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Changes in Social Capital Associated with the Construction of the Belo Monte Dam: Comparing a Resettled and a Host Community

Adam Mayer, Maria Claudia Lopez, Guillaume Leturcq, and Emilio Moran

Nations in the Global South have increasingly embraced large hydropower. Hydropower development typically involves the displacement and resettlement of entire communities and has a range of social and ecological impacts. Some communities become the operational center for the dam construction, as well as host new neighborhoods of resettlers. One of the less-studied impacts of dams is the potential loss of social capital both in resettled and host communities. Here, we ask how the Belo Monte dam in the Amazon is associated with social capital in a resettled group and a non-resettled population that, while not experiencing resettlement, nevertheless was impacted by the dam as well. We use measures of cognitive and structural social capital. Results suggest that resettlers have lower structural social capital across two proxy indicators, whereas the host community has lower cognitive social capital. Future research and social impact assessments should pay more attention to how hydropower impacts both kinds of social capital.

Key words: hydropower, social capital, energy impacts, sustainable development

Introduction

Global energy demand is expected to increase through 2050, with much of this demand coming from the Global South due to the rapid urbanization and industrial development in these countries. Sustainable Development Goal #7 identified access to reliable, affordable energy as essential to meeting other sustainable development goals (UNDP 2020). Over the past several decades, developing nations have turned to large-scale hydropower projects to satisfy their energy needs and fuel their economic development, even as hydropower has fallen out of favor in the Global North (Moran et al. 2018; O'Connor, Duda, and Grant 2015; Winemiller et al. 2016; Zarfl et al. 2015). Hydropower ostensibly holds a range of advantages for nations in the Global South—hydropower emits less carbon dioxide than fossil fuels, and electricity generated from hydropower is less subject to the wild price swings that can accompany conventional fossil fuel sources.

However, large-scale hydropower projects also bring about enormous social and ecological impacts. Kirchnerr and Charles (2016) estimate that roughly 472 million people globally are negatively impacted by dam projects. These impacts range in their nature and magnitude, but they include ecological damage to sensitive rivers and fisheries, which can, in turn, erode subsistence livelihoods and cause food insecurity among populations dependent on river food sources (Castro-Diaz, Lopez, and Moran 2018; Rudd et al. 1993; Siciliano et al. 2018; Vilela and Reid 2017; von Sperling 2012; Winemiller et al. 2016). In addition to these downstream changes, hydropower projects typically involve building reservoirs to provide the stored water energy that powers these dams, requiring the resettlement of local populations flooded by reservoirs (Cernea 2008). For example, according to Webber and McDonald (2004), 12 million people have been resettled in China because of dam construction (not only for energy purposes) since 1949.

Displacement and resettlement programs often include some form of compensation for those directly affected,

Adam Mayer is a post-doctoral researcher at the Center for Global Change and Earth Observations at Michigan State University. He studies the social aspects of energy and energy transitions. Maria Claudia Lopez is an associate professor in the Department of Community Sustainability at Michigan State University. Her scholarly work is motivated to investigate how different rules and norms, understood as institutions, might drive resource users to govern their natural resources in sustainable and cooperative ways. For the past five years, she has been working with an interdisciplinary team investigating the impacts of hydropower in communities living nearby, and to think about solutions to ensure positive environmental and socio-economic outcomes in hydropower development. Guillaume Leturcq is an associate professor at the Federal University of Rio Grande do Sul, Brazil. He is professor of the department of Regional Development. Emilio Moran is John A. Hannah Distinguished Professor in the Dept. of Geography, Environment and Spatial Sciences. He is Distinguished Professor Emeritus of Anthropology at Indiana University. He is the author of 12 books and 16 edited volumes and over 230 articles and book chapters. He is a Fellow of the Society for Applied Anthropology, Fellow of AAAS, and a member of the National Academy of Sciences.

such as providing cash payments, moving assistance, training programs for new jobs, or new housing (Cernea 2008). However, despite compensation programs, the displacement and resettlement process creates a range of challenges for impacted populations. For instance, resettled populations typically find their livelihoods and assets are disrupted and have to piece together new sources of income, sometimes working more hours per week to meet their basic needs (Bui and Schreinemachers 2011; Takesada, Manatunge, and Herath 2008). Displacement also involves the loss of cultural resources and social capital, both of which are not easily monetized in compensation programs and thus often ignored in dam planning (Hensengerth 2017; Vanclay 2017). Social capital is a vital resource that facilitates a host of benefits ranging from the psychological rewards derived from social connections and group cohesion to access essentials such as employment, informal exchanges of labor and household goods, and many others (Sanyal 2009; Seferiadis et al. 2015). Although the literature on the impacts of hydropower often alludes to a loss of social capital and to loss of social cohesion, there are few direct studies of the social capital implications of dams (see Nguyen, Phan, and De Bruyn 2017; Tilt and Gerkey 2016; Xi 2016. As we explain further below, this is a significant gap because social capital provides many benefits to individuals and communities, ranging from improving well-being to facilitating collective action to address complex problems (Brondizio, Ostrom, and Young 2009; Ferlander 2007). Governments and energy firms commonly rely on relatively simple cost-benefit analyses to understand the impact of dams (e.g., Kaneti 2019). Thus, understanding all of the dams' impacts—especially those that are not well-quantified like social capital—needs to become an essential task.

