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SciELO

THE SOCIOENVIRONMENTAL PERCEPTION OF THE ONES AFFECTED BY THE HYDROELECTRIC POWER PLANTS ALONG THE ARAGUARI RIVER/AP, EASTERN AMAZON

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Abstract: The establishment of a hydroelectric power plant commonly involves conflict between the local traditional people and the hydroelectric enterprises. The research aims to analyse the perceptions of residents of the municipality of Ferreira Gomes about the social and economic impacts of three hydroelectric dams (Coaracy Nunes, Ferreira Gomes and Cachoeira Caldeirão) installed on the Araguari River, Amapá. The data was obtained through submitting the locals to a semi-structured form, whose sample was calculated utilizing the "Central Limit Theorem', which later was charted and analysed. The research has shown that the dams established new social and economic dynamics in the affected populace's daily life, mostly negative ones, which hit directly and indirectly the quality of life, health, income, cost of living and security of the local people.

Keywords: Social impacts; Social conflicts; Social-economic dynamics; Traditional people; Hydroelectric enterprises.

São Paulo. Vol. 26, 2023

Original Article

DOI: http://dx.doi.org/10.1590/1809-4422asoc20210216r2vu2023L1OA

Introduction

The Brazilian electricity sector considers hydroelectricity to be poorly explored, but attractive, in the Amazon owing to its low cost and renewability, thus expanding the sector to meet the increasing demand for power in the country. However, the installation and implementation of major infrastructure works, such as hydropower plants (HPP), have significant socio-environmental (SE) impacts, such as flooding and the consequent loss of local biodiversity, along with landscape changes, compulsory displacement of populations affected by construction, and the appropriation of indigenous lands and conservation units (BERMANN, 2008; CRUZ, 2017).

Historically, in the Amazon, HPPs are installed in social spaces first settled by riverine populations for fishing and agriculture. However, hydropower projects occupy these spaces, giving rise to socio-environmental conflicts that can result in the appropriation of land in exchange for hydropower generation for some and social use of sociocultural reproduction as a way of life for others. Conflicts with native groups, traditional residents, fishermen, riverside population and potters from alluvial floodplains cause both great and historical losses of localities (BERMANN, 2007; BORGES; SILVA, 2011).

Understanding these conflicts based on perceptions of the affected population allows researchers to identify and measure the environmental, social and economic damage caused by dams, which, in turn, aids in decision-making aimed at developing steps to mitigate the impacts (PEIXER, 1993; BORGES; SILVA, 2011; CRUZ, 2017).

Populations can assign both positive and negative perceptions to the impacts caused by hydropower projects, while individuals may be divided in their perceptions of dam construction and its consequences. Therefore, formed perceptions can be both collective and individual and take into account historical and cultural aspects, including universal and local sociopolitics. Local politics comes into play when either defending or criticizing HPPs and the effects following construction (PEIXER, 1993).

In this context, this study aimed to assess the perceptions of residents living in Ferreira Gomes municipality on the social and economic impacts of three hydropower plants (Coaracy Nunes, Ferreira Gomes and Cachoeira Caldeirão) installed on the Araguari River, state of Amapá. Specifically, we asked how perceptions of the urban population of Ferreira Gomes municipality changed after the installation of a hydropower plant in the middle Araguari River.

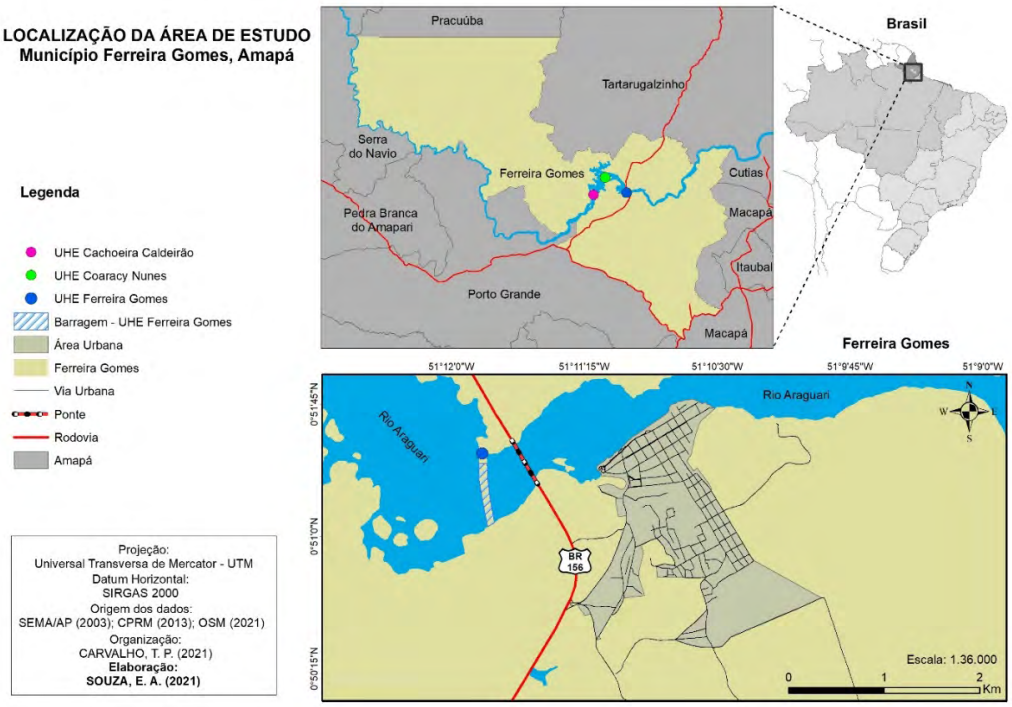
Methodology

Study area

The study area is the seat of the municipality of Ferreira Gomes, state of Amapá, Brazil (Figure 1), which is located downstream of HPPs Ferreira Gomes, Coaracy Nunes and Cachoeira Caldeirão. According to Silva *et al.* (2016), Santos *et al.* (2017) and Corrêa (2018), this is the population most affected by impacts produced by these hydropower

projects on the Araguari River.

Figure 1 – Location of the study area



Source: Prepared by the authors, 2021.

The municipality of Ferreira Gomes is bounded to the north by the municipalities of Pracuúba and Tartarugalzinho, to the east by the municipalities of Cutias and Macapá, to the southwest by the municipality of Porto Grande and to the northwest by the municipality of Serra do Navio. Its territorial area is 4,973.85 km^2 with an estimated 8,151 inhabitants in 2021 (IBGE, 2021). The three studied HPPs are located within the territory of the municipality of Ferreira Gomes and in the Araguari River basin, exclusively within the state of Amapá/Brazil, including 42,700km^2 of drainage area (BÁRBARA *et al.* 2010; CUNHA *et al.*, 2011).

The Coaracy Nunes Hydropower Plant (CNHPP), also known as Usina do Paredão, was the first hydropower plant installed in the Brazilian Amazon, starting construction in the mid-1950s and operating from 1976 onwards. At that time, no requirements for Environmental Impact Study (EIA) or Environmental Impact Report (RIMA) had been established (FARIA, 2006). It currently has 78 MW of installed power.

