Energy Research & Social Science 78 (2021) 102129

Contents lists available at ScienceDirect

Energy Research & Social Science

journal homepage: www.elsevier.com/locate/erss

Is hydropower worth it? Exploring amazonian resettlement, human development and environmental costs with the Belo Monte project in Brazil

Adam Mayer [a,*], Laura Castro-Diaz [b], Maria Claudia Lopez [b], Guillaume Leturcq [c], Emilio F. Moran [d]

[a] Center for Global Change and Earth Observations, Michigan State University, United States
[b] Department of Community Sustainability, Michigan State University, United States
[c] Universidade Federal do Rio Grande do Sul, Brazil
[d] Center for Global Change and Earth Observations, Michigan State University, United States

A R T I C L E I N F O

Keywords:
Hydropower
Amazon
Resettlement
Support
Energy justice
Perception of negative outcomes

A B S T R A C T

Nations in the Global South have turned to massive hydropower projects to provide for the energy needs of their growing economies. Large-scale hydropower projects cause untold environmental damage to river ecosystems, to fish biodiversity, and displace millions of people globally. Much research documents these impacts, yet we do not know if these populations support the development of hydropower. In this paper, we aim to understand how direct experiences with resettlement might influence the support or opposition to hydropower development considering energy justice, particularly the restorative and procedural tenets, as a motivating framework. Our research is based on social survey data from a population resettled during the construction of the Belo Monte dam in the Brazillian Amazon. Results from partial proportional odds models suggest that a slim majority feel that hydropower is worth the cost, yet even this support declines as perceived impacts increase. These populations hold nuanced views and are not uniformly negative about dams, regretting the negative outcomes for them but believing the government discourse that the energy needs of the country may require them to sacrifice for the larger good. Support for hydropower as well as energy injustices might vary considerably across communities that are impacted differentially by Belo Monte.

1. Introduction

Global energy consumption is predicted to increase by 50% by 2050, led by growing demand from developing nations [1] . The United Nations's Sustainable Development Goals emphasize that "Ensuring access to affordable, reliable, sustainable and modern energy for all", however this is a significant challenge given resource constraints and population growth. Although renewable energy technologies like wind and solar are enjoying greater market penetration, these technologies have not yet supplanted conventional fossil fuel sources to any large degree. In developing countries and emergent economies, several nations have turned to build large-scale hydropower dam projects, presented as a renewable energy source, even as developed nations increasingly decommission a growing number of large dams built before 1970 [2 3 4]. Nations build hydroelectric dams because of their desire to produce ostensibly clean, affordable energy while fostering energy independence [5]. However, evidence shows that dams negatively impact the social-ecological system where they are built [6 7 8]. One of the most significant social impacts of hydropower development is that it often involves large scale resettlement of people to make way for vast water reservoirs and their lives are rarely better off from it [9 10 11 12].

In 1997, the World Commission on Dams (WCD) was created to formulate policy recommendations for hydropower development that might mitigate the negative impacts of dams [1][15]. The WCD and many scholars and activists called for reforming the process of hydropower development. Unfortunately, many of the countries most deeply

* Corresponding author.
E-mail addresses: mayerada@msu.edu (A. Mayer), castrodi@msu.edu (L. Castro-Diaz), mlopez@msu.edu (M.C. Lopez), guillaume.leturcq@ufrgs.br (G. Leturcq), moranef@msu.edu (E.F. Moran).

[1] The report includes 26 guidelines that some organizations that finance dam construction such as the Word Bank are not following because they consider that they may interfere with the rights of soverign states [13]. Furthermore, leading hydropower building nations, like China, Brazil and India refused to endorse the recommendations of WCD [14] and continue to ignore most of the recommendations that would reduce the impacts on people living closest to dams.

https://doi.org/10.1016/j.erss.2021.102129
Received 5 January 2021; Received in revised form 12 May 2021; Accepted 19 May 2021
Available online 28 May 2021
2214-6296/

engaged in hydropower development refused to follow these recommendations, as was the case with China and Brazil, because those might constrain their future energy development. Even after the WCD recommendations, states and dam builders have rarely meaningfully engaged with impacted populations, although they may hold meetings and negotiations, especially when pressured by NGOs and social movements [16]. These meetings are rarely intended to change the outcome (i.e. completion of the project), or to mitigate the impacts for local communities (i.e consulted compensations), rather they are an instrument to show that the project allow for "participation on civil society". Indeed, in terms of procedural justice, understood as a fair and equitable process [17], hydropower projects do not involve the local population in the decision-making processes that will affect their lives.

The purpose of this paper is to understand how direct experiences with resettlement might influence support or opposition to hydropower using energy justice as a motivating framework. There are several studies of the social and economic consequences of resettlement from hydropower, but we do not know if populations experiencing resettlement would like to see *more* or less hydropower after their direct experience. Do these groups believe that hydropower was worth the environmental and social costs that they experienced? Most of the research on support for energy projects has focused on developed nations, and surprisingly little has examined hydropower views on this subject in developing countries. Resettled populations may come to accept hydropower projects and their own resettlement, especially if appropriate and generous compensation is offered to restore the harms done [10]. Yet, to the best of our knowledge, this is the first paper to evaluate support for hydropower among a resettled population in the Global South using a social survey. This is an important aim for three reasons. First, since governments in the Global South have largely embraced hydropower to further their development aims, millions of people will continue to be directly impacted by hydropower megaprojects. Secondly, there is a need to promote fair and equitable process to reduce injustices in the implementation of hydropower projects, and to do so it is necessary to understand the perspectives and experiences of those most directly impacted by dams. Thirdly, we consider the case of the Belo Monte dam in the Brazillian Amazon. Belo Monte was opposed by indigenous and environmental groups for decades, with significant mobilization against the dam by both domestic and international groups. Belo Monte became a poster child for hydropower and came to represent much of what is wrong with how it treats local and indigenous demands and notorious as an example of the peddling of influence by the construction companies. Not only did Belo Monte become a symbol for hydropower but it became reviled for its ties to corruption uncovered by the Lava Jato investigation and Odebrecht's department of bribes [18 19]. In the end, the project went ahead by Presidential fiat overlooking the environmental and social impacts [20 18 21] and the civil society opposition, which exemplifies the energy injustices of these megaprojects. Indigenous people and social movements such as Xingu Vivo maintained their resistance throughout the construction of the dam. Many times they were able to bring about work stoppages through protests and judicial interventions. On the other side the construction company brought a significant presence of National Public Security Force (Força Nacional) to keep protests from interfering with the 24/7 schedule of construction. Given this contestation and top-down implementation, it is worth paying attention to the viewpoints of resettled populations after the project was completed.

In the next section, we describe the national context of energy in Brazil, the known impacts of large-scale hydropower, then we review the literature on local responses to energy development and procedural and restorative energy justice.

2. Conceptual background

2.1. Belo Monte: A portrayal of hydropower development

Brazil is the 9th country in the world in terms of total energy consumption [22]. Hydropower in Brazil accounts for 67% of energy consumption, compared to the world average of 16% [23], making it the world's most hydropower dependent nation. China generates more total hydropower production, but it depends more on coal for its total energy consumption. Brazil's dependence on hydropower has its pros and cons. The nation is increasingly vulnerable to climate change, particularly declining precipitation that reduces water available for energy generation [22]. Brazil emits comparatively less greenhouse gases than if it were more dependent on fossil fuels, hydropower is more immune to the volatility of oil prices, the costs of electricity generation are usually lower than fossil fuel alternatives, and the reservoirs can provide opportunities for tourism and recreation that add value to the infrastructure.

Hydropower has immense deleterious social and ecological negative impacts. Dams disrupt fish migration patterns and fisheries, subsequently damaging the livelihoods of people who depend upon rivers for transportation and fisheries [24 25 26 27 28]. Farmers see declining crop yields due to loss of farm labor to the dam and associated commercial sector [29]. The construction of dams involves a sudden influx of workers into rural communities, often straining infrastructure (e.g. sewage and sanitation) while engendering a boom in crime [30 31]. Although hydropower has often been touted as a "clean" energy source in comparison to fossil fuels, it generates significant greenhouse gas emissions [32 33 34].

The impacts of large-scale hydropower and the costs and disruptions borne by impacted populations are often underestimated [35 36 36 37]. Costa Doria (2018) examined 245 large dams built between 1934 and 2007 and found that actual costs were typically 96% higher than initially estimated [38]. According to Richter et al (2010) some 472 million people living downstream from dams are negatively affected and are never compensated [15]. Populations from areas flooded to make way for reservoirs are routinely displaced [10 11 9]. Displacement tends to impact marginalized populations most intensely, often intensifying pre-existing social inequalities in the process [39 40]. Dams also disrupt subsistence livelihoods for vulnerable populations, such as reducing fish stocks and access to arable land, potentially creating food insecurity [24 25 26 27]. In the Tucuruí dam region of the Brazilian Amazon, the fish catch declined by 60% almost immediately, and more than 100,000 people living downstream were affected by the loss of fisheries, flood-recession agriculture, and other losses of natural resources [41]. Displacement from dam projects is also associated with a loss of social capital and subsequent mental distress [42]. Some evidence implies that compensation programs may mitigate some of the direct economic problems caused by displacement [43 11] but compensation is often not available to all impacted groups, most notably those downstream from a dam [15 25 44] and certain losses are difficult to quantify (e.g. social capital, cultural heritage) and rarely included in compensation programs [45 46].