The purpose of this paper is to address this important gap in the literature. We consider the case of the Belo Monte dam in the Amazon, one of the largest dams in the world whose benefits were widely touted (e.g., Schapper, Unrau, and Killoh 2019). Some of the social and environmental impacts of this dam have been evaluated elsewhere (e.g., Calvi et al. 2020; Castro-Diaz, Lopez, and Moran 2018; Gauthier et al. 2018; Gauthier et al. 2019; Randell 2016), yet the implications of this dam on social capital among riverine communities have not been studied. Here, we conduct a unique comparison between Jatoba, an urban population that was resettled into a new specially-built neighborhood in the city of Altamira, and a sample of the older population of Altamira that was affected by the construction of the dam because the city became the operational center for the dam construction and the host of new neighborhoods of resettlers. This study design allows us to compare proxy indicators of social capital between a resettled group and a non-resettled population that, while not experiencing resettlement, nevertheless has been impacted by the dam. In the next section, we provide some conceptual background around social capital and its relationship to large-scale energy projects.

Background

What is Social Capital?

Scholars have studied social capital for decades, but this concept has eluded a simple definition. In their widely cited book, Bourdieu and Wacquant (1992:119) state that social capital is "the sum of the resources, actual or virtual, that accrue to an individual or a group by virtue of possessing a durable network of more or less institutionalized relationships of mutual acquaintance and recognition." In another popular definition, Putnam (2004:67) argued that social capital is "features of social organizations such as networks, norms and social trust that facilitate coordination and co-operation for mutual benefit." After these early efforts to define social capital, some scholars argued that the construct was too vague to be effectively operationalized (Adger 2003; Hawe and Shiell 2000; Szreter and Woolcock 2004), leading many researchers to use proxy indicators of social capital. Later work qualified the nature of social capital by arguing that there are different types of social capital or different sub-constructs. For instance, a common distinction is between "cognitive" and "structural" social capital (Ferlander 2007; Forsman et al. 2012; Jones et al. 2014; Yip et al. 2007). Studies have shown that there is some connection between these two types of social capital (Uphoff and Wijayaratna 2000) and that these two types of social capital may behave in opposite directions in some communities (Brune and Bossert 2009).

Cognitive social capital is typically understood as subjective interpretations, perceptions, or attitudes related to norms of reciprocity, community and civil engagement, and trust. Trust is further distinguished between social trust (trust in other people) and trust in institutions (Bjørnskov 2011). Trust holds a wide range of benefits for social groups of all sizes, ranging from organizations to entire nations. For instance, social trust allows information to be transmitted through social groups, potentially changing group norms and leading to the diffusion of healthy behaviors (Dean et al. 2014a, 2014b; Yip et al. 2007). Social trust is associated with a range of altruistic and pro-social behaviors, such as participation in charity organizations (Sønderskov 2011; Uslaner 2002) or recycling (Harring, Jagers, and Nilsson 2019). At the national scale, trust allows for more effective governance and collective action in the face of complex problems, such as climate change (Adger 2003; Smith and Mayer 2018). Trust can also engender resilience during times of rapid change and stress, such as in the case of a health crisis or a natural disaster (Habibov and Afandi 2010). Cognitive social capital has routinely been linked to violence and conflict within a community, wherein violence is associated with reduced trust and lower cognitive social capital (Alcorta et al. 2020; McIlwaine and Moser 2001).

Structural social capital refers to more concrete aspects of social networks, such as a person's degree of connectivity to others. These can include relationships with family members, co-workers, fellow parishioners at a church, participation in

civil organization, and many other ties that people may form with one another. Social networks provide people with key resources, ranging from employment to childcare and the exchange of household labor to psychological benefits such as a sense of belonging that can bolster well-being (Curley 2010; Franzen and Hangartner 2006; Yip et al. 2007). Further, structural social capital may facilitate adaptation and resilience and the diffusion of technological innovations (Aldricht and Meyer 2015; Nakagawa and Shaw 2004). Structural social capital is also especially important in cases of community-based management of natural resources, which require participation and trust among community members (Brondizio, Ostrom, and Young 2009; Pretty 2003; Pretty and Ward 2001;), including in the Amazon (Mertens et al. 2011).

Development scholarship emphasizes the importance of social capital for effective governance, collective action, and economic growth (Farole et al. 2011; Mubangazi 2003). Pretty and Ward (2001:241) explain that, when social capital is strong, "people have the confidence to invest in collective activities, knowing that others will also do so." Social groups at any scale (e.g., local or national) accrue significant benefits from social capital. For instance, cognitive social capital, particularly trust between individuals and trust in government agencies, facilitates economic development by reducing transaction costs and allowing for cooperation between disparate individuals and groups (Fafchamps 2006; Nooteboom 2007). Social capital is especially important in places where households are more likely to rely on informal systems of exchange and reciprocity (e.g., Sanyal 2009; Seferiadis et al. 2015). Notably, the widely applied Sustainable Livelihoods Framework (SLF) foregrounds social capital among other types of capital (i.e., human capital, natural capital, physical capital, and financial capital) that are the livelihood assets essential to understand peoples' livelihood strategies and outcomes (Allison and Ellis 2001; Bebbington 1999; Ellis 2000; Serrat 2017). However, the SLF does not differentiate between "cognitive" and "structural" social capital.

Social Capital and Energy Impacts

Large-scale energy projects are related to social capital via a variety of mechanisms. Research in the "energy boomtown" tradition—which has primarily been conducted in the Global North—has documented how large mining projects in rural places eroded community cohesion due to the sudden influx of new workers, severing of pre-existing social relationships, and creating social problems such as increased crime (Freudenburg 1981; England and Albrecht 1984). On the other hand, social capital can facilitate participatory governance of energy projects and potentially more just and sustainable outcomes (e.g., Parkhill et al. 2015).

