Original article http://dx.doi.org/10.18623/rvd.v22.2863-ing

HYDROELECTRIC DAMS AND TRADITIONAL TERRITORIES IN RONDÔNIA: SIGNS OF REPRODUCTION OF THE LOWER CIRCUIT OF THE ECONOMY

HIDRELÉTRICAS E TERRITÓRIOS TRADICIONAIS EM RONDÔNIA: INDÍCIOS DE REPRODUÇÃO DO CIRCUITO INFERIOR DA ECONOMIA

Article received on: 11/14/2024
Article accepted on: 07/14/2025

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The authors declare no conflict of interest.

Abstract
The state of Rondônia is the result of several interventions in its territory since the 19th century. However, conflicts intensified in the region from 1960's, when migration was encouraged under the slogan 'land without men for landless men,' with the local population seen as 'backward,' such migratory processes altered the reproduction of capital in space, with changes in use or production and use of labor. The state was also the target of several territorial development projects: rubber and wood protection cycle, mining, Polonoroeste,

Resumo
Rondônia é resultado de diversas intervenções em seu território desde o século XIX. Contudo, os conflitos intensificaram-se na região a partir de 1960, quando a migração foi estimulada sob o slogan "terra sem homens para homens sem-terra", sendo a população local vista como "atrasada". Tais processos migratórios alteraram a reprodução do capital no espaço, com alteração de uso ou das manufaturas e uso de mão de obra. O estado também foi alvo de diversos projetos de desenvolvimento territorial: ciclo de extração da borracha e da madeira, garimpos, Polonoroeste, Planafloro

Planafloro and more recently hydroelectric projects that produced changes in the positive economic dynamics in the Upper Circuit of the Economy, without generating positive impacts in the Lower Cycle of the Economy. The construction of hydroelectric plants left the affected territories in a worse situation than before their construction (bust). Compulsory displacement altered the qualities of social and economic aspects since the limitation or impossibility of access to the river triggered a series of economic and symbolic losses. The panorama of these losses is the focus of this work, based on the study of the Cujubinzinho and Nova Mutum-Paraná Communities, which was done based on interviews at different times, over a decade.
Keywords: Brazilian Amazon; lower circuit of economy; hydroelectric dams; economic impacts; social impacts.

e, mais recentemente, projetos hidrelétricos que produziram alterações nas dinâmicas econômicas positivas no circuito superior da economia, não tendo gerado impactos positivos no ciclo inferior da economia. A construção de hidrelétricas deixou os territórios afetados em situação pior que antes de sua construção (bust). O deslocamento compulsório alterou negativamente os aspectos sociais e econômicos, uma vez que a limitação ou impossibilidade de acesso ao rio desencadeou uma série de perdas econômicas e simbólicas. O panorama dessas perdas é o foco deste trabalho, a partir do estudo das comunidades Cujubinzinho e Nova Mutum-Paraná, por meio de entrevistas em diferentes momentos, ao longo de uma década.
Palavras-chave: *Amazônia; circuito inferior da economia; hidrelétricas; impactos econômicos; impactos sociais.*

Introduction

Rondônia has been shaped by various forms of economic intervention since the 19th century. However, the most significant territorial transformations were driven by intense waves of migration throughout the 20th century, which sparked conflicts—often implicit—between economic development initiatives and the local population, who were frequently portrayed as representative of economic backwardness. Many of these interventions were tied to the extraction of forest (timber and latex) and mineral (gold, cassiterite, and diamonds) resources. Non-extractive initiatives, in turn, focused on infrastructure development, such as the construction of the BR-364 highway and hydroelectric dams, as well as the expansion of agricultural and livestock production.

These efforts were guided by the assumption that "clearing the land" was a necessary precondition for "development"[1]. The state's economic trajectory can be summarized by events such as: the construction of the Madeira-Mamoré Railway (1907–1912); latex extraction to meet rubber demand during World War II (early

[1] While development is expected to improve the Human Development Index (HDI), what occurred in the region was essentially economic growth, largely concentrated in the hands of a small elite.

1940s); the exploitation of cassiterite and gold (1970s and 1980s); commercial logging (from the 1970s onward); the expansion of agricultural production (since the early 2000s); the construction of hydroelectric dams on the Madeira River (2008); and the intensification of cattle ranching and soybean cultivation over the past two decades—a dynamic that both drives and results from intensive deforestation.

Migration altered the mechanisms of capital reproduction in the territory by shifting patterns of natural resource use, introducing manufactured goods, and increasing labor utilization. Before the migratory flows, capital reproduction was limited and followed a logic reminiscent of slavery: warehouse owners held concentrated control over capital, land, technology, and power, dominating local economic relations. Residents sold their extractive products (such as Brazil nuts, latex, and seeds) and purchased basic goods (salt, oil, gunpowder, medicines) solely through these intermediaries, often becoming caught up in cycles of debt.

The decline of this model was driven by the fall in latex commercialization from the mid-20th century onward, creating an economic vacuum as warehouse owners lost interest in maintaining trade relations with forest-based communities. Nonetheless, landownership persisted, with a shift toward logging, mineral extraction, and extensive cattle ranching. One major act of resistance to this trend was led by Chico Mendes in Acre, who organized a movement advocating for the rights of extractivist communities to remain on their settlements, produce according to traditional practices, and preserve the forest.