In Brazil, installed capacity is over 157 GW, of an estimated potential of 260 GW [1]. An important contributor to this growing installed capacity was the construction of the Belo Monte Dam. Belo Monte has an estimated 11.23 GW installed capacity, however, it will produce on average only 4.46 GW throughout the year due to the hydrological conditions in the area [22].

After years of opposition (Moran 2016 for an overview of this history; also Fearnside 2012), Belo Monte construction began in 2011 in the Xingu river, and by 2014 resettlement of an estimated 22,000 people had started. Belo Monte was supposed to be the first hydropower project in Brazil that would abide by Article 169 of the International Labor Organization (ILO) that requires that builders of dams have open and free consultation with traditional and indigenous populations. In the end, in the rush to do the project, consultation was poorly executed and did not live up to Article 169 requirements[47].

Randell [11] studied the displacement impacts among rural dwellers of the Belo Monte dam who had lived closest to the construction area, finding that residents reported improved wealth and subjective well-being *after* being resettled due to the favorable compensation provided. This is one of the few studies that reports improvement after resettlement, but it is important to note that this early group was generously compensated for their land, buildings, cattle, and cocoa. They were able to acquire good quality land and restore their productive capacity and therefore did not have to change their economic activities. However, most of the literature on resettlement is a story of broken promises and declining livelihoods [48]. Belo Monte led to significant declines in food production due to loss of agricultural labor from the farm as a result of better paying jobs in the dam or associated commercial sector[49 29] groundwater contamination [30 31] and reduced fish stocks far downstream [25].

In Belo Monte, a large portion of the resettled population were moved into collective urban resettlements (Reassentamentos Urbanos Coletivos or RUCs) built by the dam authorities. Five RUCs were built in vacant land in the periphery of the city of Altamira, the main staging area for the dam construction, located 52 km upstream from the dam [30]. The first RUC completed was *Jatoba,* the community that we study in the present analysis. In the next section, we describe how populations impacted directly by energy development experience and perceive said impacts.

2.2. Conceptual framework

A large body of research has documented local responses to energy development projects that can vary from mass mobilization against energy development to a relatively high degree of acceptance [50 51 52 53]. Impacted populations' reaction to energy projects is determined by a matrix of complex processes, ranging from media framing, to place attachments, to the degree of public engagement, and procedural injustice during the siting process [54 55 57 56]

Prior research implies that support for local energy projects is, to a significant degree, a function of the perceptions of the positive and negative impacts of said project [57 58 59]. In the current context, our respondents experienced a sometimes traumatic experience with displacement and resettlement, yet many were also financially compensated and offered new housing opportunities. As mentioned above, a scholar has noted that, in the rural area of influence of Belo Monte, resettled and compensated populations report improvements in livelihoods [10], but the restorative effect of compensation and resettlement seems to vary extensively from location to location and the impacts that researchers choose to track even within the same dam (e.g. see Vanclay (2017) for a review). Further, hydropower is often framed by the national government and the hydropower industry as beneficial, whereas the anti-dam movements show the problems and inequalities that arise with dams [18 60]. This implies that our respondents may hold complex views about it. On the one hand, they may have serious negative perceptions because of their direct experiences with displacement and everything that this entail, yet may also have some positive perceptions because of the compensation and housing program. They may also be influenced by media and state actors to perceive positive benefits to their region or nation (e.g. affordable electricity, economic development). These concerns may be more psychologically distant and abstract than the direct effects of displacement or compensation.

A related body of work has evaluated issues of justice in energy projects. Early environmental justice scholarship emphasized the distributional nature of environmental problems, highlighting how marginalized populations often bore the brunt of harms generated by industrial practices but that rarely received any benefits (e.g. [61,62]). As the environmental justice literature evolved, scholars began to incorporate considerations of different tenets of justice. A recent body of work has pioneered the concept of "energy justice", arguing that it contains both distributional, procedural, recognition and restorative justice elements [63,64]. In this paper we aim to understand how direct experiences with resettlement might influence the support or opposition to hydropower development considering energy justice, particularly the restorative and procedural tenets, as a motivating framework.

In the context of energy justice, restorative justice aims to repair the harm done to society or environment by energy projects. Restorative justice can help point out where prevention strategies and restorations need to be done and operationalize it into policy [64]. Researchers have noted that restorative justice actions should include Environmental Impact Assessments (EIAs) and Social Impact Assessments (SIAs) conducted before the energy decisions are made [39], which usually include mitigation and compensation strategies to society and the environment. Some aspects of restorative justice overlap with the procedural justice sphere [64]. For instance, have substantial engagement with affected communities to prevent, mitigate and compensate the harms done by a project.

Procedural justice occurs along a spectrum ranging from simply providing impacted populations with information or holding public meetings, to ceding substantive decision making power to communities [65]. Efforts to engage impacted populations can increase acceptance of energy projects, even those that carry significant negative impacts. For instance, several studies have considered procedural issues related to wind energy facility siting [66 67 68]. Walker and Baxter [67], studying two wind farms in Canada, challenge the "technocratic" approach to design and siting decisions, finding that empowering local populations with a fair and open planning process is associated with an increase in support for local wind development. Other analyses find that populations that engage and participate in the planning and development of an energy project are more supportive of said project [69 70]. Importantly, views on what procedures are just, vary from person to person within an impacted population—that is, procedures that seem just to one person may seem unjust to another [69]. Much of the research on communities' perceptions of impacts, procedural and restorative justice related to energy projects has been conducted in the Global North. Examples include the large volume of research on oil and gas development in the United States [71 72 73] and wind energy in the UK [69 70].

Procedural justice is often overlooked by dam authorities. Hay, Skinner and Norton [74] argue that large-scale hydropower projects, especially those in the developing world, rarely involved consultation with impacted populations. The authors trace the history of hydro development and argue that, as time progressed, operators and central governments began to consider procedural justice issues, but this was most often in the form of a few public meetings and offering compensation (e.g. cash payments, land, housing) for displaced or otherwise impacted populations. Moreover, operators, utilities, and central governments rarely consult local communities to determine culturally and economically optimal siting locations. Affected communities must be part of the decisions related to dam construction including aspects for resettlement and compensation [75 74]. If they are involved in the process of decision-making they are more likely to adapt and recover from the stress of displacement or other impacts [45].

In Brazil, consultation processes happen after the government has decided where and when dams are going to be constructed [8], and this "consultation" is just to inform the affected population and local authorities that the dam is going to be built. In fact, for the case of Belo Monte, Fearnside [37] mentions that dam authorities organized public hearings to provide information about the dam in the city of Altamira, but they limited the participation of the local community by booking small spaces as well as providing little information about the project. That is, impacted populations were not given true decision-making power. Marques et al. [76] provide one of the few studies of procedural justice and hydropower. The authors used a Portuguese sample at risk from two proposed dam projects. They found that respondents who expected the projects to use fair and open procedures generally had more positive attitudes about their construction.

Dam projects cause immense deleterious impacts on displaced populations, some of which might be partially repaired by compensation programs. Yet it is unclear if impacted populations *support* or *oppose* further hydropower development after their experience. Batel, Devine-Wright and Tangeland [77] draw a difference between acceptance and support, noting that support implies purposeful action while "acceptance" is more top-down and passive. However, to date no studies have asked population resettled by dams whether they would support the development of additional hydropower, even if they accept existing projects. This is not a trivial question, since much of the regional dam development projects have several dams planned in the same river, and thus the views of people affected by the first dam, are likely to affect how other communities will respond to another dam. These populations are remarkably well-connected by cell phones and social media and thus views in one community are likely to diffuse rapidly to other communities.

3. Hypotheses

Above we reviewed the relevant literature on the impacts of energy development on host communities, procedural and restorative justice, and support for energy development with a focus on hydropower. From this framework, we test three hypotheses that have been little-explored in the broad literature on hydropower. First, we expect that *support for hydropower will decline as perceptions of negative impacts increase, or as negative experiences with resettlement increase* (Hypothesis 1). We also expect that *procedural justice, in the form of engagement, will increase support to hydropower* (Hypothesis 2). Finally, we hypothesize that *restorative justice, in the form of fair compensation for resettlement, will increase support to hydropower* (Hypothesis 3). We address these significant gaps using the data described in the next section.

4. Study site and data collection methods

4.1. Study site

Jatoba is one of five urban collective resettlement communities built by the Belo Monte consortium, Norte Energia, to provide housing for those relocated from their riverine locations on the islands, river margin, and low lying neighborhoods of Altamira that would be flooded. As such it became the show piece for the resettlement program as it was located during its first year across from the dam builders' headquarters at the outset. The homes were standardized, built on site from reinforced concrete, and had running water and sewage disposal in-house. While they were not supposed to be modified from the standard, it took little time for the families to make modifications: adding porches, fences, perimeter walls, garages, businesses, and gardens.