Hydropower projects involve resettling large populations, some of whom may be compensated directly with cash payments, given new housing, or some combination of both (Calvi et al. 2020; Castro-Diaz, Lopez, and Moran 2018). The literature on the social and ecological impacts of dams and resettlement programs is truly massive (e.g., see Botelho et al. 2017; Vanclay 2017 for reviews). Reviewing all of the potential impacts is beyond the scope of this paper. Briefly, themes of disrupted livelihoods, material losses, and ecological damage dominate the literature (Arantes et al. 2019; Castro-Diaz, Lopez, and Moran 2018; da Costa Doria et al. 2018; Moran et al. 2018). Typically, resettlement and compensation programs are geared towards these concerns. Hydropower in developing nations engenders several impacts relevant to the study of social capital. Although scholars might not necessarily invoke the term "social capital," there are several studies that refer to social relationships, community cohesion, and similar concepts.

Displacement and resettlement also weaken or sever important social relationships, thereby reducing social capital. Social impact assessments increasingly consider this loss of social capital (Vanclay 2006), although the monetary cost of the loss of social capital is difficult to quantify (Vanclay 2017), and therefore, little is done to make up for these losses. Efforts to assign a monetary value to social capital suggest that it is quite high (Orlowski and Wicker 2015). Notably, resettled populations often make use of their social networks to mitigate the effects of displacement (Randell 2016, 2017), but when this capital is lost, readjustment becomes more difficult.

More specifically, in their review of the effects of dams in Malaysia, Aiken and Leigh (2015:72) argue that "frayed social relationships" are a common outcome. Resettled populations often must find new employment (e.g., Akça, Fujikura and Sabbağ 2013)—long-held employment can be an important source of social capital, and in new jobs, this has to be rebuilt. Takesada, Manatunge, and Herath (2008), reporting on impacts of the Kotmale Dam in Sri Lanka, find that working hours in non-household labor increased after resettlement, allowing less time for community interactions to create social cohesion; many residents suggested that community life had suffered as a result of resettlement. Loker (2003), studying a displaced population in Honduras, found that the displaced often rely upon social relationships with wealthier households to provide for their livelihoods after resettlement. Hensengerth (2017) describes how reservoirs have flooded temples and other significant Buddhist sites in Cambodia. The inability to access these familiar sites reduces community cohesion.

Three studies have evaluated social capital, displacement, and resettlement from hydropower more directly. Xi (2016) considered China's Three Gorges Dam project, finding that resettled rural populations experienced lower degrees of social integration and greater depressive symptoms than urban to urban migrants. Nguyen, Phan, and De Bruyn (2017) studied a large dam in Vietnam using several proxies for social capital. The authors find that 76 percent of the displaced and resettled population reported that social capital declined after resettlement. Tilt and Gerkey (2016) studied the impacts of a dam on the Upper Mekong River on a resettled population. To understand the effect of the dam on social capital, the authors use indicators of inter-household exchange of financial

resources and inter-household exchange of agricultural labor. Comparing a resettled population with a population that did not experience displacement, they find that borrowing from neighbors was more common among the resettled, but the resettled were less likely to give loans. Another study by Bui and Schreinemachers (2011) uses the SLF to study how the livelihood assets (capitals), including social assets, change between a resettled and a host community after the construction of the Son La dam in Vietnam. To study social capital, the authors looked at membership in associations and safety nets. The study shows that both resettled and host communities participated in more organizations after the construction of the dam, but the study does not explain why this happens or delve much into the implications of the changes in social capital. Thus, the prior literature implies that large-scale hydropower and related resettlement programs have a potentially large impact on social capital. Yet, despite the large literature on the impacts of resettlement programs, social capital has received little direct study, especially outside of Asia.

Data, Methods, and Measures

Study Context

The Belo Monte Hydroelectric Complex on the Xingu river is one of the world's largest dams, standing at 90 meters high with an installed capacity of 11,233 MW. However, reports have shown that the dam has not generated that potential capacity, showing that the project managers misestimated the hydrological conditions on the Xingu river during several months of the year when river flow declines (Higgins 2020). The dam's reservoir covers 441 square kilometers, and at least 40,000 people were directly displaced due to the dam (Randell 2016). There are many social and ecological impacts from the Belo Monte dam. During our fieldwork, informants estimated that some 50,000 workers, most of whom were young men, arrived in the region in the hope of gaining employment in constructing the dam. Authors like Miranda Neto (2015) estimate that the Belo Monte dam hired more than 45,000 workers between 2011 and 2014; that is the equivalent of 46 percent of the Altamira population in 2010 (IBGE 2017). Some other people moved to the area and found jobs in the commercial sector, including bars, prostitution establishments, various types of restaurants, and hotels. In fact, Calvi et al. (2020) noted that between 2011 and 2014, the city of Altamita saw a peak in formal urban employment, numbers that declined after the construction of the reservoir ended. This increased traffic in the area stressed sanitation services (Gauthier et al. 2019) and many other services such as hospitals, schools, and policing.

The dam had been under consideration since the 1970s, but indigenous groups and environmental activists had been successful in halting its construction (Fearnside 2017; Moran 2018). Construction began in 2011 by presidential fiat ignoring the social movements against it and not following procedures established by the Constitution, like delivering the Environmental Impact Assessment to the Brazilian Institute of the Environment and Renewable National Resources (IBAMA) without the required degree of consultation with the indigenous population (Fainguelernt 2011).

