boa Esperança; and downstream Altamira: Arroz Cru, Cotovelo, Palhal, Paratizão, Paratizinho and Trindade, and Cana Verde. Families in these locations preserved close family tights, they lived in houses in the same island or in houses located in distant communities. They interacted with the neighbors and worked together in the crops, in house building; they exchanged agricultural and forest products; and organized cultural festivals, mess, dances, games and shared food.

Besides the houses by the river, some families also had residences in Altamira, but still, they were unanimous in considering their riverine houses as the most important residence, because there was where they spent most of the time. The house in the city was just a support spot for medical care, education, trading and other services, for example, to attend meetings about the power plant construction. The ones who had two residences before Belo Monte HPP accounted for 70% of the interviewees, but this rate dropped to 10% after the displacement.

List of edible plant species

Before Belo Monte HPP construction, agricultural production spaces among riverine communities totaled approximately 248 ethnospecies (popular names), which were classified into six use categories (food, medicinal, fish bate, mystical use, ornamental and for the manufacture of utensils). After the resettlement, this number decreased to 199 ethnospecies. The mean number of plants conserved per family also decreased by 44%. A set of 55 names of plants was mentioned due to interviewees' memory recall, since the areas were already lost or were no-longer visited. In total, 54% of these 55 names belonged to the vegetation area close to, or by, Xingu River. Houses far from the river would make it impossible to have access to useful resources such as food, medications, fish bates and the manufacture of domestic utensils.

In total,143 botanical species were inventoried by taking into consideration all use categories, and this number corresponds to a whole variety of cited popular names. The edible plant species were distributed into 88 species, 60 genera and 36 botanical families (Table 1). Based on memory recalls, edible plant species accounted for 15 ethnospecies, when the plant was no-longer cultivated. The *Wilcoxon* test showed significant difference ($p < 0.0001$) in the repertoire of plants used in local dishes after the resettlement. There was 45% decrease in the mean number of plants cultivated by each FU. Table 1 presents the most used edible plant species in comparison to the number of popular name citations before and after the construction of Belo Monte HPP.

Table 1 - Edible plant species mostly used by riverine families in Altamira, Pará State, Brazil. (BBM: Before Belo Monte; ABM: After Belo Monte; Me: Medicinal; Fi: Fishing bate; Or: Ornamental; My: Mystical use; Ut: Utensils)

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FAMILY/Species	Popular name	Other uses	BBM	ABM	Total of citations
AMARYLLIDACEAE					
Allium fistulosum L.	Onion		46	22	47
ANACARDIACEAE					
Anacardium occidentale L.	Cashew	Me	47	18	51
Mangifera indica L.	Mango	Me; Fi	44	21	46
Spondias dulcis Parkinson	Cajá mango/Cajarana		3	3	5
Spondias sp.	Cajá	Fi	9	3	10
ANNONACEAE					
Annona mucosa Jacq.	Biribá		6	6	8
Annona muricata L.	Soursop	Me; My	18	9	21

Annona squamosa L.	Ata		2	2	**4**
APIACEAE					
Eryngium foetidum L.	Chicory	Me	28	15	**33**
Petroselinum crispum (Mill.) Fuss	Parsley		42	13	**44**
Pimpinella anisum L	Fennel	Me	2	2	**2**
ARECACEAE					
Attalea speciosa Mart. ex Spreng.	Coco Babassu	Me; Or; Fi; Ut	15	5	**16**
Bactris gasipaes Kunth.	Pupunha		3	3	**5**
Cocos nucifera L.	Beach coconut		23	21	**34**
Euterpe oleracea Mart.	Acai / White Acai		23	11	**29**
Oenocarpus bacaba Mart.	Bacaba		6	6	**10**
ASTERACEAE					
Acmella oleracea (L.) R.K. Jansen	Jambu	Me	5	8	**10**
BIXACEAE					
Bixa orellana L.	Annatto		4	3	**6**
BRASSICACEAE					
Brassica oleracea L.	kale		13	10	**19**
BROMELIACEAE					
Ananas comosus (L.) Merril	Pineapple	Me	23	9	**27**
CARICACEAE					
Carica papaya L.	Papaya		16	23	**28**
CONVOLVULACEAE					
Ipomoea batatas (L.) Lam.	Sweet potato		12	5	**15**
CUCURBITACEAE					
Citrullus vulgaris Schrad.	Water melon		28	10	**33**
Cucumis anguria L.	Gherkin	Me	26	9	**31**
Cucumis sativus L.	Cucumber		4	4	**8**
Cucurbita moschata Duchesne	Pumpkin	Me	25	16	**32**
Cucurbita sp.	Jerimum		9	1	**10**
DIOSCOREACEAE					
Dioscorea guianensis R. Knuth	Cassava		22	9	**24**
Dioscorea sp.	Yam		5	0	**5**
EUPHORBIACEAE					
Manihot carthagenensis (Jacq.) Müll. Arg.	Pink Cassava		4	2	**4**
Manihot carthagenensis subsp. *glaziovii* (Müll. Arg.) Allem	Cassava: juriti; black; cocoa; butter.		6	5	**6**