The Ferreira Gomes Hydropower Plant (FGHPP) is located close to the eponymous urban area and next to the Tancredo Neves Bridge on BR-156, the main interstate highway in Amapá. This hydropower plant operates on a run-of-river basis, which means that all the water the river brings in passes through the spillway or through the turbines

and follows its course downstream. Therefore, it is not necessary to form large reservoirs, and water storage is minimal. Its total installed power is 252 MW, and it has a reservoir of 17.72 km^2, of which 6.5 km^2 is the natural bed of the Araguari River with more than 10 km^2 of flooded areas (ECOTUMUCUMAQUE, 2009). Work began in 2010, and the plant began operations in 2015.

The Cachoeira Caldeirão Hydropower Power Plant (CCHPP) is located upstream of the Coaracy Nunes HPP. It has an installed capacity of 219 MW with a reservoir of 47.99 km^2, and it also operates in a run-of-river mode. Work began in September 2013, and the plant went into commercial operation in August 2016, fully realizing its energy potential.

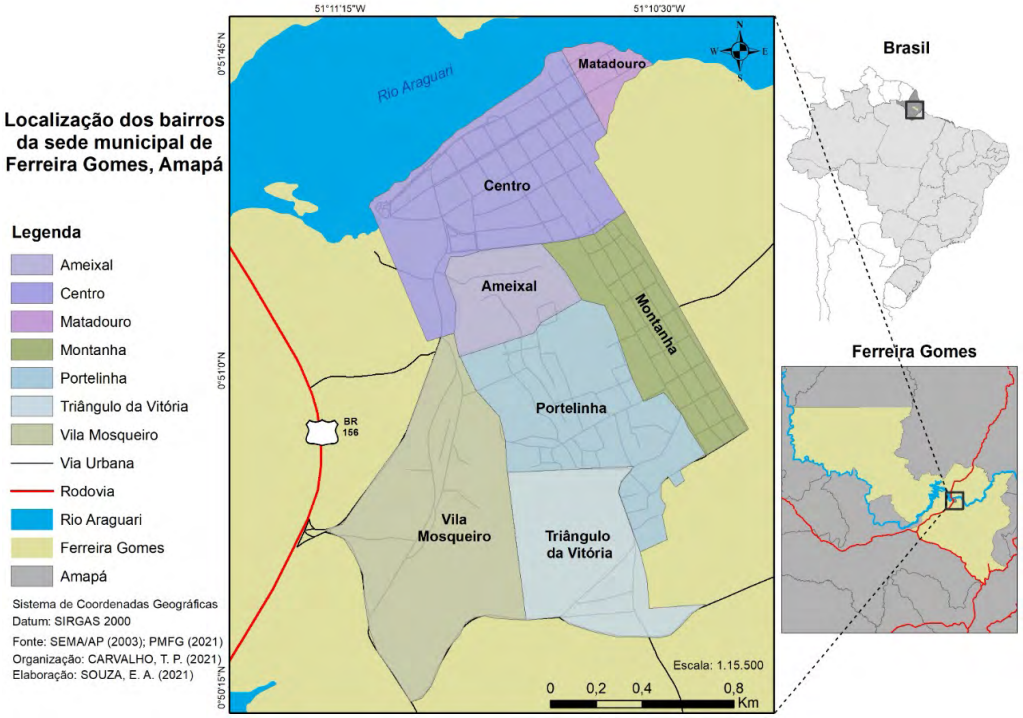
Data collection

Using a semi-structured form, data were collected from the residents of the urban area of the municipality of Ferreira Gomes, state of Amapá. These data gathered information useful in analyzing perceptions about the construction and operation of CNHPP, FGHPP and CCHPP. To support the study, researchers consulted scientific articles, books and other documents (official data, EIA, RIMA, Participatory Master Plan of the municipality of Ferreira Gomes, photos and newspapers) in order to substantiate the problems engaged in this study, as well as field research with on-site observation of the study.

The form was divided into two parts. One part was devoted to profiling participants, and the other part outlined the central object of this research, together with a questionnaire about the socioeconomic aspects of the municipality of Ferreira Gomes. Personal data requested from the participants were birth gender, age, neighborhood, place of birth (city and state), time of residence in the studied municipality, occupation, level of education, monthly family income, number of people living in the same household and number of people contributing to the family income. The questionnaire solicited opinions from participants who were asked about the influence of the FGHPP and CCHPP facilities on the socioeconomics of the municipality. The table given in Results and Discussion organizes responses according to three options: 'increased', 'decreased' and 'same'.

Data were collected in January 2021 in the urban perimeter of the municipality of Ferreira Gomes. The municipality currently has seven official neighborhoods: Centro, Matadouro, Montanha, Ameixal, Portelinha, Triângulo da Vitória and Vila Mosqueiro (Figure 2). The survey included all these districts.

Figure 2 – Neighborhoods of the municipality of Ferreira Gomes, state of Amapá



Source: Prepared by the authors, 2021.

Selection of participants

To limit the number of participants for statistical relevance, it was necessary to apply the Central Limit Theorem for sample size calculation. When the sample size is large enough, the mean distribution is an approximately normal distribution, which is pertinent to the interests of the present study (SOARES *et al.*, 2019). In this sense, the following formula was used:

$$n = \frac{\frac{z^2 \times p(1-p)}{e^2}}{1 + \left(\frac{z^2 \times p(1-p)}{e^2 \times N}\right)}$$

where

n = sample size;

N = size of the universe;

e = margin of error (percentage in decimal format);

z = deviation from the mean value that is accepted to reach the desired confidence level; and

p = proportion expected to be found.

Sample size was based on total population in the urban perimeter of Ferreira Gomes, which was estimated to be 7,967 people, according to the IBGE (2020). Of this total, 72% of the population lived in the urban area based on 2010 census data. Therefore, N (size of the universe) is 5,736 people, which is the number of people living in the urban area of Ferreira Gomes and the central object of this research.

In this study, a confidence interval (CI) of 95% was adopted with a margin of error of 10%. CI is an estimate that assumes a greater probability of the percentage of the studied population, in this case the sample, represents the real number of the source population, providing a higher reliability as to the result of the object of study. The margin of error determines the maximum error estimate of the results of a survey (DOWNING; CLARK, 2011; GREENLAND *et al.*, 2016).

Participants had to be residents of the municipality of Ferreira Gomes for more than five years and over 18 years old. That time requirement would allow for the formation of opinions about events in the social, economic, political and environmental spheres during the construction of the FGHPP and CCHPP to the present day. Only one semi-structured form was applied per household to avoid possible interference with or repetition of information.

Data analysis

The collected data were tabulated and organized in electronic spreadsheets (Microsoft Excel) and categorized for statistical analysis in order to prepare for subsequent descriptive analysis of the results. The treated data are a percentage representation of the sample universe of 95 participants.

Ethics

This research was submitted to the Research Ethics Committee of the Federal University of Amapá (UNIFAP), which was approved and registered under code CAAE: 40799520.0.0000.0003/UNIFAP, meeting the requirements of Resolution 510, of April 6 and 7, 2016. All participants signed informed consent.