In 2014, the displacement and resettlement process began. Most of the displaced population was resettled into urban collective resettlements (Reassentamentos Urbanos Coletivos or RUCs). Five RUCs were constructed in the periphery of the city of Altamira, located 52 KM upstream from Belo Monte. The Jatoba neighborhood was the first RUC constructed, with homes constructed of concrete composite. The neighborhood initially lacked many amenities and services, such as churches, and was relatively far from the central commercial district of Altamira, which proved to be crucial to the population there, especially given the lack of public transportation between the community and the central commercial area. As Mayer et al. (2021) describe, most of the resettlers in Jatoba came either from riverine locations on the waterfront or people that had businesses near the riverfront and had no choice but to resettle. It is the impression of the dam builders, gleaned from interviews with them, that the housing of this group improved because of the resettlement process, but they lost ideal locations in the commercial center of the city.

Data Collection

In the analysis below, we compare results from two different surveys conducted between 2014-2015 in the city of Altamira, during the height of the construction of the Belo Monte dam. Households were randomly sampled within census tracts. The population of Altamira had approximately 104,000 people in 2014, having grown from a population just under 80,000 in 2010 due to the arrival of dam-related workers, engineers, and associated commercial sector (IBGE 2014). Others estimate that the population reached 150,000 at this peak, but this estimate probably includes those directly employed by the dam, who lived at the construction site 52 km away from Altamira, but who came into town on their days off, and thus their presence was felt by the Altamira residents and businesses (Klein 2015). For the first survey (conducted in 2014), we sampled census tracts with probability proportional to size using the 2010 Census (IBGE 2014), wherein census tracts with more households were more likely to be chosen. We sampled ten census tracts within the city of Altamira and randomly sampled fifty households within each census tract.[1] Census tracts were located throughout the city—in the center, the north, the south, the west, along the *igarapés* and the transamazonian road, and along the Xingu river.

Students from the local universities (Universidade Federal do Para and Universidade Estadual do Para) conducted the survey interviews face-to-face using paper forms. Before data collection, one of the co-authors of this paper conducted a training program for students so they could become familiar with the survey instrument and address possible doubts related to the instrument. We invited the head of the household or his/her partner to answer the survey; as a result, 50.7 percent

of the respondents were female. In this sample, the average household size was 2.73, with the largest homes having seven people. Forty-seven percent of the male heads of household had completed middle school or more, while only 38 percent of female household heads had achieved that level of education. The average age was thirty-one years old. Among household members over sixteen years old, 69 percent were employed in paid activity. We conducted the second survey in 2015 in Jatoba—the first RUC specifically built for the resettled population. This population is composed of primarily urban-to-urban migrants, who received new homes as compensation but also included families living on islands along the reservoir and along riverbanks that would be flooded by the rising waters in the reservoir area. The majority of the responding urban population were families who lived in precarious neighborhoods on the banks of the Xingu River and in areas of the city that would be flooded by the rising waters in the reservoir. The families interviewed had lived in their new environment for less than a year. Importantly, our data covers the early migrants to Jatoba, who may differ from later waves of resettlers in that they were the most eager to move. At the time of our data collection, the Jatoba neighborhood had 1,023 homes occupied, and our final sample included some 269 respondents. Trained student researchers used a map of the Jatoba neighborhood, interviewing every third household. Because this was a new neighborhood and did not exist at the time of the 2010 Census, it was not possible to follow the same sampling method using census tracts as in the Altamira survey. In the Jatoba sample, the average household size was 3.2, although some homes had up to eight people. Thirty-five percent of the male heads of household had less than a middle school education, and 8 percent had none. Slightly less than 50 percent of the sample was female, with an average age of twenty-eight years old. Among household members over sixteen years old, 59 percent were employed in some type of paid activity.

Both surveys contained socioeconomic questions as well as information about respondents' experiences with the dam and their perspectives on the impacts of the dam on the community, among other topics. The surveys contained both open-ended and close-ended questions.

In addition, two of the authors of this paper did extended fieldwork in the years before the construction of the dam as well as during the construction of the dam as part of a five-year project funded by Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP) to understand the social and environmental impacts of the construction of Belo Monte. As a result, they interviewed, in addition to the surveyed population, more than 120 people, such as other inhabitants of Altamira, people working with the dam company and the resettlement process, the public prosecutors (both state and federal), people working in city government, and researchers from the universities in the region.

To some extent, our analysis is similar to Tilt and Gerkey's (2016) study of resettled populations in the Mekong Delta region of China, in that we compare the experiences of different groups based upon their experience with the dam rather than studying a smaller group over time. In our case, one group is a resettled community, and the other is the non-resettled community that was the staging area for the dam builders, mostly old-time residents and some people that moved to the city because of the coming dam. Consistent with much of the research on social capital and resettlement and the broader research on social capital in the Global South, we rely on proxy indicators rather than replicating social capital indicators from research conducted in developed nations.[2]

