DOWNSTREAM FISHERS AND THE IMPACTS GENERATED BY THE BELO MONTE HYDROELECTRIC DAM.

By

Laura Castro-Diaz

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ABSTRACT

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In order to reduce the dependence on fossil fuels, and reduce greenhouse emissions countries have promoted a transition toward renewable energy sources such as hydropower. In the case of Brazil, 65.2% of the energy of the country comes from hydropower. The Belo Monte Hydroelectric Dam, located in the Xingu River of the Brazilian Amazon, is the third largest dam in the world, it will generate 11 GW of electricity and its construction has caused many social, economic and environmental impacts. In this research, I study how Vila Nova, a riverside community downstream from the Belo Monte dam in the Xingu river that used to rely on fish as the main source for its livelihood has been impacted by the dam. Fishing is an activity usually carried by males, but in Vila Nova it is done both by men and women. The aim of this research, is to examine through the perception of local men and women fishers, the impacts that the Belo Monte dam has caused to the fishery and fishers' livelihoods. To my knowledge, no other study has looked at the impact to people and fisheries caused by a large-scale dam in the Amazon Basin from the perspective of local fishers. I conducted in-depth interviews, participatory observations, fishing trips and resource mapping with fishers of Vila Nova. Data analysis followed an interactive and continuous process. My findings suggest that men and women use the fisheries resources differently and perceive different impacts due to their roles in the community.

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KEY TO ABBREVIATIONS

ANEEL - National Agency of Electricity

DNAEE- Brazilian Water and Electricity Department

EIA – Environmental Impact Assessment

Electrobrás - Centrais Elétricas Brasileiras

Electronorte – Electrical Government Company of the North of Brazil

FPE – Feminist Political Ecology

IBAMA – Brazilian Environmental Control Agency

IEA – International Energy Agency

INSS – National Social Insurance

ISA – Socioenvironmental Institute

LEK – Local Ecological Knowledge

NESA – Norte Energia

PBA – Basic Environmental Plan

SIN- National System of Integration

WCD – World Commission on Dams

1. INTRODUCTION

In order to reduce the dependence on fossil fuels and to reduce greenhouse gas emissions, countries have begun to promote a transition toward renewable energy sources such as hydropower (Yüksel, 2010). In the case of Brazil, hydropower is the main source of energy, generating more than 65.2% of the country's power supply (EIA, 2015). Because if it immense potential, the country is constructing and planning more hydropower dams in the future. The Belo Monte Hydroelectric Complex, located in the Xingu River of the Brazilian Amazon, will be when the whole system be operating the third largest dam in the world. The dam will generate 11 GW of electricity but its construction has caused many social, economic and environmental impacts to local populations and the environment.

To the best of my knowledge, not many studies have looked at the social impacts of the environmental changes perceived by fishing communities living downstream from a dam. This study aims to fill this gap by studying the impacts generated by the Belo Monte Hydroelectric Complex in the lives of fishers in Vila Nova—one community downstream from the Belo Monte dam. Even though the dam is not fully operating yet, it is important to identify the impacts that fishers perceive from the dam construction and early stages of dam operation. Fishers in Vila Nova are representative of the experience of downstream communities: it is estimated that more than 472 million people are negatively affected by living downstream of large dams around the globe (Richter et al., 2010)

The study takes places in Vila Nova, a downstream community of the Xingu river with one characteristic that will receive special attention in this thesis: fishing is done both by women

and men. This situation is unusual for the Amazon basin since fishing has traditionally been a male-dominated activity.

This document is organized in two papers. In the first one, I describe the role of men and women in the artisanal fisheries of Vila Nova. To be able to identify the men and women's knowledge, practices and management on the fishery, as well as their perceptions, attitudes, behavior pattern, priorities concerns, opportunities and needs regarding fishing will portray the work that women do in the fishery. This inclusion will expand our knowledge about fisheries in the Amazon region.

Then in the second chapter, I explore how fishing activity has changed in Vila Nova with the construction of the hydroelectric complex. By addressing this issue, I seek to understand and describe the social and ecological characteristics of fisheries before and during the construction of the dam, and secondly to understand the differences in the perception of the changes generated by the construction of the hydroelectric complex by fishers. I address this question by investigating the perceptions of women and men fishers in the community.

CHAPTER 1. ARTISANAL FISHERIES AND THE GENDER DIVISION OF LABOR IN A FISHING COMMUNITY OF THE BRAZILIAN AMAZON

1. INTRODUCTION

Inland fisheries involve the extraction of fish and other living organisms from surface inland waters (Welcomme et al., 2010, p. 2881). These fisheries contribute over 40% of the world's catch, and provide food and livelihoods to millions of people worldwide (FAO, 2014; Lynch et al., 2016). Inland fisheries are very diverse, as they encompass a wide range of ecosystems, geographic settings, fish species, and different social, economic and cultural contexts of human populations (Welcomme, 2011; Welcomme et al., 2010). This diversity has created an opportunity for riparian communities to engage in this labor-intense activity, to develop diverse strategies to use the natural resources, in a small-scale for the most part, and to satisfy local fish consumption. However, inland fisheries are not a national governance priority; they are often neglected, undervalued and its threats overlooked (Cooke et al., 2016; L. E. D. Smith, Khoa, & Lorenzen, 2005).

These fisheries and the people depending on them are affected by pollution, habitat fragmentation, the introduction of non-native species, and competition for water, among others. Competition for water resources as a result of the development of hydropower dams, agriculture, mining, forestry, recreation and aquaculture threat inland fisheries by affecting the quality and magnitude of fish production (FAO, 2016).

Inland fisheries are reported to support over 60 million people in developing countries (L. E. D. Smith et al., 2005). According to the literature, women comprise 20% of the world's fishers and carry out around 90% of fishing post-harvest activities (FAO, 2014). Studies have shown that women also participate as active fishers in different regions of the world

(Bennett, 2005; Kebe, 2009; Weeratunge, Snyder, & Sze, 2010)**;** still, there is a lack of recognition of the important role of women in fisheries, which leads to a lack of literature documenting this role. More importantly, women are overlooked in policies and subsequently marginalized from decision-making (Bennett, 2005; FAO, 2013; Mills et al., 2011).

Traditional gender roles of men and women in rural areas have contributed to the widespread notion that men are the family providers, developing activities like hunting or fishing, while women stay at home performing domestic activities such as caregiving (Verchick, 2004) or taking care of household gardens. Therefore, many believe that women do not participate in hunting and fisheries' economies (Harper, Zeller, Hauzer, Pauly, & Sumaila, 2013).

In the Amazon region, the most biodiverse river basin in the world, fishing is one of the oldest and most important socio-economic activities. In this region, fishing has traditionally been a male-dominated activity, in part because women were culturally banned from it (Marques, 2001; N. Smith, 1981; Wagley, 1953; Witkoski, 2010). In fact, women were not even allowed to touch or be close to fishing gear during pregnancy or menstruation periods, because they were supposed to put a curse on the fishermen (N. Smith, 1981). Thus, research on fisheries in the Amazon Basin had focused solely on men's knowledge of fishing resources and on how they use them, as well as on the biological and ecological aspects of the fishery (Batistella, Castro, & Vale, 2005; Cetra & Petrere Jr, 2001; Goulding, 1980; Renato Silvano & Valbo-Jørgensen, 2008; N. Smith, 1981). Additionally, in Latin American fisheries, women are restricted to be fish traders, or are only acknowledged as fishermen's wives (Pereira, 2002).

An unusual situation occurs in various communities in the state of Pará, Brazil, where both men and women actively participate in fishing. This is the case of Vila Nova, a riverine community in the Xingu river, located downstream of the Belo Monte dam, where this study took place. A case study where both men and women are fishers represent an unique opportunity to expand our knowledge about fisheries in the Amazon region, and to acknowledge and describe the role of women in this sector. Men and women's knowledge, practices and management on the fishery differ, as well as their perceptions, attitudes, behavior pattern, priorities concerns, opportunities and needs (Agarwal, 1997; Cavendish, 2000; Sunderland et al., 2014). Hence, in this chapter I am exploring the role of men and women in the artisanal fisheries of Vila Nova. By including a gender approach, I aim to broaden our understanding of fisheries' management and explore how men and women fishers engage with their natural resources. This is an important contribution to the knowledge of the Amazonian fisheries, and I hope to portray the work women do for supporting these fisheries and their families.

The chapter is organized in the following sections: in the next section I will present Feminist Political Ecology as the conceptual and theoretical framework for this research; second, I will provide a background of the role of women in fisheries in the Amazon Basin; then, I will describe the methods of the study, followed by the results and a discussion on them; I will conclude with some final remarks.

2. FEMINIST POLITICAL ECOLOGY: THE IMPORTANCE OF LOCAL KNOWLEDGE

Feminist Political Ecology (FPE) is a framework understanding gender as a critical variable to explain resource access and control. It interacts with class, race, culture and ethnicity. The goal of the framework is to understand locals' experience in the context of global processes

of environmental and economic change (Rocheleau, Thomas-Slayter, & Wangari, 1996). This framework embraces different types of knowledge to inform decision makers in policy and management development. FPE considers three main themes that help understanding the environmental and economic changes, from a local experience while including global processes: (i) gendered science; (ii) gendered rights; and (iii) gendered organizations and political activity (Rocheleau et al., 1996). For the purpose of this paper, I will focus my attention in the first two themes.

According to Rocheleau et al. (1996), gendered science is where gender and environment converge and are informed by different sources and knowledges, highlighting the importance of considering local knowledge in processes of decision making. Local knowledge is contextual, dynamic and adaptive to external change, and it is transmitted informally (Kelkar, 2007). The knowledge that men and women have of nature has been called local ecological knowledge (LEK) and/or traditional ecological knowledge (TEK). LEK includes locals' perceptions, beliefs, classifications and understanding of socioecological dynamics (Begossi, 2015). On the other hand, TEK is defined by Berkes (2008) as a "cumulative body of knowledge, practice and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment" (Berkes, 2008, p. 7). Then, the knowledge that multiple individuals have about the same object, topic or activity will be different depending on their gender, age, class, occupation and power dynamics (Haraway, 1991).

In the case of fisheries, knowledge is passed from generation to generation, and from other fishermen with whom they have fished in the past (Johannes, Freeman, & Hamilton, 2000).

Fishers' knowledge includes aspects such as fish habitats, species, migration, and stock structure (Thornton & Scheer, 2012). According to Begossi (2008), local knowledge in fishery management can be classified in the following dimensions: (a) use of resource units; (b) use of resource system --for inland fisheries it refers to lakes, rivers, small streams, etc--; (c) fisher behavior; and (d) fishers' knowledge about biology and ecology of species.

Gendered rights refer to the control, access and responsibilities that men and women have over the resources. Usually, the rights over resources that men and women have differ spatially: men have rights in public spaces, whereas women do in private spaces, such as the household. Authors like Ortner (1974) and Rocheleau et al. (1996) have discussed this men and women duality, where women have been associated with domestic and private contexts, while men with the public and culture contexts.

Men and women natural resources' knowledge varies because of their differential roles, access and rights over the resources. Gender is a dynamic concept in which the roles of men and women differ from one culture to another. This social construction has implications for women and men regarding the management of natural resources (Meinzen-Dick, Kovarik, & Quisumbing, 2014). The use of natural resources depends on the characteristics of the ecosystems in which human populations are located, but also on the gender of the user. The knowledge that men and women have about natural resources depends on the rights each group has over those resources. The nature of these rights changes from one place to another, and it might affect the appropriation and maintenance of natural resources. For instance, men (including male children) are frequently the ones having contact with natural resource extraction, as they participate in harvesting activities such as hunting, farming and fishing. On the other hand, women (including female children) usually help with domestic

chores, including the process of cleaning what has been hunt and fished by their husbands. Witkoski (2010) refers to this, when stating that the head of the household, usually a male, is the one in charge of the socialization outside of the house and the one teaching young men traditional harvesting techniques. Meanwhile, domestic and some of the agricultural duties fall on the wive or the daughters. Young females learn the cultural practiques from their mothers. Thus, this is linked to the way local ecological knowledge is transmitted from one generation to the next. Understanding the knowledge, importance, use and motivation that men and women have over the same resource, promotes a holistic understanding of the social, ecological, and economic context, instead of considering only one side of the history, which is consider ambiguous (Meinzen-Dick et al., 2014).

2.1. Gendered Inland fisheries in the Amazon Basin

Alencar (1993) found that in Amazonian fisheries, the role of men and women does not occur in the same spaces and with the same frequency. Fishing is recognized as one of the few productive activities performed usually by a group of men as a means of achieving social cohesion (Witkoski, 2010). Women were traditionally banned from fishing, because it was believed that they gave bad luck to the fishermen (Marques, 2001; N. Smith, 1981; Witkoski, 2010).

> *A menstruating woman is apparently capable of giving a fisherman panema[1] if she touches any of his fishing gear, steps over it, or treads on the scales, bones, or viscera of his catch. The fear of panema is a major reason why women never*

[1] *Panema* is a local term used by hunters and fishers referring concerns about a constant failing in their catching (N. Smith, 1981).

> *accompany men on fishing trips, and it has been acquired at least in part from aboriginal cultures… [A] pregnant women may provoke panema if they eat the catch of a fisherman… Apparently, pregnant wives of neighbors are particularly likely to empanemar a fisherman.* (N. Smith, 1981, pp. 99–100)

Because of *panema* women do not fish. Instead, they stay at home doing domestic chores. Smith (1981) and Witkoski (2010) recognized that the fear of *panema* plays a role in the labor division inside the households. Clearly, it also shapes the rights over the fishery resources by gender. Witkoski (2010) highlighted the importance of women in fisheries: despite the fact that they do not harvest, they sew and fix the fishing gears, clean the fish, and when necessary, they preserve the fish with salt. According to this description, all of women's activities are performed within the domestic space, but they support allows men's fishing activity. Clearly, it is important to study fisheries with a gender perspective since it allow us with the opportunity to determine the allocation of property rights and responsibilities for each group, allowing us to see a "wider" variety of practices for natural resource management (Meinzen-dick, Feldstein, & Quisumbing, 1997).

3. METHODS

This research explores and describes the role of men and women in a riverine community on the Xingu river. The study was designed to better understand the management of fisheries and how men and women engage with the fisheries resources. I approached the research questions from a qualitative, case study approach. A case study is an intensive description and analysis of a single unit, which in this case is Vila Nova. Also, a qualitative approach is

ideal for this study because it facilitates the search for topics that are not well explored in the literature.

3.1. Study area

Vila Nova is a riverine community that was chosen as the study area because fishing is the main socio-economic activity and men and women are both engaged with fisheries. Vila Nova is located on the eastern side of the Xingu River (See figure 1). Like in other sub-basins of the Amazon, the river flow depends on the weather seasonality, with high peaks in June and July and shallow waters in October and November, the so-called dry season (Moran, 1981). The Xingu River is a clear-water river (*agua clara)*, a type of river characterized by poor levels of nutrients, low development of herbaceous plant communities, and high transparencies (Goulding, 1980).

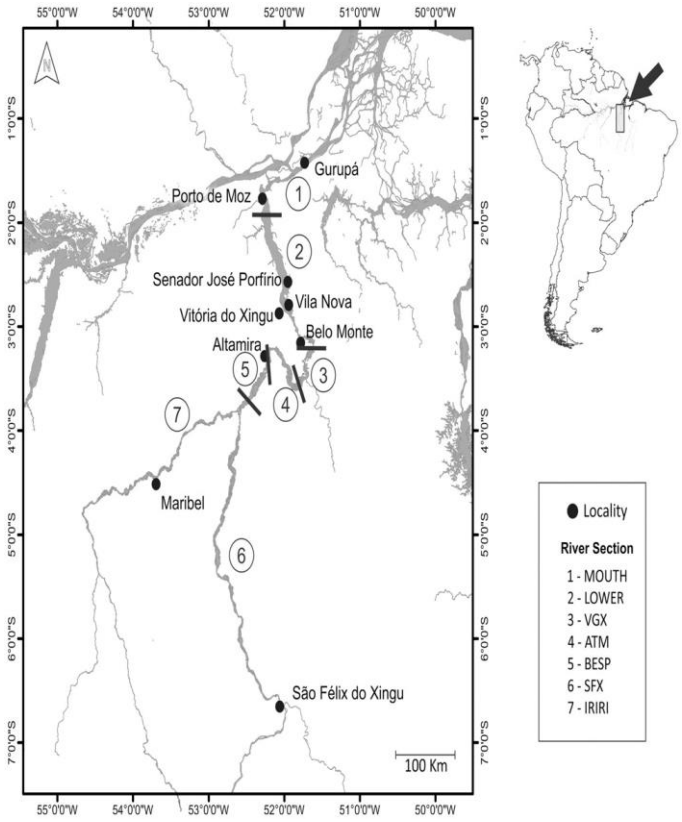

Figure 1. Map of the study area(Isaac, Almeida, Cruz, & Nunez, 2015, p. 127)

Vila Nova belongs to the municipality of Senador José Porfírio. The closest urban center is Vitoria do Xingu, located 12 km North (by river) of Vila Nova. According to health care workers and the school director, there are 156 families in Vila Nova and 752 inhabitants. The inhabitants of Vila Nova are riverine people, usually referred as *Caboclos* in the literature, which is considered a derogatorily and stigmatic term in the region (Brondizio, 2008). Wagley (1953) states that the term *Caboclo* was used when referring to a person of low social status with indigenous physical characteristics.

3.2. Data collection

I conducted the field work during the summer of 2016. Since the beginning of the field work I started the data collection exploring the community and observing the role of men and women in Vila Nova through direct observation. This allowed me to identified fishers who

have been fishing in the region for about ten years or more and to gain context about fisheries and the region.

Following that I conducted 26 in-depth interviews with fishers (interview guide in Appendix 1), of these interviews thirteen were with fisherwomen, twelve with fishermen and one with a married couple of fishers. The interviews lasted between 40-60 minutes. Interviewees were chosen based on their participation in fishing activities, their willingness to participate, and availability. With the permission of the interviewees, I used a voice recorder to record the conversation, and my field assistant and I took notes during each of the interviews.

Additionally, I did fishing trips accompanying two (2) fishermen to their fishing spots, and one (1) fisherwoman to the most frequently visited fishing spots. We navigated the area used by fishers to observe and discuss with them the use and management of their natural resources. I recorded GPS coordinates with a Garmin GPS and took pictures with a GPS-enabled camera Panasonic Lumix. Meanwhile, I recorded field notes in notebook.

Finally, I implemented *participatory mapping* to obtain information about mobility patterns of men and women and their knowledge regarding the resources in those areas. I conducted ten (10) participatory mapping activities with six (6) individual men, three (3) individual women and one (1) additional group of four (4) fisherwomen. Besides exploring the gender differences in fisheries, I also considered the extreme ecological differences between the flood and the dry seasons in the area. Table 1 presents a summary of the data collection methods and its main purposes.

Table 1. Data collection methods

Method	Main purpose	Participants	Records of data collection	Location
In-depth interviews	Explore fishers' livelihoods and knowledge of the fishery resources.	13 fisherwomen 12 fishermen 1 Married couple (both fishers)	Audio recording, field notes, transcription, expanded notes and contact summary sheet	Usually in the interviewee house
Fishing trips	Explore the use and management of natural resources. Visiting the fishing spots with men and women.	2 fishermen 1 fisherwoman and her adult son	Field notes, expanded notes, GPS coordinates and photos	Fishing spots
Participatory Mapping	Explore the fishing spots and areas where fishers have access to withdraw resources	3 fisherwomen 6 fishermen 1 fisherwomen's group	Final maps, field notes, expanded notes	School teacher's house
Observation	Understand the role of fishers, men and women in the community	Daily observation in the river bank of the community and walks through Vila Nova	Field notes, expanded notes	Vila Nova

3.3. Data analysis

The analysis of the information followed an interactive and continuous system composed of: data collection, data condensation, data display and conclusions as proposed by Miles Huberman and Saldaña (2014) . Data analysis was conducted in two phases. The first phase of the analysis was conducted during the field which included a field note writing process.

The second phase was after the field work when my research assistant transcribed verbatim each of the interviews, then I reviewed the transcripts, and compared them to the recordings of each of the interviews. The research codes used for this project were inductive (Appendix 2). They were created during the data collection and the coding process in order to identify emergent themes. Each of the codes was summarized and organized into displays.