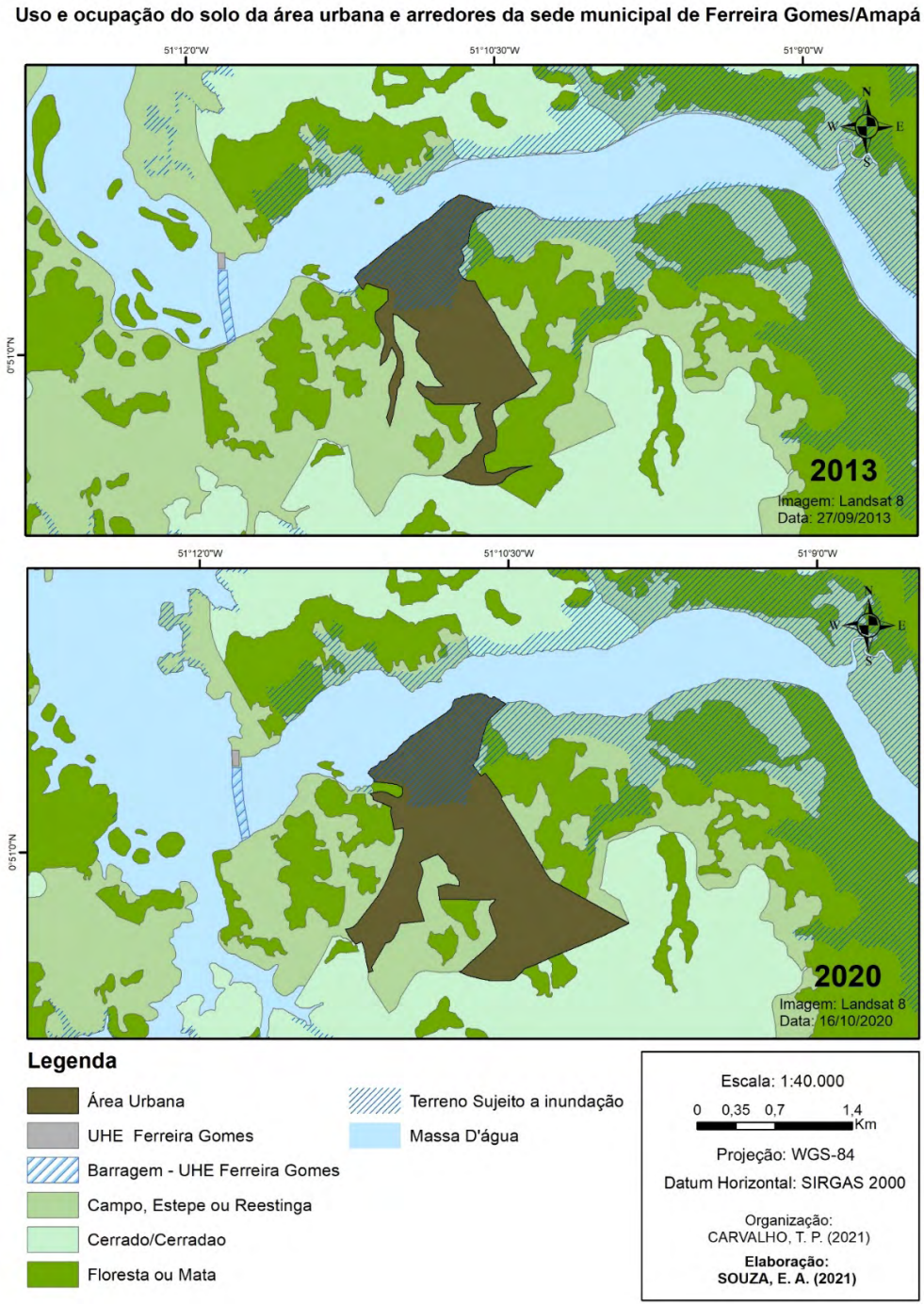
Results and Discussion

In this study, most participants indicated low education (up to completion of high school), low family income and residence time of more than 10 years in the municipality of Ferreira Gomes. As noted previously, this span of time allows for evolution of the municipality in terms of events resulting from the construction of the FGHPP and CCHPP

on the Araguari River. The age group with the highest participation in the study was from 31 to 50 years (58.95%). Most participants were self-employed (42.10%) housewives, retirees, salespeople, fishermen, micro-entrepreneurs, farmers and traders.

According to field research, spatial distribution showed a greater concentration of participants in the Centro, Montanha, Matadouro and Ameixal neighborhoods. The neighborhoods closest to the Araguari River (Figure 2) are the oldest and, hence, form the beginnings of the occupation of the municipality. For riverside communities, Brito and Almeida (2017) explain that the trend for population growth starts at the riverbank and moves toward more distant regions. Therefore, the results are consistent with local reality. As shown in Figure 3, occupation increased in the urban area of Ferreira Gomes after the implementation of HPPs Ferreira Gomes and Cachoeira Caldeirão.

Figure 3 – Growth of the urban area of Ferreira Gomes during and after the construction of HPPs Ferreira Gomes and Cachoeira Caldeirão



Source: Prepared by the authors, 2021.

Figure 3 shows the landscape of the Araguari River and the municipality of Ferreira Gomes at the beginning CCHPP construction and the final phase of FGHPP construction in 2013. Then, in 2020, Figure 3 shows the current landscape created by flood areas resulting from the formation of reservoirs and operation of all three hydropower plants. Urban growth and the emergence of new neighborhoods can be seen in the peripheral regions, such as Portelinha and Triângulo da Vitória. In addition, the land prone to flooding includes part of the neighborhoods on the banks of the Araguari River, demonstrating the harmful effect to the environment and dangers to the local population caused by close proximity to hydropower plants.

The municipality of Ferreira Gomes became, in a way, an extension of the construction site of the FGHPP and CCHPP. Work on these projects began in 2010-2014 and 2013-2016, respectively, and in this period, the municipality received most of the migratory flow of workers. As a consequence of this flow, social dynamics were altered, constituting an evident population growth in the region and triggering what is commonly termed urban sprawl, i.e., occupation not foreseen in the Participatory Master Plan of the municipality of Ferreira Gomes (FERREIRA GOMES, 2013).

The study by Massoli (2014) cites the negative aspects arising from the construction of the Estreito HPP, such as population growth, crime and prostitution, as well as abandonment of families and environmental degradation, including the displacement or extinction of native fauna. The author suggests problems of public order since the community was not prepared for the expansion of space brought about by the migration and resettlement of plant workers, nor was it prepared to manage issues of public safety or the control and monitoring of environmental perturbances. This is similar to what happened in Ferreira Gomes with the transformation of the urban space and the social framework.

The table below describes the perception of Ferreira Gomes residents about the socioeconomic repercussions following the construction of the FGHPP and CCHPP, including changes in the daily life of the affected population with respect to the quality of life, health, food, leisure, public safety and housing.