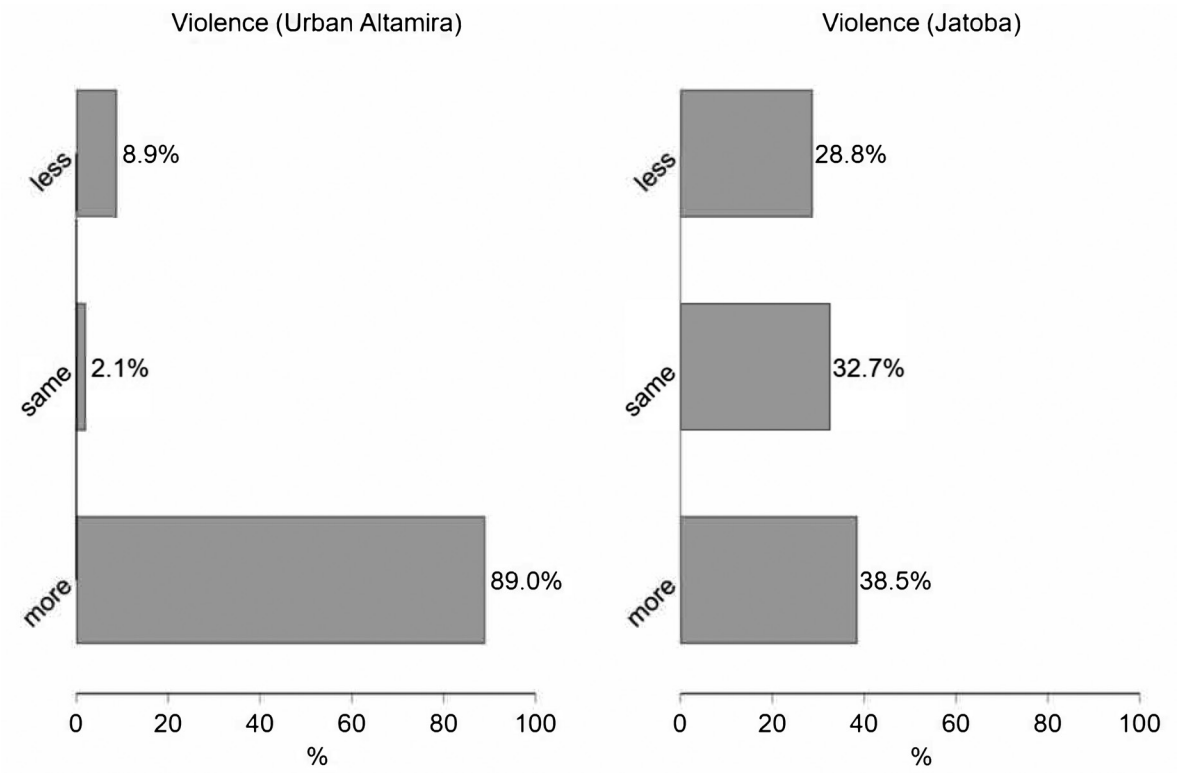
Social Capital Variables

Informed by our discussion of social capital and resettlement above, we use several different indicators of social capital. In both surveys, respondents were asked if violence in the community had gotten better, worsened, or stayed the same as a result of the Belo Monte dam. We view this variable as a proxy for cognitive social capital, especially the subjective interpretation of shared understanding of trust (Alcorta et al. 2020; McIlwaine and Moser 2001). To capture the more structural aspects of social capital, respondents were asked if their relationship with neighbors had improved, stayed the same, or gotten worse since the construction of the dam. Local organizations often facilitate social capital; among these, religious institutions are highly important. Accordingly, respondents were asked if they regularly attended church. Our final indicator of social capital is related to connections to family. We asked both groups if they had relatives in the city of Altamira. We use these variables as a proxy for structural social capital.

Analysis

We first consider our indicator of cognitive social capital, and to measure it, we use perceptions of violence in the community as a proxy for trust within a community; proxies are commonly used in the relevant literature (e.g., Nguyen, Phan and De Bruyn 2017; Tilt and Gerkey 2016). Altamira residents were far more likely to state that violence had gotten worse since the dam construction. Some 89 percent of urban Altamira residents stated that violence had increased since the construction of the dam had started, while only 38.5 percent of Jatoba residents stated that violence had increased since being resettled. Indeed, 28.8 percent of the Jatoba sample, compared to 8.9 percent of the Altamira sample, indicated that violence had declined, implying that the Altamira group perceived more issues with violence than the Jatoba group. Using a chi-squared test, we determined that the difference between groups was statistically significant (chi-squared=286.26, p=0.000). From our open-ended interviews, we learned that for residents of Altamira, one of the unintended outcomes of the vast inflow of capital to build the dam was the increase in drugs, especially crack, and its impact on young people in the community. In addition, the large number of men arriving hoping to find work on the dam, but many not finding it,

Figure 1. Perceived Effect of the Belo Monte Dam on Violence. Note: chi-squared=286.26, *p*=0.000