4. RESULTS

The aim of this research is to explore the role of men and women in the artisanal fisheries of Vila Nova. I focused my research in understanding the roles of men and women but also the rights to natural resources access and management that they have.

Women and men in Vila Nova are active fishers, with different access and withdrawal rights over fishing resources. From the observation activities and in-depth interviews of fishers in Vila Nova the differences among men and women roles in fisheries appeared. Fishers interact with the ecosystem at different extends based on gendered roles and relations which limit or enhances their access to resources. Those relationships and roles are described in the following sections: Fishing as a way of life in Vila Nova, fishing gender roles, spatial distribution of fishery resources and gender patterns of mobility and different institutions affecting the fishery.

4.1. Fishing as a way of life in Vila Nova

Inhabitants of Vila Nova rely on fishing as their main source of protein and income. Women and men have been engaged with fisheries since their childhood and both are knowledgeable about the local fishery, which is the main socio-economic activity.

Contrary to previous studies in the region, where researchers stated that fishermen are also part-time farmers due to weather seasonality (N. Smith, 1981), fishing is now a full-time occupation for most of the fishers living in Vila Nova. However, this had not always been the case. Like in most of the Amazon region, the rubber industry also influenced Vila Nova society. Rubber was the "basic economic pursuit" in the areas of the Amazon where it was collected (Wagley, 1953, p. 90). Two fisherwomen and two fishermen who were interviewed recognized having extracted rubber from the forest when they started to fish, which implies that fishing was not their only activity. Fishing was aimed for consumption, while with the earnings of rubber they accessed other basic products. In relation to that a fisherwoman stated:

> *We worked like this: He* [her father] *cut the rubber during the dry season, we stayed in the seringal* [forest area with rubber trees*] for hours. At that time we set tin cans under the trees to collect the rubber. During the breaks, we walked to the river to fish. After we clean, cut, salt the fish and cook it in the fire…*- Antonia.

In his book *Amazon Town* (1953), Charles Wagley stated that due to the traditional extraction of natural resources, including rubber extraction, Amazonian communities were allowed to access exported resources, which pulled them away from food production. Wagley (1953) and Moran (1974) mentioned that this behavior comes from the fact that in this region inhabitants based their economy on the extraction of rubber, and historically the rubber barons did not permit rubber tappers to cultivate crops, forcing them into indebtedness to ensure their services. This situation perfectly portrays the current socio-economic context of Vila Nova: fishing became a full-time activity and the main source of income after the

rubber extraction ended. In fact, people do not have crops, except for a couple of houses where they have animal husbandry and house gardens with small plants such as aloe, cilantro, lemon grass, and scallion. But in general, most of the fishers in Vila Nova do not own land to plant crops or raise animals in Vila Nova or other places. Therefore, households depend on markets to access all other goods, except fish.

All of the fishermen interviewed were born in the state of Para. Nine of them were born and raised in Vila Nova, two moved during their childhood, and one fisherman moved in because of his wife: "I am from Senador, "I was living there but I decided to move to Vila Nova because my wife is from here, I decided to live here" –*David.* In the case of fisherwomen, only two out of thirteen were born out of the state of Para. Six were born in Vila Nova and most of the fisherwomen that were not born in the community moved to Vila Nova with their parents during their childhood. All fishers interviewed, women and men, have been fishing in the area for ten years or more. One fisherwoman narrates how she and her family moved in to Vila Nova:

> *My father decided to come and visit one of my uncles who was living here* [in Vila Nova]. *he liked the community because of the fisheries. My father was also a fisher, he fished Pirarucu, Jacare, and big fish, he liked to fish big animals. He liked it here and he decided to move here with two of my brothers and me*…- Maria.

All of the interviewees stated that most of the inhabitants in Vila Nova are fishers. They learned to fish with their parents using artisanal gears such as handlines and as they grew up, they learned to use other fishing gears. Although fishermen during the interviews mentioned having taught their wives how to fish, specifically how to use the gillnets and in fact two of the younger interviewees learned to fish with their husbands with their gillnets.

Within the family men and women could be both active fishers: spouses fish together or separated, but their motivation to fish differs. Women fish for consumption and to support their families. Depending on the quantity of fish that they catch, they might sell some to the intermediaries in the communities. From the observations and interviews it is evident that there is a difference in the frequency of fishing between married and elderly women and women who are head of the household. Fishing is women's means to bring food for their families, and this is mentioned by all of the women during the interviews: if they have fish enough they will be able to sell a small amount of their catch. To portray this situation one fisherwoman who is married explained that "when I fish and I catch enough to sell, I will sell fish. If I sell fish I can buy goods that I need for home"-Flavia.

Furthermore, the two older women that were interviewed have been fishing all of their life and besides find food for their family they also enjoy fishing. One of them explains that she h

Elderly women have been fishing all of their life and find in it a joy, as one of them explains:

> *Since I was 10 I have never stopped fishing, I was raised fishing and it is my routine. They [her children] get mad at me because I say: I want to go to the river and have fun with the fish'*
>
> *- But how are you going to have fun with the fish?*
>
> *- While fishing I am chatting, I fish one day in one place, the other day in another and so on, I have fun…*- Antonia,

On the other hand, men fish because it is the only option they have to support their families. All of the fishermen mentioned that they don't have other socio-economic activities in the

closer region in which they could participate and obtain profit, as it is described by a fisherman“ I fish because it is the only way of living, before there were lots of fish, hence, fishing was the best option to support the family”-Jose. Another fisherman noted that “most of the people from here [Vila Nova] live from fisheries…the activity here is fishing. There is not a sawmill or a place to work. Nowadays fishing is difficult, but we don’t have any other way to survive, we live from the fisheries-Lorenzo.

4.2. Fishing gender roles

Adding to the motivation gender differences, men and women have different roles within the community and specifically in fishing. These includes the fishing gears used, the fishing spots visited, and fishers’ patterns of mobility In Vila Nova fishing is usually a social activity, fishers might fish by themselves or accompanied by a partner. I identified by the observations and interviews at least three modalities in which people fish: 1) Women who fish by themselves or with more women; 2) men who fish by themselves or with other men; 3) and men and women related to each other, who fish together (usually a married couple or a woman with a male son).

Depending on the modality of the fishery, fishers have clearly designated roles associated with gender. Table 2 Displays the gender roles in fisheries in three different stages of the fishery process: a) Pre-harvest, is the stage when fishers prepare gears, boats, capture bait, and prepare food for fishers; b) Harvest, the activities include driving the boat, paddling, using the gear; and c) Post-Harvest, the stage right after fishers arrive to the community, include activities such as fish trading, nets mending, motor fixing, food preparation, and keeping control of accounts.

Table 2. Gender roles in fisheries by stages

		Fisher woman	Fisher man	Fisher women	Fishermen	Men and woman relatives
Pre-harvest	Gear preparation	X	x	x	x	Man
	Boat preparation	X	x	x	x	Man
	Bait capture	X	x	x		
	Food for fishers	X		x		Woman
Harvest	Driving the boat	X	x	x	x	Man
	Fishing	X	x	x	x	Both
Post-harvest	Fish trading	X	x	x	x	Man
	Mending nets		x		x	Man
	Fixing the motor		x		x	Man
	Food for fishers	X		x		Woman
	Keeping accounts		x		x	Man

As was mentioned above, in general, there are clearly designated fishing roles associated with gender in Vila Nova. In one side men are responsible for the preparation and maintenance of gears (specially gillnets) and are usually the ones who trade fish and oversee household' accounts. Rather women are responsible for the preparation of food for fishers (before and after the journey).

While male roles are mostly related to fisheries, women's roles are related with fisheries but also with domestic tasks that includes cooking, cleaning and childcare, among others. Hence, women besides fish also provide full care for the household. The is a difference between women who are married and women who are head of the households. Married women could stay some days of the week at home and not fish because their husbands will provide food for the household. On the other hand, women head of the household cannot afford stay at home, they are full-time fishers and household care providers. A married fisherwoman noted

that situation: “I do not fish everyday because I also have activities at home, I have to clean and organize the house… Now that she is here, [her older daughter] she does the house activities and I go fishing”-Monica.

Most of women and men roles are not transferable within genders. For example, domestic roles performed by women are rarely transferable to men, only male living alone such as widowers carry out domestic activities. For instance, during the interviews four of the fishermen refer to their wives as the ones who have the responsibility to stay at home. Their wives only fish when when them invite them to as explained by a married fisherman,

> *Most of the time I fish alone, but every now and then my wife joins me, I take her to fish with me…We use the hook and line, it is difficult for her to fish with me often because women should stay more in the house*…-David.

In point of fact, both of the younger married women who were interviewed noted that they always fish with their husbands and sometimes with other women who are relatives. For instance, Angela a 26 years old fisherwoman fishes always with her husband but she is also responsible for the task of the household, she illustrated this circumstances in the following quote,

> *Sometimes he* [her husband] *does not want to take me fishing because the fishery is not good, and I usually got headaches…If we do not catch any fish it is a trip that will brings losses. If he, who is a man and arrives to the house tired. Imagine when I arrive to the house with headache, but despite of that I have to clean the house, cook the meals, take care of my children… that’s why some times I prefer to stay at home...* –Angela.

Men, in comparison to women, fish constantly. Most women during pregnancy do not fish, and do not navigate in the river. If they need to fish they will do it in the shore of the Tamandua river, the river where Vila Nova is located by. Seven of the interviewes noted that they do not fish when pregnant, while one of them mentioned fish even during her pregnancy. Besides, not all the women return to fishing as early as others. Somen women because of their traditional role as caregivers do not fish during the first year after giving birth, as explained by Maria a married fisherwoman.

> *When we got married and pregnant of my first son I stopped fishing. I waited until he was a little bit older and I went back fishing… I liked to fish, we went with my husband and my son fishing, he stayed in the canoe until he was 5 or 6 years old, he was raised in the canoe"*-Maria

Added to the above, Fishers in Vila Nova have adapted their fishing strategies to the two main weather seasons of the region: the rainy season or "inverno" and the dry season or "verão" due to fisheries depend on weather seasonality.

The rainy season is the time of the year when everything is flooded; the forest, the islands and even the community. It starts in December when the level of the river starts to increase until May when the water starts to descend. During this time most of the fishermen use their fishing nets to harvest larger fish in the Xingu River such as Filhote and Pescada, and they enter the lakes and the flooded forest to harvest fish with handlines. On the other hand, this is the time of the year when fisherwomen fish in the flooded forest and in the lakes. Most of the women use handlines (to harvest fish such as pescada and piau). Women and the elderly

Table 3. Summary of the fisheries seasonality by the three modalities

Season	Gender	Mobilization	Fishing gear	Main species	Fishing spot (habitat)	Bait
Rainy 'Inverno'	Women	Canoe & Paddle	Hand lines, caniço	Piau	Flooded Forest, Lakes (less than 5 km from Vila Nova)	Tree fruits and seeds. Igapo.
	Men	Motorized canoe, Canoe & Paddle	Gillnet	Pescada, Filhote, Dourada, Curimata, Marapá	Xingu river, lakes	N/A
			Hand lines, caniço	Pacu	Flooded forest, lakes	Tree fruits and seeds
	Spouses	Motorised canoe, Canoe & Paddle	Gillnet	Curimata	Xingu river, lakes	N/A
Dry 'Verão'	Women	Canoe & Paddle	Hand lines, caniço	Piau Traira Cara	River bank	"Piabinha" little fish (river bank), earthworm (quintal); wet farinha
	Men	Motorized canoe, Canoe & Paddle	Gillnet	Cará, Curimatã, Ariru	Xingu river and lakes	N/A
			Hand lines	Ariru, Tucunare	Xingu river bank and lakes	"Piabinha" little fish (river bank),
			Diving	Tucunare	Igarapes, lakes, shore of the tamanua	N/A

Table 3 (cont'd)

Spouses	Most by motorized canoe, Canoe & Paddle	Gillnet	Cará, Curimatã, Ariru	Lakes, igarapes and igapos in the Xingu	N/A
		Hand lines	Pacu Cara	Lakes, igarapes and igapos in the Xingu	"Piabinha" little fish (river bank),
		Diving	Tucunare	Igarapes, lakes, shore of the tamandua	N/A

men, who use handlines, collect seeds and fruits such as Urucurana, Invira and Yahuanari to be used as bait.

The dry season last from June to December. This is the time of the year that they cannot access some fishing spots because the streams to get to those places are dry. During the dry season fishermen harvest fish such as Curimatã and Ariru on the shore of the islands on the Xingu river and they use fishing nets and some of them dive to harvest Tucunare (the fish with the highest economic importance). Fisherwomen, as in the rainy season, use handline and caniço they use *Minhoca* (earthworms), and wet *farinha*[2] as bait.

As a result of the collection of data throught interviews, participatory mapping and fishing trips I will describe in the folowing table how fishing fluctuates throught the year in the three fisheries modalities.

4.2.1. Gears

Fishers stated that they use different types of fishing gear during the year. The use of those depend on the species to catch, the fishing spots, the seasonality, and gender. I will describe the gears used by fishers in Vila Nova based on three of the five categories proposed by Smith (1981): Nets, hooks and projectiles.

4.2.1.1. Nets

Nets are made from synthetic fibers, they are the most common fishing gear used among fishermen. The nets have different uses, length, wide and mesh sizes. Gillnets-*Malhadeiras* are made locally from nylon but most recently, fishers buy the nets in Vitória do Xingu and

[2] Flour made from manioc root, it is a traditional Brazilian side dish

Altamira. This fishing gear could be used during the day and night in different fishing habitats: flooded forest, lakes and rivers. The mesh size depends on the fish species they want to harvest. For small fishes such as Piau and Cara they use gill nets of mesh 7-8, for larger fishes such as Tucunaré and Curimatã they use gillnets of mesh size 50.

When fishing with gillnets, fishers can use the gear as a stationary or as an active strategy. The former refers to a strategy in which fishers place the net quietly in the water, depending on the size of the net, and the position where they are setting the net, they might tie one of both ends to a tree or a pole and then they move away. While waiting sometimes they fish with other gears or wait close to the net. When using this strategy, fishermen can be by themselves, with their wives or with a male partner, usually a family member. Fisherwomen do not use this fishing gear when fishing by themselves or with a female partner.

Two or more fishers are necessary to use gillnets as an active strategy. When fishers arrived at the fishing spot, one of them –if is a married couple will be the woman- rows around the area looking for fish. When they find fishes, the fishermen throw the gillnet encircling the fish and harvest it.

Fisherwomen of Vila Nova stated they do not use fishing nets by themselves due to personal preferences, Tatiana, a fisherwoman head of the household states that she does not use fishing nets because of the strength required when using nets.

> *It requires a lot of work to use fishing nets, I do not know how to fix and sew the fishing nets. I don't know how to sew the holes in the net…that's why I say that is more difficult, I prefer to use handlines* -Tatiana.

4.2.1.2. Hooks

Hooks gears are the most frequently used fishing gear by women and children in Vila Nova through the year. Fishers noted that they use different baits to fish depending on the weather season and the size of hook.

The handlines, a type of hook gear, is locally called "*linhas de mão*" or "*tela".* The handline consists on a hook attached to a nylon line, with a fishing weight to facilitate the sinking of the hook. Normally, the end of the line is moored to a piece of wood. As was mentioned above, most of the fisherwomen in Vila Nova use handlines as their primary fishing gear. Two elderly fishermen mentioned that they also prefer to use handlines because it is an artisanal fishing gear, for instance Juan noted that he is an artisanal fisherman "…mine is an artisanal fishery, I buy the hooks in Altamira because is cheaper than here [Vila Nova] and I use hooks all year…''- Juan.

Besides, handlines fishers also use "caniço" a fishing gear that has a clear nylon line with a hook and a fishing weight on the end, but it is tied to a pole usually made from a branch of a tree, e.g. bamboo tree. This gear is commonly used to catch small fish like Piau.

Fishers use hooks of different sizes that are named by number, when the number decrease the size of the hook increases. For instance, fishers use hook #8 to harvest Tucunaré, a bigger fish, and they use hook #20 to harvest smaller fish.

4.2.1.3. Projectiles

Fishing with projectiles is exclusively a male-dominated activity during the dry season. This activity involves the use of a projectile that is thrown toward the fish. It is performed during the day in the shore of lakes and small rivers. Fishermen in Vila Nova use three types of

projectiles: arrows, tridents and harpoons. The elders use arrows and tridents, while young and adults use harpoons.

Younger fishermen use harpoons when diving- *pesca de mergulho*. This technique is frequently used to harvest larger fishers of economic importance such as the Tucunaré. Fishermen look for fish in shore of the rivers in low and clear water spots. The required equipment is a diving mask and a harpoon. Two of the fishermen mentioned that when diving, fishermen should be accompanied by at least one partner who stays in the canoe. Otto, a 26-year-old married fishermen describes how they use the harpoons,

> *…while swimming we are searching for big fishes, when we find the fish we throw the harpoon to the fish, when we catch the fish we swim to the surface, breath, and then pull a cord that is securing the harpoon…someone should stay in the canoe rowing and following us*-Otto, fisherman.

Table 4. Summary of the fishing gears used by modalities of fisheries in Vila Nova

Fishing gear		**Fisher woman**	**Fisher man**	**Fisher women**	**Fishermen**	**Spouses**
Nets	Gill nets		x		x	
Hooks	Hand lines	x	x	x	x	x
	caniço	x	x	x		x
Projectiles	Arrow		x			
	Diving-Harpoon				x	x

4.3. Spatial distribution of fishery resources and gender patterns of mobility

Fishers of Vila Nova have access to diverse habitats and variety of fish depending on gender. As was described above men and women use different fishing gears that will let them access to different varieties of fish. Added to this, as a result of the in depth interviews, participatory

mapping, fishing trips and observation it is noticeable that men and women access to fish and habitats differs. Vila Nova is located by the Tamandua rivers edge, women fish in the shore of this river while men harvest fish in the Xingu river which is the largest river in the region.

Most of the differences in fishing among men and women are explained by how far they are able to travel and fish. The differences in mobility among men and women include the access to boats and motors and household gender roles (See section 4.2 fishing gender roles).

Most of the fishermen in Vila Nova and all of the fishermen that were interviewed own boats and long tailed outboard motors- *rabeta,* that allows them to travel longer distances. In fact, four of the fisherwomen stated during interviews have bought their motors with money that they received from the government, but their husbands and older sons, who travel longer distances, are the ones who use the motors. For example, in the following quote a 24 married fisherwoman, who just fishes with her husband is waiting for the money of the government subside to buy a new motor and a boat " I am waiting for the money that I receive from the subsidy, I need the money to buy anoter [she is talking about the boat]. The boat is broken, we fixed it but it is not working - Daniela.

Accompanying this situation, fishers also perceive that motors provide them a better option to fish and having a motor is also a symbol of wealth. Julia, who is a divorsed fisherwoman has a boat and a motor mainly used by her male sons, when the motor was broken she had to buy a new one. "When the motor was damaged, I bought a new one for us…we need it to fish… If a fishermen does not have a canoe and a rabeta he is considered poor"-Julia.

Women closeness with the domestic domain is also reflected in the fishing spots (fish habitats) that they visit. During the participatory maps activities women focused most of their attention on the localization of community (Figure 2). Fisherwomen draw Vila Nova in the middle of the map, it fills half of the draw. During the design of the map, women agreed that the five main fishing spots are: Tamandua, Tariri, Guariba, Cacau and the Cajui lake. According to them the later is the fishing spot with the greater number and variety of fishes.