Most of the resettlers in Jatoba came either from riverine locations or had businesses near the riverfront, serving the riverine population, and the downtown areas of the city. Some of the houses in these flood-prone areas were known as *Palafitas*, houses built over wood stakes without water, energy, and sewage services [78]. The river underneath the homes provided the water and the sewage removal, while energy was sometimes obtained by wildcat connections to houses nearby that had electrical connections or by the use of kerosene. Houses located in these areas were considered as under flooding risk due to the construction of the dam, therefore they had to be resettled by the dam authorities [78]. This sample represents what Vanclay (2017) calls an "involuntary resettled" population as they were given no choice whether to resettle or not. Our sample was compensated with housing that was of higher quality, from the developer's perspective, than their previous homes, and the dam consortia promised to build also community infrastructure. This may have influenced our results—we suspect that our sample has more positive attitudes towards hydropower than persons who were displaced but not compensated. Moreover, as they were the first to resettle, it probably included some who were eager to move, rather than those most resistant to being resettled who ended up going to communities built later. Most (some 95%) stated that their previous location was "urban" and they were settled into an urban setting. Thus, our analysis is of primarily urban-to-urban resettlement.

Several energy injustices are manifest in the case of the Belo Monte project and in the more narrow case of the Jatoba residents. As we noted earlier, Belo Monte was constructed without much input from the impacted populations, many of who were not compensated for the impacts they bore —indicating a lack of procedural and restorative justice. Regarding Jatoba, the resettled group had little say in the type of compensation they would receive and could not provide meaningful input regarding the compensation mechanisms and resettle policies. Thus, there are energy injustices apparent in the case of Belo Monte. Houses given to families, as a form of compensation, were not supposed to be sold but within a couple of years, many houses bore "For Sale" signs. Some families did not find the location of Jatoba amicable to their social needs and to make a living from wages given its location.

Jatoba was nearly one hour and a half from the commercial center of Altamira. Initially, no public transportation was provided and this became a major problem for its residents because many basic activities require going to the city center. Banks, hospitals, doctors, and other businesses like grocery and clothing stores are in the downtown commercial areas of Altamira. Besides, it became prohibitive to take private taxis. A sense of isolation and lack of services permeated the community in its first couple of years, and many wished to move elsewhere. The other four RUCs were also in the city's periphery and had similar problems of initial lack of public services. See Fig. 1 for a map of the location of Jatoba and other resettled communities, in relation to Altamira and the region.

Altamira was an entrepot in the rubber trade during the late 19th century and early 20th century. It sits above the rapids that block traffic from the main Amazon river to the upper Xingu, and the city of Vitoria do Xingu some 20 km away was how people moved between the main river and up and down the Xingu. Altamira was connected to Vitoria do Xingu by road. Until the Transamazon Highway was built, most goods and people had to go to Vitoria. After the highway, Altamira became connected to the rest of Brazil by road, and goods and services began to come from all over the country [79 80].

Altamira has been host of two large infrastructure development projects that increased its population abruptly. The first one was the construction of the Trans-Amazon Highway in the early 1970 s and the second is the construction of the Belo Monte hydroelectric dam between 2011 and 2016 [21]. The population grew from 1,000 people to 10,000 people in less than two years at the start of the 1970 s and it grew into a regional center for agropastoral development by 1985 when it reached a population of 85,000. It stagnated at that population level but its economy was stable and based around cattle and cocoa production. One of the co-authors has conducted research in this area for decades and witnessed this process of regional change. The arrival of Belo Monte brought huge investments to the region with more than 31 billion reais (13 billion USD at that time) spent on the construction, which supported growth in the commercial sector to support the construction. This resulted in huge inflationary pressures in the first three years, as the city was unprepared for the influx of population, jobs, and businesses. It is in this context that one needs to place the experience of the resettled population.

Due to population growth and a lack of land-use planning there was a significant number of homes built in flood high-risk areas and they later became the first to be required to resettle when Belo Monte came. In the next section, we describe our data collection procedures.

4.2. Data collection

We administered a survey between Oct. 9 and Oct. 27, 2015 and we sampled 25% of households resident in Jatoba at the time. The data was

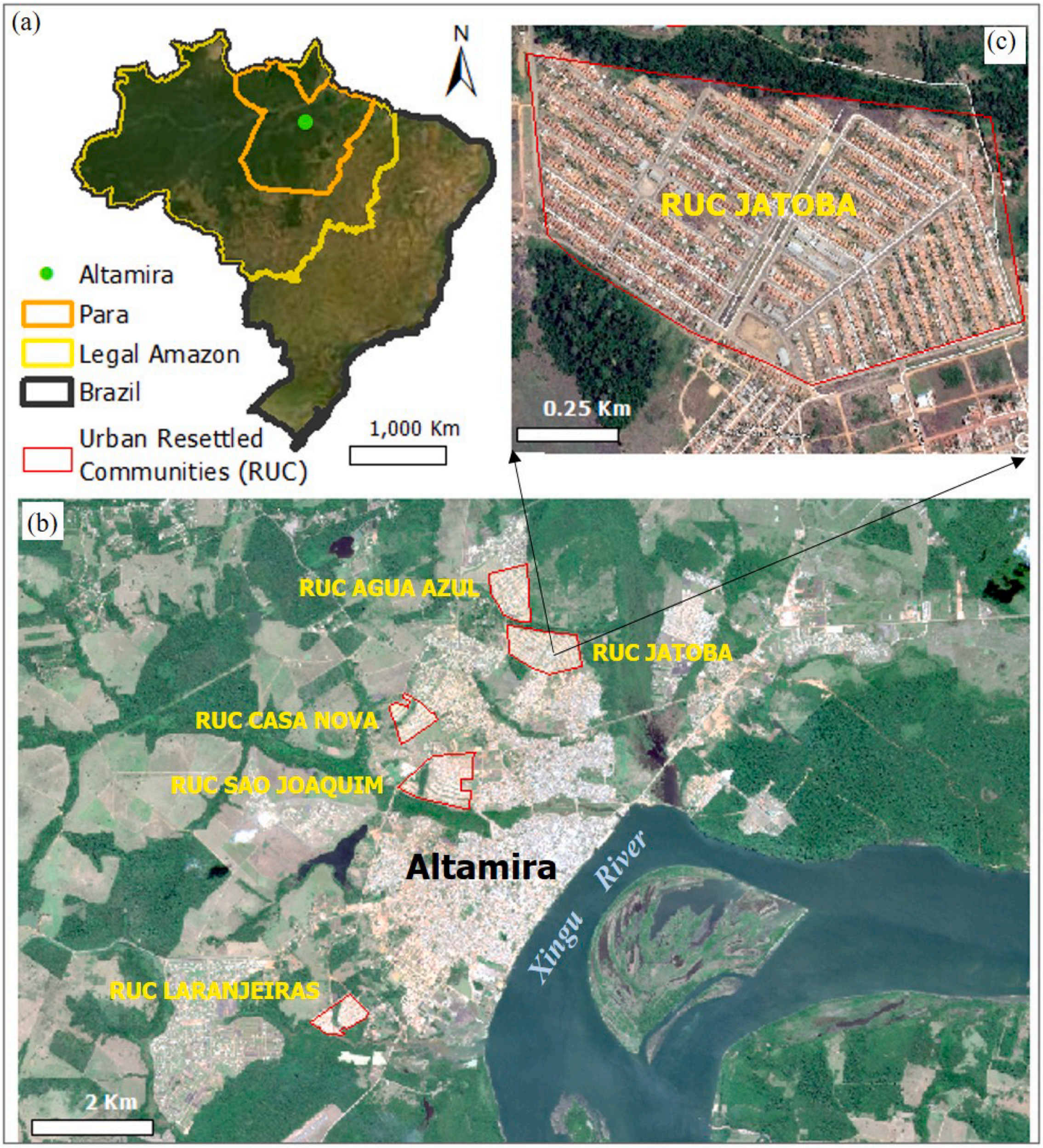

Fig. 1. Map of the Jatoba RUC and Altamira.

collected by 9 undergraduate student enumerators from universities in the region supervised by one of the co-authors of the current manuscript. All students underwent extensive training before starting the survey. Jatoba was divided into 28 blocks constituting 1,043 houses. The sampling was done by randomly choosing houses evenly divided between the two sides of each of the streets. Because of the possibility of some failures in the completion of surveys, 269 households were sampled with the target of having 250 completed surveys. Each student carried out approximately 30 surveys, and each was responsible for one or two streets in the Jatoba settlement. The survey had a combination of opened-ended and closed-ended questions, and it contained information about respondents' experiences with displacement, health information (e.g. fertility), among other topics. This survey was part of a much larger, more extensive project evaluating the social, economic, and ecological impacts of dams in the Amazon region. The data collection was funded by the *Fundação de Amparo à Pesquisa do Estado de São Paulo* (FAPESP) and the current data analysis is funded by a grant from the National Science Foundation (see details in the acknowledgments section).