Table – Socioeconomic aspects

SOCIOECONOMIC ASPECTS			
	Increased	Decreased	The same
Offer of regional agricultural products	9,47%	55,79%	34,74%
Offer of regional fish products	5,26%	86,32%	8,42%
Water quality for domestic consumption	7,37%	68,42%	24,21%
Waterborne diseases	60,00%	4,21%	35,79%
Quality of bathing places (local tourism)	20,00%	50,53%	29,47%
Commercial activities	48,42%	31,58%	20,00%
Cost of electricity	89,47%	1,05%	9,47%

Living costs	80,00%	7,37%	12,63%
Job opportunities	11,58%	74,74%	13,68%
Criminality	78,95%	10,53%	10,53%
Housing costs	69,47%	23,16%	7,37%
Number of inns or hotels	45,26%	22,11%	32,63%
Quality of life	20,00%	31,58%	48,42%

Source: Prepared by the authors (Field research, 2021).

This table shows that a majority of participants perceived a decrease in offers for agricultural products by 55.79% of participants and regional fish products by 86.32% of participants. These negative perceptions are a direct consequence HPP construction. The literature shows that the flooding of agricultural areas used for family farming and small rural producers and resultant decline in fish fauna stocks and increase in fish mortality were among the first impacts of the dam (MENESTRINO; PARENTE, 2011; ROCHA, 2014; CARVALHO *et al.*, 2020).

The study by Lopes and Brito (2021) investigated impacts of the implementation of the Santo Antônio do Jari Hydropower Plant on riverside communities in southern Amapá and revealed a decrease in arable land, mainly caused by flooding to fill the reservoir. Residents of the Jari River Valley reported difficulties in accessing agricultural products with consequent food insecurity.

Impacts on agricultural products occur mainly from the low value of flooded properties; conversely, land close to the dams was overvalued, making it hard to sell in one case and hard to buy in another. Meanwhile, carrying out agricultural activities, as before, becomes unrealistic (PAZ, 2006; ROCHA, 2014).

Decrease in the offer of fish products is widely debated in the literature, largely owing to changes in aquatic environments that directly affect fish production, quality and quantity. According to Miranda *et al.* (2013), it is expected that impacts from dams will promote changes in the richness and abundance of species based on riverine reconfiguration by formation of reservoirs and likely decrease in water flow in some river stretches.

The study by Santos *et al.* (2017) aimed to analyze affected fishing communities before and after filling the FGHPP reservoir. The study reported a forced and severe socioeconomic adaptation with a drastic decrease in monthly income and increase in fishing production costs, along with the loss of fish sales and fish mortality owing to aquatic contamination from changes in the physicochemical characteristics of the water in the Araguari River.

This also happened to fishermen near Peixe Angical HPP, state of Tocantins, as reported by Souza *et al.* (2016). However, in addition to the decline in fishing, self-employment increased by the lack of competitiveness when attempting to enter a formal labor market with few technical skills and little education and training. The results in the present study corroborate those of Silva and Paula (2018) who cited the plight of Ponta de Abunã fishermen and the reduced availability of fish after the start of construction on the Jirau HPP, Madeira River, state of Rondônia.

In the present study, participants perceived a reduction in water quality for domestic consumption (68.42%). The water supply in the urban area of Ferreira Gomes is carried out through Amazon dug wells[1] and distributed by the public network. However, facilities have degraded with compromised treatment quality. This has contributed to the emergence of waterborne diseases and high infant mortality. Moreover, the local population is forced to draw water of dubious quality from distant sources (FERREIRA GOMES, 2013; CORRÊA, 2018). Extraction of water for distribution is carried out on the Araguari River, and since treatment is deficient, perception of the quality of river water directly influences the perception of the water consumed by the local population.

The most recent studies related to water from the Araguari River, within the area under influence of the HPP, report that the analyzed water presents physical, chemical and microbiological parameters not in compliance with the current environmental norm, as given in Resolution 357, of 2005, of the National Council for the Environment (CONAMA), which provides guidelines for the classification of water bodies (SILVA, 2015; FAÇANHA, 2019). Changes in the analyzed parameters point to impacts caused by hydropower projects on water from the Araguari River in stretches close to the urban area of Ferreira Gomes.

Malcher *et al.* (2020) analyzed the public water supply in the state of Amapá, including data on locations influenced by the Santo Antônio do Jari HPP. Results indicated that water from the Jari River that is distributed in nearby cities showed non-compliance with quality standards required by health legislation in force in the country, thus posing a risk to consumers.

No water quality studies for the municipality of Ferreira Gomes are available in the literature. This only increases the fear over water supplies owing to poor treatment facilities and the need to seek alternatives, such as Amazon dug wells. However, these alternatives present even more risks from poor basic sanitation in the municipality that leads to a high level of fecal contamination (SILVA *et al.*, 2018; GROTT *et al.*, 2018).

Lauthartte *et al.* (2016) evaluated the quality of groundwater in the District of Jaci-Paraná, state of Rondônia, an area under the direct influence of the Santo Antônio HPP. The results point to a high contamination with coliforms and parameters in non-compliance with national health legislation.

Our results also show that the local population perceives a growth in the number of cases of waterborne diseases directly caused by construction of the HPP. Sixty percent of participants acknowledged such increase, while 35.79% perceived the same number of cases, and a small portion (4.21%) pointed to a decrease in the occurrence of waterborne diseases in the municipality.

In the construction of a hydropower plant, Couto (1999) reports a large-scale environmental intervention with evidence of increasing high-risk diseases transmitted by such vectors as yellow fever, leishmaniasis, filariasis and malaria. However, it is during

1 - Amazon dug wells for groundwater extraction are characterized by having, generally, a diameter larger than 0.5 m with depths quite varied from one meter to tens of meters, directly depending on the lithification of the geological formation (VASCONCELOS, 2017).

the operational phase that disease proliferates.

Ecological conditions of the Amazon facilitate the introduction and proliferation of these diseases, such as rich river basin, high rainfall and high humidity. Reiterating, Moreno *et al.* (2019) carried out a study along the North Perimetral Highway (BR-210) in Amapá. This is a stretch of about 150 km connecting the municipalities of Ferreira Gomes, Porto Grande, Serra do Navio and Pedra Branca do Amapari. Based on their analysis of data from indigenous areas, settlements and mines, it was concluded that malaria and leishmaniasis outbreaks in the region could not be separated spatially and temporally from events involving deforestation, mining and the implementation of an HPP.

According to participants in the present study, the quality of bathing places in the region decreased (50.53%). This was attributed to the change in water quality in the river and vegetation by deforestation. Changes in aquatic environments can affect the local economy, not only from the point of view of fishing sales, but also tourism, which is a strong feature present in the studied municipality and accounts for the income of many residents of Ferreira Gomes.

Roscoche and Vallerius (2014) reported the impacts of Belo Monte HPP on tourism in the Xingu region and showed that the dam caused the disappearance of islands and beaches close to the cities of Altamira. According to the authors, not only was the scenic beauty of the Xingu River and its beaches as potential tourist attractions lost, but also one of the main forms of local recreation.