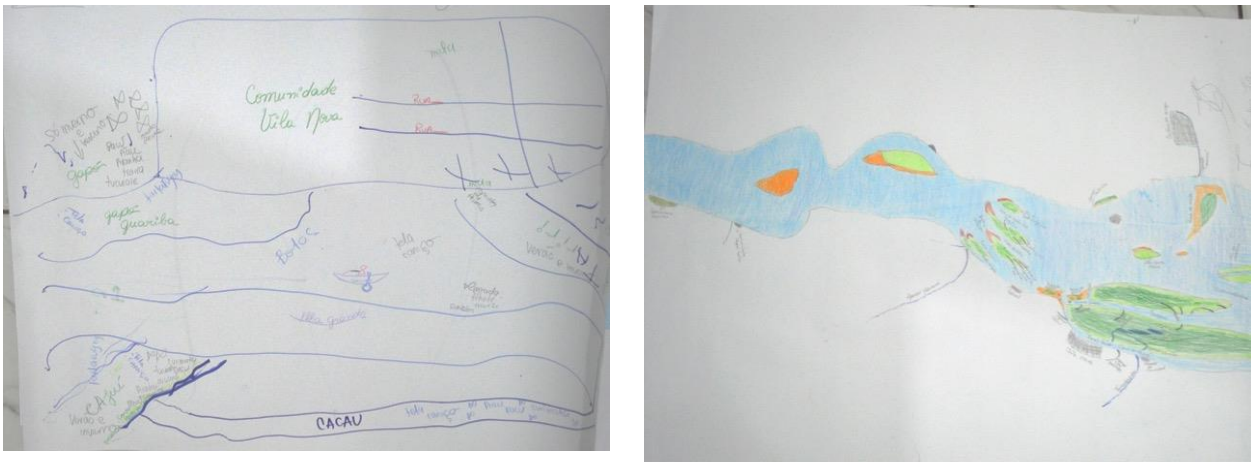

Figure 2. Women's and men's fishing mobility. Left map portrays the women's mobility and right map portrays men's mobility

In contrast to women's maps, where the community was the focus of the draw, in the men's maps the Xingu River was the central item. Thus, men usually draw the fishing spots located along the Xingu river. Two fishermen were so interested in drawing the fishing spots that they decided to use a bigger piece of paper to describe the fishing spots that are located in the area. All fishermen explained that not all the places that they were drawing were used all year long. They ploted a diversity of habitats such as islands, small streams, flooded forest and lakes.

With the information obtained throught the interviews, participatory maps and fishing trips I identified the areas in which fisherwomen, fishermen and spouses fish. There are

differences in physical mobility among fishermen and fisherwomen while fishing. Figure 3. portrays and summarizes the information regarding the patterns of mobility of the three modalities of fisheries in Vila Nova. In the center, closer to the community is the area where women usually fish by themselves or with more women, following is the area where men and women related to each other fish together and in the larger area is where men fish by themselves or with more men.

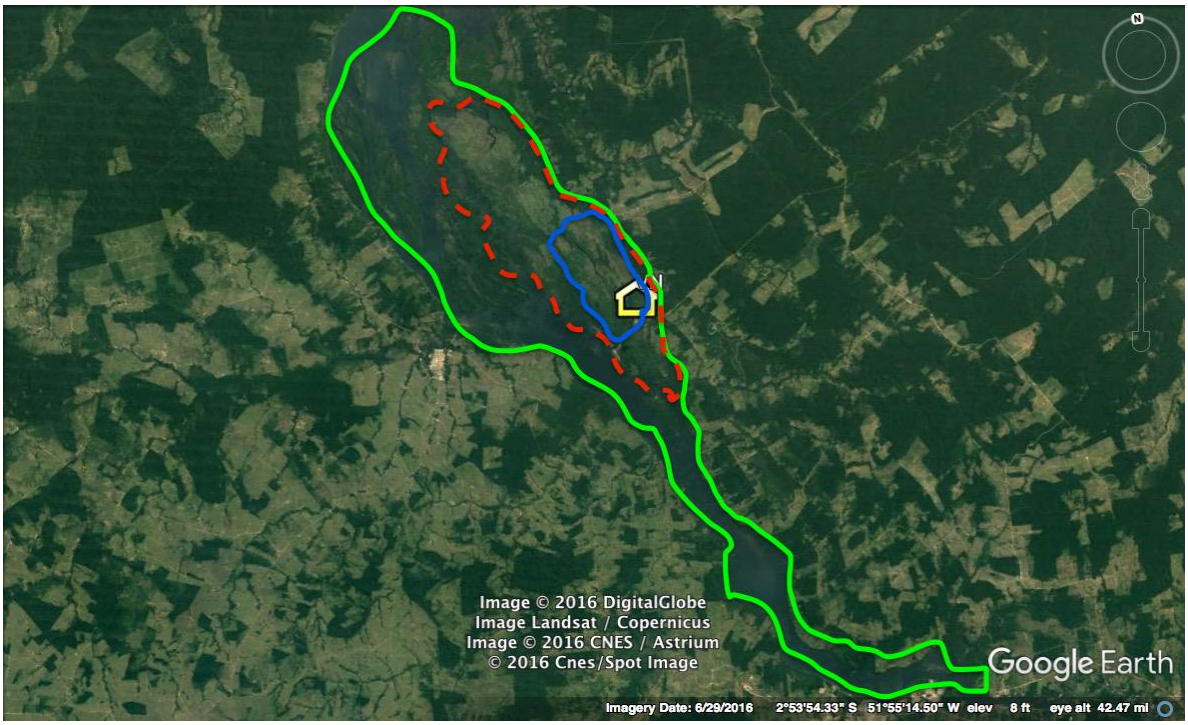

Figure 3. Mobility by fisheries modalities

4.4. Different institutions affecting the fishery

There are different formal and informal institutions affecting the fishery in Vila Nova. In this section I am describing two institutions that were described by the fishers as part of their fisheries: a closed season with a government subsidy and a closed area.

4.4.1. Closed season and the government subsidy: Seguro defeso

During the interviews and informal dialogues with inhabitants of Vila Nova, it is visible that every fisher should have a permit to fish provided by a local fishermen association or Colônia de Pescadores. The permit allows fishers to fish for subsistence and consumption. Fishers from Vila Nova are members of the Colônia de Pescadores Z-12, which is one of the two associations of the Vitória do Xingu municipality. In Vila Nova, a married couple oversees the communication between the Fishermen association and the fishers. The husband is recognized as a fishers' leader who informed me that at least 200 fishers from Vila Nova are registered in the fisher's association. He is an active fisher and an intermediary he shared the process that a fisher should do when obtaining the fishing permit:

> *If someone wants to be part of the fishers' association he should talk with the president. Then, the president will call me, asking for references. Me and other fishers should explain to the fisher who wants to be part of the association, what is the type of fishing that is allowed and where he can fish…Later, the person must ask two fishers to accompany him to the association. They will witness the process, they must ensure that the person who is asking for the permit is a fisher"*
>
> - Jairo, fisherman.

Every fisher who is a member of the fishermen association has to pay a monthly fee to the association and a fee to the National Social Insurance (INSS) to had the right to receive (until 2015) an unemployment subsidy during the closed season. A closed season or fishery closure is a period during fishing for a given species and using a given fishing gear is legally prohibited. All of the fishers in Vila Nova that were interviewed acknowledge the existence of the closed season, a fisherman explains the time and the reason of the closed season in

this quote: “the closed season is from the 15 of November to the 15 of March. During those four months, it is prohibited to fish, we do not fish because it is forbidden. Also, it is the spawning season” –Caio.

In fact, for the state of Para, the closed season lasted four months, which coincided with the rainy season and fish spawning season. During that time fishers were not allowed to use gillnets, but they were able to fish 5kg or less, just for consumption an institution recognized by all of the fishers that were interviewed.

Fishers in Brazil are receiving the unemployment subsidy or the seguro defeso since 1991. In December of that year the Brazilian government decreed a law providing an economic benefit to artisanal fishers during the closed season. Subsistence fishers without any other employment could benefit from this subsidy presenting: their fishers’ registration to the fishermen association (at least a year before the closed season); and their INSS registration (Presidência da República, 2003).

One of the fishermen, noted that the role of women in fisheries has increased in recent years because of the subsidy, he mentioned that for instance his wife was not a fisher until the subsidy was decreed by the government.

> *My wife didn’t use to fish, she was not one of those women who fishes. Maybe it is because I did not like to take her to the river, so she could stay with the children at home…She started to fish when the subsidy began, she needs the permit to obtain the subsidy, she needs to prove that she is fishing, so she must go*-Jairo.

Some fishers identify the subsidy as a fishers’ right, and indeed one of the fisherman stated that the federal government has the responsibility to pay fishers for the months that they cannot do not fish, he states that the subsidy “is a fisherman right, the president created it

20 or 30 years ago, they created that fishermen right… the government is obligated to pay to us for our right"-Juan.

On the other hand, fisherwomen also acknowledge that during the closed season they should follow some rules, but also, they recognize that some fishers from the community do not follow those rules in some fishing areas. One fisherwoman acknowledges during the interview that despite they know the existence of the formal institution they do not follow the rules always:

> *During the closed season, no one trade fish…we harvest the fish that is not forbidden. The fishes that have egg during those months are forbidden to catch, those are Cara, Pescada, Curimata and Pacu. We could fish Tucunare with hooklines because it does not have eggs… It is a crime to fish Curimata during that time, if the IBAMA finds out, that it is complicated, they could confiscate fisher's gillnet and motor… if that happens the person could loss the right of the unemployment subsidies…*
>
> *Despite, during the closed season fishing in the Cajui is forbidden, some people fish there because the IBAMA does not enter, but no one is dumb to fish with gillnet in the Xingu or in the Tamandua*" – Angela, Fisherwoman.

Considering that fishers have received the subsidy for more than ten years, the money that fishers obtained from it became essential for the households. In the case of women the money from this subsidy is used to buy family and fisheries supplies. Priscila a fisherwoman explains the use of the subsidy in fisheries supplies "with the money of the defeso I bought a motor, a boat a fishing net… we need all of that to fish" –Priscila.

During the field work (summer 2016) all fishers, men and women, shared their concern regarding the subsidy. They did not receive it during the last closed season (November 2015-March 2016), therefore they fished with gillnets in all the fishing spots during the spawning season. "Before we fished for consumption [during the closed season] with hook line, we did not use the gillnets, we keep the gillnets. But know as we didn't receive the subsidy we fished with gillnets all year long"-Pedro. Another fisherman also stated "This year we did not get the defeso…everyone went fishing, because we needed to support our families. That money has not arrived, I think is going to be difficult to get that money back…"-Lorenzo.

4.4.2. Closed areas

Added to the closed season there are also two areas that are closed for fishing through the year. One of them is recognized by the fishers and the other is a new sanctuary of the state of Para, unknown by fishers. The first one is an island recognized and respected by fishers as a closed area. This is called *Ilha Tabuleiro*, a turtle spawning island in the Xingu river. This island is protected and controlled by IBAMA (Brazilian Environmental Control Agency) as explained by a local fisherman,

> …*we have to respect the Tabuleiro area, we cannot fish in that beach when the turtles start to arrive. The IBAMA did some meetings with us to inform us that we should be at least 50, 100 meters from the beach. It is forbidden to fish in that area during the year* -Jairo.

Fisherwomen know that they cannot fish in the Tabuleiro island, even though that it is not located in the area where they usually fish. They also recognize that it is forbidden to harvest turtles, but when they are craving to eat turtle they go to the lakes and islands to harvest one.

The second area and unknown closed area, is a wildlife sanctuary created in June 2016 by the State of Para "Tabuleiro do Embaubal", which includes the Tabuleiro Island but also most of the fishing spots used by fishers in this region such as the Cajui lake. All of the fishers identified the Cajui lake as the fishing spot with the highest availability of fish. In other words, the fishing habitat with the highest number of fish species. Nevertheless, none of the fishers mentioned the creation of that sanctuary.

5. DISCUSSION

Men and women in Vila Nova a riverine community from the Brazilian Amazon are fishers. This is an unusual situation in the Amazon Basin were fishing has traditionally been a male-dominated activity (N. Smith, 1981; Wagley, 1953; Witkoski, 2010). Even more, where women have been banned from even touching fishing gear. Fishing for families in Vila Nova is the main socio-economic activity, fishers have been involved in fisheries since their childhood. Children accompany their parents to fish while learning about fish habitats, species, weather seasonality, among other fishery aspects.

Despite men and women participate in fisheries there are some differences in the access that fishers have over the natural resources. First, the fishing motivation is different between men and women. Most fishermen, as household providers, want to generate income to support their families. Fisherwomen found in fishing a way to access food and other resources that help them supporting their families.

Second, because of gender physical mobility differences (Agarwal, 2000; Terry, 2009), men and women access to knowledge and to fish habitats vary. Men could move to areas located further from the community and fish species of high economic importance such as *Filhote* and *Tucunare*. While women stay closer to the community harvesting fish of low economic

importance such as *Piau* or *Cara*, because they have to be back in their homes to do other activities. Men can fish in the areas where women fish, but a woman without a male partner does not fish in an area where men use gillnets. This situation is mainly caused by the fact that men are the ones who use the long tailed outboard motors as a mode of transportation, which allows them to travel longer distances, while most women access to the fishing spots by canoes and paddles.

Third, there are roles associated within genders in Vila Nova. Women and men play multiple roles in fisheries. Male roles are predominantly related with fisheries and women roles are related both with fisheries and the domestic space. Women because of their household responsibilities need be closer to the community than men. Women have to carry out domestic activities whereas fishermen as household providers could travel longer distances looking for fish. This situation reflects the duality among men and women and the traditional association that women have in regards to the domestic and private context, while men with the public and culture context (Ortner, 1974).

This scenery, where women and men are engaged in fisheries but women are also the main caregivers and responsible for providing food to their children is a common situation in small-scale fisheries around the globe (Lentisco & Lee, 2015). Women usually hold at least three main roles: biological, social and economic role (Williams, Hochet-Kibongui, & Nauen, 2005). Likewise, women in Vila Nova hold the biological role of reproduction; the social role of holding the family together and the economic role of contributing income and food to their families.

Added to the above, fisherwomen have some periods of time in their lives when they cannot fish. Most women do not fish during pregnancy, they must stay at home carrying out

domestic chores. Some of them may fish in the shore of the Tamandua river, but do not navigate. Furthermore, some of fisherwomen do not fish during the menstruation days because they fear the river dolphin or Boto. When asking women about the details of the Boto they were not sure about the story, they mentioned that they did not go to the river during menstruation days because that is what their mothers told them to. According to Wagley (1953) the Boto in some traditional groups of the Amazon is the guardian of the underwater world and it has enchanted and "supernatural powers" but also it has sexual associations in the communities. The Boto is attracted by menstruating women, if a woman is menstruating and navigates the river, the Boto will follow her and will try to tip over the canoe, that is the reason because women would not travel by canoe when menstruating (Wagley, 1953).

The role of women as active fishers in the Amazon Basin, like in other regions of the world, has been overlooked and under acknowledged (Weeratunge et al., 2010). This situation could be generated by two main reasons. First, in the Amazon basin fishing is primarily a male activity, therefore there is expanded literature exploring the relation between fishermen and natural resources (Goulding, Smith, & Mahar, 1996; N. Smith, 1981; Witkoski, 2010). The second reason is tied to a cultural taboo; women were supposed to generate bad luck to the fishermen (N. Smith, 1981; Witkoski, 2010). Consequently, the role of women in the capture fisheries has been invisible due to the assumption that the sector is dominated by men (Bennett, 2005; Harper et al., 2013).

Including the knowledge that women have about fisheries in this region provide us a broader perspective of the use of natural resources in the Brazilian Amazon. This case study shows that the natural resources, the spatial distribution and gender are linked, a relationship

already described by other authors in other regions (Siar, 2003). Moreover, it shows that the fish caught by the women is essential for the food security of the household.

Fishers from Vila Nova have different perceptions and knowledge regarding the social and environmental context of the community, and those are based on gender, the extracted resources, fishing spots and age of the fishers. For instance, fisherwoman and elderly fishermen are more familiar with the habitats and ecosystems that are closer to the community, also about the seeds and fruits among other baits that are used to catch the fishes. While, most of the adult fishermen are well-known about the fishing habitats that are further from the community specially in the Xingu river.

Also, elderly fishers exposed their concern about the increase in the number of fishers and gillnets. They are worry about the pressure that this could have in natural resources. While adult fishermen are concerned about the availability of the resources in the area and the loss of the unemployment subsidy. In fact, there is some uncertainty among fishers regarding the termination of the unemployment subsidy. At the beginning of 2017, the decree No. 8.967 of the Brazilian government states that the subsistence fishers will not have access to the unemployment subsidy during the closed season. It means that the fishers from Vila Nova and from other regions of the country will not receive the subsidy. They will fish with gillnets all year long, during fishing spawning season. But also, the money that fishers obtained from the subsidy was used to maintain and buy fishing equipment and support the families.

In the same way, there are inhabitants of the community that were not fishers that also received the subsidy. As was presented in the result section some of the fishermen states that their wives began to fish when the subsidy was launched. This subsidy was working as

a perverse incentive, which is the result of a policy stated by the central authorities. Further research should explore this situation more deeply.

The research also exposes the lack of effectiveness of the closed areas and seasons. Fishers still fish in the areas where it is prohibited by the law. This is caused by the following reasons. First, most of the closed areas and seasons are top-down decision that was made without considering the participation of local actors in the process of decision making. Fishers acknowledged that they cannot fish in some areas where the IBAMA is constantly monitoring, fishers do not fish in those areas because they were worried about losing the unemployment subsidy and or getting their fishing gears confiscated by IBAMA. Also, they recognized that they use gillnets and fish turtles during the closed season in areas where there is not monitoring

6. FINAL REMARKS

The results of this study demonstrate that men and women in a riverine community in the Xingu river participate actively in fisheries. Despite men and women are both involved in fisheries, the gender roles in Vila Nova are consistent with the traditional Amazonian household roles. Women and young females besides fish also oversee the domestic space which constrain their fishing physical mobility. Whereas men' main role is fishing, they are the household providers, their physical mobility constrains are related to the seasonality, fishing gear and their boats including their motors. Indeed, most of the differences of men' and women' knowledge and perspectives about fisheries resources are mainly caused by patterns of mobility.

This research also confirms the lack of compliance with the central government institutions in the region. Fishers do not fish with gillnets during the closed season in the areas that they

recognize as continually monitored by the IBAMA but they use the gillnets in non-monitored fishing spots. Added to this, there is a new state wildlife sanctuary which contains most of the fishing spots used by Vila Nova fishers but there has been no reference during the field work about these. This situation reveals that when designing successful policies, the knowledge, roles and perspectives of men and women fishers in the region should be considered.

Future research should explore what are the implications in fishers and fishery resources in this region caused by the termination of the unemployment subsidy during the closed season.

CHAPTER 2 DOWNSTREAM FISHERS AND THE IMPACTS GENERATED BY THE BELO MONTE HYDROELECTRIC COMPLEX

1. INTRODUCTION

The increasing demand for energy generated by the continued growth of human population and economic development has resulted in a growing use of fossil fuels and emissions of greenhouse gases that have now reaching unprecedented levels (Arvizu et al., 2011). In order to reduce the dependence on fossil fuels and to reduce greenhouse gas emissions, countries have begun to promote a transition toward renewable energy sources such as hydropower (Yüksel, 2010). Hydropower provides 16.3% of the electricity in the world and currently generates the largest quantity of renewable energy (IEA, 2015). It is an appealing energy generation option because it has low life-cycle costs (IEA, 2012); it appears to create economic opportunities; and addresses climate change concerns by reducing emissions of greenhouse gases (REN21, 2015). Therefore, this technology offers an alternative source to fossil fuels (Oud, 2002), and it is gaining ground in many nations in the Southern Hemisphere (Abril et al., 2005; Fearnside, 1995).

Globally, hydropower is the largest source of renewable energy (IEA, 2012). Brazil is the second country after China in terms of developed hydropower capacity (IHA, 2015; REN21, 2015). The Belo Monte hydroelectric complex, located in the Brazilian Amazon, has been a priority of the country for more than 20 years (Fearnside, 2006; Sousa Junior & Reid, 2010; Sousa Júnior, Leitão, & Reid, 2006) and because of its size and socioecological impacts has generated a lot of controversy (Fearnside, 2006). The construction of the Belo Monte complex was approved in 2010 and construction began in 2011 (Fleury & Almeida, 2013). The reservoir was filled in February of 2016, and the first turbines started to operate in April of 2016. The construction will be complete in 2019, when all 24 turbines are operational

when it will generate an expected 11 GW of energy per hour—making it the third largest hydroelectric dam in the world,, behind the Three Gorges Dam in China and the Itaipu Dam located at the border of Brazil and Paraguay (von Sperling, 2012).

The benefits of dams—largely renewable energy—are offset by negative impacts in social and ecological terms, among them: displacement of human populations (Fearnside, 1999; IPCC, 2014; Junk & Mello, 1990; Trussart, Messier, Roquet, & Aki, 2002; von Sperling, 2012), blocking fish migrations (Baran & Myschowoda, 2009; IPCC, 2014; Orr, Pittock, Chapagain, & Dumaresq, 2012; Trussart et al., 2002; von Sperling, 2012), and deforestation (Alho, Reis, & Aquino, 2015; Fearnside, 2015; Hallwass, Lopes, Juras, & Silvano, 2013; Winemiller et al., 2016). Countries like Brazil with vast hydropower potential find it alluring to invest in hydropower dams.