In addition to the survey, two of the authors of this paper did numerous interviews with stakeholders such as the managers of the dam building, the department in charge of resettlement, the public prosecutors (both state and federal), the department of urban planning for the city, hospital and education directors, health post doctors, local merchants, taxi drivers, and other business owners or employees, real estate companies, and university department chairs and faculty. In total, we interviewed more than 120 people across Altamira and Jatoba during the 5 years of the FAPESP-funded project (see above).

5. Variables

5.1. Outcome: Support for hydropower

Our dependent variable is an indicator of support for hydropower. Respondents were asked "In general, do you think hydropower dams are worth building?". Forty-eight percent of respondents answered "Yes", 34% stated “No” and 16% stated “don’t know”. We provide the distribution of this variable in Fig. 2.

6. Predictors

6.1. Impacts of Belo Monte

The survey included a series of questions to determine perceived impacts of the Belo Monte dam on the community of Jatoba, Altamira, the region (Amazon), Brazil, the environment, and the local population with the response categories of “good”, “acceptable” and “poor”. Fig. 3 provides the distribution of these items. Strong majorities reported that Belo Monte’s impacts on Jatoba, Brasil and the region were “good” yet responses were decidedly more mixed for other impacts. A majority (54.7%) stated that the environmental impact of Belo Monte was “poor”.

We conducted an exploratory factor analysis on these items using the iterated principal factors method with a varimax rotation—the varimax rotation assumes that the factors are correlated—and report the results in Table 1. The factor analysis strongly suggested a single factor solution. The eigenvalue for the first factor was 5.525, while the eigenvalue for the second factor was well below the standard criteria of 1.0. Further, all of the variables loaded strongly on the first factor, with very modest loadings on the second factor. We also inspected an unreported scree plot, which again indicated a single factor solution. From here, we calculated a standardized factor (mean = 0, standard deviation = 1) score for use in our regression models below, where higher scores correspond to greater perceived impact.

6.2. Changes after migration

Respondents answered a battery of questions about their experiences with the resettlement process and if various aspects of their lives had improved since relocation. Respondents were asked “In comparison to your former house, how would you rate nowadays…” with questions for their home, neighbors, neighborhood, water, electricity, health, transportation, violence, education, garbage, pollution, and life in general. The distribution of these items are provided in Fig. 4. On several fronts, respondents reported that their lives had improved since migrating to Jatoba—improvements were especially pronounced for homes, the neighborhood and “life in general”. Nearly half reported that neighbors and education were the same as before, while exposure to violence had gotten worse since being resettled to Jatoba.

Like the impact items, we performed an exploratory factor analysis using the iterated principal factors method with a varimax rotation, with results reported in Table 2. The results generally lend themselves to a single factor solution. All the indicators loaded strongly on the first factor (e.g. above the conventional cut-off of 0.4) and the eigenvalue for the first factor was 5.525, while the second factor had an eigenvalue of 0.967. From here, we estimated a standardized factor score to use as a predictor in the regression models below. These two predictors—perceived impacts from Belo Monte and changes after migration—are used to operationalize hypothesis 1.

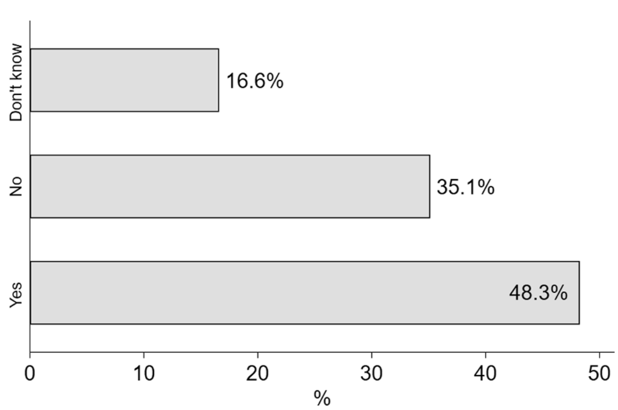

Fig. 2. Distribution of Outcome Variable of “In general, do you think hydropower plants are worth building?”

6.3. Procedural justice

The survey also included a question to assess respondent’s engagement with the process. Respondents could state that they did nothing, attended a meeting, participated in a social movement, or engaged in protests. Only 1 respondent participated in a protest, and only 4 reported joining a social movement. Most (nearly 52%) had no engagement and the rest (35%) attended a meeting. For our analysis, we created a binary variable from this data, where respondents who did something to engage with the process (e.g. meeting, protest, or social movement) were scored as a “1″ and the “no action” group was scored as a “0”. [2]Another question asked if respondents had a choice to where they moved to using response categories of “yes” or “no”, with 34% indicating that they could chose their location.

6.4. Restorative justice

For hypothesis 2, we suggest that perceptions of restorative justice can influence support for energy projects independent of positive and negative impacts. Respondents were asked “Do you think your compensation was fair, with some 59% indicated “yes” and the remainder stating “no” [3].

7. Modeling strategy

Oftentimes, analysts will code “don’t know” responses as missing to create binary variables, thus allowing relatively straightforward modelling approaches such as binary logistic regression. In our case, a non-trivial number of respondents (16.6%) stated “don’t know”, implying that “don’t know” might be substantively interesting. Rather than removing these cases, we have opted for a modelling approach that will facilitate their use and provide more qualified and nuanced results.

Given that our outcome variable is categorical, one obvious modeling candidate is the multinomial logistic regression model. However, the multinomial model is notoriously difficult to interpret, producing a unique coefficient for each predictor at each category of the outcome variable. Another option for multi-category outcome variables is the ordinal logistic regression model. However, our outcome variable is not truly ordinal because of the “don’t know” category and proportional odds assumption is likely violated. Rather than opt for a very complex multinomial model or an overly simplified ordinal model, we employ the partial proportional odds (PPO) model [81 82] . The PPO model relaxes the effect of a predictor across categories of the outcome variable when the proportional odds assumption has been violated—this assumption is tested via a Wald test. Thus, the PPO model is an excellent compromise between the overly complex multinomial approach and the ordinal logistic regression model. We use the *gologit2* package in Stata 15/ IC to estimate the partial proportion odds models. We examine AIC and BIC statistics to determine the best fitting model [83]. We estimate and visualize predicted probabilities to render our modelling results

[2] Respondents who found employment in the Belo Monte project may have different perspectives than others. We asked respondents if anyone in their household had worked at any point at Belo Monte. Only 3% respondend “yes”. Given this small number, we do not use this variable as a predictor in our regression models.

[3] Respondents were also given the opportunity to clarify why they stated that compensation was fair. Most (some 90%) offered a brief explanation. The most frequent response was related to the speed and ease of the compensation process, few mentioned the actual amount of the compensation in their answer.

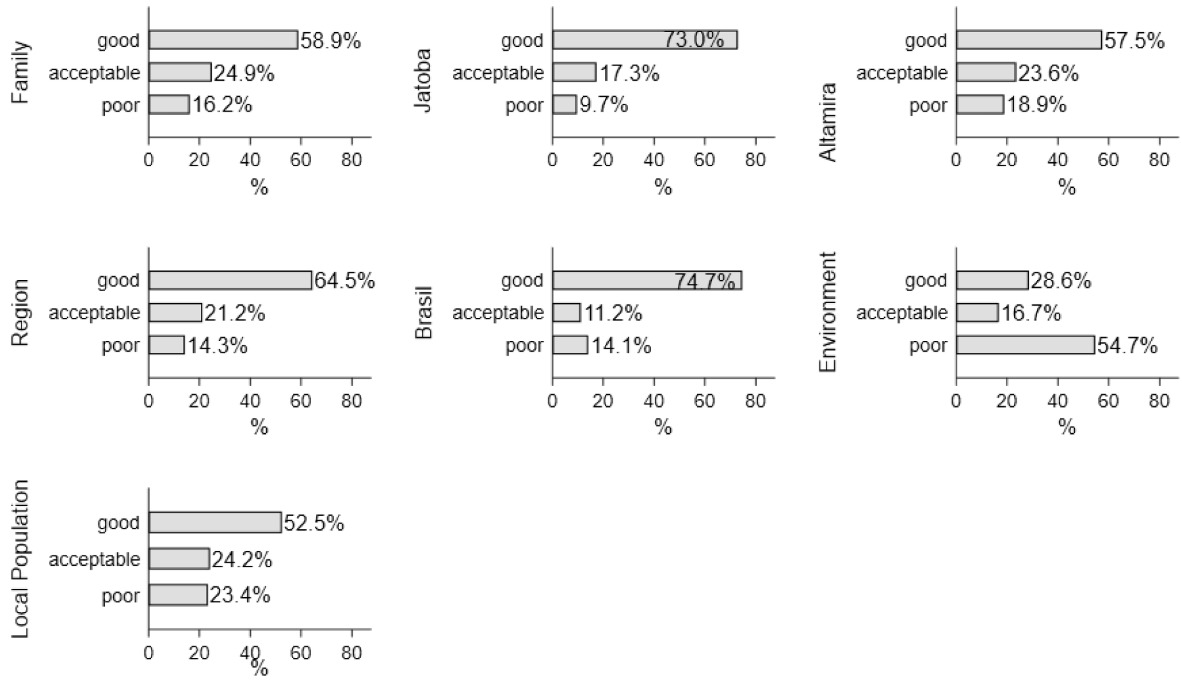

Fig. 3. Distribution of perceived impacts from the Belo Monte Dam.