The growth of commercial activities in the urban area of Ferreira Gomes is indicated by 48.42% of participants, but another 31.58% of participants perceived a decrease in commercial activities, and for 20%, this situation has not changed. The divided perceptions may point to confusion over defining commercial activity, but we can advance some hypotheses that may account for this. First, participants might associate commercial activities with the retail sector, including clothing sales, supermarkets and small stores, where the increase is noticeable in relation to the period prior to HPP construction. Second, some locals associate the sale of fish, agricultural products, dairy products and others from outdoor fairs with commercial activities, and they would be the same participants who perceived a decrease in these products. Third, the different perceptions arise from different views of commercial activity, so the divide between growth and decline may be associated with different sectors of the local economy and the results following installation of HPP.

From the results obtained in items 7, 8, 9 and 10 of the Table, we gain relevant social data that reveal information about changes in the way of life of the affected population. For 89.47% of participants, an increase in the cost of electricity was perceived, which could be interpreted as societal irony, considering the damages resulting from HPP construction, but none of the benefits of energy production. In the study by Ribeiro and Moret (2014), energy costs increased for residents around the Santo Antônio HPP in Porto Velho, state of Rondônia, indicating that the results in the present study are not isolated.

As a result of increasing energy costs, participants perceived that the cost of living also increased (80%) after the implementation of the HPP; however, while the study does not specify the factors influencing this increase, it is notable that cost of living and cost of

electricity are correlated. Electricity is essential, and its production passes through many processes that leads to the final cost (WERNKE, 2018).

Increase in the cost of living after the HPP installation is verified by Roscoche (2012) and Oliveira (2013) in Altamira, state of Pará, where the authors show a generalized increase in rent and food owing to population growth and, consequently, an increase in the cost of living in general.

Participants perceived that employment opportunities decreased (74.74%). The overall perception is that the decrease in opportunities happened in parallel with the completion of the HPP installation. According to studies, such as Balieiro (2018) and Maldaner *et al.* (2019), large-scale projects like HPP initially require an equally large number of workers, but produce a mass of unemployed people after their completion since job opportunities generated during the implementation of the HPP are generally lower than the number of people who migrated in search of work when construction began.

The perception is that the formal market in the municipality slowed down after at the end of construction. An expected impact, according to the literature, is the high unemployment rate and low number of new vacancies, which induce a significant part of the population to look toward the informal market. Maldaner *et al.* (2019) found declining employment in municipalities affected by HPPs Peixe Angical and São Salvador, stating that the positive effect of job generation was only in the short term and that a deficit in employment opportunities occurred post-construction.

Participants believe that crime rates in the municipality of Ferreira Gomes increased, especially theft (78.95%). This perception stems from an increase in the price of foodstuffs, hygiene and electricity, which negatively impacts the cost of living., When added to the growing population, the results are increased crime, little opportunity in the formal market, unemployment and transformation in the dynamics and constitution of the city's urban area, i.e., the emergence of new neighborhoods, usually far from the center.

The EIA of hydropower plants, in many cases, does not address violence and criminality as a socio-environmental impact, nor does it specify mitigating measures to solve the problem. Yet, violence and crime are obvious consequences of social disorganization inevitably produced by the implementation of large hydropower projects as a result of the large flow of people who move from other regions to find construction work (REIS; SOUZA, 2016). This study pointed to the number of occurrences in municipalities most directly affected by Belo Monte HPP owing to new population dynamics caused by its construction and resultant increase in crimes, such as threats, homicides, trafficking of drugs, rape and traffic deaths. Corroborating the above, the study by Herrera and Moreira (2015) further deepens the debate about violence in the region where the Belo Monte HPP is located and presents data about the growth of crime. According to the authors, the increase in violence is a substantial cause, but not the only one, for the spread of fear and public insecurity.

According to data provided by the military police of the state of Amapá, through the Directorate of Operations, crime in the municipality of Ferreira Gomes significantly increased from 2013 to 2015, especially bodily injuries, threats, disorder/disruption at work

or disturbance of the peace, aggression, traffic violations, theft and arrest in flagrante delicto. These statistics mirror the consequences of population increase during the period of FGHPP construction when most workers lived in the municipality.

Displacement of workers is one of the first impacts during the implementation of an HPP, and since the affected regions do not have adequate infrastructure to support the number of displaced employees, several social problems arise (ROSCOCHE; VALLERIUS, 2014). The urban area grows with the mass of workers as long as the civil construction sector is leveraged by the recurring demand for labor by hydropower projects, but at the end of construction, the opposite occurs, and workers return to their places of origin.

According to Silva *et al.* (2020), the population dynamics of Ferreira Gomes changed during the construction of the HPP with a considerable population increase during the period of its construction, an increase mainly attributed to the jobs generated during the construction of the projects and by the migrant population in search of opportunities from the economic support in the region. This accounts for the results showing an increase in the offer of properties (69.47%) However, Ferreira Gomes presents a different picture after plant construction and the departure of many workers with an increase of abandoned properties or 'for sale' and 'for rent' signs as common sights (Figure 4).

A similar condition occurred in Altamira, with the construction of the Belo Monte HPP. According to Fleury and Almeida (2013), an intense real estate speculation occurred, triggered by a sudden increase in land and rent costs in Altamira with many reports of rents going up more than five times. This was a significant consequence of the influx of workers owing to construction jobs.

Figure 4 – Photos of properties for sale, for rent and abandoned in Ferreira Gomes, state of Amapá.

Source: Collection of the authors (2021).

At the same time, the number of inns or hotels increased per participants in this study (45.26%), reflecting growth of the hotel sector during the construction of the HPP

with the objective of serving workers. Currently, hotels and inns remain in operation, but with greater emphasis on tourism in the region, as Ferreira Gomes has always attracted tourists in search of leisure and rest.

Residents of Ferreira Gomes perceived that their quality of life had worsened (31.58%), while for 48.42% of participants, the installation of HPP did not change the outlook of the affected population to the point that warranted a positive perception of the enterprise and its benefits to the population. As reported by Fleury and Almeida (2013), not everyone benefits from development and modernity which, otherwise, are seen as characteristics that would improve the quality of life.

Although quality of life is defined numerous ways, no one definition is widely accepted. However, consensus seems to hold that it includes factors related to health, such as physical, functional, emotional and mental well-being, and other important elements of people's lives, such as work, family, friends and other circumstances of everyday life (GILL; FEISNTEIN, 1994; PEREIRA *et al.*, 2012). Therefore, the perception of a worsening in the quality of life by participants in this study comes from insecurity that results from an increase in crime, incidence of disease, decrease in job opportunities, and increase in the cost of living, all of which impact the quality of food, housing, comfort and well-being.

Based on our accumulated data, it can be said that hydropower plants have changed the socioeconomic dynamics of the residents of Ferreira Gomes. During construction, mainly at the FGHPP, the number of police incidents increased considerably, undermining public safety during this period. After construction, people who depended on fishing, agriculture and tourism to survive had to look for work alternatives to supplement their income as job opportunities decreased and the cost of living (food, electricity, housing and taxes, for example) increased. Finally, although these events were linked to hydropower projects, no mitigating measures were in place that could compensate for or repair the social and economic damage done.