Brazil has the largest electricity sector in South America and the third largest in the Americas after United States and Canada (EIA, 2015). Hydropower in Brazil is the main source of energy, generating more than 65.2% of the country's power supply (EIA, 2015). The Amazon region has the highest hydropower potential in the country (IHA, 2015), and therefore it is the focus of new dam construction projects since the south of the country's hydropower potential has already been tapped (Sousa Júnior et al., 2006). Today in the Amazon Basin (which includes not only Brazil but also Peru, Bolivia, Colombia, Ecuador, Venezuela, Guyana and Suriname), 334 dams are in the planning stage (Winemiller et al., 2016), 84 of them in the Brazilian Amazon (Zarfl, Lumsdon, Berlekamp, Tydecks, & Tockner, 2014). Hydroelectric dams are located in areas far from the majority of urban consumers who will get most of the energy produced, (Siciliano, Urban, Kim, & Lonn, 2015) supporting the criticism that the

energy generated by hydroelectric dams is not used in the areas where it is produced (Stenberg, 2006).

One serious concern about dams is their potential impact on biodiversity. The Amazon Basin is one of the most biodiverse river basins in the world. According to Winemiller et al., (2016), the basin has 2320 fish species of which 1488 are endemic. It is not surprising then that fishing is the most important subsistence activity for Amazonian communities. Fishing guarantees families' livelihoods and it has been the main source of animal protein in the region (Bayley & Petrere, 1986; McGrath, de Castro, Futemma, & Domingues de Amaral, Benedit Calabria, 1993; Silvano, Juras, & Begossi, 2005).

The World Commission on Dams (WCD) states that the consequences of dams for downstream communities come only after the completion of the dam (WCD, 2000). However social impacts reported in the literature —such as resettlement of populations—occur prior to dam construction (Fearnside, 1999; Junk & Mello, 1990; Trussart et al., 2002; von Sperling, 2012). In Brazil, riverine populations living downstream from the dam are often not considered as "directly affected" by builders of hydroelectric projects, and because of that they are not included in the consultation process prior to the dam construction nor compensated for negative impacts. In the particular case of the Belo Monte Hydroelectric Complex, fishers were not included in the environmental assessment generated for the construction and operation of the dam (De Francesco & Carneiro, 2015), nor did they receive compensation for their lost fishing livelihoods.

To the best of my knowledge, not many studies have looked at the social impacts of the environmental changes perceived by fishing communities living downstream from a dam.

This study aims to fill this gap by studying the impacts generated by the Belo Monte Hydroelectric Complex in the lives of fishers in Vila Nova—one community downstream from Belo Monte. Fishers in Vila Nova are representative of the experience of downstream communities: it is estimated that more than 472 million people are negatively affected by living downstream of large dams around the globe (Richter et al., 2010).

The study takes places in Vila Nova, a downstream community of the Xingu river with one characteristic that will receive special attention in this thesis: fishing is done both by women and men. This situation is very unusual for the Amazon basin since fishing has typically been a male activity, and women were traditionally banned from it (Marques, 2001; N. Smith, 1981; Wagley, 1953; Witkoski, 2010). Studying a community where women and men are engaged in fishing offers a wider view of the impacts generated by the dam since management of fisheries resources is strongly linked to gender (Cavendish, 2000). Men and women may have different perspectives about the hydroelectric dam and its impacts on their fishery and livelihoods. It is also an opportunity to explore the reasons that may have led to the breakdown of a traditional taboo and a radical change in the division of labor.

In this chapter, I am exploring how fishing activity has changed in Vila Nova with the construction of the hydroelectric complex. By addressing this issue, I seek to understand and describe the social and ecological characteristics of fisheries before and during the construction of the dam, and secondly to understand the differences in the perception of the changes generated by the construction of the hydroelectric complex by fishers. I will address this question by investigating the perceptions of women and men fishers in the community.

This chapter is organized into the following sections. Section 2 is a literature review including an overview of the social and ecological impacts generated by hydroelectric dams worldwide in fisheries and in local communities, an overview of fishers and Local Ecological Knowledge and a background on the Belo Monte Hydroelectric Complex. This is followed by the methods section (3), results (4) and discussion of the results (5).

2. LITERATURE REVIEW

2.1. Hydropower and dams

According to the International Energy Agency (IEA) the construction of dams and their reservoirs provides the flexibility to generate energy on demand since large reservoirs can retain months or years of average water inflows (IEA, 2012). Hydroelectric projects are an alternative energy source to fossil fuels (WBG, 2009). They supply energy to people who lack access (REN21, 2015), they generate jobs, they may generate road and infrastructure improvements during construction(Koch, 2002), and they can reduce seasonal flooding (IPCC, 2014). However, they also generate negative socio-ecological impacts (IPCC, 2014). For instance, hydropower projects in general tend to overestimate the economic benefits for society and underestimate the cost of the construction (Winemiller et al., 2016).

The main negative ecological impacts caused by hydroelectric dams are related to the changes in the geomorphology of the rivers (Stenberg, 2006) causing obstacles in river navigation and to migratory species of fish (Baran & Myschowoda, 2009; IPCC, 2014; Orr et al., 2012; Trussart et al., 2002). Therefore, hydroelectric dams generate changes in flora and fauna, in habitats and can bring about losses in biological diversity (Stenberg, 2006; Trussart et al., 2002) and can increase the rate of landscape fragmentation (Alho, 2011). In addition, they cause reservoir sedimentation and loss of soils downstream that can negatively affect

agriculture along river banks (Junk & Mello, 1990), and they affect water quality and hydrological regimes (IPCC, 2014; Trussart et al., 2002). They also foster an increase in the rate of deforestation during construction (Fearnside, 2015). Specifically in fishing, the main impact generated by hydroelectric dams is the reduction of fish production (Baran & Myschowoda, 2009; Orr et al., 2012) because dams block fish migration routes (Baran & Myschowoda, 2009; Stenberg, 2006).

Hydroelectric dams also generate many socioeconomic problems. For instance, hydroelectric dams displace human populations during the construction period, and communities seldom are resettled in ways that improve their livelihoods (IPCC, 2014; Junk & Mello, 1990; Trussart et al., 2002; von Sperling, 2012). Furthermore, high migration during the construction phase from other regions to the project area increases the risk of disease, criminality, drugs and prostitution (von Sperling, 2012) and also increases the occurrence of water-borne disease transmission, particularly in tropical environments (Koch, 2002; Trussart et al., 2002). Table 5 presents a summary of the main socioeconomic and ecological impacts reported in the literature generated by large-scale dams.

Table 5. Main socioeconomic and ecological impacts of dams

Main socio-economic and ecological impacts of large-scale hydroelectric dams reported in the literature			
	Positive	**Negative**	**References**
Increase in human migration		X	(von Sperling, 2012)(von Sperling, 2012)
Increase in criminality, drugs, prostitution		X	(von Sperling, 2012)
Increase of teenage pregnancy		X	(von Sperling, 2012)
Increase in disease transmission		X	(Fearnside, 1999; Grisotti, 2016; Koch, 2002; Soito & Freitas, 2011; Trussart et al., 2002; von Sperling, 2012; WCD, 2000)

Table 5 (cont'd)

	Positive	Negative	References
Population resettlement with little consultation		X	(Boanada Fuchs, 2016)
Generates job opportunities	X		(Arvizu et al., 2011; Koch, 2002; von Sperling, 2012; WCD, 2000)
Low operating and maintenance cost	X		(IHA, 2003)
Loss of social cohesion		X	(WCD, 2000)
Supply energy to people who lack access	X		(REN21, 2015)
Improve roads and infrastructure	X		(Koch, 2002)
Poor sanitation and water quality during construction		X	(Grisotti, 2016)
Increasing cost for electricity		X	(Tilt, Braun, & He, 2009)
Supply water for irrigation	X		(IHA, 2003; Yüksel, 2009, 2010)
Enhance water quality	X		(von Sperling, 2012)
Generates "clean energy"	X		(Bartle, 2002)
Produces greenhouse gases		X	(Abril et al., 2005; Fearnside, 1995)
Reduces CO_2 emission in comparison with fossil fuels	X		(Arvizu et al., 2011; von Sperling, 2012)
Loss of biodiversity		X	(Stenberg, 2006; Trussart et al., 2002)
Depletion of forest resources		X	(Tilt et al., 2009)
Reduce seasonal flooding	X	X	(IPCC, 2014)
Change in river geomorphology		X	(Stenberg, 2006)
Decline in agricultural productivity and animal husbandry		X	(Tilt et al., 2009)

2.2. Socio-ecological impacts generated by hydroelectric dams on fisheries

Hydroelectric dams affect the inhabitants who live in areas where the infrastructure is built (Richter et al., 2010). Two years after the construction of the Tucuruí dam, located in the Lower Tocantins River in Brazil and the first big dam in the Brazilian Amazon, a study found

that the quantity of captured fish downstream of the dam was three times smaller than the quantity of fish captured before the dam was constructed (Fearnside, 1999). According to the WCD, after the damming, 11 species of fish were no longer in the area (WCD, 2000).

Reduction in fish populations might be caused by the change that the construction of dams generated in the geomorphology of the river, the alteration of the flooded forest, increases in rates of deforestation, and habitat fragmentation among other impacts reported in the literature (see table 6). The construction of dams in rivers generates a change from a lotic to a lentic system, a lotic system is a freshwater habitat with slow water movement, contrary to a lentic system which is a fresh water habitat with rapid water movement. This change cause a decrease in the quantity of dissolved oxygen and therefore reduces fish populations (Agostinho, Pelicice, & Gomes, 2008; Fearnside, 2014). For instance, the Tucuruí hydroelectric dam caused high fish mortality and generated social-ecological impacts associated with the changes in the river flow levels. It caused fish mortality because of the low water level in wetlands, lagoons and channels. In addition, it caused loss of natural ecosystems such as the flooded forest, a sensitive ecosystem that is underwater several months a year but is now underwater the whole year following dam construction (Manyari & de Carvalho, 2007). The dam construction also generates changes in the diet of the population since fish is traditionally the mainstay of the diet, (Agostinho et al., 2008; Fearnside, 2014, 2016; Stenberg, 2006).

Table 6. Socio-ecological and economic impacts of hydroelectric dams on fisheries

Socio-ecological and economic impacts of large-scale hydroelectric dams on fisheries			
	Positive	Negative	References
Generates obstacles in river navigation		X	(Baran & Myschowoda, 2009; IPCC, 2014; Orr et al., 2012; Trussart et al., 2002)
Change in river geomorphology		X	(Stenberg, 2006)
Alter hydrological regimes		X	(Cleber J.R. Alho, 2011; IPCC, 2014; Trussart et al., 2002; Yüksel, 2010)
Increases the rates of deforestation		X	(Cleber J R Alho et al., 2015; Fearnside, 2015; Hallwass et al., 2013; Winemiller et al., 2016)
Increases habitat fragmentation		X	(Cleber J.R. Alho, 2011)
Reduction in dissolved oxygen		X	(Agostinho et al., 2008; Cleber J.R. Alho, 2011; Fearnside, 2014)
Loss of biodiversity		X	(Stenberg, 2006; Trussart et al., 2002)
Reduces water quality in the reservoir by increasing eutrophication		X	(Fan, He, & Wang, 2015)
Blocks fish migration		X	(Baran & Myschowoda, 2009; IPCC, 2014; Orr et al., 2012; Trussart et al., 2002; von Sperling, 2012)
Reduces fish production		X	(Baran & Myschowoda, 2009; Orr et al., 2012)
Reduction of primary productivity)		X	(Cleber J.R. Alho, 2011)
Changes in the diet of population		X	(Agostinho et al., 2008; Fearnside, 2014, 2016; Stenberg, 2006)
Loss and alteration of flooded forest		X	(Fearnside, 2016; Manyari & de Carvalho, 2007; von Sperling, 2012)
Increase fish mortalities when fish pass below the dam (turbines)		X	(Zhong & Power, 1996)

2.3. Perspectives of Local Actors on The Impacts of Dams on Fisheries

Research has shown that community members and institutional actors such as decision-makers and workers of governmental offices have different perceptions of the impacts generated by large-scale projects. In Cambodia, community members and institutional actors were interviewed for a comparison of their perceptions on the social and environmental impacts caused by large dam construction. Through interviews and ranking methods Siciliano et al. (2015) found that government officials gave priority to positive economic and environmental impacts at national or regional scales whereas community members prioritize socioeconomic cost to the affected communities and destruction of the environment around the dam. The local actors perceived changes in their livelihoods because of the loss of crop areas from the flooding of the reservoirs and the decrease in firewood resources. In addition, they specify that they did not get any compensation for these damages. The government officials also identified changes in people's livelihoods associated with change in the access to natural resources, the impacts on biodiversity, the decline in tourism in the area, and lack of mitigation strategies. The authors of this research show that one of the main impacts mentioned by local actors was the lack of consultation with local communities and lack of implementation of mitigation strategies by the construction company (Siciliano et al., 2015).

Amazon rainforest researchers report that fisheries and fishers have not been addressed "in previous impact assessments and scientific surveys related to river impoundments in the Brazilian Amazon" (Silvano et al., 2005, p. 145). Some attempts have been conducted in the Tucurui dam, where 22 years after the construction of the dam fishers were interviewed to understand their perception about it. The study shows that according to fishermen, the main

environmental changes after the construction of the dam were an overall decrease in fish abundance, deterioration of water quality, changes in water levels, (information supported by biological sampling), and also that fish were trapped above the dam (Hallwass et al., 2013). That study supports the importance of including local knowledge to understand the changes of a large-sale project.

2.3.1. Fishers and Local Ecological Knowledge (LEK)

The understanding of locals about their natural context enriches the knowledge that scholars and policy makers have about natural resources and facilitates a dialogue between different stakeholders (Bach Dang & Momtaz, 2015; Brook & McLachlan, 2008; Gaspare, Bryceson, & Kulindwa, 2015; Johannes & Neis, 2007; Ram Silvano & Begossi, 2012; Tengö, Brondizio, Elmqvist, Malmer, & Spierenburg, 2014). For this reason, it is becoming increasingly common to include local ecological knowledge into climate change adaptation (Leonard, Parsons, Olawsky, & Kofod, 2013); forest conservation (Charnley, Fischer, & Jones, 2007); risk management (Failing, Gregory, & Harstone, 2007); agricultural, horticultural, fisheries systems; and fisheries management (Begossi, 2015).

Local ecological knowledge (LEK) goes beyond traditional ecological knowledge (TEK), or indigenous ecological knowledge (IEK) since it "includes the knowledge local people have of nature: their perceptions, classifications, and understanding of ecological dynamics and functions (ethno-ecology), as well as their beliefs" (Begossi, 2015, p. 7). Similarity, TEK is defined as a "cumulative body of knowledge, practice and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment" (Berkes, 2008, p. 7).

Fishers' local ecological knowledge is passed from generation to generation and from other fishers with whom they have fished with in the past (Johannes et al., 2000). The knowledge that individuals have differs because of experiences, age, class, occupation and is also influenced by power dynamics (Kelkar, 2007). Gender is one of the most important factors that produces different locations for knowledge construction (Haraway, 1991). In the case of natural resources men and women use the resources according to their assigned roles in different ways (Agarwal, 1997; Bechtel, 2010; Cavendish, 2000; Sunderland et al., 2014) Therefore, not only may their knowledge, practices and management of the fishery differ, but also their perceptions, attitudes, behavior pattern, priorities, concerns, opportunities and needs.

Begossi (2008) recognized four dimensions of local knowledge in fishery management:1. Use of resource units; 2. Use of resource system (for inland fisheries: lakes, rivers, igarapes, etc.); 3. Fisher behavior; and 4. Fishers' knowledge about biology and ecology of species. Fishers' LEK includes knowledge of aspects such as habitats, species, migration, and stock structure (Thornton & Scheer, 2012).

To my knowledge, no other study has looked at differences in the Amazon basin of fishers' local ecological knowledge based on gender. Considering this, having a gender perspective provides us with the opportunity to see a "wider" variety of natural resource management techniques (Meinzen-dick et al., 1997) and environmental and social changes perceived by locals.

Gender is a critical variable when exploring environmental change (Banerjee & Bell, 2007) since men and women have different perceptions due to their gender roles which affects their perceptions of changes. Aspects such as the gender division of labor, physical mobility

and household-community decision making could increase men and women's vulnerability to changes (Terry, 2009).

Women are more vulnerable to environmental changes particularly because of their "relatively" limited access to natural resources (Terry, 2009). For example, Agarwal (1992) discusses how women in rural households in India are victims of environmental degradation in gender-specific ways based on their class, race, ecological zone, and caste. The same author points out that when managing common pool resources, the distribution of benefits in a community are usually distributed to the heads of the households, so despite the fact that women participate in and are members of the institution, only men receive the benefits (Agarwal, 2000).

Understanding the knowledge and the perceptions of social and environmental change of men and women and where these interact will provide a better comprehension of the impacts generated by the Belo Monte Hydroelectric Complex. Men and women might be affected in different aspects and to different extents. Some approaches recognize that men and women may be disadvantaged by social and economic structures. Depending on the social, economic, political and even environmental context, men and women have some advantages or disadvantages. History has shown that women are more oppressed than men, but there are some instances when men are equally oppressed. They are vulnerable in different aspects (Terry, 2009), but both are vulnerable.

The negative impacts of large-scale development disproportionately burdens the rural poor, but also creates stronger pressures on women compared to men (Y. A. Braun, 2011; Tilt et al., 2009). This is because women, when compared to men, have unequal rights and access

to land and other resources, are poorly protected by the law against domestic violence, lack access to education and employment opportunities (Adams, 2009; Barry, 1997).

A survey that was conducted in the upper Mekong river in China by the World Bank in 1994 showed that when communities are resettled because of dam construction, the effects vary by gender (Tilt et al., 2009). The authors argue that one of the explanations is that the money provided by the compensation company is usually given to the male head of the household. Another impact identified by the study is that because men have found wage jobs outside the communities, women have become responsible for agriculture which used to typically be men's responsibility in that region. The Lesotho Highlands Water Project has also generated negative impacts on women including socio-ecological impacts such as an increase in workloads, less access to resources and compensation benefits, among others (Y. Braun, 2005).

2.4. Background of Belo Monte Hydroelectric Complex

The Belo Monte Hydroelectric Complex is located in the Amazon region of Brazil in the Volta Grande (Big Bend) of the Xingu river in the State of Pará (Figure 4). The hydroelectric complex occupies sectors of the municipalities of Altamira, Vitória do Xingu, Senador José Porfírio and Brasil Novo. Its construction began in 2011 (Boanada Fuchs, 2015), and the 516 square kilometer reservoir was filled in February 2016. The dam is expected to have 18 turbines in operation at the main power house at Belo Monte and six turbines at the secondary power house at Pimental by 2019. When the construction is complete and all the turbines are working, it will generate more than 11 GW of energy per hour (Boanada Fuchs, 2015). Many believe the amount will be just 38% of the 11GW installed capacity (Stickler et al., 2013).

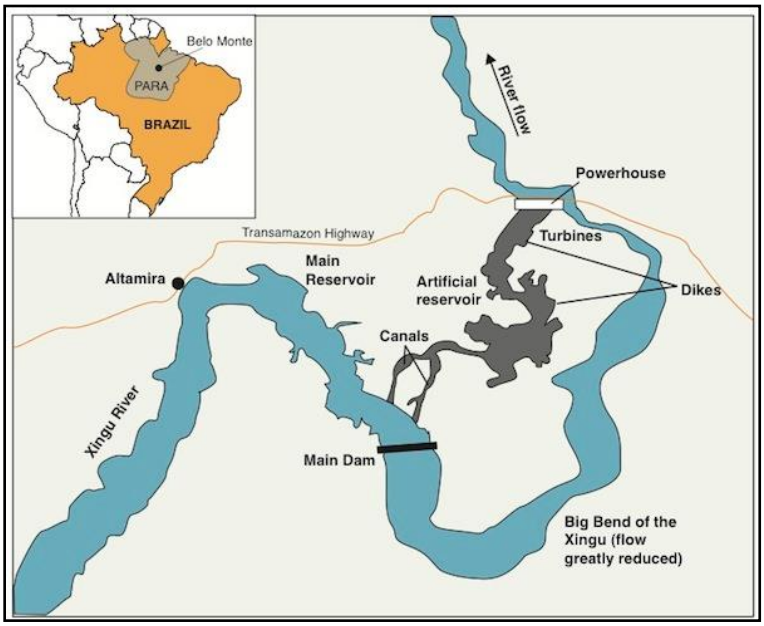

Figure 4. Map of the lo Monte Hydroelectric complex

The Belo Monte Hydroelectric Complex has been a priority of Brazil for many years (Fearnside, 2006; Sousa Junior & Reid, 2010; Sousa Júnior et al., 2006) and has been the object of immense controversy (Fearnside, 2006, p. 16). According to Stickler et al. (2013) this controversy was because of the dam's predicted impacts on the inhabitants of the region, the restriction of river discharge during the annual dry season, and the high economic cost.