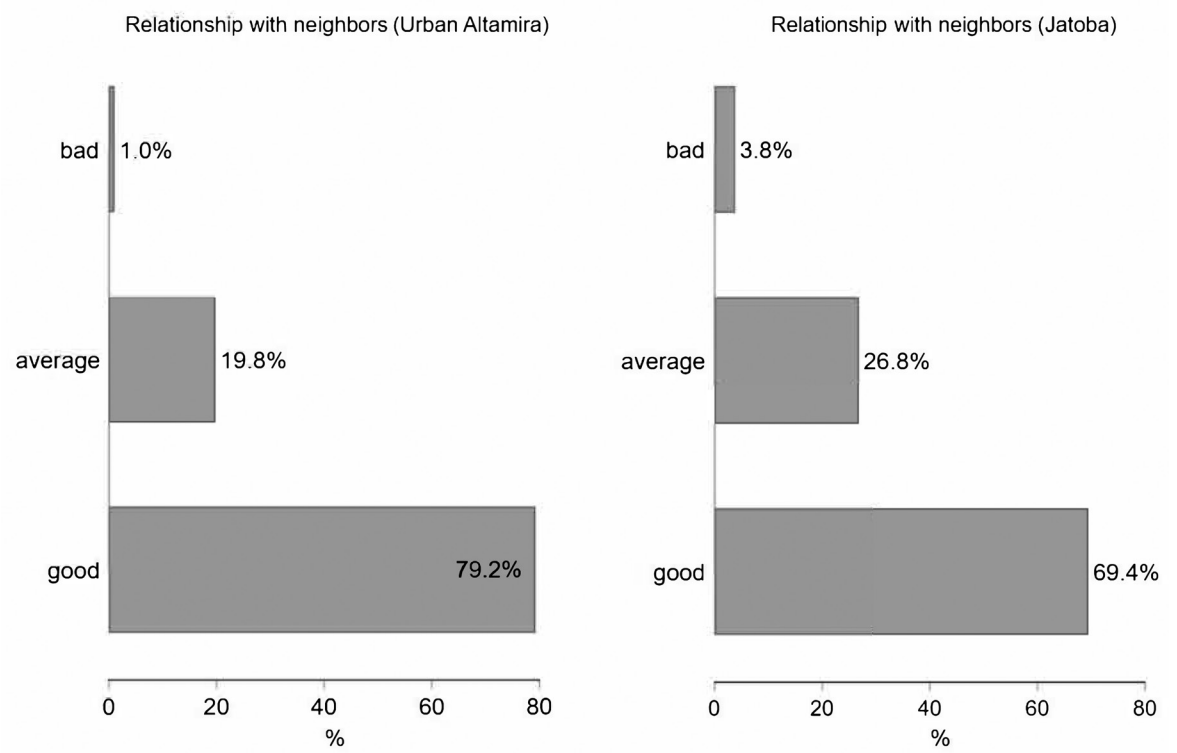


turned to violent ways to make a living, and the urban area of Altamira bore the brunt of this unemployed male population. During our fieldwork, many respondents (particularly women) commented that they felt afraid to go out at night. There was no increase in the number of police in Altamira, despite the doubling of population. This made controlling the increase in violence and drugs in the city very difficult. These fears were also present in Jatoba, which had poor illumination and even less policing than the city. But since the residents came uniformly from neighborhoods, which were poorly policed in the past because of the poverty of the population and possibly violent already, the situation was less dramatic for them than for those in better-off neighborhoods in the city. Further, many of the Jatoba residents had been resettled from precarious homes to homes constructed of concrete—this may have also enhanced feelings of security among some.

We next consider measures of structural social capital, and to do so, we use three variables: relations with neighbors, church attendance, and having relatives in the city. Regarding relationships with neighbors (Figure 2), 78 percent of the Altamira sample stated that their relationship with neighbors was "good," while only 68 percent felt the same for the Jatoba sample. Jatoba residents were also somewhat more apt to say that their relationship with neighbors was "average" or "bad." This difference between groups was statistically significant (chi-squared=13.843, p=0.003). One heavy price of forced resettlement is that it disrupts relationships with neighbors and shatters social networks. People along the river and in low-lying areas were moved one hour or more away from their original location to a new neighborhood without public transportation. In addition, there was no effort by the dam builders to keep old neighbors together when they were resettled, and this delayed the formation of a sense of community in Jatoba. In fact, during the fieldwork, people often commented on a sense of isolation from former friends and neighbors. In a sense, everyone overnight experienced being very far away from their family and friends. The lack of public transportation from the center to Jatoba for the first two years exacerbated the difficulties of seeing family, attending church, and connecting with others with whom they were familiar.

Our next indicator was church attendance (Figure 3). The resettled Jatoba population was less likely to state that they regularly attended a church; some 64 percent stated "yes" compared to 82.4 percent in the Altamira sample. Again using a chi-squared test, we determined that the difference between the two samples was statistically significant (chi-squared=33.080, p=0.000). Even after one year, the congregations were struggling to build churches in Jatoba, and the difficulties and cost of transportation in and out of Jatoba in that early period made it difficult to attend church. Jatoba residents mentioned that they needed to take a taxi or a moto-taxi to get in and out of Jatoba, and the cost of both

Figure 2. Relationship with Neighbors. Note: chi-squared=13.843, *p*=0.003



in Altamira was relatively high. Many did not feel that they could have friends visit them, or vice versa, given this cost. The same probably holds true for going to church on Saturday or Sunday. Today, most church denominations (Assembly of God, Latter-day Saints, etc.) have built a church, and the responses now may be quite different. But at the time of resettlement, this was one added source of dislocation for residents given the importance of worship as a source of solace in difficult times.

Our final indicator of social capital is constructed from a question that asked if respondents had any relatives in the city, and we find fewer differences between groups. Roughly 81 percent of the Jatoba sample stated that they had relatives in Altamira, while that same figure for Altamira residents is 85 percent. This is the only difference between the two groups that are not statistically significant (chi-squared=1.376, p=0.241). This is not surprising given that both Altamira and Jatoba residents are de facto in the Altamira urban area. Jatoba is a new neighborhood to resettle people from low-lying areas of the city and along the riverbanks near the city.