Table 1
Factor loadings for impact items.

	Factor1	Factor2
Impact on Family	0.823	−0.288
Impact on Jatoba	0.867	−0.283
Impact on Altamira	0.927	0.077
Impact on Region	0.954	0.038
Impact on Brasil	0.881	−0.102
Impact on Environment	0.709	0.345
Impact on Local Population	0.880	0.250
Eigenvalue:	5.252	0.361

Note: Factors extracted from a polychoric correlation matrix using the iterated principal factors method with a varimax rotation. KMO = 0.8972. Factor 1 explains 53% of the interitem variance.

more intuitive because of the well-documented difficulties in directly interpreting logistic regression coefficients [84]. The probabilities are the primary way that we interpret our models.

8. Results

Table 3 provides the results from our partial proportional odds model. In the first model, we enter only our two factor scores as predictors. The factor score for resettlement has violated the proportional odds assumption in this model. Both the effects of resettlement and perceived impacts of Belo Monte are statistically significant in the "Yes" category. Model 2 drops the Displacement Factor Score and Impact Factor score and adds the items for procedural justice (fair compensation, choice of location, and engagement). None of the procedural justice items reach statistical significance, although the p-value for "Fair Compensation" (our indicator of restorative justice) approaches statistical significance for the "No" category ($p = 0.066$). Notably, the AIC and BIC have increased, implying a worse model fit. The lack of significant coefficients and the seemingly worse model fit imply that procedural justice does little to predict support for hydropower. In Model 3 we use both sets of predictors, again finding that the effects of displacement and perceived impacts are statistically significant. This model has also produced the lowest AIC and BIC statistics, implying a better model fit that simply using the displacement and perceived impact items.

The predicted probabilities are displayed in Fig. 5. These probabilities were calculated from Model 3 in Table 3 by manipulating values on the displacement factor score and the impact factor score and holding all other predictors at their observed values. Panel 1 displays probabilities by different values of the impact factor score. The graphic indicates that as impacts increase, the probability of stating "Yes" decreases. For instance, if a respondent perceived little to no negative impacts (i.e. a score of "-2") then their probability of "Yes" is some 0.70. However, a respondent who perceives large, negative impacts (i.e. a score of "2"), their probability of stating "Yes" hovers near 0.30. Thus, perceived negative impacts from Belo Monte sharply reduce support for additional hydropower. However, this finding comes with an important qualification that is revealed by examining the curves for "No" and "Don't Know". As impacts increase, the probability of stating "No" increases in tandem yet the probability of "Don't know" also grows. That is, perceiving negative impacts seems to drive respondents away from stating that hydropower is worth pursuing yet many of those who perceived large, negative impacts are likely to say "don't know" instead of "no".

The second panel, which presents probabilities based upon manipulated values of the displacement factor score, also reveals several complicated findings about the effects of resettlement. Recall that higher scores are associated with a negative view of the effects of displacement and lower scores represent the view that various life conditions have improved since resettlement. Like our impacts factor score, the probability of "Yes" declines markedly as experiences with displacement become more negative. When the effects of displacement are low, the probability of stating "No" or "Don't know" overlap, yet experiencing negative effects from displacement creates a stark difference in these curves wherein those who report negative impacts from displacement are much more like to state "No". Thus, the probabilities suggest that positive or modest negative effects of displacement (i.e. scores below the mean of zero) can alternatively drive individuals to state that "No" or "Don't know" when asked if hydropower is worth it. Yet, as these negative experiences increase, the "No" and "Don't know" responses are more clearly sorted, with the likelihood of "No" much higher when displacement effects are largely negative.

The open-ended section of the survey provides a richer

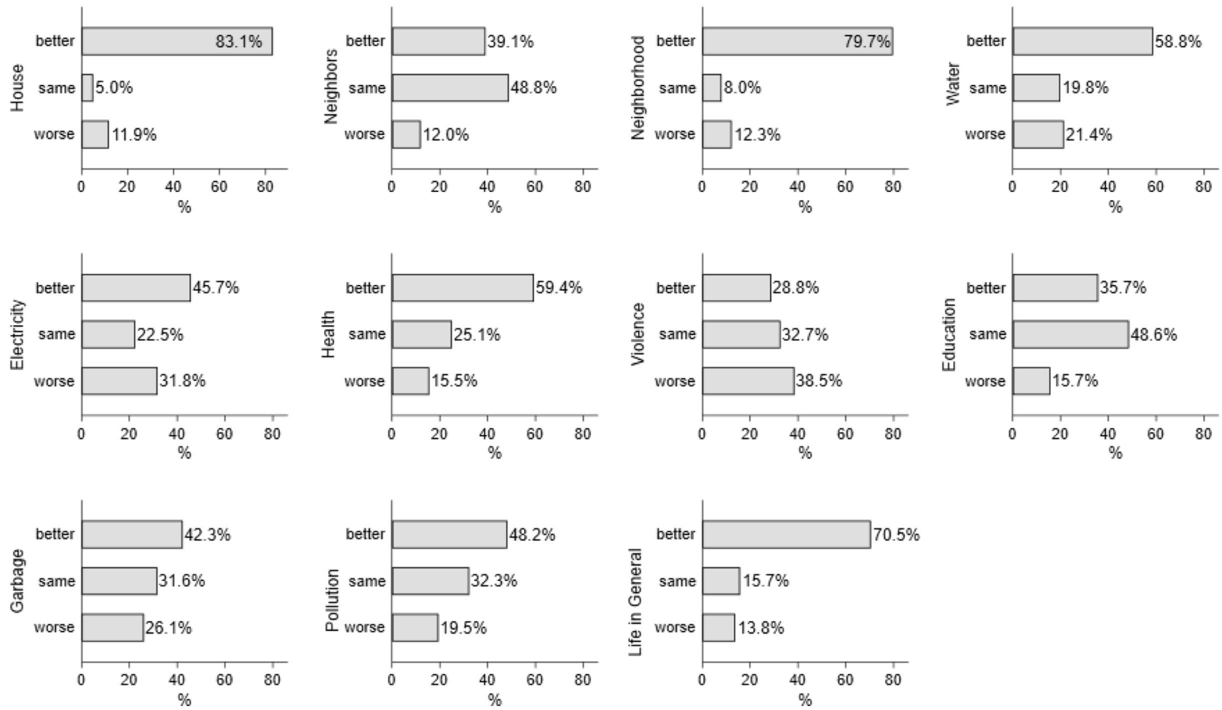

Fig. 4. Changes from displacement and resettlement.

Table 2
Factor loadings for changes after migration.

	Factor 1	Factor 2
Housing	0.704	−0.062
Neighbors	0.520	0.055
Neighborhood	0.748	0.080
Water	0.628	−0.063
Electricity	0.724	0.304
Health	0.807	0.255
Transportation	0.466	0.613
Violence	0.485	−0.408
Education	0.620	0.076
Garbage	0.686	−0.303
Contamination	0.706	−0.368
Better Life	0.852	−0.116
Eigenvalue	5.451	0.967

Note: Factors extracted from a polychoric correlation matrix using the iterated principal factors method with a varimax rotation. KMO = 0.8445. Factors 1 explains 93% of the interitem variance.

Table 3
Partial proportional odds model for support for Hydropower.

	Model 1	Model 2	Model 3
	b/(se)	b/(se)	b/(se)
"Yes" vs. "No" and "Don't Know"			
Displacement factor score	0.408*		0.370*
	(0.16)		(0.17)
Impact Factor Score	0.476*		0.420*
	(0.20)		(0.21)
Fair compensation		0.541	0.185
		(0.29)	(0.34)
Choice of location		−0.145	−0.349
		(0.27)	(0.34)
Engagement		0.359	0.386
		(0.26)	(0.33)
"No" vs. "Yes" and "Don't Know"			
Displacement factor score	−0.227		−0.289
	(0.22)		(0.24)
Impact Factor Score	0.476*		0.420*
	(0.20)		(0.21)
Fair compensation		−0.562	0.185
		(0.41)	(0.34)
Choice of location		−0.145	−0.349
		(0.27)	(0.34)
Engagement		0.359	0.386
		(0.26)	(0.33)
AIC	344.938	459.243	317.714
BIC	361.013	479.686	342.464

Note: Data collected in 2014 in Jatoba, Brazil. *= $p < 0.05$, **= $p < 0.10$. In model 1, the proportional odds assumption was violated for Impact Factor Score and Displacement Factor Score. In model 2, the assumption was violated for Choice of Location. In model 3, the assumption was violated for the displacement factor score. N = 249.

understanding of our results. Positive views about hydropower development are focused on the national level, they argue that it generates electricity and that it is a benefit for Brazil. Respondents also noted that a positive aspect is that the construction of the dam at the local level generated jobs and resettled people from flood-prone areas to new houses on higher ground. On the other hand, negative views about hydropower are focused on the local scale. They noted that hydropower has generated negative impacts in the environment; it has increased violence and insecurity in the city; there is a lack of public transportation; an increase in the price of goods and services such as electricity; and, that the benefits of the construction of the dam are for people living in other regions. This situation portrays a perception of injustice in the distribution of the benefits and negative impacts generated by hydropower development.