Manihot esculenta Crantz	Cassava	Me	32	10	38
Manihot sp.	Cassava: yellow; white; cocoa; from Bahia; club bent; purple; purple; Cassava: najazinha; club bent; six months; six months;		81	36	86
FABACEAE - CAES.					
Hymenaea courbaril L.	Jatoba	Me; Fi	24	6	24
Tamarindus indica L.	Tamarind		1	1	2
FABACEAE - MIM.					
Inga edulis Mart.	Inga	Fi	19	9	21
FABACEAE - PAP.					
Vigna sp.	Beans	Fi	17	4	19
LAMIACEAE					
Ocimum americanum L.	Basil	Me; My	15	11	15
Ocimum campechianum Mill.	Wild Basil	Me	25	12	26
Ocimum gratissimum L.	Big Wild Basil	Me	3	4	4
Plectranthus amboinicus (Lour.) Spreng.	Thick Mallow	Me	29	24	33
LAURACEAE					
Cinnamomum verum J. Presl	Cinnamon	Me	3	2	5
Persea americana Mill.	Avocado	Me	13	16	21
LECYTHIDACEAE					
Bertholletia excelsa Bonpl.	Brazil Nut	Me	14	3	14
LYTHRACEAE					
Punica granatum L.	Pomegranate	Me	3	3	3
MALPIGHIACEAE					
Byrsonima crassifolia (L.) Kunth	Murici	Fi	37	12	40
Malpighia punicifolia L.	Acerola	Fi	13	10	17
MALVACEAE					
Abelmoschus esculentus (L.) Moench	Okra / Branch Okra		24	18	30
Hibiscus sp.	Vinegar tree		3	3	4
Theobroma cacao L.	Cocoa		12	15	24
Theobroma grandiflorum (Willd. ex Spreng.) K. Schum.	Cupuacu		18	15	25
MORACEAE					
Artocarpus heterophyllus Lam.	Jackfruit		12	4	13

MUSACEAE					
Musa sp.	Banana		33	19	41
MYRTACEAE					
Plinia cauliflora (Mart.) Kausel	Jabuticaba		1	1	2
Psidium guajava L.	Guava	Me; Fi	46	17	50
Psidium guineense Sw.	Arrack		4	1	5
Syzygium cumini (L.) Skeels	Plum	Me; Fi	8	3	9
Syzygium malaccense (L.) Merr. & L.M. Perry	Jambu		7	6	9
OXALIDACEAE					
Averrhoa carambola L.	Star fruit		3	1	3
PASSIFLORACEAE					
Passiflora edulis Sims	Passion fruit		10	8	13
PEDALIACEAE					
Sesamum sp.	Sesame	Me	2	3	3
POACEAE					
Cymbopogon citratus (DC.) Stapf	Lemon Grass / Holy Grass	Me; My	48	29	53
Oryza sp.	Rice		9	1	10
Saccharum officinarum L.	Sugarcane		4	6	7
Zea mays L.	Maize		28	16	33
PORTULACACEAE					
Talinum paniculatum (Jacq.) Gaertn.	Cariru/Caruru		3	5	5
RUBIACEAE					
Coffea arabica L.	Coffee		7	1	8
Genipa americana L.	Jenipapo		0	2	2
RUTACEAE					
Citrus × *limon* (L.) Osbeck	lemon	Me	35	15	40
Citrus L.	Lime / Lemon Galician / Lemon Tahiti	Me	5	4	6
Citrus reticulata Blanco	Pocã / Tangerine	Me	16	9	19
Citrus x aurantium L.	Orange	Me	28	20	34
SAPINDACEAE					
Talisia sp.	Pitomba		1	1	2
SAPOTACEAE					
Chrysophyllum cuneifolium (Rudge) A.DC.	Golosa	Fi	9	2	11
SOLANACEAE					
Capsicum annuum L.	Hot pepper	Fi	26	14	28