Considerations

Out data revealed that the simultaneous operation of HPPs CN, FG and CC established new social, economic and environmental dynamics and had complex impacts on daily life, mostly in a negative way, confirming the main hypothesis of this study.

Based on the results of this study, unregulated growth of the population in the urban area of Ferreira Gomes has taken place owing to the migration of labor for the construction of hydroelectric plants. The pressures caused by such migratory phenomenon on the municipality's infrastructure, given the new social dynamics, contributed to the growth of the hotel and civil construction sectors. In addition, new neighborhoods emerged, but without planning and without adequate sanitation, directly affecting the health and safety of residents.

For small livestock farmers, agricultural producers and fishermen, post-construction events should be monitored, irrespective of payment of indemnities or any compensatory actions. Monitoring is justified given the social risk that results from unanticipated

changes in culture and daily life.

In general, our data show that implementation of hydropower projects on the Araguari River did not benefit the residents of Ferreira Gomes, considering the negative impacts in the social and economic spheres, as enumerated and quantified in our study. Overall, the results of our study show that development has a price, but in this case, the price is paid by those least likely to afford it.

Thus, the present study highlights the need for dialogue among all stakeholders involved in building hydroelectric plants, in particular residents of nearby communities most directly and negatively affected. Also, discussion about the HPP implementation process in the Amazon deserves more attention by including indigenous populations, as well as government and companies. Otherwise, measures to mitigate negative effects are ignored, causing problems for those who have the most to lose.

Acknowledgements

The authors are grateful to Graduate Program in Environmental Sciences and the Graduate Department of the Federal University of Amapá for financial support.

References

BALIEIRO, M. H. A questão das hidrelétricas – desmistificando inverdades propagadas no ensino de geografia. **Ciência Geográfica**, Bauru, v. 22, n. 1, jan./dez. 2018.

BÁRBARA, V. F; CUNHA, A. C; RODRIGUES, A. S. L, SIQUEIRA, E. Q. Monitoramento sazonal da qualidade da água do rio Araguari - AP. **Revista Biociências**, v. 16, n. 1, p. 57-72, 2010.

BERMANN, C. Impasses e controvérsias da hidreletricidade. **Estudos Avançados**, v. 21, n. 59, p. 139-153, abr. 2007.

_____. Crise ambiental e as energias renováveis. **Ciência e Cultura**, v. 60, n. 3, p. 20-29, set. 2008.

BORGES, R. S.; SILVA; V. P. Usinas Hidrelétricas no Brasil: a relação de afetividades dos atingidos com os lugares inundados pelos reservatórios. **Caminhos de Geografia**, v. 12, n. 40, p. 222-231, dez. 2011.

BRASIL. **Resolução CONAMA 357**, de 17 de março de 2005. Conselho Nacional de Meio Ambiente. Brasília: DOU, 2005.

_____. **Ministério da Saúde. Portaria de Consolidação nº 5/2017, anexo XX**. Dispõe sobre os procedimentos de controle e de vigilância da qualidade da água para consumo humano e seu

padrão de potabilidade. Diário Oficial [da] República Federativa do Brasil, Brasília, 2017.

BRITO, E. P. de; ALMEIDA, M. G. de. No itinerário dos expulsos pela UHE estreito. Território dos sujeitos ribeirinhos no rio Tocantins. **Revista de Geografia**, Recife, v. 34, n. 3, 2017.

CARVALHO, K. M. de; SANTOS, M. E. P. dos; CABRAL SILVA, J. A.; AZEVEDO, R. E. A.; CARVALHO DOS SANTOS, V. de L. Rio abaixo, rio acima: o pescador, o rio e os riscos no baixo São Francisco. **Ambiente & Sociedade**, São Paulo, v. 23, 2020.

CORRÊA, K. M. A. **A formação do complexo hidrelétrico no rio Araguari**: Impactos no ordenamento territorial de Ferreira Gomes, Amapá. 2018. 129 f. Dissertação (Mestrado em Desenvolvimento Regional) – Universidade Federal do Amapá, Macapá, 2018.

COUTO, R. C. S. Saúde e projetos de desenvolvimento na Amazônia. **Novos Cadernos NAEA**, v. 2, n. 2, dez. 1999.

CRUZ, G. R. **Impactos socioambientais e econômicos da Usina Hidrelétrica de Marabá-PA (2014-2016) na comunidade da Ilha de São Vicente - TO**. 2017. 162 f. Dissertação (Mestrado em Sociedade e Fronteiras) - Centro de Ciências Humanas, Universidade Federal do Roraima, Boa Vista, 2017.

CUNHA, A. C; BRITO, D. C; CUNHA, H. F. A.; SCHULZ, H. E. Dam Effect on Stream Reaeration Evaluated with QUAL2kw Model: Case Study of the Araguari River, Amazon Region, Amapá State/Brazil. In: BILLIBIO, C., HENSEL, O., SELBACH, J. (Eds.), Sustainable Water Management in the Tropics and Subtropics –And Case Studies in Brazil. **Fundação Universidade Federal do Pampa**, Jaguarão/RS, v. 2, p. 697, 2011.

DOWNING, D.; CLARK, J. **Estatística Aplicada**. 3. ed. São Paulo: Saraiva, 2011.

ECOTUMUCUMAQUE. **Estudo de Impacto Ambiental e Relatório de Impacto Ambiental do Aproveitamento Hidrelétrico Ferreira Gomes**: Diagnóstico do Meio Socioeconômico (vol. IV). 2009.

FAÇANHA, E. B. **Avaliação físico-química da qualidade de águas de reservatório de usinas hidrelétricas na Amazônia oriental**. 2019. 48 f. Dissertação (Mestrado em Ciências Ambientais) – Programa de Pós-Graduação em Ciências Ambientais, Fundação Universidade Federal do Amapá, Macapá, 2019.

FARIA, A. M. M. Hidroelétricas amazônicas: fontes energéticas apropriadas para o Desenvolvimento Regional? **Papers do NAEA**: Núcleo de Altos Estudos Amazônicos (NAEA), Universidade Federal do Pará, Belém, n. 190, p.3-41, 2006.

FERREIRA GOMES. **Plano Diretor Participativo do Município de Ferreira Gomes**. Diagnóstico das Condicionantes, Deficiências e Potencialidades Municipais Propostas e Ações. Ferreira Gomes: Ferreira Gomes Energia, Estado do Amapá, 2013.

FLEURY, L. C.; ALMEIDA, J. A construção da Usina Hidrelétrica de Belo Monte: conflito ambiental e o dilema do desenvolvimento. **Ambiente & Sociedade**, São Paulo, v. 16, n. 4, p. 141-

158, out./dez. 2013.

GILL, T. M.; FEINSTEIN, A. R. A critical appraisal of the quality of quality-of-life measurements. **Journal of the American Medical Association**, Chicago, v. 272, n. 8, p. 619-626, 1994.