9. Discussion

A large body of research documents the social, economic and ecological impacts of dams [85 15 6] yet we know comparatively little about the degree to which populations directly affected by hydroelectric dams support hydropower development after their experience with it, even though hydropower megaprojects are routinely opposed by indigenous, environmental and other groups. In this section, we discuss our results in the context of the hypotheses we stated above.

Recall that in hypothesis 1, we suggested that perceived impacts

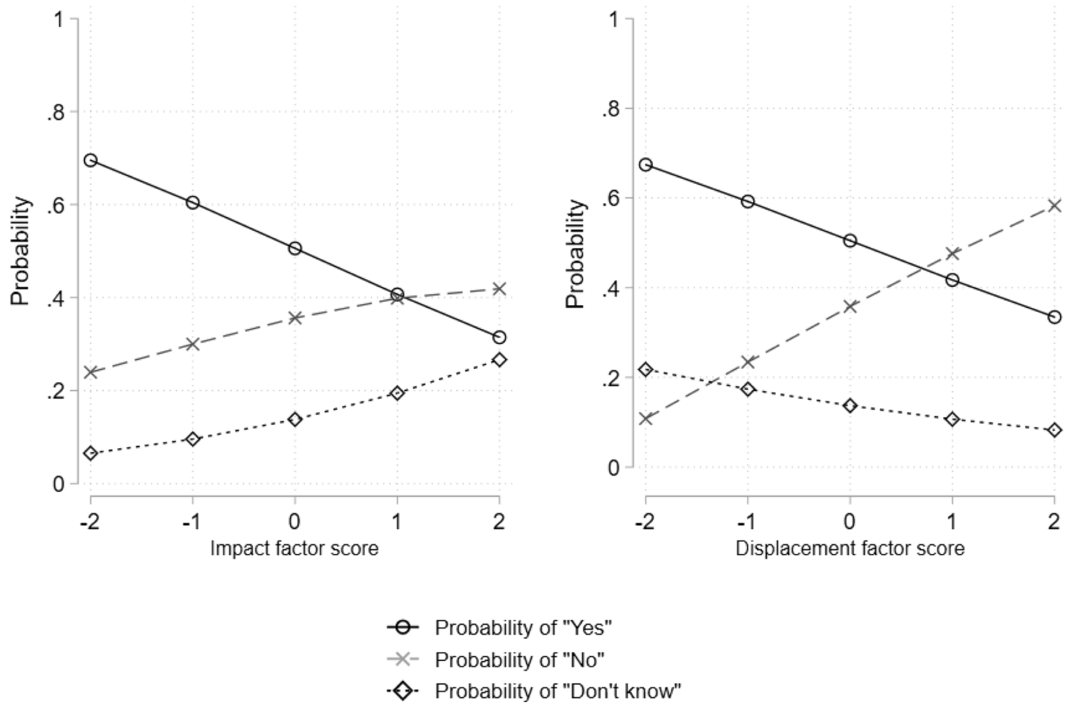

Fig. 5. Predicted probabilities for “In general, do you think hydropower plants are worth building?”

reduce support for hydropower—we operationalized this relationship using two series of questions to capture perceived impacts from the Belo Monte dam and household changes caused by the process of migration and resettlement. Our results reveal several implications. First, as perceived impacts increase, support for hydropower declines yet respondents were also more likely to state “don’t know”. We observed a similar pattern for the negative effects of resettlement—respondents were more likely to state “no” or “don’t know” compared to “yes”. That is, negative impacts appear to increase the likelihood of opposition to Belo Monte and uncertainty about it. Coupled with our descriptive results—in which we found that a non-trivial proportion of the respondents stated “don’t know”—our study implies that there is some degree or uncertainly or perhaps ambivalence about hydropower among displaced populations, who see some aspects of their lives improved and others damaged. In particular, large negative impacts (captured by our impact factor score) seem to cause a situation wherein some displaced individuals are less supportive, but others become more uncertain. That is, perceiving negative impacts from hydropower seems to simultaneously intensify both opposition to hydro and uncertainty about hydropower. Exploring the reasons for this seeming uncertainty is an important task for future research.

From the intensive fieldwork in the area by two of the co-authors of this paper, in the years previous to and during the construction of the dam, they observed that the urban population of Altamira was very supportive of the building of Belo Monte, and they were unhappy with the opposition to it from indigenous peoples. The direct experience with the dam seems to have changed them from strong support to opposition or ambivalence. They recognize some truth in the advocates’ claim that Brazil needs the energy production, but that the benefits to them personally were not commensurate. Recall that many of the impact questions were focused on impacts beyond the family, such as impacts on the region or the entire nation. Turning to the more personal effects of displacement (captured by our displacement factor score), we found less ambiguous effects in support for hydropower. Those who reported that various aspects of their lives were worse after displacement and resettlement were consistently more likely to state “No” when asked if hydropower was worth it. These same individuals were somewhat less likely to say “don’t know”. Direct, negative experiences with displacement and resettlement seem to have a more consistent and ultimately less ambiguous effect on support for hydropower than perceptions of broader impacts. Thus, we find qualified and mixed support for hypothesis 1. The builders made a lot of promises that were simply not kept. They promised local jobs, but these turned out to be temporary, sometimes lasting as little as three months. They promised improvements in the water and sewage system, and even years after the dam was completed, there were still neighborhoods with unreliable water supplies and the sewage connections in Jatoba performed poorly. Schools and transportation were not provided when people moved in, and the households felt burdened by the cost of taking taxis to do basic things like shopping and banking, because of a lack of public transportation to their part of town.

Following the literature on procedural justice and energy development [69 67], we suggested that procedural justice is associated with more support for hydropower (Hypothesis 2). To operationalize this hypothesis, we used predictors that captured the degree to which respondents participating in meetings held by the dam builder and if they were offered any choice of location. Contrary to our expectations, we find that procedural justice did not have any meaningful effect on support for hydropower—respondents’ views appeared to be mostly motivated by perceived impacts, not the extent to which more just processes were built. We also hypothesized that restorative justice—captured as the perception of fair compensation—would lead to greater support (Hypothesis 3). However, our models imply that perceptions of fair compensation do not predict support.

We were surprised that procedural and restorative justice had little to no influence on support for hydropower, especially given that prior research indicates that procedural justice and engagement increases support for energy projects in other settings [67]. We suspect that our results diverge from those of other studies for a few key reasons. First, much of the research on procedural justice and support has focused on renewable projects (e.g. wind and solar) in European nations. Perhaps these studies do not generalize to the case of hydropower and Brazil which has a very different historical and social context. Secondly, our indicators of procedural justice relate specifically to the displacement aspect of the Belo Monte dam. Resettled families were not able even to decide whether or not they wanted to be resettled, their resettlement, as well as the construction of the dam, were top-down decisions. Energy justice scholarship emphasizes the democratization of energy and the meaningful participation of communities in local energy projects in terms of ownership, design features, and siting locations [63 86]. Of course, none of these are typically options for a large-scale hydropower project and definitely not for Belo Monte—which was built by presidential fiat and against the environmental agency's recommendations and social movements' opposition. Thus, our indicators of procedural justice differ somewhat from prior studies given the unique context of hydropower in Brazil where local participation and stakeholder engagement has not been encouraged and often actively discouraged. Then, Jatoba resettlers, and other communities affected by the Belo Monte dam have suffered procedural injustices.

As with all research, our findings come with caveats and qualifications. Prior research indicates that industry public relations efforts can influence public opinion, leading some populations to be more supportive of energy projects than they would otherwise [87]. Similar efforts have occurred in Brazil, which historically has had broadcast media under the control of the military government and has significant media concentration even now [88, 89]. Even though the military ended its control of the Presidency in 1985, none of the governments that followed repudiated the economic priorities they set, nor the role of hydropower in powering the economic engine of the country. We suspect that these government efforts promoting hydropower as the solution for Brazil's energy needs may have influenced our results. Brazil has also experienced periodic energy crises—this cultural backdrop might also create more public acquiescence to hydropower projects because the industry holds the specter of future blackouts as a possibility unless hydropower development proceeds without restraint [47]. Finally, as noted earlier, our sample was among the first resettled populations of Belo Monte, these families were resettled from an urban to an urban area and received housing, as part of the compensation. This population may be more supportive of hydropower than a group of people who received no compensation. Certainly, we found the old residents of Altamira are much less favorably inclined to Belo Monte than the Jatoba residents, a subject for another paper currently being developed. Support for hydropower as well as energy injustices might vary considerably across communities that are impacted differentially by Belo Monte. This variation could be fertile ground for future research.