2.4.1. Timeline of the Belo Monte Hydroelectric Complex

The Belo Monte Hydroelectric Complex planning dates to the 1970s during the military dictatorship when the government established the Amazon region as one of the priorities for the development of hydropower in the country. In 1973, the electrical government company of the North of Brazil (Eletronorte- a subsidiary of Electrobrás[3]) was created. The creation of this state-owned subsidiary shows the expansion of the electricity sector in Brazil both in the geographical and installed capacity cover (Boanada Fuchs, 2015).

[3] It is the biggest company of the electric power sector in Latin America. According to (Goulding et al., 1996) Electrobrás is a government monopoly that controls all major power resources in Brazil.

In 1975, the hydroelectric inventory for the Xingu Basin began. The study proposed the construction of five dams on the Xingu river and one on the Iriri River for optimal exploitation of the Xingu Basin. Then in 1987, Centrais Elétricas Brasileiras (Electrobrás) produced the *Plan 2010*, a national program that provided information about the dams that were expected to be constructed by 2010 (Fearnside, 2006). The plan recommended the construction of 165 hydroelectric dams all over the country of which 40 were proposed for the Amazon region (Fernandes, 2016). The plan concluded that the Belo Monte Hydroelectric Complex was the best option to begin the integration of the Xingu river into the National System of Integration (SIN- Sistema Interligado Brasileiro) (Fainguelernt, 2016; Fernandes, 2016).

In 1986, the Xingu Basin Hydroelectric Inventory was presented and published. At the time, the participation of indigenous groups and social movements increased, drawing the attention of international forums in which the construction of dams in the Xingu Basin were discussed (Fernandes, 2016). Then in 1988, the Brazilian Water and Electricity Department (DNAEE), approved the final inventory for the Xingu Basin, but the construction of the hydroelectric complex was declared unfeasible because the project impacted indigenous territories (Fainguelernt, 2016). However, according to Boanada-Fuchs (2015) the project was also stopped due to an electricity sector debt crisis, hyperinflation and an external debt crisis that led to government challenges in the access to loans,, and the introduction of environmental licensing and social participation requirements associated with the new constitution of Brazil in 1988.

In February of 1989 the first Summit of Indigenous Communities of the Xingu river, Encontro dos Povos Indígenas do Xingu, took place in Altamira. The goal of the indigenous

communities was to protest the construction of the hydroelectric complex in the Xingu river. About 3000 people gathered at the meeting including indigenous leaders and representatives of Eletronorte and the Brazilian government (Fleury & Almeida, 2013). The meeting provided the opportunity to discuss one of the first controversies of Belo Monte. Prior to this meeting, Electronorte named the proposed hydroelectric dam Kararaô which is a Kaiapó[4] war cry. That was considered an aggression by the indigenous people. During the Summit it was decided that from that point on, no hydropower project in Brazil would be named using an indigenous word (Fleury & Almeida, 2013).

It was not until 1998, during the privatization of the electricity sector in Brazil, that Electrobrás and Electronorte requested an authorization from the National Agency of Electricity (Aneel) to conduct a new viability assessment for the Belo Monte Hydroelectric Complex (Electrobrás et al., 2009). In 2001, Eletronorte presented a new proposal for the construction of the hydroelectric complex. That proposal included changes in the construction such as moving the dam from the indigenous territories to the Big Bend (Volta Grande) of the Xingu, as well as to use new technology that leverages the natural flow of the river to power the turbines, thereby reducing the size of the needed reservoir (Moran, 2016). In 2001, Brazil suffered an energy crisis due to blackouts across the country due to reduced rainfall and insufficient hydropower generation. The country was under the mandate of president Fernando Henrique Cardoso (1995-2002) whom, with the help of the National Council for Energy Policies, created a workgroup called Grupo de Trabalho (GT) to study the planning and implementation of the Belo Monte Hydroelectric Complex (Fleury & Almeida,

[4] Brazilian indigenous group from the North region

2013). GT concluded that Belo Monte Dam was a strategic project to raise the energy supply in Brazil, and it would also aid Amazonian development (Fleury & Almeida, 2013).

In 2005, during the presidency of Luís Inácio "Lula" da Silva (2003-2010), the Brazilian National Congress authorized Electrobrás to complete and update the viability assessment for the Belo Monte Hydroelectric Complex (Electrobrás et al., 2009). Mr. da Silva also launched a campaign to highlight the role of Amazonia in Brazilian development (Fainguelernt, 2016).

In 2010, an environmental license for the construction of the dam was issued by IBAMA (Brazilian Environmental Control Agency). According to Sousa Júnior and Reid (2010), this licensing process is still controversial due to the lack of consultation with inhabitants of the region and because the environmental impacts were underestimated. Despite that, the provisional environmental license was approved in 2010, and the construction of the Belo Monte Hydroelectric Complex began in 2011. Since then, the environmental license has been suspended multiple times by Federal Judges only to be reinstated soon after.

By 2010, the federal government organized a bidding process that was obtained by a consortium formed by Brazilian private and public companies called Norte Energia (NESA). This consortium has the "concession for the exploitation of the "public good' (water) for thirty-five years" (Boanada Fuchs, 2015, p. 311). In 2016, the hydroelectric complex was inaugurated by then President Dilma Rousseff (2011-2016). By that, time the activation of two turbines began in March 2016. In January 2017, the ANEEL authorized the commercial activation of a fourth turbine in the Belo Monte Dam.

As was described above, the environmental license has been suspended multiple times. It might be explained by the social, ecological and economic impacts that the construction of

the Belo Monte Hydroelectric Complex had already caused in the region. The impacts generated by the construction of the complex will affect the municipalities of Altamira, Senador José Porfírio, Porto de Moz, Anapu, Vitória do Xingu, Medicilândia, Gurupá, Brasil Novo, Placas, Uruará and Pacajá (Alves, 2013).

The construction of Belo Monte is a 'giant population magnet' that incentivized the migration of up to 80,000 people in search of direct and indirect work (Hall & Branford, 2012, p. 855). In addition, there is also an estimate that the project will displace 40,000 people from their homes (Boanada Fuchs, 2015). Most of them resettled in planned urban neighborhoods far from the river from which they derived their sustenance. This situation generates a growth in the population density of the region bringing social instability such as increased cases of violence (Grisotti, 2016), and crime and income disparity (Stickler et al., 2013). Migration to the urban area also increased stress on public services such as education, health, public security and sanitation services (Boanada Fuchs, 2015). In fact, there is a current researcher studying the sanitation risk caused by the population growth and the stressed wastewater and sanitation system in Altamira (Gauthier, 2017).

The Environmental Impact Assessment (EIA) that was conducted to obtain the environmental license in 2009, included studies about the impact of construction on species of fish in the region. In this document, Norte Energia acknowledges the important role that fisheries have as one of the main sources of protein in the region. However, the EIA monitored fish landings in the main urban centers (Altamira, Senador José Porfirio, Vitória do Xingu) and in one riverine community (Belo Monte) from November 2000 to September 2001, though they stated that they collected the data "randomly." Then, they collected daily reports of fish landings during two seasons just in the municipality of Altamira (February

2006- August 2007; October 2007-March 2008) they also collected random information in Porto de Moz, Maribel (an indigenous community in the municipality of Altamira) and Vila Nova (the community where my research was conducted) without previous explanation about the data collection.

Even though Vila Nova is located downstream of the dam, and the EIA collected information on the fish landings, the inhabitants of the community were never consulted nor included in the mitigation and compensation programs. In 2015 Instituto Socioambiental, (ISA – Socioenvironmental Institute) a non-governmental organization, published a booklet presenting the lack of information that the EIA had about the impacts the dam will cause in fisheries and in the lives of the fishers of the region (De Francesco & Carneiro, 2015). They stated that the construction of the complex will generate the extinction of river turtles, that traditional fishers were not considered as an affected group and that fishers were ignored by IBAMA and NESA.

2.4.2. Fisheries monitoring: The Sustainable Fisheries Project

In the Basic Environmental Plan (PBA-Plano Básico Ambiental[5]), Norte Energia presented one of the strategies for the mitigation of impacts on fisheries generated by the Belo Monte Complex. The strategy was to develop a project that aims to ensure the continuation of fishing activities in the region affected by the hydroelectric complex. According to the PBA[6], they have been collecting information at nine different points along the Xingu River since

[5] It is a formal document that is product of the EIA that established the environmental processes to be observed/conducted by the constructor during the construction of the project (in this case, the construction of the dam).

[6] http://licenciamento.ibama.gov.br/Hidreletricas/Belo%20Monte/Relatorios%20Semestrais/2%C2%BA%20Relatorio%20Semestral%20Consolidado/CAP%CDTULO%202%20-%20PLANOS,%20PROGRAMAS%20E%20PROJETOS/13/13.3/13.3.5/13.3.5-%20CAP%202%20-%20FINAL.pdf

2012. Vila Nova is one of the localities where they collect data, but there is no explanation about how they defined the data collection sites. Besides, communities downstream from the Belo Monte Dam were not considered impacted, and they have not been compensated for the impacts generated by the construction of the hydroelectric complex.

LEME Engenharia[7] is a consulting company for energy, water and infrastructure projects. The company oversees the project "sustainable fisheries in the Xingu river" sponsored by Norte Energia, the construction company of the Belo Monte Hydroelectric Complex. According to a fisher in Vila Nova who was a data collector, the project collected data from 2010 until 2011, and then from April 2012 until the present (June 2016).

The office of LEME in Altamira informed me that they have been collecting data in 21 different points without interruption since 2012. They want to understand differences in fishing between the areas impacted by the dam and the areas that are not impacted. They collect data in a collaborative way and say that they only collect information if fishers are willing to participate. The most important information for the consulting company is the catch-per-unit-effort. They stated that until the time of the interview [August 2016] there has not been any change in the catch-per-unit-effort or in the species of fish that fishers harvest.

The consulting company states that they have meetings with the fishers of the region every other month to validate the data that they are collecting. It is important to point out that during the interviews none of the fishers and data collectors make any reference about these meetings.

[7] According to the website they are now called Tractebel

In Vila Nova, the community where I conducted my research, there are two data collectors (both women) who collect fisheries information from Monday to Saturday in Vila Nova. They stay in different points in the community collecting data from the fishers including the type of fishery, the quantity of fish, the price of the gas and the quantity of gas used, which fishing gear they used, the fishing spot they went to, the planned destination of the fish that they caught, the species of fish they caught and the weight. They collect information from the fishers that had harvested fish, not from the fishers that returned from fishing without any catch. One of the data collectors explains the goal of the project" "*I am a data collector, I collect data of fish, the collectors are there to help the consortium, Norte Energia, to know, and be certain, about the fish before and after the dam*" -Isabel, collector. Norte Energia is the proprietary of these data, they have been reluctant to share the information collected.

Fishers of Vila Nova think that they must give the information to the data collectors to keep receiving a government subsidy during the closed season. Closed season is a specified period when fishing for a given species and fishing gear is legally prohibited (see Chapter1).

3. METHODS

The purpose of this research is to explore and describe fishers' knowledge about fishing activity and their perceptions of the social-ecological impacts generated by the Belo Monte Hydroelectric dam on fisheries and on fishers livelihoods. I approached the research questions with a qualitative, case study approach, which is ideal for this study because it facilitates the exploration for topics that are not well studied in the literature. Through this study, I aim to illustrate the importance of including local ecological knowledge with a gender perspective in the social and environmental assessments conducted before the construction of large-scale hydroelectric projects or any other big infrastructure project.

3.1. Study area

Vila Nova is a community located on the eastern side of the Xingu River, municipality of Senador José Porfírio in the State of Pará-Brazil. Vila Nova has three main characteristics that fullfill my research interest: 1) it is located downstream from the reservoir and the turbines of the Belo Monte dam; 2) women and men were both engaged in fisheries; 3) and artisanal fishing is the main socioeconomic activity of its inhabitants.

Vila Nova inhabitants are riverine people, and are usually called *Caboclos*, a derogatory term in the region (Brondizio, 2008). As other riverine communities from the state of Pará fish is their most abundant protein source (Moran, 1981). By the summer of 2016, and reported by the health workers and the school director, Vila Nova had 752 inhabitants and 156 families.

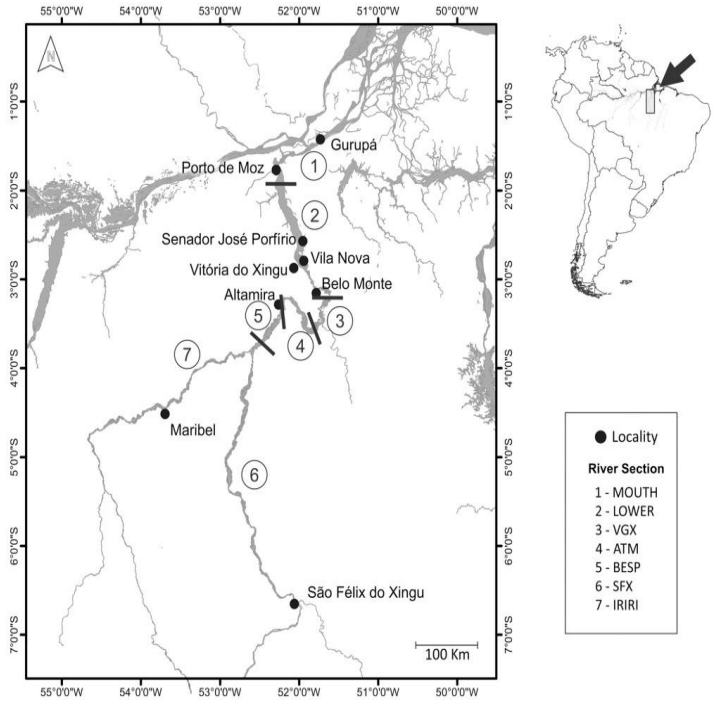

Figure 5. Map of the study area(Isaac et al., 2015, p. 127)

Field work was conducted during the summer of 2016 in Vila Nova. I began data collection recognizing the community and its inhabitants. I conducted informal dialogues with local actors and I also identified fishers, men and women, who have been fishing in the area for 10 years or more. To answer the research questions, I used a mixed methods approach including direct observation, in-depth interviews with fishers, participatory mapping meetings and fishing trips.

I conducted a total of 26 in-depth interviews with fishers (interview guide in Appendix 1) to explore fishers' livelihoods, knowledge of artisanal fisheries and the changes that fishers perceived during the construction and the early operation of the Belo Monte hydroelectric dam. Subjects were chosen based on their willingness to participate, their availability and the time that they have been fishing. Thirteen of the interviewees were fisherwomen, twelve were fishermen and I conducted one interview to a married couple of fishers. With the permission of all the interviewees I audio recorded the conversation and I and my field assistant also took notes during the interviews.

With the purpose of get deeply understanding of artisanal fisheries and the changes generated on fishers' lives by the Belo Monte dam I did fishing trips and participatory mapping. Through the fishing trips**,** my field assistant and I accompanied 2 fishermen and I accompanied 1 fisherwoman to their fishing spots. We navigated the area used by fishers to observe and discuss with them the use and management of their natural resources (e.g. fishing spots, gear, captured species, distances, challenges etc.). I recorded GPS coordinates with a Garmin GPS and I also took pictures with a GPS-enabled camera (i.e. a Panasonic Lumix). Additionally, we recorded our notes in a fieldwork notebook.

P*articipatory mapping* activities allowed me to obtain information about rights to natural resources, seasonal trends in fisheries and how the fishing activity was done before and during the construction of the dam. I conducted 10 participatory mapping activities with six individual men, three individual women and one additional group of four fisherwomen. Besides exploring the gender differences in fisheries, I also considered the extreme ecological differences between the flood and the dry seasons in the area and the changes generated by the hydroelectric complex in the region.

3.2. Data analysis

I followed Miles Huberman and Saldaña (2014) data analysis process which is and interactive and continuous system of data collection, condensation, display and conclusions. I conducted the analysis of data in two main phases: during the field work and after the field work. During field work I followed the process of fieldnote writing proposed by Bernard (1995): writing every day about each data collection and writing-up field jottings.

After the field work, my research assistant transcribed verbatim the interviews, then I reviewed the transcripts, and compared them to the recordings of each of the interviews. Next, I began the *data condensation* stage. I used inductive codes (Appendix 3) for analyse my data, afterwards I organized and summarized each of the codes into displays.

4. RESULTS

Fishers from Vila Nova use the fisheries resources differently. Consequently their perceptions of the impacts generated by the Belo Monte Hydroelectric Dam also differ, mainly due to the gender roles in the community (see Chapter1). Fishers recognized ecological changes caused by the construction of the dam in the flooded forest and

subsequently in the fishery resources and in their livelihoods. In this section I will present first the fisheries seasonality in Vila Nova. Then, the ecological changes perceived by fishers and finally the social and economic impacts generated by the dam on fishers' lives and how these differ by gender.

4.1. Fisheries seasonality

Fisheries in the Amazon basin depend on weather seasonality. Thus, depending on the season, fishers use different gears and catch different species of fish in different spots. In Vila Nova fishers identified two main seasons: the rainy season or "inverno" and the dry season or "verão". All of the fishers are knowgeable about the weather seasonality, Maria a fisherwoman explains the dynamic of the flooded forest: "November is when because of the rain, fishing starts to change. The water of the river starts to rise and other fish arrive…fish enter the igapo… it is the time of the year when fish such as pescada are fat." Maria. The seasonality described by fishers corresponds to the montlhy average rainfall information provided by the Brazilian Institute of Metereology for the city of Altamira (Figure 6).

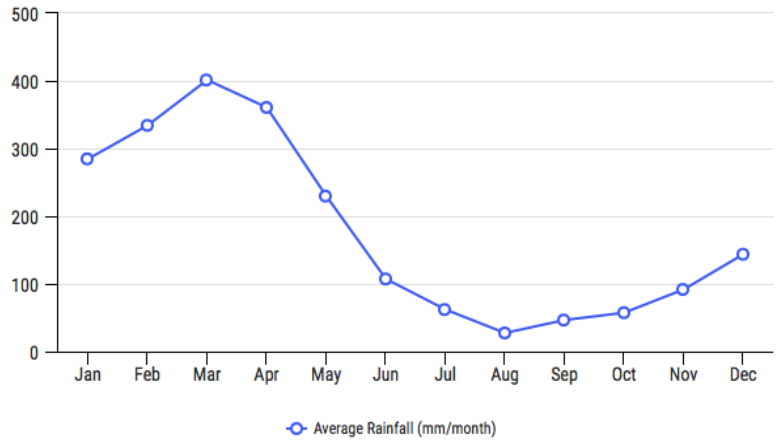

Figure 6. Average rainfall data for the city of Altamira from the national institute of meteorology (Brazil) 1990 - 2016

The rainy season is the time of the year when everything is flooded; the forest, the islands and even the community. It starts in December when the level of the river starts to increase until May when the water starts to descend. During this time most of the fishermen use their fishing nets to harvest larger fish in the Xingu River such as Filhote and Pescada, and they enter the lakes and the flooded forest to harvest fish with handlines. On the other hand, this is the time of the year when fisherwomen fish in the flooded forest and in the lakes. Most of the women use handlines to harvest fish such as Pescada and Piau. Women and the elderly men, who use handlines, collect seeds and fruits such as Urucurana, Invira and Yahuanari to be used as bait.