Capsicum frutescens L.	Chilli pepper	Me; My	23	10	**25**
Capsicum odoriferum Vell.	Fisheye Pepper		9	2	**11**
Capsicum sp.	Pepper / Goat Pepper		4	4	**6**
Capsicum sp. 1	Burning pepper		1	2	**2**
Capsicum sp. 2	Table pepper	Me	3	3	**3**
Capsicum sp. 3	lady finger pepper		3	0	**3**
Capsicum sp. 4	Purple Pepper		1	1	**2**
Capsicum sp. 5	Bell Pepper	Fi	10	2	**12**
Solanum lycopersicum L.	Tomato	Fi	22	11	**27**
Solanum aethiopicum L	Scarlet eggplant		6	3	**6**
Solanum sp.	Cherry tomato		2	2	**2**
VERBENACEAE					
Lippia alba (Mill.) N.E.Br. ex P. Wilson	Lemon balm	Me	45	19	**47**
VITACEAE					
Vitis sp.	Grape		2	2	**4**
TOTAL: 88 species			1,381	737	**1,663**

Source: data in the research.

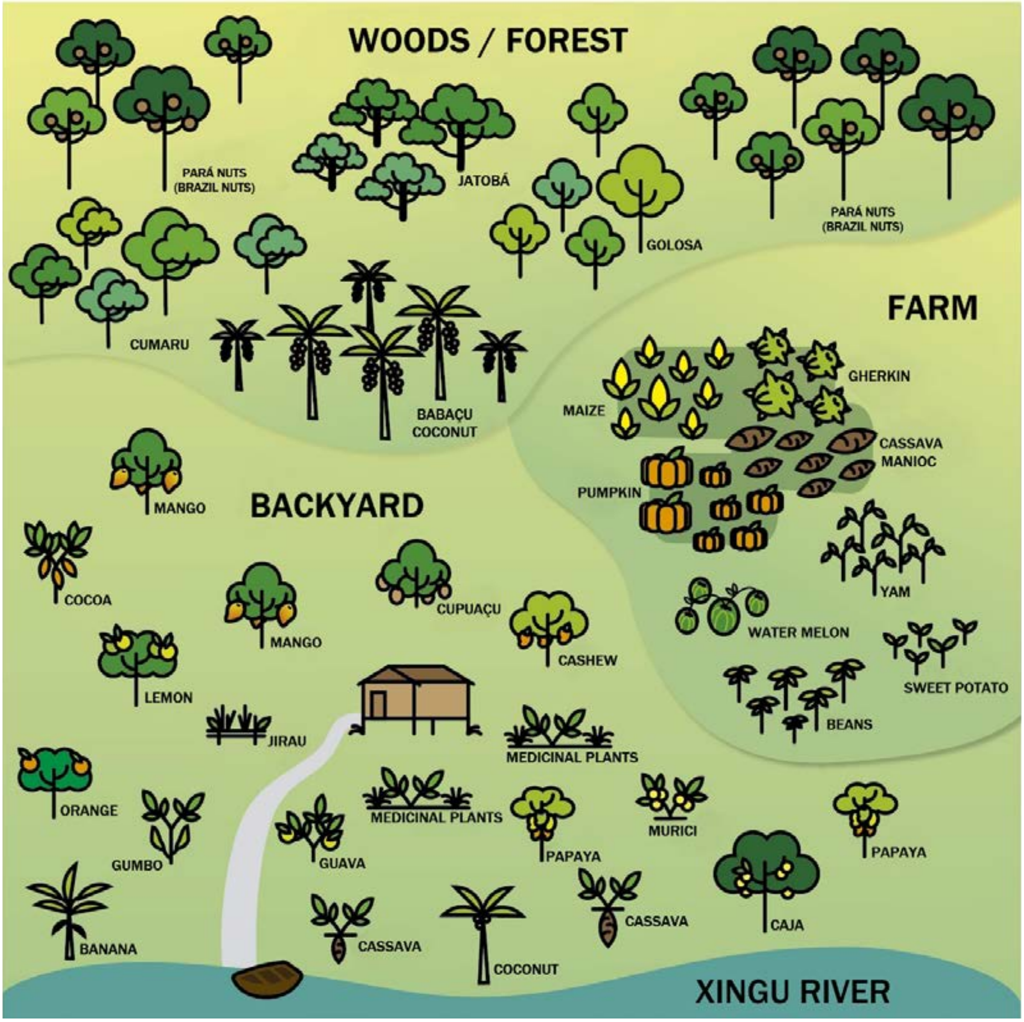
In total, 45% of the total of plants used for cooking were recommended for other applications, with emphasis on the multiple uses of several species. Besides human and animal nutrition, 31 traditional medicinal species were recommended as medicinal therapy, 14 were recommended for fishing bates, 4 were used for good luck and protection, 1 was ornamental and 1 was used as raw material in house construction.