GREENLAND, S., SENN, S. J., ROTHMAN, K. J. *et al.* Statistical tests, P values, confidence intervals, and power: a guide to misinterpretations. **Eur J. Epidemiol.**, v. 31, n. 4, p. 337–350, apr. 2016. DOI: https://doi.org/10.1007/s10654-016-0149-3

GROTT, S. L.; FAÇANHA, E. B.; FURTADO, R. N.; CUNHA, H. F. A.; CUNHA, A. C. Variação espaço-sazonal de parâmetros da qualidade da água subterrânea usada em consumo humano em Macapá, Amapá, Brasil. **Eng. Sanit. Ambient.**, Rio de Janeiro, v. 23, n. 4, p. 645-654, 2018. DOI:https://doi.org/10.1590/s1413-41522018162018

HERRERA, J. A.; MOREIRA, P. Espacialidade do medo e insegurança pública: Ensaio sobre os efeitos da UHE Belo Monte na cidade de Altamira no Pará. **Revista Políticas Públicas & Cidades**, v. 3, n. 2, p. 48-63, mai./ago. 2015.

IBGE Cidades. Instituto Brasileiro de Geografia e Estatística. Disponível em: <https://cidades.ibge.gov.br/brasil/ap/ferreira-gomes/panorama> Acesso: 21 set. 2020.

_____. Instituto Brasileiro de Geografia e Estatística. Censo 2010. Disponível em: <https://cidades.ibge.gov.br/brasil/ap/ferreira-gomes/panorama> Acesso: 21 out. 2021.

_____. Instituto Brasileiro de Geografia e Estatística. Disponível em: <https://cidades.ibge.gov.br/brasil/ap/ferreira-gomes/panorama> Acesso: 19 nov. 2021.

LAUTHARTTE, L. C.; HOLANDA, I. B.B.; LUZ, C.C.; MUSSY, M. H.; PANSINI, S.; MANZATTO, A.G.; YAMASHITA, M.; BASTOS, W.R. Avaliação da qualidade da água subterrânea para consumo humano: estudo de caso no Distrito de Jaci-Paraná, Porto Velho–RO. Águas subterrâneas, v. 30, n. 2, p. 246-260, 2016.

LOPES, M. S.; BRITO, D. M. C. Impactos socioambientais ocasionados por hidrelétrica no Vale do Jari, Amapá, Brasil: percepções comunitárias. **Ambiente & Sociedade**, São Paulo, v. 24, 2021. DOI: http://dx.doi.org/10.1590/1809-4422asoc20190068r3vu2021L2AO

MALCHER, J. A. S.; BRITO, D. C.; CARVALHO, T. P.; SANTOS, J. O.; PENHA, E. C. M.; GUEDES, J. N.; CUNHA, A. C. Qualidade da água para abastecimento público em municípios com menos de 50 mil habitantes na Amazônia. **Revista Ibero Americana de Ciências Ambientais**, v. 11, n. 7, p. 284-304, 2020. DOI: http://doi.org/10.6008/CBPC2179-6858.2020.007.0025

MALDANER, K. L. S.; LIMA, A. M. T. de; AKAMA, A.; MARQUES, E. E. A avaliação ambiental integrada e os cenários socioeconômicos de municípios impactados pelas Usinas Hidrelétricas Peixe Angical e São Salvador no rio Tocantins. **RBCIAMB**, n. 52, p. 119-134, jun. 2019. DOI: 10.5327/Z2176-947820190094

MASSOLI, E. C.; BORGES, F. Q. Análise das externalidades geradas pela Usina Hidrelétrica de Estreito (MA) e o processo de desenvolvimento. **Desenvolvimento em questão**, v. 12, n. 28, p.

251-278, 2014.

MENESTRINO, E.; PARENTE, T. G. O estudo das territorialidades dos povos tradicionais impactados pelos Empreendimentos Hidrelétricos no Tocantins. **Brazilian Geographical Journal: Geosciences and Humanities research medium**, Uberlândia, v. 2, n. 1, p. 1-19, jan./jun. 2011.

MIRANDA, J. C.; FERREIRA, C. G. W.; ANDRADE, D.C. Estrutura da comunidade de peixes na área de influência direta da Pequena Central Hidrelétrica Braço, RJ/SP. **HOLOS**, vol. 5, p. 293-304, 2013.

MORENO, E. S.; OLIVEIRA, J. C.; SHIMABUKURO, P. H. F.; CARVALHO, L. Licenciamento ambiental de grandes empreendimentos: quais os limites para avaliação de impactos diretos e indiretos em saúde? Estudo de caso na Terra Indígena Wajãpi, Amapá. **Boletim do Museu Paraense Emílio Goeldi. Ciências Humanas**, v. 13, n. 3, p. 519-540, set.-dez, 2018. DOI: http://dx.doi.org/10.1590/1981.81222018000300003.

OLIVEIRA, A. da C. Consequências do neodesenvolvimentismo brasileiro para as políticas públicas de crianças e adolescentes: reflexões sobre a implantação da Usina Hidrelétrica de Belo Monte. **R. Pol. Públ.**, São Luís, v. 17, n. 2, p. 289 - 302, jul./dez. 2013.

PAZ, L. R. L. da. **Hidrelétricas e Terras Indígenas na Amazônia: Desenvolvimento Sustentável?** 2006. 232 f. Tese (Doutorado em Ciências em Planejamento Energético) – COPPE, Universidade Federal do Rio de Janeiro, Rio de Janeiro, 2006.

PEIXER, Z. I. **Utopias de progresso: ações e dilemas na localidade de** Itá frente a uma hidrelétrica. 1993. 131 f. Dissertação (Mestrado em Sociologia Política.) – Departamento de Sociologia Política, Universidade Federal de Santa Catarina, Florianópolis, 1993.

PEREIRA, E. F.; TEIXEIRA, C. S.; SANTOS, A. Qualidade de vida: abordagens, conceitos e avaliação. **Rev. Bras. Educ. Fís. Esporte**, São Paulo, v. 26, n. 2, p. 241-250, abr./jun. 2012.

REIS, J. F. G.; SOUZA, J. L. C. de. Grandes projetos na Amazônia: A hidrelétrica de Belo Monte e seus efeitos na segurança pública. **DILEMAS: Revista de Estudos de Conflito e Controle Social,** v. 9, n. 2, p. 215-230, mai./ago. 2016.

RIBEIRO, A. M.; MORET, A. de S. A construção da hidrelétrica de Santo Antônio e os impactos na sociedade e no ambiente. **Interfaces Científicas - Humanas e Sociais**, Aracaju, v. 2, n. 3, p. 81-92, jun. 2014.

ROCHA, H. J. da. O controle do espaço-tempo nos processos de instalação de hidrelétricas. **Tempo Social – Revista de sociologia da USP**, v. 26, n. 1, p. 259-280, jun. 2014.

ROSCOCHE, L. F. Funcionários públicos federais de Altamira desejam sair do município. In: **Jorge – Jornal de Geografia**, v. 2, n. 13, 2012.