There are several policy implications from this study. First, communities' opposition to hydropower seems to be largely driven by negative impacts, implying that compensation programs may often be inadequate. Secondly, our sample reported a loss of community resources that lend to a lack of support. More broadly, our results imply that confusion, uncertainty or ambivalence may be understudied, representing an important challenge for policy-makers and planners.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

The authors wish to acknowledge the support of the National Science Foundation through grant 1639115 and of tlhe Fundacao de Amparo a Pesquisa do Estado de Sao Paulo (FAPESP) through 2012/50615-0. They also wish to recognize the support of Michigan State University and the research support provided by the Hannah Distinguished Professorship. None of these sources should be held responsible for any of the views espoused herein. They are the sole responsibility of the authors. They also wish to thank the people of Altamira and Jatoba for their cooperation in this study.

References

[1] A. Asghedom, Country Analysis Executive Summary: Brazil, (n.d.) 7.
[2] J.E. O'Connor, J.J. Duda, G.E. Grant, 1000 dams down and counting, Science 348 (2015) 496–497.
[3] K.O. Winemiller, P.B. McIntyre, L. Castello, E. Fluet-Chouinard, T. Giarrizzo, S. Nam, I.G. Baird, W. Darwall, N.K. Lujan, I. Harrison, Balancing hydropower and biodiversity in the Amazon, Congo, and Mekong, Science. 351 (2016) 128–129.
[4] C. Zarfl, A.E. Lumsdon, J. Berlekamp, L. Tydecks, K. Tockner, A global boom in hydropower dam construction, Aquat. Sci. 77 (2015) 161–170.
[5] S. Namy, Addressing the social impacts of large hydropower dams, The Journal of International Policy Solutions. 7 (2007) 11–17.
[6] M. Cernea, The risks and reconstruction model for resettling displaced populations, World Dev. 25 (1997) 1569–1587.
[7] M. Cernea, Compensation and benefit sharing: Why resettlement policies and practices must be reformed, Water Sci. Eng. 1 (2008) 89–120.
[8] C.E.E. Hess, E. Fenrich, Socio-environmental conflicts on hydropower: The São Luiz do Tapajós project in Brazil, Environ. Sci. Policy 73 (2017) 20–28.
[9] T.M.H. Bui, P. Schreinemachers, Resettling farm households in northwestern Vietnam: livelihood change and adaptation, Int. J. Water Resour. Dev. 27 (2011) 769–785.
[10] H. Randell, The short-term impacts of development-induced displacement on wealth and subjective well-being in the Brazilian Amazon, World Dev. 87 (2016) 385–400.
[11] H. Randell, Forced migration and changing livelihoods in the Brazilian Amazon, Rural Sociology. 82 (2017) 548–573.
[12] Y. Huang, W. Lin, S. Li, Y. Ning, Social impacts of dam-induced displacement and resettlement: a comparative case study in China, Sustainability. 10 (2018) 4018.
[13] C. Sneddon, C. Fox, Struggles over dams as struggles for justice: The world commission on dams (WCD) and anti-dam campaigns in Thailand and Mozambique, Society and Natural Resources. 21 (2008) 625–640, https://doi.org/10.1080/08941920701744231.
[14] R. Fujikura, M. Nakayama, Resettlement policy in large development projects, Routledge, 2015.
[15] B.D. Richter, S. Postel, C. Revenga, T. Scudder, B. Lehner, A. Churchill, M. Chow, Lost in development's shadow: The downstream human consequences of dams, Water Altern. 3 (2010) 14.
[16] E. Bratman, Passive revolution in the green economy: activism and the Belo Monte dam, International Environmental Agreements: Politics, Law and Economics. 15 (2015) 61–77.
[17] D. Schlosberg, Reconceiving environmental justice: global movements and political theories, Environmental Politics. 13 (2004) 517–540.
[18] E. Atkins, Dammed and diversionary: The multi-dimensional framing of Brazil's Belo Monte dam, Singap. J. Trop. Geogr. 38 (2017) 276–292.
[19] P.M. Fearnside, Belo Monte Dam: A spearhead for Brazil's dam building attack on Amazonia, in: Global Water Forum, 2012.
[20] E. Brum, O dia em que a casa foi expulsa de casa, El País. 14 (2015).
[21] E.F. Moran, Roads and Dams: Infrastructure-Driven Transformations in the Brazilian Amazon, Ambiente & Sociedade 2016, XIX (2016) 207–220, https://doi.org/10.1590/1809-4422ASOC256V1922016.
[22] R.C. da Silva, I. de Marchi Neto, S.S. Seifert, Electricity supply security and the future role of renewable energy sources in Brazil, Renew. Sustain. Energy Rev. 59 (2016) 328–341.
[23] E. von Sperling, Hydropower in Brazil: overview of positive and negative environmental aspects, Energy Procedia 18 (2012) 110–118.
[24] H.T. Nguyen, T.H. Pham, L. Lobry de Bruyn, Impact of hydroelectric dam development and resettlement on the natural and social capital of rural livelihoods in Bo Hon Village in Central Vietnam, Sustainability. 9 (2017) 1422.
[25] L. Castro-Diaz, M.C. Lopez, E. Moran, Gender-differentiated impacts of the Belo Monte hydroelectric dam on downstream fishers in the Brazilian Amazon, Human Ecology. 46 (2018) 411–422.
[26] E.G. Stevenson, L. Buffavand, Do Our Bodies Know Their Ways? Villagization, Food Insecurity, and Ill-Being in Ethiopia's Lower Omo Valley, African Studies Review. 61 (2018) 109–133.
[27] D. Lukasz Wiejaczka, L. Piróg, P.P. Tamang, Local residents' perceptions of a dam and reservoir project in the Teesta Basin, Darjeeling Himalayas, India, Mountain Research and Development. 38 (2018) 203–210.
[28] A.A. Tur, H. García-Andreu, G. Ortiz, J.A. Domínguez-Gomez, Discourse analysis of the debate on hydroelectric dam building in Brazil, Water Altern. 11 (2018) 125.
[29] A.S. Bro, E. Moran, M.F. Calvi, Market participation in the age of big dams: the Belo Monte Hydroelectric Dam and its impact on rural agrarian households, Sustainability. 10 (2018) 1592.
[30] C. Gauthier, E.F. Moran, Public policy implementation and basic sanitation issues associated with hydroelectric projects in the Brazilian Amazon: Altamira and the Belo Monte dam, Geoforum 97 (2018) 10–21.
[31] C. Gauthier, Z. Lin, B.G. Peter, E.F. Moran, Hydroelectric infrastructure and potential groundwater contamination in the Brazilian Amazon: Altamira and the Belo Monte Dam, The Professional Geographer. 71 (2019) 292–300.
[32] J. Giles, Methane quashes green credentials of hydropower, Nature Publishing Group, 2006.
[33] P.M. Fearnside, S. Pueyo, Greenhouse-gas emissions from tropical dams, Nat. Clim. Change 2 (2012) 382–384.
[34] P.M. Fearnside, Greenhouse gas emissions from Brazil's Amazonian hydroelectric dams, Environ. Res. Lett. 11 (2016), 011002.
[35] D.M. Rosenberg, P. McCully, C.M. Pringle, Global-scale environmental effects of hydrological alterations: introduction, Bioscience 50 (2000) 746–751.