Of the total of interviewees, 61.6% transported plants from their production sites to their new homes. This moment was very significant for riverine families that moved to Altamira City (16 families), for the ones who moved to rural areas (3) and for those who moved to other riverine houses. However, fruits and seeds planted in plastic bags were moved along with other personal objects. The main species moved along with family belongings were cassava (*Manihot* sp.), holly grass (*Cymbopogon citratus* (DC.) Stapf), chicory (*Eryngium foetidum* L.), mango (*Mangifera indica* L.), onion (*Allium fistulosum* L.), orange (*Citrus x aurantium* L.), papaya (*Carica papaya* L.), chilli pepper (*Capsicum frutescens* L.) and beach cocconut (*Cocos nucifera* L.).

Cultivation Systems

Three main conservation and agricultural spaces were identified, namely: peri-home backyard, family crop and woods, or forest. Riverine families in these areas keep a whole variety of fruits, vegetables, seasoning herbs, legumes, among others, which are available for family and community use. The scheme in Figure 2 depicts the main elements found at land plots by the river; it focuses on vegetal resources and their distribution in different systems.

Figure 2 - Graphic representation of vegetal resources in the riverine ecosystem.



Source: data of the research.

Backyards showed 59 species (67%), and the most frequent ones were lemon (*Citrus × limon* (L.) Osbeck), cashew (*Anacardium occidentale* L.), guava (*Psidium guajava* L.), banana (*Musa* sp.), mango (*Mangifera indica* L.) and orange (*Citrus x aurantium* L.). Overall, these fruits are consumed *in natura*, they are also used as ingredient in local dishes or processed in juices and porridges; cashew nuts are toasted for feeding purposes. Vegetables used as food seasonings included onion (*Allium fistulosum* L.), parsley (*Petroselinum crispum* (Mill.) Fuss) and chicory (*Eryngium foetidum* L.). These seasoning herbs add flavor to fish preparations and, overall, they are planted in suspended jiraus, rarely on the ground; they are protected from floods in rainfall periods – between January and May.

Family crops were other spaces observed in 44% of FUs, which have recorded 19 prevailing cultivations (21%), with emphasis on cassava (*Manihot* sp.; *Manihot esculenta* Crantz), maize (*Zea mays* L.), water melon (*Citrullus vulgaris* Schrad.), pumpkin (*Cucurbita moschata* Duchesne), Gherkin (*Cucumis anguria* L.), cassava (*Dioscorea guianensis* R. Knuth) and beans (*Vigna* sp.). Cassava, maize and pumpkin were quite referred in the history of riverine agriculture. These ingredients are used in the local cuisine for the preparation of stews or fried, in cakes, sweets and porridges. Maize and cassava are also used to feed birds bred in backyards.

Cassava species (*Manihot* sp.) were referred to 134 times. Riverine farmers know all the varieties of these food crops and differentiate one from the other based on plant external features (structure and leaf color, pedicle color and length, plant height) and on internal root color. These classifications highlighted 10 cassava ethnovarieties, according to Table 2.

Table 2 - Ethnovarieties of cassava (*Manihot* sp.) cultivated by riverine farmers, Altamira, Pará State, Brazil. *non-informed.

Ethnovarieties	Morphological Differences	Post-cooking Features	Citations
Cocoa	Greener and larger leaves; roots with purple-bark; plants do not grow much.	Shorter cooking time; yellow root; the root can get sour in case of heats.	28
White	Purple leaves; they do not grow much	Whitish roots.	16
Bahia	Grows more than the others.	More tasteful/yellowish.	11
Butter	Red pedicles.	Yellowish.	4
Yellow	*	Yellowish.	4
Rosinha	Smaller leaves.	*	4
Black	*	*	1
Pau torto	Bended steam.	*	2
Vanessa	White pedicles.	Absence of sourness in the cooked root, when it is previously heated	1
Juriti	Red pedicles	Absence of sourness in the cooked root, when it is previously heated	1

Source: Data of the research.

The most appreciated cassava varieties were cocoa, white and bahia. Cocoa cassava reached the highest absolute frequency (20.4%) - this number is associated with its post-cooking features. Color features such as more yellowish and shorter cooking time favor the preference for using these varieties in food preparation and for trade. Cassava (*M. esculenta* Crantz) is the raw material for flour, tapioca gum, tucupi and porridge production. Before the displacement due to the implementation of Belo Monte HPP, cassava flour was the most sold and profitable vegetable product, which was followed by tapioca gum. This trading often followed fish sales, because family consumption was the common priority. After the power plant installation, cassava cultivation in FUs dropped by 72%.