Table 7. Fisheries seasonality by gender

Season	Gender	Mobilization	Fishing gear	Main species	Fishing spot	Bait
Rainy or "inverno"	Women	Canoe & Paddle	Hand lines	Piau	Flooded Forest, Lakes (less than 5 km from Vila Nova)	Tree fruits and seeds. Igapo.
	Men	Motorized canoe, Canoe & Paddle	Fishing net (Gillnet)	Pescada, Filhote, , Dourada, Curimata, Marapá	Xingu river, lakes	N/A
			Hand lines	Pacu	Flooded forest, lakes	Tree fruits and seeds
Dry or "verão"	Women	Canoe & Paddle	Hand lines	Piau Cara Traira	River bank	"Piabinha" little fish (river bank), earthworm (quintal),wet farinha
	Men	Motorized canoe, Canoe & Paddle	Fishing net (Gillnet)	Cará, Curimatã, Ariru	Xingu river and lakes	N/A
			Hand lines	Ariru, Tucunare	Xingu river and lakes, river bank	"Piabinha" littlefish (river bank)

The dry season last from June to December. This is the time of the year that they cannot access some fishing spots because the streams to get to those places are dry. During the dry

season fishermen harvest fish such as Curimatã and Ariru on the shore of the islands on the Xingu river and they use fishing nets and some of them dive to harvest Tucunare, the fish with the highest economic importance. Fisherwomen, as in the rainy season, use handline and caniço they use *Minhoca* (earthworms), and wet *farinha*[8] as bait. Table 8 presents summarizes the seasonality of fisheries for men and women, the type of boat used, fishing gear, the main species of fish harvested, fishing spots, bait that is used and where bait is obtained.

4.2. Ecological changes perceived by fishers

Most of the fishers of Vila Nova complained about the construction of the Belo Monte Dam and the impacts that its construction is generating on their lives. Underneath these complaints are the ecological changes perceived by men and women fishers. All of the changes are interelated and some lead to others. In the interviews, participatory mapping activities and fishing trips fishers identified two specific moments during the construction of the dam that generated changes in the ecosystem and in their livelihoods. The first one was during the process of construction and land removal, which included the dynamiting of rocks in the river and the use of a lighting system that allowed the construction company to work 24 hours each day (the lights were comparable to a well-lit football stadium). The second one was related to the moment when the construction company started to fill the Belo Monte reservoir. For fishers this was the moment of time when the flow of the river changed and consequently this produced other ecological impacts described below.

[8] Flour made from manioc root, it is a traditional Brazilian side dish

4.2.1. Dam construction

All fishers pointed out that before the construction of the dam the water of the Xingu river was clear, that they could see fish and rocks in the water and it was easy to fish. The first ecological change that fishers noticed in the community was when the dynamite explosions and land removal began. All of them identified a change in the color of the water, and a decrease in the availability of fish caused by the amount of sediments in the water and the noise generated by the explotions. In the quote below a fisherman narrates how the impacts generated by the construction of the dam began.

> *Before they* [Norte Energia] *started to use the lights at night and exploited the dynamite, the water was clean, fish were easily caught in the hook with baits. Two years after they started with the construction the water didn't rise, the water was muddy. Water was not in condition to support fish, it was dirty. The fish were not used to those explosions so the fish didn't stay in the region. The explosions' noise scared fish. During the first year, there was a lot of machinery and the noise of the bombs. Also, the lights that they used was like a condemnation to fish to leave the area. Then was when the problems for the people close to the dam began* – Jairo.

Half of the interviewee fishers identified that due to the decrease in water quality fish are dying and dissapearing from the region, as noted by this fisherman:

> *Now the water is ugly, it looks like 'tucupi', it is yellow. Fish are dying, we found dead fish in the middle of the river. The water used to be clean and clear. We*

could see through the water. Now the water is bad, we cannot drink it . Everytime we go to the igarape we have to bring water. Sometimes the water also has a bad smell" –Lorenzo.

Most of women find that the color and aspect of the water does affect the fish in the region; but half of them are also concerned about the effects that this could have in their health. Two of the interviewees have already felt sick and half of them stopped consuming water from the river. During the interviews women call the attention to the quality and aspect of water just as this interviewee,

That dam finished everything, the fish that came from the upstream is dying, we have found dead fish… they [Norte Energia] *have heavy machinery with mountains of dead fish, they are throwing the fish everywere, the water is dirty, we cannot drink it anymore, before we didn't need to bring a drop of water, we drank natural water. Now we cannot, the water is too dirty, it is so dirty, if it is killing the fish, what will happen to the human being*?...- Angela.

Before they used the water of the river to drink when they were fishing. Nowadays they use the water that comes from one community well that provides water to most of the inhabitants of Vila Nova and some of them are not bathing in the river anymore, as they used to do. Nevertheless most of the women continue washing clothes and dishes in the river. Carmen, a fisherwoman who felt sick after taking a bath in the river, a typical scene in Vila Nova, describes her esperience,

After the dam, my sister, the water is not working for anything. No one can drink the water, it makes people sick, even just taking a bath. One day I went to the

shore of the river to take a bath and in this side [pointint at one of her arms] *I got an allergy, I had to go to the health center and ask for a cream, I had an allergy, a terrible allergy, Oh my god* – Carmen.

At the same time, the company installed stadium light towers in the construction area that deterred fishers' work. Those lights generated a full-moon effect, and usually fishermen do not fish during the full-moon nights. They prefer darker nights because according to fishermen, fish can not see the gillnets. One fisherwoman and two of the fisherman noted the effects that the light caused in fish and in fisheries,

The light scared the fish, we used before 120 meters of net to catch a good quantity of fish, now we are just catching between 2 and 3 fish in the net. Fish is disappearing because of that… we [fishers] *know the area, we move around and we know the fisheries… I find that everything is empty now, there are not more fish, the fish is running away, perhaps they leaved to the* Amazon [referring to the river]. *Now, is bad for a fisherman to live here*.. – Rafael.

Added to the above, an elder fisherman pointed out that also during the construction of the dam there were high levels of deforestation, which caused the dissapearence of the forest and animals' habitat.

The company cleaned everything [deforested], *there is no space for animals to stay, how are we going to find animals? It is going to be a desert. The animals do not have anywhere to stay, we had plenty of wild animals, native animals, and the fish was the first to feel the change* -Juan

4.2.2. Reservoir filling

All of the fishers identified the river flow alteration as one of the most evident changes. Before the construction of the dam and until the rainy season of 2014, the flooded forest was usually flooded during at least four months of every year. It was in the rainy season of 2015-2016 when Norte Energia began to fill the reservoir that fishers perceived that the flow of the river decreased. The flooded forest, called *igapo* by the fishers of Vila Nova is the main ecosystem used by fishers to fish during the rainy season but also this ecosystem plays an important role providing fish a space for protection, reproduction and fruits and seeds from which they feed.

According to fishermen, the spawning season of most of the fish that are in region ocurrs during the rainy season. A local fisherman explains that there is only one fish that lays its eggs all year long: the Tucunare:

> *During the 'verão' the only fish that reproduces is the Tucunaré, it happens because the Tucunaré is not a shoal fish, it reproduces all year long, it spawn its eggs in the mud and stays until its only 'son' is born* -Juan.

Fisherwomen, on the other hand, when reffering to the flooded forest describe the importance of the forest' trees. Most of the fisherwomen use the flooded forest to fish and also they collect seeds and fruits from forest' trees to be used as bait. They collect fruits in the igapo and fish in the same place on the shore of the river or in the lakes. A fisherwoman noted during the interview "fish eat many fruits from the igapo…they eat Envira, Jauari and Urucurana" Carmen. Other participant stated that "during the 'inverno' I fish in that igarape

[she points to the South of the community where is located the igapo Tariri] and in the shore of the river" Blanca.

Hence, because the flow of the river decreased during the reservoir filling the igapo did not get flooded during the last rainy season. What does it mean to fishers in Vila Nova? First of all, it is important to highlight, as was mentioned above, the social and ecological role of the flooded forest for fishers in Vila Nova. The flooded forest is the habitat where fish reproduce, seek food and protection from predators. Therefore, it is one of the favorite fishing spots for fishers, especially women When the flow of the river did not rise to the usual level, and when the flooded forest was not flooded, fish did not enter the igapo nor spawn. All of the fishers noted during the interviews the impact of the change in the flow of the river in fish reproduction, as explained by a fisherman:

> *This year* [2016] *was when fisheries became bad because the water didn't raise, this year is more than bad, the water didn't' raise, it was supposed to raise…Every year fish enter the igapo to lay their eggs, but this year the river was not in conditions to let the fish lay the eggs, the river didn't have water* –Caio.

Furthemore, all fishers pointed at the construction of the dam as the cause of the change in the river flow. This situation explained well by a local fisherman:

> *When they constructed the dam the water didn't enter here* [the community], *didn't flood the fields, and we need water, the level of the water was low, besides there was not enough water, there are some places where there is mud everywhere…we do not have places to fish, everything has mud, now everything is mud, to move from one place to another is challenging… you have been there,*

you know how we are suffering. What Norte Energia did is affecting the fish and many people because people here just live from fishing"-Lorenzo, fisherman.

4.3. Fishers mobility patterns and loss of fishing spots

As was described above, due to the construction of the dam and the accumulation of water in the reservoir there is a loss of fishing spots in the region mostly during the rainy season when fishers usually harvest fish in the flooded forest. Traditionally in Vila Nova, most of the fishermen fish in the Xingu river and in the igapos that are formed along it, while women fish in the igapos close to Vila Nova and in the shore of the Tamandua river.

In Figure 7, the dashed circle portrays the area were most of women fish, and the line represents the fishermen's area of mobility. It is important to point out that fishers in Vila Nova have daily journeys; they do not spend more than a day or a night fishing in the river so their mobility compared to commercial fishers is limited. Because of the patterns of mobility that men and women have in Vila Nova and due to household roles, fisherwomen are not able to move to areas further from the community (See chapter 1).

Figure 7. Fishers patterns of mobility

Fishers claim that during the last flood season, they were not able to fish in the flooded forest close to the community, and fishermen were not able to fish in the islands that used to get flooded during that time of the year. The construction of the dam generated a loss of fishing spots during the rainy season.

Fishers were not able to access some fishing spots that they used before because of the change in the flow of the river. Women have been forced to fish during the rainy season in the shore of the river where they used to just fish for family consumption. They identified a reduction in the flow of the river and in the fishing spots. They do not identify a change in the fish species, however they identified that the fish abundance has decreased. Elderly fisherwomen recognized that some fish species, mainly Curimatã, did not had a spawning season. Figure 8 portrays the fishing spots that are frequently used by women, all of the fishing spots represented in the map where frequently used by women before the construction of the dam. In blue are the fishing spots that women are not accessing anymore due to the change in the flow of the river (during the construction of the dam).

Figure 8. Women fishing spots and the change in the access during the construction of the dam

Due to the fishwomen' mobility patterns in the community and the loss of fishing spots, women claimed that they are fishing less time each day and also less days per week. Before the construction of the dam, most of the women used to fish by themselves or with a partner almost all of the weekdays; some days they left early and returned before noon. However, nowadays with the changes in the fisheries they have decided to spend more time at home taking care of their children and performing other household roles, since it is simple no longer rewarding to go out fishing given the decline in fish productivity.

On the other hand, men who traditionally fished in spots located further from Vila Nova and who provide income to the households, identified the loss of fishing spots along the Xingu river and the loss of three of the species of fish that they recognized as the ones with the highest economic importance: *Filhote, Marapá* and *Dourada*. They used to fish these catfish

species during the rainy season in the Xingu river. Contrary to women, fishermen have increased their time fishing because they are traveling longer distances than they used to in order to find fish. Despite the considerable efforts fishermen are still getting less fish than before the construction of the dam.

Figure 9 describes the most frequented fishing spots used by fishermen in Vila Nova. Fishing spots in yellow are the areas where they fished during the rainy season of 2015-2016 and in blue the fishing spots that they could not enter during the same season.

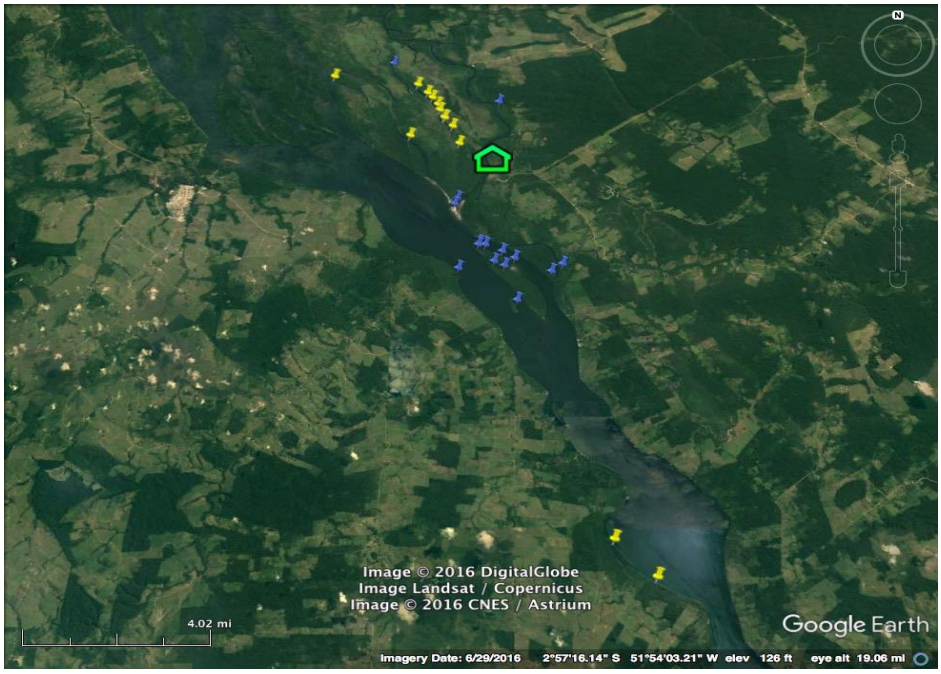

Figure 9. Women fishing spots and the change in the access during the construction of the dam

4.4. Social and economic impacts generated by the dam on fishers lives by gender

As was mentioned in the previous section the Belo Monte hydroelectric dam has generated changes in fisheries and in fishers dynamics. Due to patterns of mobility men and women have different perceptions about the environmental changes in the area but also in the

changes that the dam has generated in their lives. Table 8 summarizes the main changes identified by fishermen and fisherwomen in Vila Nova generated by the construction and early operation of the Belo Monte hydroelectric dam.

While men are concerned about the decrease in fisheries and the income received, women are concerned about the decrease in fisheries and the access to food for them and their families. This is caused due to the gender roles, patterns of mobility and household roles that men and women have in Vila Nova.

For all fishermen the dam, besides the ecological changes, has impacted them because they are not fishing the species with the highest economic value (Filhote, Marapa and Dourada). Also, they are traveling further to fishing spots and because of that they are expending more money in gasoline thereby reducing their net benefit from fishing effort. Related to that, they have noticed that the price of gasoline has doubled since the construction of the dam began in 2010, so they have to fish more kilograms (kg) to be able to sustain their families, pay for gasoline and gears.

In the case of women, all of them had also perceived ecological changes generated by the dam related to the availability of fishing spots and fish. After the construction of the dam they have been limited to fish in fewer places and just for consumption. In comparison to men they noticed a significant increase in food prices, not only gasoline. Since fish is the main source of protein in Vila Nova, families have to adapt to the new realities of the fishery. In the community a few families have housegardens or a small plantations with manioc and squash, therefore the only way that they access other goods besides fish is purchasing those in the community market.

In the market, they access basic goods like rice, beans, salt, sugar, among others. Since the construction of the dam, 5 of the 13 interviewed fisherwomen have identified an increase in the price of those products. The following excerpt illustartes that situation *That dam runout the fish, if we want to buy 1kg of farinha, we need to sell 3 kg of fish…1 kg of farinha cost 7, 6 , 8 real* [$2.56 USD]*… 2 kg of fish to buy 1 kg of farinha* –Blanca..

Table 8. Changes caused by the impacts generated by the Belo Monte dam in fishers lives

Changes caused by the social, ecological and economic impacts of the Belo Monte Dam in fishers lives.		
	Women	**Men**
Loss of fish of economic importance		X
Loss of fishing spots	X	X
Increase distance to fishing spots from VN		X
Increase in fishing expenses prices		X
Limited food access	X	
Low water quality	X	
Reducing time fishing	X	
Increasing time fishing		X

The price of a fish depends on the species, size and weight. Fishers usually sell the fish to intermediaries within the community. For instance, a fisher sells 1 kg of Curimatã for $3 Reais ($0.32 USD) to the intermediary. Then the intermediary sells the same kg of Curimatã for $7 Reais ($2.24 USD) to other intermediaries or outsiders. Few inhabitants of Vila Nova buy fish from intermediaries-- most of them fish for consumption.

5. DISCUSSION

Fishers living in Vila Nova, have been affected by the construction and early operation of the Belo Monte dam. I found that men and women have different perceptions about the ecological, social and economic impacts the dam has generated in their lives, these differences are explained by the gender roles in fisheries and inside the households. In this section I will discuse the impacts generated by the Belo Monte Hydroelectric complex in fishers livelihoods and the importance of including Local Ecological Knowledge in the consultation and Environmental Impact Assessment processes.

The fieldwork for this paper was done before the full operation of the dam, so by that time fishers had identified two specific situations that had generated changes in the ecosystem and in their livelihoods. The first one is related to the dam construction and the second one when filling of the dam began.

The ecological changes perceived by fishers in the community, during the construction of the Belo Monte Dam were mainly caused by the processes of land removal and dynamite explosions. Both men and women recognized that the quality and color of the water changed as soon as these two processes began, and these changes had affected peoples' lives. This fishers perception contradicts the statement of the World Commission of Dams (WCD, 2000) that the impacts of dams for downstream communities come only after the completion of the dam. Furthermore, the deterioration of water quality, has been also reported by previous studies as one of the impacts generated by dams in the downstream (Hallwass et al., 2013) a fact confirmed by fishers in Vila Nova.

For them, the water is "dirty and yellow". Men and women identified different impacts in their lives due to water deterioration. Women perceived that the water is not drinkable, that

they cannot use it to cook and that it is generating health issues, whereas most men did not emphasize the effects of the quality of water in human health, but they mentioned that process of dynamiting rocks altered the quality of the water and likewise women identified a diminishing of fish stocks because of that.

Undoubtedly, the main environmental change perceived by fishers occurred during the dam filling process. As in other studies have reported (Alho, 2011; IPCC, 2014; Trussart et al., 2002; Yüksel, 2010) Vila Nova fishers identified an alteration in the hydrological regimes. Fishers noticed a reduction in the river flow, which afterwards led to the loss of flooded forest (Fearnside, 2016; Manyari & de Carvalho, 2007; von Sperling, 2012), the most important habitat for fisheries in the Amazon basin. This subsequently generates a decrease in fish availability (Baran & Myschowoda, 2009; Orr et al., 2012; Stenberg, 2006; Trussart et al., 2002), and the fishermen reported a change in the fish species.

The results from this research indicate that as fishing is the main socioeconomic activity in the area, the reduction on fish abundance is also affecting local economy. A situation also reported in the Lower Tocantins River (Brazilian Amazon) after the impoundment of the Tucuruí reservoir (Hallwass et al., 2013).

Additionally, men and women fishing and household roles are also affected differently by the construction of the dam. In the past, women could split their time fishing with their household responsibilities (childcare, cooking, etc). Now, they have reduced their fishing time effort, because they are not finding fish in the fishing spots that are accessible to them near the community. This change in women access to fish will have effects in the family diets, a topic that need to be studied in the future. Men have increased their fishing effort by traveling longer distances because they are not getting the most important species (in

economic terms) where they use to fish them. This also means that they have to fish longer hours that they use to do, spend more money on gas and fish closer to other riverine communities.

Second, before the construction of the dam, men and women provided fish as the main protein for their families, whereas nowadays fishers observe fish reduction. Men are concerned about the income reduction and the loss of fish species of economic importance, whereas women are concerned about the challenges regarding food availability. There is no tradition in Vila Nova of cultivating crops for consumption, this behavior comes from the fact that in this region inhabitants based their economy on the extraction of rubber, and historically the rubber barons did not permit rubber tappers to cultivate crops, forcing them into indebtedness to ensure their services (Moran, 1974; Wagley, 1953).

The dam has created a change in prices that is affecting Villa Nova dwellers. Fishermen are paying more for the gasoline and women are paying more for the food that they buy at the market. It seems that the dam is creating an "inflation" impact that is clearly affecting the communities living nearby.