[36] A. Van Cleef, Hydropower development and involuntary displacement: Toward a global solution, Ind. J. Global Legal Stud. 23 (2016) 349.
[37] P.M. Fearnside, Dams in the Amazon: Belo Monte and Brazil's hydroelectric development of the Xingu River Basin, Environ. Manage. 38 (2006) 16–27.
[38] C.R. da Costa Doria, S. Athayde, E.E. Marques, M.A.L. Lima, J. Dutka-Gianelli, M. L. Ruffino, D. Kaplan, C.E. Freitas, V.N. Isaac, The invisibility of fisheries in the process of hydropower development across the Amazon, Ambio 47 (2018) 453–465.
[39] G. Siciliano, F. Urban, M. Tan-Mullins, G. Mohan, Large dams, energy justice and the divergence between international, national and local developmental needs and priorities in the global South, Energy Res. Social Sci. 41 (2018) 199–209.
[40] P.W. Yankson, A.B. Asiedu, K. Owusu, F. Urban, G. Siciliano, The livelihood challenges of resettled communities of the Bui dam project in Ghana and the role of Chinese dam-builders, Development Policy Review. 36 (2018) O476–O494.
[41] W.C. on Dams,, Dams and development: A new framework for decision-making: The report of the world commission on dams, Earthscan, 2000.
[42] J. Xi, S.-S. Hwang, Unmet expectations and symptoms of depression among the Three Gorges Project resettlers, Soc. Sci. Res. 40 (2011) 245–256.
[43] S. Karimi, W.D. Taifur, Resettlement and development: a survey of two of Indonesia's Koto Panjang resettlement villages, Int. J. Water Resour. Dev. 29 (2013) 35–49.
[44] A. Zhouri, R. Oliveira, Development, social conflicts and violence in rural Brazil: the case of hydroelectric dams, Ambiente & Sociedade. 10 (2007).
[45] F. Vanclay, Project-induced displacement and resettlement: from impoverishment risks to an opportunity for development? Impact Assessment and Project Appraisal. 35 (2017) 3–21, https://doi.org/10.1080/14615517.2017.1278671.
[46] W.N. Green, I.G. Baird, Capitalizing on compensation: Hydropower resettlement and the commodification and decommodification of nature–society relations in southern Laos, Annals of the American Association of Geographers. 106 (2016) 853–873.
[47] V.B. Fuchs, Blaming the weather, blaming the people: socio-environmental governance and a crisis attitude in the brazilian electricity sector, Ambiente & Sociedade. 19 (2016) 221–246.
[48] T. Scudder, The world commission on dams and the need for a new development paradigm, Int. J. Water Resour. Dev. 17 (2001) 329–341.
[49] M.F. Calvi, E.F. Moran, R.F.B. da Silva, M. Batistella, The construction of the Belo Monte dam in the Brazilian Amazon and its consequences on regional rural labor, Land Use Policy. 90 (2020), 104327.
[50] A. Scheidel, L. Temper, F. Demaria, J. Martínez-Alier, Ecological distribution conflicts as forces for sustainability: an overview and conceptual framework, Sustain. Sci. 13 (2018) 585–598.
[51] D. McAdam, H. Boudet, Putting social movements in their place: Explaining opposition to energy projects in the United States, 2000–2005, Cambridge University Press, 2012 https://books.google.com/books?hl=en&lr=&id=CzwgAwAAQBAJ&oi=fnd&pg=PR9&dq=mCadam+and+boudet&ots=vWh-oebSOX&sig=iq8gXs-sGidZms24zRy8e0-wo00.
[52] R.C. Sayan, Exploring place-based approaches and energy justice: Ecology, social movements, and hydropower in Turkey, Energy Res. Social Sci. 57 (2019), 101234.
[53] S.A. Malin, The price of nuclear power: uranium communities and environmental justice, Rutgers University Press, 2015.
[54] N. Cass, G. Walker, Emotion and rationality: The characterisation and evaluation of opposition to renewable energy projects, Emotion, Space and Society. 2 (2009) 62–69.
[55] S.K. Olson-Hazboun, R.S. Krannich, P.G. Robertson, Public views on renewable energy in the Rocky Mountain region of the United States: Distinct attitudes, exposure, and other key predictors of wind energy, Energy Res. Social Sci. 21 (2016) 167–179.
[56] A. Mayer, Economic Identity, Price and Policy: Willingness to Pay for Fracking Regulation in Colorado, Journal of Rural, Social Sciences. 33 (2018) 1–31.
[57] J.W. Stoutenborough, S.G. Sturgess, A. Vedlitz, Knowledge, risk, and policy support: Public perceptions of nuclear power, Energy Policy. 62 (2013) 176–184.
[58] A. Leiserowitz, Climate change risk perception and policy preferences: The role of affect, imagery, and values, Clim. Change 77 (2006) 45–72.
[59] S.J. Dreyer, H.J. Polis, L.D. Jenkins, Changing tides: Acceptability, support, and perceptions of tidal energy in the United States, Energy Res. Social Sci. 29 (2017) 72–83.
[60] E. Atkins, Disputing the 'National Interest': The Depoliticization and Repoliticization of the Belo Monte Dam, Brazil, Water. 11 (2019) 103.
[61] R. Bullard, Dumping in dixie, Boulder, Westview, CO, 1990.
[62] D.E. Taylor, The rise of the environmental justice paradigm: Injustice framing and the social construction of environmental discourses, American Behavioral Scientist. 43 (2000) 508–580.
[63] K.E. Jenkins, Energy Justice, Energy Democracy, and Sustainability: Normative Approaches to the Consumer Ownership of Renewables, in: Energy Transition, Springer, 2019: pp. 79–97.
[64] R.J. Heffron, D. McCauley, The concept of energy justice across the disciplines, Energy Policy. 105 (2017) 658–667.
[65] S. Fuller, D. McCauley, Framing energy justice: perspectives from activism and advocacy, Energy Res. Social Sci. 11 (2016) 1–8.
[66] G. Ottinger, T.J. Hargrave, E. Hopson, Procedural justice in wind facility siting: Recommendations for state-led siting processes, Energy Policy. 65 (2014) 662–669.
[67] C. Walker, J. Baxter, Procedural justice in Canadian wind energy development: A comparison of community-based and technocratic siting processes, Energy Res. Social Sci. 29 (2017) 160–169.
[68] J. Liljenfeldt, Ö. Pettersson, Distributional justice in Swedish wind power development–An odds ratio analysis of windmill localization and local residents' socio-economic characteristics, Energy Policy. 105 (2017) 648–657.
[69] N. Simcock, Procedural justice and the implementation of community wind energy projects: A case study from South Yorkshire, UK, Land Use Policy. 59 (2016) 467–477.
[70] B.J. Walker, B. Wiersma, E. Bailey, Community benefits, framing and the social acceptance of offshore wind farms: an experimental study in England, Energy Res. Social Sci. 3 (2014) 46–54.
[71] A. Mayer, Scalar controversies in oil and gas governance: Perspectives on who should regulate the oil and gas industry from policy actors in Colorado and Utah, The Extractive Industries and Society. (2018).
[72] S.A. Malin, T. Opsal, T. O'Connor Shelley, P.M., Hall, The Right to Resist or a Case of Injustice? Meta-Power in the Oil and Gas Fields, Soc. Forces (2018).
[73] S.A. Malin, S. Ryder, M.G. Lyra, Environmental justice and natural resource extraction: intersections of power, equity and access, Taylor & Francis, 2019.
[74] M. Hay, J. Skinner, A. Norton, Dam-induced displacement and resettlement: a literature review, Available at SSRN 3538211. (2019).
[75] D. Goulet, Global governance, dam conflicts, and participation, Human Rights Quarterly. 881–907 (2005).
[76] S. Marques, M.L. Lima, S. Moreira, J. Reis, Local identity as an amplifier: Procedural justice, local identity and attitudes towards new dam projects, Journal of Environmental Psychology. 44 (2015) 63–73.
[77] S. Batel, P. Devine-Wright, T. Tangeland, Social acceptance of low carbon energy and associated infrastructures: A critical discussion, Energy Policy. 58 (2013) 1–5.
[78] M.F. Coutinho, R.H. Santana, Reassentamentos Urbanos Coletivos (RUCs) em Altamira: impactos sociais da UHE Belo Monte, Revista Do Instituto Histórico e Geográfico Do Pará (IHGP). 3 (2016) 149–160.
[79] E.F. Moran, Agricultural development in the Transamazon Highway [Brazil], Latin American Studies Working Papers (USA) (1976).
[80] E.F. Moran, Developing the Amazon, Indiana Univ. Press, 1981.
[81] R. Williams, Generalized ordered logit/partial proportional odds models for ordinal dependent variables, Stata Journal. 6 (2006) 58.
[82] A.S. Fullerton, J. Xu, Ordered Regression Models: Parallel, Partial, and Non-Parallel Alternatives, Chapman and Hall/CRC (2016).
[83] J.D. Singer, J.B. Willett, Applied longitudinal data analysis: Modeling change and event occurrence, Oxford University Press, 2003 https://books.google.com/books?hl=en&lr=&id=PpnA1M8VwR8C&oi=fnd&pg=PA1&dq=singer+and+willet&ots=N4uatFbzpL&sig=dp2HcfUrhBP0tZwjO1OWfEj9lC4.
[84] C. Mood, Logistic regression: Why we cannot do what we think we can do, and what we can do about it, Eur. Sociol. Rev. 26 (2010) 67–82.
[85] B. Tilt, D. Gerkey, Dams and population displacement on China's Upper Mekong River: Implications for social capital and social–ecological resilience, Global Environ. Change 36 (2016) 153–162.
[86] B. Van Veelen, Negotiating energy democracy in practice: governance processes in community energy projects, Environmental Politics. 27 (2018) 644–665.
[87] S.E. Bell, R. York, Community economic identity: The coal industry and ideology construction in West Virginia, Rural Sociology. 75 (2010) 111–143.
[88] C. Matos, Media democratization in Brazil: Achievements and future challenges, Critical Sociology. 38 (2012) 863–876.
[89] J.D. Straubhaar, Television and video in the transition from military to civilian rule in Brazil, Latin American Research Review. 24 (1989) 140–154.