Flour also meant a gift given by riverine families to their guests and friends who lived in the city. It expresses the proud of supplying products from the land that "provides all".

The third observed system concerned "riparian forest" regions and forests farther from the riversides; 11 species stood out in these regions (12%). These regions are conserved areas located by the river, they are part of residential backyards where one extracts products such as açai (*Euterpe oleracea* Mart.), Babassu cocconut (*Attalea speciosa* Mart. ex Spreng.) and Brazil nuts (*Bertholletia excelsa* Bonpl.). These nuts are found in spots farther from the river. Açai (*E. oleracea* Mart.) is often collected and prepared through joint efforts by community leaders. Açai juice is made by mixing or hand-smashing the fruits, it is drunk along with cassava flour. Babassu coconut (*A. speciosa* Mart. ex Spreng.) is used for milk, oil and charcoal production; moreover, the fruits can be used to feed fish. Brazil nut seeds (*B. excelsa* Bonpl.) are appreciated for consumption *in natura* and for trading to increase family income.

Cultural importance

The Salience Index in Cultural domain (SIC) was calculated for plants conserved after Belo Monte HPP implementation, based on the free list. SIC values ranged from 0 to 0.28 and it allowed classifying them into frequency and salience decreasing order. In parallel, Importance Values (IVs) determination was used to measure FUs fractions that have selected the most important plants. Of the total number of assessed FUs, 40 individuals nominated 31 species from 22 botanical families – IVs ranged from 0.03 to 0.18.

Table 3 shows ten ethnospecies that have reached the highest absolute frequency values (AF), as well as the number of citations after Belo Monte HPP (BMD) implementation.

Table 3 - Ethnospecies classification based on frequency and salience index values of plants cultivated by riverine families in Altamira, Pará State, Brazil (did not have IVs).**

Popular name	Species	AF (%)	SIC	IVs	BMD
Holly Grass	*Cymbopogon citratus* (DC.) Stapf	46.3	0.28	0.18	29
Papaya	*Carica papaya* L.	38.9	0.21	**	23
Onion	*Allium fistulosum* L.	38.9	0.21	0.10	22
Orange	*Citrus x aurantium* L.	37.0	0.19	0.13	20
Cashew	*Anacardium occidentale* L.	37.0	0.19	0.03	18
Mango	*Mangifera indica* L.	37.0	0.20	**	21
Banana	*Musa* sp.	35.2	0.21	0.03	19
Brach cocconut	*Cocos nucifera* L.	35.2	0.19	0.08	21
Avocado	*Persea americana* Mill.	33.3	0.20	0.03	16
Guava	*Psidium guajava* L.	31.5	0.20	**	17

Source: data of the research.

Discussion

Families have translated the multiple meanings, features and singular dynamics of the shared use of land plots or of islands in the reservoir coverage area. Most interviewees (69%) were born in communities located by the Xingu and Iriri rivers, many of them have emphasized the expression "I was born and raised in *beiradão*", which highlights their historical bonds to the river. According to Little (2002), the cosmography of a group, i.e., their singular relationship with their territory, includes the ownership regime, affection bonds, the history of their land occupation – which remains in the collective memory – and social use, as well as the ways to defend the place they live in.

The close relation riverine inhabitants have with the city results in "provisional separations" (living by the river and in the city) in order to fulfil education needs, access to social policies focused on healthcare, or access to local markets (MAGALHÃES; CUNHA, 2017). This housing method, also known as double housing or bi-location, is seen as the very basis of the lives of individuals living by Xingu River" (DE FRANCESCO et al., 2017).

Edible plant species

Riverine inhabitants have shown strongly rooted behaviors towards many plant species, which are highlighted by their knowledge on flora, which was acquired through tradition, management of seeds to be sown, exchange of agricultural products and through multiple plant uses. These observations are in compliance with the literature on the broad knowledge, and plant use and management by traditional populations (DIEGUES; ARRUDA, 2000; LUCAS et al., 2017).

The 45% reduction in the number of plants conserved by riverine families pointed out that territory loss has impaired the continuity of social and productive relationships in FUs. This result meets reports by Zhouri and Laschefski (2010), who stated that the territorial displacement of these populations means not just losing their land, but losing the material and symbolic basis of their socialization, production and economic modes.