6. CONCLUSION

This is the first study reporting changes caused by a dam in a downstream Amazonian community with a gender approach. Understanding the knowledge, perspectives and concerns of local riverine people plays an important role when analyizing the damages of an infraestructure project. Furthermore, scientists had stated that the populations who suffer more from large-scale dam construction are those who are displaced, forced to resettle because their livelihoods were distroyed and their homes are flooded, and they have few

benefits of the projects (Adams, 2009). Although this study does not try to underestimate this problematic, it shows how other communities not included in the consultation process are also impacted by the construction of the dam.

Vila Nova fishers' and their livelihoods had been impacted by the dam and they will not receive any compensation for that. In this study, I showed how these impact differ for women and for men. While men are concerned about the decrease in fisheries, the distance they now have to travel to fish, the price of the gasline and the income received, women are concerned about the decrease in fisheries, the loss of fishing spots that are excluding them from the fishery, the amount of fish they families are eating and therefire the need to buy more products in the market. So clearly the households are been negatively affected by the dam, and this situation may not change in the future. Households are going to find new strategies for their lievlihoods. Years ago when the extracted rubber they had fishing as an alternative, the problem now is that they do not recognize any new economic alternative.

To make things worse for these fishers, since 1991 they were getting a subsidy- Seguro Defeso- compensated them for four months for not fishing during the closed season. In chapter 1, I showed how this subsidy is vital for these families. However, when I was in the field, I was told that in the last season they did not receive that subsidy. Clearly the fishers are impacted by the dam, but also by this change in policy.

Even though, research about the impacts on human health generated by the construction of hydroelectric dams' suggest that they increase the rates in diseases transmission (Fearnside, 1999; Grisotti, 2016; Koch, 2002; Soito & Freitas, 2011; Trussart et al., 2002; von Sperling, 2012; WCD, 2000), I have not found a study exploring the impacts generated by the change of water quality on human health of communities located downstream from dams. This will

be an interesting question to address in the future.

By the time that I went to the field the dam was not in full operation, in fact only four of the 24 turbines were in operation. So, it will be interesting to visit the community again to explore if other impacts have been identified or if maybe some impacts have changed. It would be also important to study how are communities coping with all these changes, what type of strategies have fishermen and fisherwomen found for their livelihoods.

APPENDICES

Appendix 1. Semi-structured interview guide

IN-DEPTH INTERVIEW GUIDE

Thank you for accepting being part of this research project. The goal of this interview is to talk about fishing in the region.

1. Demographic information

Subject ID
Gender
Age
Education level
Time living in the area

2. Could you tell me about the first time that you fish?
    - Who taught you how to fish?

3. How did you decide that you want to become a fisher?

4. Who else fishes in your family?

5. Besides fishing could you tell me what other activities do you do during the day? (seasons)

6. Let's talk about fishing before the construction of the hydroelectric, could you tell me how was a typical fishing journey?
    - How did you prepare for fishing?
    - What did you do during the fishing activity? (Fishing spot, fishing gear, time)
    - Then after the journey finish, what did you do with the fish? (Consumption, selling, drying, etc.)

7. How was the access to the fishing areas?
    - Authorization to enter, areas that were and were not allowed to fish
8. Now could you tell me what is happening with fishing?
9. How is a typical fishing journey?
    - How do you prepare for fishing?
    - What do you do during the fishing activity? (Fishing spot, fishing gear, time)
    - Then after the journey finish, what do you do with the fish? (Consumption, selling, drying, etc.)

10. How is the access to the fishing areas?
    - Authorization to enter, areas that were and were not allowed to fish
11. If they are not fishing anymore, what are the other activities that they do to fulfill their needs

Appendix 2. Coding rules, definitions and examples Chapter 1
Table 9. Coding rules, definitions and examples Chapter 1

Code	TAG	Definition	Rule	Example
Motivation	MOT	The incentives that fishers have to participate in fisheries.	Use statements that include the motivation of the interviewee to fishing.	"Ai era aquela situação, as coisas eram mais difíceis, era fácil por um lado e mais difícil pelo outro. Ai a gente teve que ajudar o papai criar os outros irmãos mais pequenos, ajudar pescando.."
Fishing grounds	SPOT	Place where fishers harvest fish and how to they mobilize	Use statements regarding the ecosystem where they harvest the fish, the time that they spent fishing and getting to the spot.	"eu pesco ai no Cajuí no Tariri, ai pro rumo do cacau. Ai os igarapé que eu pesco mais ai pro Pitinga ali... ai tem muitos igarapé ai pra fora mas ai não pesco assim, eu pesco é mais pra cá pra dentro"
Fishing	Pre-Harvest	Activities performed by the fisher before the harvesting	Include statements regarding the investment of time and capital before the fisher gets to the fishing spot to harvest.	"[isca que as pescadoras coletan antes da pescaria] os peixes a gente pega com Minhoca, Jauari, Uruá, esses um é a isca do verão né; Envira. Agora do inverno é Sardinha, Piaba, esses são as iscas do inverno." "gasta uma base de uns 15 a 20 litros de gasolina que vai pescar com 3, 4 horas de viagem pra poder conseguir, as vezes pessoal chega pra ali a vez com aquele peixinho…"
	Harvest	Sector of fisheries when fisher catch the fish	Include statements that reference to the activities, responsibilities of fisher while catching the fish. Inputs and gear that they use for harvest fishes	"é remando [risos] ai vamos remando assim por exemplo, tem uma caída de pau né, ai a gente vê lá é bom de colocar a malhadeira por fora pra não engatar a malhadeira"
	Post-harvest	Sector of fisheries after the fisher arrives to the fishing landing.	Include statements that reference to the activities and responsibilities of fisher when land to the community after harvesting.	"O atravessador vende peixe a pessoal da comunidade mais tambem a outros intermedearios que vialham a porto de moz, soucel, vitoria. Quando por exemplo e a gente ta pescando ou que engata ou que o boto rasga, a gente conserta eu e ele [o irmao] ele costura..."

Table 9 (cont'd)

Code	TAG	Definition	Rule	Example
Earnings control and management	MONEY MANAGEMENT	Decisions regarding the use of the earnings from the harvesting activity	Statements that include the person who control and manage the earnings from the fishing activity	"ele vende o peixe lá, vem pra casa, come, e quem vai é eu. Ai os meninos do Nilson do peixe fala até assim "a mulher do dinheiro" [risos] é porque só eu que vou buscar o dinheiro..."
Women barriers in fisheries	WOMEN	Challenges that women face, which not allow them to fish.	Include statements from the respondent regarding barriers to fishing because of their condition as woman	"Quando eu saio... quando estava com a barrigona que não dava pra eu ir com ele, ele nem pescava de malhadeira, ele pescava de flecha"
Household gender roles besides fishing	HH_ROLE	Activities and responsibilities at the household level	Include statements regarding the household gender roles.	"quando eu chego estou com dor de cabeça ai ainda tem que limpar casa, fazer comida, cuidar de menino, ai as vezes eu prefiro nem ir, prefiro estar em casa porque desanima a gente indo pegar no…"
External income	E_INCOME	Money received by other sources but fishery	Include statements of the interviewee among external sources of income.	"ai eu recebo R$79 por pessoa no caso lá em casa é 5 é R$386. Ai muitas pessoas daqui não passa fome pelo Bolsa Família porque do peixe não esta dando mais nada"
LEARN	LEARN	How fishers learned to fish	Include statements of the interviewee reporting how she/he learned to fish	"Ai eu me ajuntei com ele, ele e pescador, ai depois casamos. Ai dai passei a pescar com ele. E ai a gente foi pescando. Desde desse dia agora a rotina é pescar"
RULES FORMAL AND INFORMAL	RULES	Rules regarding the access and use to fishery resources	Include information about the formal and informal norms of fisheries.	"dezembro, janeiro, fevereiro, março, é os 4 meses do Defeso" "Seguro defeso", todo ano faziam, quando dava dia 15 de novembro fazia, por que a proibição da preservação da desova do peixe e dia 15 de novembro fecha e só abre dia 15 de março, "

Appendix 3. Coding rules, definitions and examples Chapter 2
Table 10. Coding rules, definitions and examples Chapter 2

Code	TAG	Definition	Rule	Example
Seasonality	SEASONALITY	Ecological and climatic seasonality of the region	Use statements that describe the annual climatic seasonality of the area before and after the construction of the hydroelectric dam. And fish seasonality.	"quando é o inverno é quando a água esta subindo... ela sobe é... ela cresce, no período de janeiro até abril...o verão seria... o inverno seria de janeiro até junho e o verão de junho até dezembro"
Water level	Water_QUA	Change of the Level of water during the rainy and dry season.	Include statements explaining change in the water level	"Quando ela esta de quebra, seca até que pega mais um peixinho... Quando enche os peixe se espalha tudo, vai tudo pra fora"
Water quality	WATER_QUA	Changes perceived by local fishers in the quality of water	Include statements that explain the causes and consequences of the water caracteristics	"o que perturbava era explosão, a claridade. No outro ano os peixes já começaram a fracassar, por causa da explosão e claridade. E o peixe não se acostumou com aquel"
Natural fishery system	NATURAL	Biological description of fisheries, what includes the biological and ecological cycles of fish.	Use this code to describe the fish species ecology before and after the construction of the dam.	"Porque a água não cresceu, elas só desovam se a água crescer porque elas entram, elas escolhem aqueles lugares mais feio mesmo que elas sabem que não vai ter como ninguém entrar lá, que é pra desovar..."
Social and economic fishery system	SOCIAL	Socioeconomic description of fishery	Use statements from the respondent regarding the quantity, quality of fish that they harvest, the species, fishing grounds and that they use	"Agora caboco bate o dia inteiro e não pega 1kg! Que a água não oferece a condição, tanto esta suja, como esta seca." "Como esse ano nos não tivemos inverno aqui não. Ai já o peixe não teve o comer, peixe não engordou, peixe diminuiu, começou nossa crise" "a malhadeira, entendeu!? Malhadeira é aquilo que esta ali [apontou mostrando do que se tratava] você sabe o que é malhadeira?

Table 10 (cont'd)

Code	TAG	Definition	Rule	Example
Inflation rate	INFLATION	Increased inflation rates of basic food and fishery products	Excerpts from the interviewee that explain the increase in the price level of goods and services after the construction of the dam.	"Aqui na hora que fala que o feijão aumentou..., esta R$13 o quilo do feijão aqui, 13. E as coisas aumentam muito rápido, muito. A gasolina já é R$5, quando eu cheguei aqui o quilo da farinha era R$1,50 esta R$7 [risos]. Muito caro"
Causes of change in fisheries generated by the dam	CAUSES	Causes of change in the fishery natural and socioeconomic system	Include excerpts reporting the explanation of the modifications in fisheries generated by the dam	"Esta, o igapó esta seco agora de inverno... Agora não enche mais nao por que é, esse negócio dessa Barragem ai não tem como não. Que isso aqui de inverno de primeiro alagava tudo [senhala o quintal de sua casa], a gente andava de canoa por aqui…"
Causes of change in fisheries generated by other except by the dam	CAUSES_O	Causes of change in the fishery natural and socioeconomic system	Include excerpts reporting the explanation of the modifications in fisheries. Do not include changes generated by the construction of the dam.	foi da quantidade de produção, foi da produção e também as famílias como eu te falei ainda agora, tem dois ou três rapazes em uma casa quando cresce a tendência é usar uma malhadeira, duas ou três malhadeira né. E o material aumentou, 100% de material, por que que assim se produz 50 quilos a medida de quilo nunca chega né..
Copping strategies	COPPING	Strategies that fishers are implementing to supply their needs previously supplied by fisheries	Use statements that include activities, attitudes, behavior of fishers to fulfil their basic needs	ainda é eu faço assim, ainda vendo pão, as vezes faço pão caseiro, só hoje que não fiz... Tudo é pouquinho mais serve né, pra gente não passar fome, agora ta ruim, tem vez que a gente procura comida, um peixe pra comer aqui não tem, por causa que é difícil.

Table 10 (cont'd)

Code	**TAG**	**Definition**	**Rule**	**Example**
Compensation	COMP	Something that is asked by the fishers to compensate the damages that the dam has generated in fisheries	Include statements among things that fishers expect to receive as reparation for the impacts generated by the dam	"Mas ai se fosse na questão de conselho eu, eu apostaria também ai né, se criasse alternativa que pudesse ressarcir a economia dos pescadores, uma criação de alguma coisa, uma plantação de algum alimento ou criação de suínos ou de aves, avicultura, de piscicultura né que... aquicultura né, alguma forma assim de algum projeto que pudesse ressarcir a economia do pescador"
Motivation	MOT	The incentives that fishers have to participate in fisheries.	Use statements that include the motivation of the interviewee to fishing.	"Ai era aquela situação, as coisas eram mais difíceis, era fácil por um lado e mais difícil pelo outro. Ai a gente teve que ajudar o papai criar os outros irmãos mais pequenos, ajudar pescando..."

REFERENCES

REFERENCES

Abril, G., Guérin, F., Richard, S., Delmas, R., Galy-Lacaux, C., Gosse, P., … Matvienko, B. (2005). Carbon dioxide and methane emissions and the carbon budget of a 10-year old tropical reservoir (Petit Saut, French Guiana). Global Biogeochemical Cycles, 19(4), n/a-n/a. https://doi.org/10.1029/2005GB002457

Adams, W. M. (2009). Green Development 3rd edition: Environment and sustainability in a developing world.

Agarwal, B. (1992). The Gender and Environment Debate: Lessons from India. Feminist Studies, 18(1), 119. https://doi.org/10.2307/3178217

Agarwal, B. (1997). Bargaining''and Gender Relations: Within and Beyond the Household. Feminist Economics, 3(1), 1–51. https://doi.org/10.1080/135457097338799

Agarwal, B. (2000). Conceptualising environmental collective action: why gender matters. Cambridge Journal of Economics, 24(1996), 283–310. https://doi.org/10.1093/cje/24.3.283

Agostinho, A. A., Pelicice, F. M., & Gomes, L. C. (2008). Dams and the fish fauna of the Neotropical region: impacts and management related to diversity and fisheries. Brazilian Journal of Biology, 68(4), 1119–1132. https://doi.org/10.1590/S1519-69842008000500019

Alencar, E. (1993). Genero e trabalho nas sociedades pesqueiras. In L. Furtado, W. Leitao, & A. Mello (Eds.), Povos das Aguas. Realidades e perspectivas na Amazonia (p. 292). Belem: Museu Paraense Emilio Goeldi.

Alho, C. J. R. (2011). Environmental Effects of Hydropower Reservoirs on Wild Mammals and Freshwater Turtles in Amazonia: A Review. Oecologia Australis, 15(3), 593–604. https://doi.org/10.4257/oeco.2011.1503.11

Alho, C. J. R., Reis, R. E., & Aquino, P. P. U. (2015). Amazonian freshwater habitats experiencing environmental and socioeconomic threats affecting subsistence fisheries. Ambio, 412–425. https://doi.org/10.1007/s13280-014-0610-z

Alves, J. M. (2013). Luta e resistência dos movimentos sociais à Hidrelétrica Belo Monte na

Transamazônica – PA. IDeAS-Nterfaces Em Desenvolvimento, Agricultura E Sociedade, 7, 9–35.

Arvizu, D., Bruckner, H., Chum, O., Edenhofer, S., Estefen, A., Faaij, M., … Zwickel, T. (2011). Technical Summary. (O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Eickemeier, P. Matschoss, … C. Von Stechow, Eds.), IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation. Cambridge, United Kingdom and New York, USA: Cambridge University Press. https://doi.org/10.5860/CHOICE.49-6309

Bach Dang, N., & Momtaz, S. (2015). The contributions of fishers' knowledge to marine fisheries management: A case study of a coastal commune in Vietnam. First Asia Pacific Conference on Advanced Research, (August), 12.

Banerjee, D., & Bell, M. M. (2007). Ecogender: Locating Gender in Environmental Social Science. Society & Natural Resources, 20(October), 3–19. https://doi.org/10.1080/08941920600981272

Baran, E., & Myschowoda, C. (2009). Dams and fisheries in the Mekong Basin. Aquatic Ecosystem Health & Management, 12(3), 227–234. https://doi.org/10.1080/14634980903149902

Barry, B. (1997). Sustainability and intergenerational justice. Theoria: A Journal of Social and Political Theory, 45(89), 43–65. https://doi.org/10.3167/004058197783593443

Bartle, A. (2002). Hydropower potential and development activities. Energy Policy, 30(14), 1231–1239. https://doi.org/10.1016/S0301-4215(02)00084-8

Batistella, A. M., Castro, C. P. de, & Vale, J. D. do. (2005). Conhecimento dos moradores da comunidade de Boas Novas, no Lago Janauacá - Amazonas, sobre os hábitos alimentares dos peixes da região. Acta Amazonica, 35(1), 51–54. https://doi.org/10.1590/S0044-59672005000100008

Bayley, P. B., & Petrere, M. J. (1986). Amazon Fisheries: Assessment Methods, Current Status and Management options. In D. P. Dodge (Ed.), Proceedings of the International Large River Symposium (LARS) (pp. 385–398). Honey Harbour, Ontario, Canada: . Canadian Special Publication of Fisheries and Aquatic Sciences. Retrieved from http://www.dfo-mpo.gc.ca/Library/111846.pdf

Bechtel, J. D. (2010). Gender, poverty and the conservation of biodiversity. A review of

Issues and Opportunities. MacArthur Foundation Conservation White Paper Series. Retrieved from http://production.macfound.org/media/files/CSD_GENDER_WHITE_PAPER.pdf

Begossi, A. (2008). Local knowledge and training towards management. Environment, Development and Sustainability, 10(5), 591–603. https://doi.org/10.1007/s10668-008-9150-7

Begossi, A. (2015). Local Ecolgical Knowledge (LEK): Understanding and managing fisheries. In J. Fischer, J. Jorgensen, H. Josupeit, D. Kalikoski, & C. M. Lucas (Eds.), Fishers' knowledge and the ecosystem approach to fisheries. Applications, experiences and lessons in Latin America (pp. 7–18). Rome: Food and Agriculture Organization of the United Nations.

Bennett, E. (2005). Gender, fisheries and development. Marine Policy, 29(5), 451–459. https://doi.org/10.1016/j.marpol.2004.07.003

Berkes. (2008). Sacred Ecology (2nd ed). New York: Routledge.

Bernard, H. R. (1995). Research Methods in Antropology. Walnut Creek, CA: AltaMira Press.

Boanada Fuchs, V. (2015). Breaking the Walls Down: The Practice of Prior, Free and Informed Consultation between Colonial Designs and a New Environmental Governance Framework in Brazil (the Belo Monte case). Geneva (CH).

Boanada Fuchs, V. (2016). Blaming the weaher, blaming the people: Socio-anvironmental governance and a crisis attitude in the brazilian electricity sector. Ambiente & Sociedade, 19(2), 221–246. https://doi.org/10.1590/1809-4422ASOC0260R1V1922016

Braun, Y. (2005). Resettlement and Risk: Women's Community Work in Lesotho. Advances in Gender Research, 9, 29–60. https://doi.org/10.1016/S1529-2126(05)09006-5

Braun, Y. A. (2011). The Reproduction of Inequality: Race, Class, Gender, and the Social Organization of Work at Sites of Large-Scale Development Projects. Social Problems, 58(2), 281–303. https://doi.org/10.1525/sp.2011.58.2.281

Brondizio, E. S. (2008). The Amazonian Caboclo and the Açaí Palm. Forest Farmers in the

Global Market. New York: The New York Botanical Garden Press.

Brook, R. K., & McLachlan, S. M. (2008). Trends and prospects for local knowledge in ecological and conservation research and monitoring. Biodiversity and Conservation, 17(14), 3501–3512. https://doi.org/10.1007/s10531-008-9445-x

Cavendish, W. (2000). Empirical regularities in the poverty-environment relationship of rural households: Evidence from Zimbabwe. World Development, 28(11), 1979–2003. https://doi.org/10.1016/S0305-750X(00)00066-8

Cetra, M., & Petrere Jr, M. (2001). Small-scale fisheries in the middle River Tocantins, Imperatriz (MA), Brazil. Fisheries Management and Ecology, 8(2), 153–162. https://doi.org/10.1046/j.1365-2400.2001.00233.x

Charnley, S., Fischer, a. P., & Jones, E. T. (2007). Integrating traditional and local ecological knowledge into forest biodiversity conservation in the Pacific Northwest. Forest Ecology and Management, 246(1), 14–28. https://doi.org/10.1016/j.foreco.2007.03.047

Cooke, S. J., Allison, E. H., Beard, T. D., Arlinghaus, R., Arthington, A. H., Bartley, D. M., … Welcomme, R. L. (2016). On the sustainability of inland fisheries: Finding a future for the forgotten. Ambio, (June), 1–12. https://doi.org/10.1007/s13280-016-0787-4

De Francesco, A., & Carneiro, C. (2015). Atlas do impatos da UHE Belo Monte sobre a pesca. Sao Paulo.