ROSCOCHE, L. F.; VALLERIUS, D. M. Os impactos da Usina Hidrelétrica de Belo Monte nos atrativos turísticos da região do Xingu (Amazônia – Pará - Brasil). **Revista Eletrônica de Administração e Turismo**, v. 5, n. 3, p. 414-430, jul./dez. 2014.

SANTOS, E. S. dos. **Modelagem Hidrodinâmica e Qualidade da Água na Foz do Rio Araguari, Amapá – Amazônia Oriental – Brasil**. 2012. 113 f. Dissertação (Mestrado em Biodiversidade Tropical) – Programa de Pós-Graduação em Biodiversidade Tropical, Fundação Universidade Federal do Amapá, Macapá, 2012.

SANTOS, E. S. dos; CUNHA, A. C. da; CUNHA, H. F. A. Usina hidrelétrica na Amazônia e impactos socioeconômicos sobre os pescadores do município de Ferreira Gomes-Amapá. **Ambiente & Sociedade**, São Paulo, v. 20, n. 4, p. 197-214, out./dez. 2017.

SILVA, C. N. da; LIMA, R. Â. P. de; SILVA, J. M. P. da. Uso do território e impactos das construções de hidroelétricas na bacia do rio Araguari (Amapá - Brasil). **PRACS: Revista Eletrônica de Humanidades do Curso de Ciências Sociais da UNIFAP**, Macapá, v. 9, n. 2, p. 123-140, jul./dez. 2016. DOI: http://dx.doi.org/10.18468/pracs.2016v9n2. p123-140.

SILVA, E. dos S.; FERREIRA, J. F. de C.; TOSTES; J. A. A implantação de empreendimentos hidrelétricos no médio Araguari e a nova configuração urbana de Ferreira Gomes-AP, na Amazônia brasileira. **Geosul**, Florianópolis, v. 35, n. 75, p. 376-396, mai./ago. 2020. DOI: http://doi.org/10.5007/1982-5153.2020v35n75p376

SILVA, F. M. da; PAULA, E. A. de. Usinas hidrelétricas sob os véus da "sustentabilidade": os pescadores artesanais da Ponta do Abunã e a Usina Hidrelétrica de Jirau, em Rondônia. **Novos Cadernos NAEA**, v. 21, n. 1, p. 159-178, jan./abr. 2018.

SILVA, G. C. X. da. **Alterações da qualidade da água durante enchimento de reservatório Pós-Fragmentação do Escoamento Livre**. 2015. 151 f. Dissertação (Mestrado em Biodiversidade Tropical) – Programa de Pós-graduação em Biodiversidade Tropical, Universidade Federal do Amapá, Macapá, 2015.

SILVA, L. P.; BARBOSA, J. P.; SILVA, G. A. Análise exploratória de dados da qualidade da água de poços amazonas na cidade de Macapá, Amapá, Brasil. **Águas Subterrâneas**, v. 32, n. 1, p. 43-51, 2018. DOI: https://doi.org/10.14295/ras.v32i1.28941

SOARES, D. J. M.; SOARES, T. E. A.; EMILIANO, P. C. Uma aplicação do teorema central do limite. **Brazilian Journal of Development**, Curitiba, v. 5, n. 12, p. 32165-32173, dec. 2019. DOI: https://doi.org/10.34117/bjdv5n12-293

SOUZA, M. F.; MARQUES, E. E.; MIRANDA, E. B.; ARAUJO, A. F. Do rio Tocantins a Hidrelétrica de Peixe Angical: os peixes e as pescarias na memória dos pescadores. **Revista Interface**, n. 12, p. 119-134, dez. 2016.

VASCONCELOS, M. B. O que são poços? Um panorama das terminologias utilizadas para captações de águas subterrâneas. **Águas Subterrâneas**, v. 31, n. 2, p. 44-57, 2017. DOI: http://dx.doi.org/10.14295/ras.v31i2.28666

WERNKE, R. **Análise de custos e preços de venda: ênfase em aplicações e casos nacionais**. 2ª. ed., São Paulo: Saraiva Uni, 2018.

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Submitted on: 08/12/2021
Accepted on: 24/12/2022
2023;26:e02162

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SciELO

A PERCEPÇÃO SOCIOECONÔMICA DOS ATINGIDOS PELAS USINAS HIDRELÉTRICAS DO RIO ARAGUARI/AP, AMAZÔNIA ORIENTAL

Thais Pantoja de Carvalho
Jorge Angelo Simões Malcher
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Resumo: A implantação de uma hidrelétrica comumente envolve conflitos, entre os povos tradicionais e os empreendimentos hidrelétricos. O objetivo da pesquisa foi analisar as percepções dos moradores da sede municipal de Ferreira Gomes sobre os impactos sociais e econômicos de três hidrelétricas (Coaracy Nunes, Ferreira Gomes e Cachoeira Caldeirão) instaladas no rio Araguari, Amapá. Os dados foram obtidos mediante aplicação de formulário semiestruturado, cujo tamanho da amostra foi calculado usando o 'Teorema do Limite Central', que posteriormente foram tabulados em planilhas eletrônicas e analisados. A pesquisa revelou que as hidrelétricas estabeleceram novas dinâmicas sociais e econômicas no cotidiano da população atingida, em sua maioria de forma negativa e afetaram direta e indiretamente a qualidade de vida, saúde, renda, custo de vida e segurança da população local.

Palavras-chave: Impactos sociais; Conflitos sociais; Dinâmicas socioeconômicas; População tradicional; Empreendimentos hidrelétricos.

São Paulo. Vol. 26, 2023

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SciELO

LA PERCEPCIÓN SOCIOECONÓMICA DE LAS PERSONAS AFECTADAS POR LAS CENTRALES HIDROELÉCTRICAS DEL RÍO ARAGUARI/AP, AMAZONIA ORIENTAL

Thais Pantoja de Carvalho
Jorge Angelo Simões Malcher
Daguinete Maria Chaves Brito

Resumen: La implantación de una central hidroeléctrica suele conllevar conflictos entre los pueblos tradicionales y las empresas hidroeléctricas. El objetivo de esta investigación es analizar las percepciones de los residentes del centro municipal de Ferreira Gomes sobre los impactos sociales y económicos de tres plantas hidroeléctricas (Coaracy Nunes, Ferreira Gomes y Cachoeira Caldeirão) instaladas en el río Araguari, Amapá. Los datos se obtuvieron mediante la aplicación de un cuestionario semiestructurado, cuyo tamaño de muestra ha sido calculado mediante el 'Teorema del Límite Central', que posteriormente fueron tabulados en hojas de cálculo electrónicas y analizados. La investigación reveló que las presas han establecido una nueva dinámica social y económica en la vida cotidiana de la población afectada, en su mayoría de forma negativa, afectando directa e indirectamente a la calidad de vida, la salud, los ingresos, el costo de vida y la seguridad de la población local.

Palabras-clave: Impactos sociales; Conflictos sociales; Dinámicas socioeconómicas; Población tradicional; Emprendimientos hidroeléctricos.

São Paulo. Vol. 26, 2023

Artículo Original