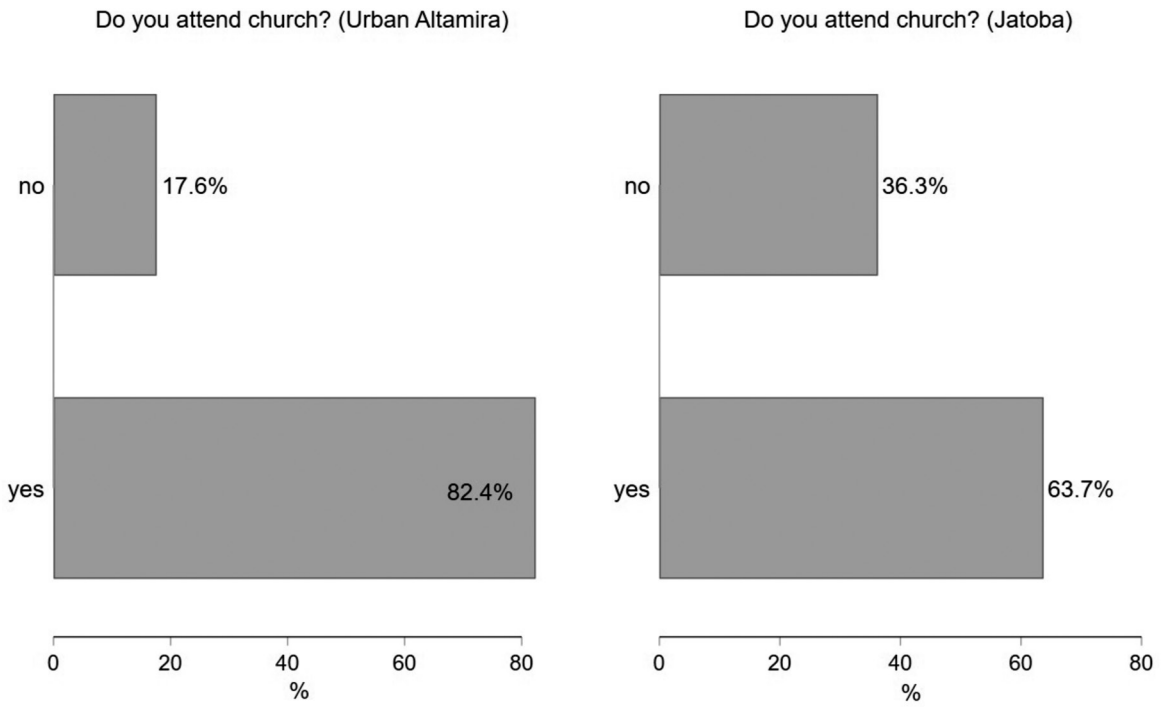
The data analysis presented in this section indicates that our sample of resettled residents from Jatoba has lower structural social capital across two proxy indicators, whereas the residents of Altamira have lower cognitive social capital. In this next section, we discuss these results further in the context of displacement and resettlement due to large-scale hydropower.

Discussion and Conclusion

The purpose of this paper is to understand if both cognitive and structural social capital are different in a resettled community and in a host community in the context of a large-scale hydropower project—the Belo Monte dam in the Amazon. We sought to compare the levels of social capital between a resettled population, Jatoba, and an urban area, Altamira, that experienced changes due to the construction of the dam. Although the vast literature on hydropower often alludes to impacts related to social cohesion and a loss of social relationships (e.g., Aiken and Leigh 2015), there is comparatively little direct study of social capital in the context of hydropower and resettlement. Thus, the current work extends the contributions of Xi (2016), Nguyen, Phan, and De Bruyn (2017), and Tilt and Gerkey (2016). We also contribute to the literature by investigating the changes in cognitive and structural social capital, which is valuable because previous results have shown that in some contexts, these two may operate in opposite directions.

Some indicators of structural social capital—such as church attendance and problems with neighbors—imply that this type of social capital was lower among Jatoba residents. The lack of coordination with church denominations to make sure there was a church to attend for the Jatoba population shows either a serious lack of planning or willful intent to interfere with the maintenance of social capital of the resettled

Figure 3. Church Attendance. Note: chi-squared=33.080, *p*=0.000



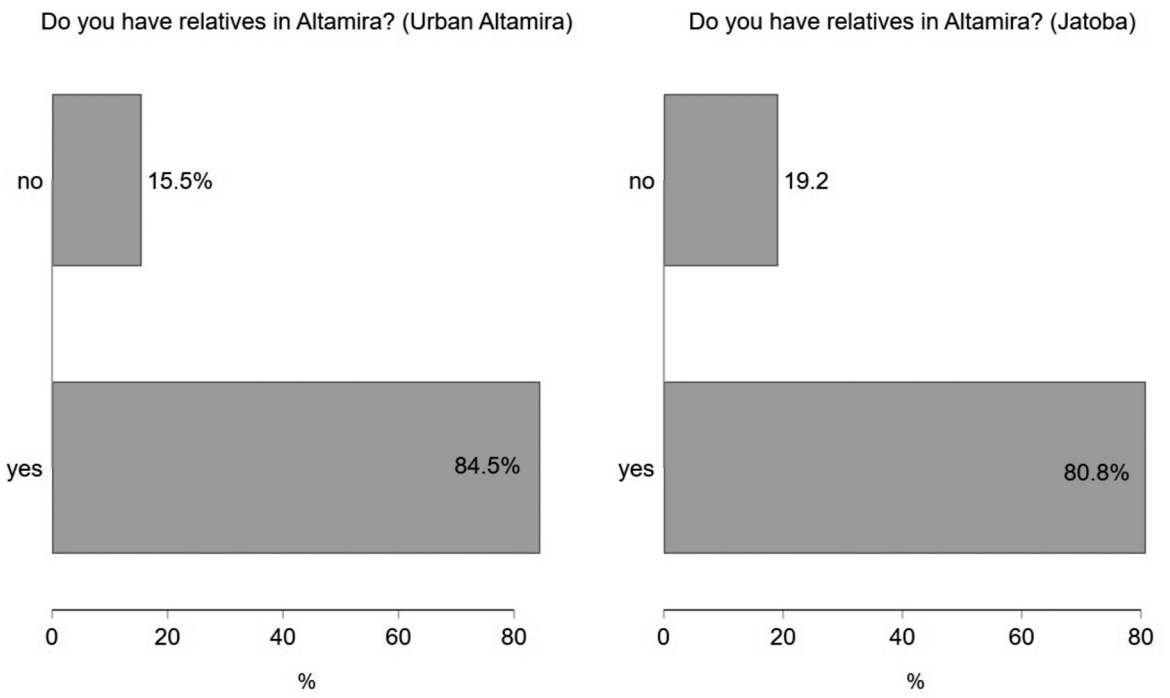
population. Yet, urban Altamira residents reported greater perceptions of violence, our proxy for cognitive social capital. Our results suggest that the Belo Monte dam changed social capital for both samples, often for the worse. Residents of Jatoba had to go quite a distance to attend schools for the first two years they lived there, and over time, built their own churches. The changes in their social capital were likely significant.