As for the current study, by taking into account the total of inventoried species (n=143), the rate of edible plants (61%) was close to results found by Martins et al. (2012), who assessed plant species cultivated by riverine families in Acre State. This use category often accounts for the largest number of species in ethnobotanical diagnostics (SABLAYROLLES; ANDRADE, 2009; MARTINS et al., 2012; LOBATO et al., 2014). According to Lucas et al. (2017), the prevalence of one, or more, categories would follow the study site, problems experienced by the population, the affection to these resources, the space available for crops, as well as economic and socio-cultural aspects.

The medicinal value of edible plants' multiple use was essential to the comparison to the other categories. Based on such definition, the most recalled species were cashew (*Anacardium occidentale* L.) and guava (*Psidium guajava* L.), which are consumed *in natura,* in the form of juice, sweets, as well as of teas to treat gastrointestinal issues. Holly Grass (*Cymbbopogon citratus* (DC.) Stapf) is used to replace coffee and to work as soothing medication. Carneiro (2005) observed that food was always related to health in almost all cultures, since its abundance or scarcity puts in check human survival itself.

The speech by riverine community members is frequent, they outspread their existence as riverine inhabitants, which lies on the following condition: preserving biological diversity means supporting cultural diversity. Plants found in backyards, family crops and forests in Xingu correspond to biological collections of high educational and conservation value – they are applied to local natural resources (WEN et al., 2015). These "collections" act as the source of living materials that document and work as plant and animal-sample repositories used by human populations; these repositories are associated with humans' traditional knowledge. Families that use plants on a daily basis use to take them along to new residences, whenever possible. This scenario shows these individuals' resistance in maintaining and restarting their lives by taking along what was important for them, such as plant resources.

Traditional cultivation systems

The diversity of agricultural and forest environments (backyards, crops and the woods) leads to abundance of natural resources, which many interviewees referred to when they recalled life in the island, before Belo Monte HPP implementation. Backyards resembled the areas described by Castro et al. (2007), Fraxe et al. (2007) and Martins et al. (2012), where one finds the prevalence of fruit trees to fulfil family demands and herbs preserved in *jiraus* or suspended gardens. The habit of keeping seasoning herbs close to the house also intends to facilitate the job of women who search for them (GERMANO et al., 2014).

The observed species in the crop areas were managed through exchanges between relatives and neighbors, they were also registered by Martins et al. (2012), who observed the prevalence of cassava, maize and beans, with emphasis on cassava (*Manihot* sp.). However, the present study did not record *Manihot* sp. ethnovariety level higher than the ones found by Peroni et al. (2007), who found 68 varieties of it in fisherman communities in São Paulo State, and by Lima et al. (2013), who identified 52 varieties in communities in Pará State.

The 72% reduction in cassava cultivation after the power plant was implemented has shown that the transition to the city and the lack of space for agricultural production (crops and flour-house) have stopped this activity. This outcome represents a vital element for the food culture and economic survival of these communities, since it has direct impact on their income, food safety and quality of life. Plants and products previously cultivated, sold and given as gifts by these individuals at social relationship scope, started being bought in local markets after the territorial displacement. Products belonging to these riverine families' agricultural collection are a reason of proud, a register of their memory towards a certain plant.

Agro-forest backyards and crops are among the sub-systems that mostly standout in riverine communities, since they allow the constant production of many products that complete their family income and that are real germplasm banks *in situ* (CASTRO et al., 2007). Conserving *in situ* includes the definition of wild populations that can be preserved in protected areas and of cultivated species that are "conserved in original agricultural areas, i.e., in domestic gardens, crops and cultivated fields", that constitute an in-farm conservation system (CLEMENT et al., 2007, p. 2).

Based on the different alteration and destruction scenarios caused by HPP implementation, the aforementioned traditional cultures are very valuable and their value goes beyond communities of users because it involves economic and social, healthcare, education and community-services development. These topics are the very core of the Global Strategy for Plant Conservation – GSPC, which is acknowledged by the Convention on Biological Diversity (CBD) (CDB, 2010; 2012). Moreover, the elaboration of the new 2011-2020 Strategic Biodiversity Plan counted on a whole set of targets focused on biodiversity loss reduction at global scope, on "Aichi Targets", which are organized into five great strategic goals. One of these targets is to improve biodiversity, since it protects ecosystems, species and the genetic diversity of cultivated plants, bred and domesticated animals, and wild varieties, including other species of sociocultural and/or cultural importance (MELO et al., 2019).

Species cultural importance

Cultivars recording the highest SIC and IVs were often found in pre-house backyards located either at riversides or in cities and other visited rural fields. They comprise herbs and fruits used in daily meals, some of them are abundant in Xingu River's sides (mango, cashew and guava). According to Valadares (2015), orange (*Citrus sinenses* L.) and banana (*Musa paradisiaca* L.) were essential in *quilombola* communities in the coast of Santa Catarina State, since they recorded salience indices equal to 0.16 and 0.12, respectively.