EIA. (2015). Brazil. International energy data and analysis. Retrieved from https://www.eia.gov/beta/international/analysis_includes/countries_long/Brazil/brazil.pdf

Electrobrás, Ministério de Minas e Energía, Governo Federal Brasil, Andrade Gutierrez, Camargo Correa, & ODEBRECHT. (2009). Rima. Relatório de Impacto Ambiental. Aproveitamento Hidrelétrico Belo Monte.

Failing, L., Gregory, R., & Harstone, M. (2007). Integrating science and local knowledge in environmental risk management: A decision-focused approach. Ecological Economics, 64(1), 47–60. https://doi.org/10.1016/j.ecolecon.2007.03.010

Fainguelernt, M. (2016). A trajetoria historica do processo de licenciamento ambiental da usina hidreletica de Belo Monte. Ambiente & Sociedade, XIX(2), 247–265.

FAO. (2013). El rol de la Mujer en la Pesca y Acuicultura en Chile, Colombia, Paraguay y Peru. Santiago de Chile.

FAO. (2014). The State of World Fisheries and Aquaculture 2014. Rome: Food and Agriculture Organization of the United Nations.

FAO. (2016). The State of World Fisheries and Aquaculture. Contributing to food security and nutrition for all. Rome: Food and Agriculture Organization of the United Nations.

Fearnside, P. M. (1995). Hydroelectric Dams in the Brazilian Amazon as Sources of "Greenhouse" Gases. Environmental Conservation, 22(1), 7. https://doi.org/10.1017/S0376892900034020

Fearnside, P. M. (1999). Social impacts of Brazil's Tucurui Dam. Environmental Management, 24(4), 483–495. https://doi.org/10.1007/s002679900248

Fearnside, P. M. (2006). Dams in the Amazon: Belo Monte and Brazil's Hydroelectric Development of the Xingu River Basin. Environmental Management, 38(1), 16–27. https://doi.org/10.1007/s00267-005-0113-6

Fearnside, P. M. (2014). Impacts of Brazil's Madeira River Dams: Unlearned lessons for hydroelectric development in Amazonia. Environmental Science and Policy, 38, 164–172. https://doi.org/10.1016/j.envsci.2013.11.004

Fearnside, P. M. (2015). Emissions from tropical hydropower and the IPCC. Environmental Science & Policy, 50(Table 1), 225–239. https://doi.org/10.1016/j.envsci.2015.03.002

Fearnside, P. M. (2016). Environmental and Social Impacts of Hydroelectric Dams in Brazilian Amazonia: Implications for the Aluminum Industry. World Development, 77, 48–65. https://doi.org/10.1016/j.worlddev.2015.08.015

Fernandes, M. (2016). Os Atingidos de Belo Monte Experiências de sofrimento e agravos à saúde no contexto de um megaprojeto hidroelectrico na Amazonia brasileira. Universidade de Coimbra.

Fleury, L. C., & Almeida, J. (2013). A construção da usina hidrelétrica de Belo Monte: Conflito ambiental e o dilema do desenvolvimento. Ambiente & Sociedade, 16(4), 141–158.

Gaspare, L., Bryceson, I., & Kulindwa, K. (2015). Complementarity of fishers' traditional ecological knowledge and conventional science: Contributions to the management of groupers (Epinephelinae) fisheries around Mafia Island, Tanzania. Ocean and Coastal Management, 114, 88–101. https://doi.org/10.1016/j.ocecoaman.2015.06.011

Gauthier, C. (2017). Public Policy and Sanitation Issues raised by Amazonian Dam Expansion. In Annual Meeting Association of American Geographers. Boston, MA.

Goulding, M. (1980). The fishes and the forest, explorations in Amazonian natural history. Berkeley, Los Angeles: University of California Press.

Goulding, M., Smith, N., & Mahar, D. J. (1996). Floods of Fortune. Ecology & Economy Along the Amazon. New York: Columbia University Press.

Grisotti, M. (2016). the Construction of Health Causal Relations in the Belo Monte Dam Context. Ambiente & Sociedade, 19(2), 287–304. https://doi.org/10.1590/1809-4422ASOC0252V1922016

Hall, a., & Branford, S. (2012). Development, Dams and Dilma: the Saga of Belo Monte. Critical Sociology, 38(6), 851–862. https://doi.org/10.1177/0896920512440712

Hallwass, G., Lopes, P. F., Juras, A. a., & Silvano, R. a M. (2013). Fishers' knowledge identifies environmental changes and fish abundance trends in impounded tropical rivers. Ecological Applications, 23(2), 392–407. https://doi.org/10.1890/12-0429.1

Haraway, D. (1991). Situated Knowledges: the science question in Feminism and the privilege of partial perspective. In Simians , Cyborgs , and Women: The reinvention of nature. New York, NY: Taylor & Francis Group.

Harper, S., Zeller, D., Hauzer, M., Pauly, D., & Sumaila, U. R. (2013). Women and fisheries: Contribution to food security and local economies. Marine Policy, 39, 56–63. https://doi.org/10.1016/j.marpol.2012.10.018

IEA. (2012). Technology Roadmap: Hydropower. Paris, France.

IEA. (2015). IEA Statistics: Renewables Information. Paris, France.

IHA. (2003). The Role of Hydropower in Sustainable Development. IHA White Paper (Vol. 13). Retrieved from http://www.ewra.net/ew/pdf/EW_2006_13-14_08.pdf

IHA. (2015). 2015 Hydropower Status Report.

IPCC. (2014). Mitigation of Climate Change - Working Group III Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. (O. Edenhofer, R. Pichs-Madruga, Y. Sokona, J. C. Minx, E. Farahani, S. Kadner, … T. Zwickel, Eds.). United Kingdom and New York, USA, USA: Cambridge University Press. Retrieved from http://report.mitigation2014.org/spm/ipcc_wg3_ar5_summary-for-policymakers_approved.pdf

Isaac, V., Almeida, M., Cruz, R., & Nunez, L. (2015). Artisanal fisheries of the Xingu River basin in Brazilian Amazon. Brazilian Journal of Biology, 75(3), 125–137.

Johannes, R. E., Freeman, M., & Hamilton, R. J. (2000). Ignore fishers' knowledge and miss the boat. Fish and Fisheries, 1, 257–271. https://doi.org/http://dx.doi.org/10.1046/j.1467-2979.2000.00019.x

Johannes, R. E., & Neis, B. (2007). The value of Anecdote. In N. Haggan, B. Neis, & I. G. Baird (Eds.), Fishers' Knowledge in Fisheries Science and Management (pp. 41–58). France: UNESCO.

Junk, W. J., & Mello, J. a. S. N. De. (1990). Impactos ecológicos das represas hidrelétricas na bacia amazônica brasileira. Estudos Avançados, 4(8), 126–143. https://doi.org/10.1590/S0103-40141990000100010

Kebe, M. (2009). Taking the contribution of fisheries into account in development policy. In Å. Barklund (Ed.), Fisheries, Sustainablility and Development (pp. 365–376). Royal Swedish Academy of Agriculture and Forestry (KSLA).

Kelkar, M. (2007). Local knowledge and natural resource management: A gender perspective. Indian Journal of Gender Studies, 14(2), 295–306. https://doi.org/10.1177/097152150701400205

Koch, F. H. (2002). Hydropower - The politics of water and energy: Introduction and overview. Energy Policy, 30(14), 1207–1213. https://doi.org/10.1016/S0301-4215(02)00081-2

Lentisco, A., & Lee, R. U. (2015). A Review of Women's Access to Fish in Small-Scale Fisheries (Vol. 1098). Rome: Food and Agriculture Organization of the United Nations.

Leonard, S., Parsons, M., Olawsky, K., & Kofod, F. (2013). The role of culture and traditional knowledge in climate change adaptation: Insights from East Kimberley, Australia. Global Environmental Change, 23(3), 623–632. https://doi.org/10.1016/j.gloenvcha.2013.02.012

Lynch, A. J., Cooke, S. J., Deines, A. M., Bower, S. D., Bunnell, D. B., Cowx, I. G., … Beard, T. D. (2016). The social, economic, and environmental importance of inland fish and fisheries. Environmental Reviews, 24(2), 115–121. https://doi.org/10.1139/er-2015-0064

Manyari, W. V., & de Carvalho, O. A. (2007). Environmental considerations in energy planning for the Amazon region: Downstream effects of dams. Energy Policy, 35(12), 6526–6534. https://doi.org/10.1016/j.enpol.2007.07.031

Marques, J. G. (2001). Pescando Pescadores: Ciência y etnociência em uma perspectiva ecológica (2da. Ediçã). Sao Paulo: Núcleo de apoio à pesquisa sobre populações humanas e áreas úmidas brasileiras, USP.

McGrath, D. G., de Castro, F., Futemma, C., & Domingues de Amaral, Benedit Calabria, J. (1993). Fisheries and the Evolution of Resource Management on the Lower Amazon Floodplain. Human Ecology, 21(2), 167–195. https://doi.org/10.1007/BF00889358

Meinzen-Dick, R., Kovarik, C., & Quisumbing, A. R. (2014). Gender and Sustainability. Annual Review of Environment and Resources, 39(1), 29–55. https://doi.org/10.1146/annurev-environ-101813-013240

Meinzen-dick, R. S., Feldstein, S., & Quisumbing, A. R. (1997). Gender , Property Rights , and Natural Resources, 25(8), 1303–1315.

Miles, M., Huberman, A. M., & Saldaña, A. (2014). Qualitative data analysis: A methods sourcebook. SAGE Publications.

Mills, D., Westlund, L., de Graaf, G., Kura, Y., Willman, R., & Kelleher, K. (2011). Under-reported and Undervalued Small-Scale Fisheries in the Developing World. In R. Pomeroy & N. Andrew (Eds.), Small-scale Fisheries Management (pp. 1–15). CABI.

Moran, E. F. (1974). The adaptive system of the Amazonian caboclo. In C. Wagley (Ed.), Man in the Amazon (pp. 136–159). Gainesville: University of Florida Press.

Moran, E. F. (1981). Developing the Amazon. Bloomington: Indiana University Press.

Moran, E. F. (2016). Roads and Dams: Infrastructure-Driven Transformations in the Brazilian Amazon. Ambiente & Sociedade 2016, XIX, 207–220. https://doi.org/10.1590/1809-4422ASOC256V1922016

Orr, S., Pittock, J., Chapagain, A., & Dumaresq, D. (2012). Dams on the Mekong River : Lost fish protein and the implications for land and water resources. Global Environmental Change, 22(4), 925–932. https://doi.org/10.1016/j.gloenvcha.2012.06.002

Ortner, S. B. (1974). Is Female to Male as Nature Is to Culture? Woman, Culture, and Society, 68–87. https://doi.org/10.2307/3177638

Oud, E. (2002). The evolving context for hydropower development. Energy Policy, 30(14), 1215–1223. https://doi.org/10.1016/S0301-4215(02)00082-4

Pereira, G. (2002). Women in fisheries in Latin America. Global Symposium on Women in Fisheries: Sixth Asian Fisheries Forum, 175–180.

Presidência da República. LEI No 10.779, DE 25 DE NOVEMBRO DE 2003. (2003). Brasil. Retrieved from http://www.planalto.gov.br/ccivil_03/LEIS/2003/L10.779.htm

REN21. (2015). Renewables 2015 Global Status Report. Annual Reporting of Renewables: Ten years of excellence. Paris. Retrieved from http://www.ren21.net/wp-content/uploads/2015/07/REN12-GSR2015_Onlinebook_low_nolinks.pdf

Richter, B. D., Postel, S., Revenga, C., Scudder, T., Lehner, B., Churchill, A., & Chow, M. (2010). Lost in development's shadow: The downstream human consequences of dams. Water Alternatives, 3(2), 14–42. https://doi.org/10.1007/s11195-009-9131-2

Rocheleau, D., Thomas-Slayter, B., & Wangari, E. (1996). Gender and Environment. A

feminist political ecology perspective. In D. Rocheleau, B. Thomas-Slayter, & E. Wangari (Eds.), Feminist Political Ecology: Global Issues and Local Experiences (pp. 3–23). New York: Routledge.

Siar, S. V. (2003). Knowledge, gender, and resources in small-scale fishing: the case of Honda Bay, Palawan, Philippines. Environmental Management, 31(5), 569–80. https://doi.org/10.1007/s00267-002-2872-7

Siciliano, G., Urban, F., Kim, S., & Lonn, P. D. (2015). Hydropower, social priorities and the rural–urban development divide: The case of large dams in Cambodia. Energy Policy, 86, 273–285. https://doi.org/10.1016/j.enpol.2015.07.009

Silvano, R., & Begossi, A. (2012). Fishermen's local ecological knowledge on Southeastern Brazilian coastal fishes: contributions to research, conservation, and management. Neotropical Ichthyology, 10(1), 133–147. https://doi.org/10.1590/S1679-62252012000100013

Silvano, R., & Valbo-Jørgensen, J. (2008). Beyond fishermen's tales: contributions of fishers' local ecological knowledge to fish ecology and fisheries management. Environment, Development and Sustainability, 10(5), 657–675. https://doi.org/10.1007/s10668-008-9149-0

Silvano, Juras, A., & Begossi, A. (2005). Clean energy and poor people: ecological impacts of hydroelectric dams on fish and fishermen in the Amazon rainforest. Energy, Environment, Ecosystems, Development and Landscape Architecture, 139–147.

Smith, L. E. D., Khoa, S. N., & Lorenzen, K. (2005). Livelihood functions of inland fisheries: policy implications in developing countries. Water Policy, 7, 359–383. Retrieved from http://fisheriessolutions.org/wp-content/uploads/2015/02/Smith-SNK-KL-2005.pdf

Smith, N. (1981). Man, Fishes, and the Amazon. New York: Columbia University Press.

Soito, J. L. D. S., & Freitas, M. a V. (2011). Amazon and the expansion of hydropower in Brazil: Vulnerability, impacts and possibilities for adaptation to global climate change. Renewable and Sustainable Energy Reviews, 15(6), 3165–3177. https://doi.org/10.1016/j.rser.2011.04.006

Sousa Junior, W. C., & Reid, J. (2010). Uncertainties in Amazon hydropower development: Risk scenarios and environmental issues around the Belo Monte dam. Water

Alternatives, 3(2), 249–268. Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-77956637011&partnerID=tZOtx3y1

Sousa Júnior, W., Leitão, N., & Reid, J. (2006). Custos e benefícios do complexo hidrelétrico Belo Monte: Uma abrodagem econômico-ambiental (4th ed.). Conservation Strategy Found. Retrieved from http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Custos+e+benef?cios+do+complexo+hidrel?trico+Belo+Monte:+Uma+abrodagem+econ?mico-ambiental#0

Stenberg, R. (2006). Damming the river: a changing perspective on altering nature. Renewable and Sustainable Energy Reviews, 10(3), 165–197. https://doi.org/10.1016/j.rser.2004.07.004

Stickler, C. M., Coe, M. T., Costa, M. H., Nepstad, D. C., McGrath, D. G., Dias, L. C. ., … Soares-Filho, B. (2013). Dependence of Hydropower generation on forests in the Amazon Basin at local to regional scales. Proceedings of the National Academy of Sciences of the United States of America, 110(23), 9601–9606. https://doi.org/10.1073/pnas.1215331110

Sunderland, T., Achdiawan, R., Angelsen, A., Babigumira, R., Ickowitz, A., Paumgarten, F., … Shively, G. (2014). Challenging Perceptions about Men, Women, and Forest Product Use: A Global Comparative Study. World Development, 64(S1), S56–S66. https://doi.org/10.1016/j.worlddev.2014.03.003

Tengö, M., Brondizio, E. S., Elmqvist, T., Malmer, P., & Spierenburg, M. (2014). Connecting diverse knowledge systems for enhanced ecosystem governance: The multiple evidence base approach. Ambio, 43(5), 579–591. https://doi.org/10.1007/s13280-014-0501-3

Terry, G. (2009). No climate justice without gender justice : an overview of the issues No climate justice without gender justice : an overview of the issues. Gender and Development, 17(1, Climate changes and climate justice), 5–18. https://doi.org/10.1080/13552070802696839

Thornton, T. F., & Scheer, A. M. (2012). Collaborative engagement of local and traditional knowledge and science in marine environments: A review. Ecology and Society, 17(3). https://doi.org/10.5751/ES-04714-170308

Tilt, B., Braun, Y., & He, D. (2009). Social impacts of large dam projects: A comparison of international case studies and implications for best practice. Journal of Environmental Management, 90(SUPPL. 3), S249–S257. https://doi.org/10.1016/j.jenvman.2008.07.030

Trussart, S., Messier, D., Roquet, V., & Aki, S. (2002). Hydropower projects: A review of most effective mitigation measures. Energy Policy, 30(14), 1251–1259. https://doi.org/10.1016/S0301-4215(02)00087-3

Verchick, R. R. M. (2004). Feminist Theory and Environmental Justice. In R. Stein (Ed.), New Perspectives on Environmental Justice: Gender, Sexuality, and Activism (pp. 63–77). Rutgers University Press.

von Sperling, E. (2012). Hydropower in Brazil: Overview of positive and negative environmental aspects. Energy Procedia, 18, 110–118. https://doi.org/10.1016/j.egypro.2012.05.023

Wagley, C. (1953). Amazon Town. A Study of Man in the Tropics (1976th ed.). New York: Macmillan.

WBG. (2009). Directions in Hydropower: Scaling up for development. Water Working Notes.

WCD. (2000). Dams and development: a New Framework for Decision-Making. The report of the World Comission on Dams (Vol. 23). London. https://doi.org/10.1097/GCO.0b013e3283432017

Weeratunge, N., Snyder, K. A., & Sze, C. P. (2010). Gleaner, fisher, trader, processor: Understanding gendered employment in fisheries and aquaculture. Fish and Fisheries, 11(4), 405–420. https://doi.org/10.1111/j.1467-2979.2010.00368.x

Welcomme, R. L. (2011). An overview of global catch statistics for inland fish. ICES Journal of Marine Science, 68(8), 1751–1756. https://doi.org/10.1093/icesjms/fsr035

Welcomme, R. L., Cowx, I. G., Coates, D., Béné, C., Funge-Smith, S., Halls, A., & Lorenzen, K. (2010). Inland capture fisheries. Philosophical Transactions: Biological Sciences, 36(1554), 2881–2896. https://doi.org/10.1098/rstb.2010.0168

Williams, S. B., Hochet-Kibongui, A.-M., & Nauen, C. (2005). Gender, fisheries and aquaculture: Social capital and knowledge for the transition towards sustainable use of aquatic ecosystems. Brussels.

Winemiller, K. O., McIntyre, P. B., Castello, L., Fluet-Chouinard, E., Giarrizzo, T., Nam, S., … Saenz, L. (2016). Balancing hydropower and biodiversity in the Amazon, Congo, and Mekong. Science, 351(6269), 128–129. https://doi.org/10.1126/science.aac7082

Witkoski, A. C. (2010). Terras, Florestas e Águas de Trabalho. Os Camponeses Amazônicos e formas de uso de seus recursos naturais. (A. C. Witkoski, Ed.). São Paulo: Annablume.

Yüksel, I. (2009). Dams and Hydropower for Sustainable Development. Energy Sources, Part B: Economics, Planning, and Policy, 4(1), 100–110. https://doi.org/10.1080/15567240701425808

Yüksel, I. (2010). Hydropower for sustainable water and energy development. Renewable and Sustainable Energy Reviews, 14(1), 462–469. https://doi.org/10.1016/j.rser.2009.07.025

Zarfl, C., Lumsdon, A. E., Berlekamp, J., Tydecks, L., & Tockner, K. (2014). A global boom in hydropower dam construction. Aquatic Sciences, 77(1), 161–170. https://doi.org/10.1007/s00027-014-0377-0