Scholars and activists have routinely argued that compensation and resettlement programs fail to provide comprehensive and multidimensional compensations. Vanclay (2017) notes that the monetary value of social capital is difficult to ascribe, although efforts to do so imply that social capital is typically of great value to people (e.g., Orlowski and Wicker 2015). Directly compensating resettled populations for a loss of social capital may be a dubious undertaking; that is, how can one truly estimate the value of a severed friendship or loss of regular contact with loved ones? Our research underscores the need to consider social capital in resettlement programs and host communities in new and innovative ways that would reduce social capital losses and maintain social relationships. But to do that, it is necessary to take into consideration the different types of social capitals that people have and are affected by the construction of dams. For starters, dam builders should let people that will be resettled have a say in the ways the resettlement process should be done, for example, decide whom they would like to live near in the resettled community and the type of facilities and services that are primordial for them, such as churches, schools, and public transportation. For the case of the host communities, local governments, together with dam builders, should make sure that the city is ready to receive this influx of people and the facilities they are going to need. In Belo Monte, that was not the case, and it was even suggested by community leaders that the builders purposely disrupted social networks to reduce the capacity of community members protesting.

Monetary compensation may not be the ideal route to make up for this loss of social capital. Perhaps future resettlement and compensation programs could include initiatives to help resettled populations rebuild social capital in their new environs and foster a renewed sense of community cohesion. Ensuring that schools and churches are in place to provide some of those fundamental elements of social organization would seem to be a clear path forward. To the best of our knowledge, governments and industry have not made these sorts of efforts in resettlement programs.

Communities like Altamira bear many costs that are often not recognized in the literature of dam construction in the Global South but described in the energy boomtown literature for the Global North (Freudenberg 1981; England and Albrecht 1984). The impacts on the old-time residents of Altamira were similar to prototypical "boomtown" effects described in this literature. From a quiet community supporting a prosperous agricultural sector, Altamira suddenly felt overrun by outsiders seeking employment and opportunities, who failed to respect the local community by their behavior in public places. The predominantly male population, unconstrained by

Figure 4. Do You Have Relatives in Altamira? Note: chi-squared=1.376, *p*=0.241



adequate policing, inspired fear in the traditional population of Altamira, and violence and prostitution prospered. Money flowed in, drugs and prostitution became commonplace, and the municipal government was woefully unprepared for this influx of new people. Schools, hospitals, and other services were overrun, and the quality of the services notably declined for the residents of Altamira. No new hospitals were built, as promised, to accommodate this doubling of population, and thus access to health care became precarious for old-time residents accustomed to much shorter waiting times to be seen by health professionals. It was no longer the same quiet town; it had doubled in population overnight, and the town became unrecognizable to those who had known it before. Thus, the Belo Monte dam eroded social capital among both the resettled population and host community but in different ways and through different mechanisms.

The apparent loss of both social capitals may have far-reaching long-term and short-term consequences. Networks may be key to maintaining livelihoods, access to key services, and even survival in these settings (e.g., Randell 2016), and social capital may be just as important as other types of capital (Serrat 2017). Indeed, Mubangizi (2003) characterizes social capital as an "all-important form of capital" that is a prerequisite for economic development. More generally, social capital is tightly linked to several indicators of health and well-being (Dean et al. 2014a, 2014b; Yip et al. 2007). Social capital becomes especially important during difficult changes or transitions, such as during the rebuilding phase after a natural disaster (Nakagawa and Shaw 2004). Communities with more trust and cohesion adapt and recover more rapidly and engage in collective action to address problems (Adger 2010; Habibov and Afandi 2010; Smith and Mayer 2018). Thus, the erosion of social capital that we document here likely has significant long-term consequences for the residents of the Jatoba neighborhood and the city of Altamira. Some of this lack of cohesion may have resulted in the growing number of Jatoba residents who have left or abandoned their homes in Jatoba since 2015, particularly when compounded with the loss of access to the river and its resources. Both Jatoba and Altamira residents saw a loss of community in this process. The Altamira residents had slightly more social capital built over many years, which allowed them to better withstand the impact of violence, drugs, and dangerous traffic. The Jatoba residents had to rebuild their social capital, their social networks, their churches, their schools, and their capacity to move around their city. This loss of social capital may have imperiled the ability of the Jatoba residents to organize to solve problems, reduce their individual well-being, and render access to important resources more difficult.

Planning should have done more to mitigate these impacts and ensure that these communities' long-term resilience was preserved. Other research implies that the social capital declines because communities lose shared cultural resources and spaces to congregate (e.g., Hensengerth 2017). This suggests that simply providing housing is not sufficient compensation for displacement; rather, dam authorities should

provide public spaces, community centers, houses of worship, and other infrastructure that help rebuild social capital. Further, this work and others also indicate that resettlement programs should attempt to keep established social networks together, perhaps by creating opportunities for entire communities and extended families to move together. Exploring these policy options and further unpacking the relationship between displacement, resettlement, compensation, and social capital is an important research need moving forward.

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Notes

[1]We cannot list the specific census tracts to protect respondent anonymity.

[2]We remind the reader that this paper does not study indigenous populations. However, these groups were not consulted as required by the Brazillian constitution and experienced significant deleterious impacts to their livelidhoods (Fainguelernt 2011).

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