Holly grass (*C. citratus* (DC.) Stapf) recorded the highest values in all parameters. It is known for the aroma of its leaves, which are the main parts handled for tea preparation. The aroma is pleasant for food preparation and its constituents are beneficial for human health (soothing medicine). Fishermen in Mato Grosso State *Pantanal* recorded the same categories for this species in the ethnobotanical inventory carried out by Morais et al. (2009). Most fruit trees in Table 3 were also pointed out due to their medicinal profile (Orange, cashew, mango, guava, coconut and avocado). Based on Vendruscolo and Mentz (2006), the larger the number of uses referred for a species, the greater its importance for the community.

Cassava varieties, and the other plants found in family crops did not reach high values in salience index results. Despite the low score, the value of these products was evidenced by the preserved flavors, mainly by land management, since they were eaten in daily meals. On the other hand, it is essential analyzing that low values reflect the frequency and order of plant citations after Belo Monte; therefore, it highlights the current species-loss context resulting from the influence of the power plant. This process has affected the relation between use and belonging, and plant resources in riverine culture, which lies on memories of what once was, and remains, important for the culture of this population, although these plants are no-longer cultivated.

The promise of progress brought by Belo Monte HPP stated that families affected by the project would live under similar, or even better, conditions after their displacement. Despite the positive propaganda, many riverine families got poorer; before the power plant, they had access to a whole variety of food for their survival: "the thing is, we were not rich, but we had all we needed to survive, to live well" (R.C.S, 45 years). Therefore, the concept of development contradicts deterritorialization when it comes to the construction of the dam, because the way "modernity" surpassed "tradition" disrupted social customs and practices, whereas re-territorialization was not capable of recomposing the ways and conditions of life of the affected ones (BORTONE et al., 2016).

Xingu River appropriation for electric power generation unbalanced the territory and the lives of riverine families, since it forced them to leave their houses and traditions behind; it turned the river into a reservoir; impaired the fishing practices and family survival. Belo Monte Power Plant depicts a case of Environmental Racism: i.e., it happens when groups facing social, ethical and/or economic vulnerability pay for the socio-environmental injustice and damage caused by "development" (HERCULANO; PACHECO, 2006). This inequality form was approached in the documentary "Interfaces do Racismo: Racismo Ambiental", which was produced by Defensoria Pública da União. The documentary showed reports by *quilombolas* who faced a process similar to that observed in Xingu: impoverishment caused by the advancement of great projects over their lands (INTERFACES DO RACISMO, 2018).

Injustice in the process to resettle populations due to ventures were also recorded in different continents. Jehom (2016) assessed the resettlement of an indigenous community due to the construction of Bakun Hydroelectric Power Plant in Sarawak, Malaysia. People were removed from their root lands, from the environment where they lived in collectivity and practiced subsistence agriculture and were relocated without the necessary conditions to go on with their lives. Hausermann (2018) assessed the implications of building the Bui Dam, in Gana. He found that the subsistence agricultural and fishing means of the rural population were radically changed and that it has resulted in food unsafety, in lower family income and in psychological distress. Resettlements forced by great projects were seen by Vanclay (2017) as one of the greatest issues concerning lack of attention to social matters, a fact that has impact on the lives of the affected individuals.

Conclusions

Xingu riverine families built a biodiverse environment in their territories with plant species organized in their backyards, crops and woods. Peri-house backyards presented the highest diversity of cultures and cultural salience. The environment proved to keep food safety and economic stability to these families. Family crops provide essential agricultural components for nutrition and for the traditional economy, mainly due to cassava cultures. Forest areas provide native products historically used by these communities.

The significant number of plants used by agro-extractive families and specimens transportation to new houses show the dependence relationship between riverine communities' ways of life and plant resources. Based on the results, edible plant species are relevant for riverine communities in Xingu, for the value given to the local culture, for the sustainable use and conservation of spaces where one finds the plant collections.

Based on the bio-cultural context these communities are inserted in, Belo Monte's construction has affected the identity of their territory, a fact that has threatened the agricultural activity and the socio-cultural relationships in the region. Irreversible losses, such as the extinction of many plant species, still harm the affected region and put the conservation of local agro-biodiversity collections at risk.

It is important conducting further studies to value the food systems of traditional peoples and communities, be them riverine, *quilombolas*, indigenous, extractive or family farmers, mainly of the ones affected by great projects such as power plants, roads and mines. Traditional groups maintain the memories, identities, knowledge and practices bond to food types that face the risk of being lost and extinct due to the implementation of big ventures or of other actions (for example, monocultures and industrialized systems for food production). This finding is in compliance with the report published by Observatório Brasileiro de Hábitos Alimentares da Fundação Oswaldo Cruz (OBHA, 2016). Shared efforts by universities and communities have to work to produce scientific documents to show the damages caused to the food cultural patrimony related to biodiversity and to HPPs.

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Original Article

RIVERINE COMMUNITIES AND BELO MONTE POWER PLANT: DETERRITORIALIZATION AND INFLUENCE ON THE CULTIVATION OF EDIBLE PLANTS

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RIVERINE COMMUNITIES AND BELO MONTE POWER PLANT: DETERRITORIALIZATION AND INFLUENCE ON THE CULTIVATION OF EDIBLE PLANTS

***Abstract*:** The research aimed to evaluate the importance of plant food in maintaining the lifestyles of the *ribeirinhos* who are affected by the Belo Monte Dam. We interviewed 60 families affected by Belo Monte. The data collection was done through recorded semi-structured interviews, participant observations, guided tours and botanical collection. The data was interpreted qualitatively and quantitatively using the following the Wilcoxon test for statistical analysis. We identified 143 species, it was registered 88 food plants, distributed in 36 botanical families. When comparing the above-mentioned plants, before and after Belo Monte, there was a significant difference, with a reduction of 45% in the number of species. Three systems of traditional cultivation were observed, yard, garden and forest areas. Despite the expected socio-environmental risks, the loss of territories has generated wide-ranging impacts, including food production and the individual and societal cultural identities of human.

***Keywords*:** Food, Hydropower, Traditional people, Plants.

RIBEIRINHOS E A HIDRELÉTRICA BELO MONTE: A DESTERRITORIALIZAÇÃO E INFLUÊNCIAS NO CULTIVO DE PLANTAS ALIMENTÍCIAS

Resumo: A pesquisa objetivou avaliar a importância das plantas alimentícias na manutenção do modo de vida dos ribeirinhos afetados pela Hidrelétrica Belo Monte, num cenário de mudanças socioambientais. Com 60 Unidades Familiares, realizaram-se entrevistas semiestruturadas, observações participantes, turnês guiadas e coletas botânicas. Os dados foram interpretados quali e quantitativamente, empregando-se o teste de Wilcoxon para análise estatística e os índices de Saliência Cultural e Valor de Importância das espécies. Foram identificadas 143 espécies vegetais, das quais registraram-se 88 alimentícias, pertencentes a 36 famílias botânicas. Houve diferença significativa na quantidade de espécies cultivadas antes e após a usina, com declínio de 45%. Observaram-se três espaços de cultivo: quintal, roça e floresta/mata. Este estudo detectou forte tradição e dependência das famílias com o modo de vida à beira do rio e a produção de alimentos. Apesar dos riscos socioambientais previstos, a perda dos territórios gerou impactos de amplas dimensões, incluindo a produção de alimentos e as identidades culturais do ser humano individualmente e em sociedade.

***Palavras-chave*:** Alimentação, Hidrelétrica, Povos tradicionais, Recursos vegetais.

RIBEREÑOS Y LA HIDROELÉCTRICA BELO MONTE: DESTERRITORIALIZACIÓN E INFLUENCIA EN EL CULTIVO DE PLANTAS ALIMENTICIAS

***Resumen*:** Esta investigación buscó evaluar la importancia de las plantas alimenticias en el mantenimiento del modo de vida de los ribereños afectados por la Hidroeléctrica Belo Monte, en un escenario de cambios socioambientales. Con participación de 60 Unidades Familiares, fueron realizadas entrevistas semiestructuradas, observaciones participantes, caminatas guiadas y colectas botánicas. Los datos fueron interpretados cualitativa y cuantitativamente, empleando la prueba de Wilcoxon para análisis estadístico y los índices de Destaque Cultural y Valor de Importancia de las especies. Fueron identificadas 143 especies vegetales, de las cuales se registraron 88 alimenticias, pertenecientes a 36 familias botánicas. Se encontró diferencia significativa en la cantidad de especies cultivadas antes y después de la Hidroeléctrica, con una reducción de 45%. También, se observó tres espacios de cultivo: patio trasero, chacra y bosque/mata. A pesar de los riesgos socioambientales previstos, la pérdida de territorios generó impactos de gran alcance, incluida la producción de alimentos y las identidades culturales del ser humano, individual y en sociedad.

***Palabras clave*:** Alimentación, Hidroeléctrica, Pueblos tradicionales, Recursos vegetales.