Although Brazilian migratory flows were not highly coordinated, they followed specific patterns of territorial occupation and responded both to migrants' individual aspirations and to broader geopolitical strategies guided by two primary objectives: the occupation of so-called "empty spaces" and the establishment of a sanitary belt to prevent the infiltration of guerrilla movements from Peru, Bolivia, and Colombia. Other relevant factors that contributed to the intensification of such migratory movements included the mechanization of agriculture, the surplus of unskilled labor in urban centers, the opening of roads, and the expansion of transportation infrastructure. These elements fueled east–west migration flows, extending from well-established urban centers to still sparsely developed areas, reinforcing the military dictatorship's propaganda, which promoted *slogans* such as "*ocupar para não entregar*" (occupy to not surrender) and "terra sem homens para homens sem-terra" (empty land for landless people) thus encouraging a rush toward the Amazon as people sought to settle in the region in pursuit of a promised "El Dorado".

The formation and reorganization of the territory are the result of interventions carried out *in* and *by* society, particularly through the introduction of technologies aimed at fostering local development. In more recent cases, spatial intervention has taken place through the implementation of hydroelectric dams on the Madeira River—large-scale projects that diverge from local economic dynamics but meet the energy demands of Brazil's Central-South regions. In this analysis, the construction of these hydroelectric plants is regarded as a key restructuring agent, transforming spatial configurations, social dynamics, economic expectations, and the operational scale of companies that established themselves in the region, thereby integrating into the so-called *upper circuit of the economy*.

Within this context, the process of capital reproduction was reorganized and intensified, reflecting capital's capacity to reinvent itself in times of crisis. The scale of investment, power relations, financing mechanisms, and incentive structures played a decisive role in this process and contributed, to some extent, to the growing discourse over the past two decades that agribusiness can bring "progress" to the region.

This article focuses on the municipality of Porto Velho, the capital of Rondônia, which in the early 21st century became the site of major projects under the *Programa de Aceleração do Crescimento* (PAC – Growth Acceleration Program), particularly the hydroelectric power plants (HPPs) of Jirau and Santo Antônio, both located on the Madeira River, with a combined installed capacity of 6,500 MW—approximately 3% of the country's total electricity capacity (205,722.5 MW)—significantly transforming the territory and underscoring the consolidation of the upper circuit of the economy.

These projects triggered additional infrastructure initiatives in the region, including new hydroelectric plants, roads, railways, waterways, ports, and bridges, initiating a cycle of territorial reorganization that aligned the interests of various fractions of capital in the Amazon, particularly those linked to the expansion of cattle ranching and soybean cultivation. This process intensified deforestation, wildfires, rural conflicts, and water management disputes, and contributed to environmental phenomena such as desertification, droughts, and floods.

Segments of the lower circuit of the economy were also affected—at first positively—through increased employment opportunities and workforce development. However, this impact proved to be temporary, as the training programs were designed exclusively to meet the demands of hydroelectric construction, never reaching other local productive sectors.

Conversely, sectors of the lower circuit located in areas of interest to the HPPs experienced negative impacts, particularly riverside communities, fishers, and farmers who directly relied on the Madeira River and its tributaries for production, transportation, and subsistence.

This article seeks to analyze the impacts of the hydroelectric plants on the Madeira River from the perspective of the lower circuit of the economy, focusing on two localities near Porto Velho: Cujubinzinho and Nova Mutum-Paraná. Both communities were directly impacted by the projects. Cujubinzinho, an agricultural and fishing community, is located downstream from the Santo Antônio dam; Nova Mutum-Paraná, in turn, is a resettlement of the former community of Mutum-Paraná, which was located upstream from the Jirau dam. In both localities, despite corporate discourse claiming that economic benefits would be broadly distributed through job creation, employment, and income generation within the upper circuit of the economy, the actual impacts over the years have demonstrated that individuals embedded in the lower circuit were excluded from the benefits of the expanded reproduction of capital.

1 Research methodology

This article is based on exploratory research, intended to provide greater familiarity with the subject and a deeper understanding of the problems and challenges faced by the object of study (Gil, 2008). Fieldwork was conducted in the two communities under investigation, beginning in 2012, during research developed for academic theses and dissertations.

Structured interviews were conducted to gather data and information; although they were not audio-recorded, they were directly documented by the researchers at the time of collection. Thus, literal transcriptions of the interviewees' statements were not used. In addition to interviews, the research involved participant observation, analysis of secondary data from official sources, and the production of photographic records to visually document the spatial transformations that occurred.

The methodological approach adopted was inductive in nature, aiming to develop interpretations based on empirical observation and analysis of the evidence collected. This approach was grounded in reference studies on socio-environmental conflicts in communities affected by large-scale projects, such as those conducted in small towns and settlements across Minas Gerais (Teixeira; Zhouri; Motta, 2020), as well as in dissertations and theses addressing the

implementation of hydroelectric dams in Porto Velho (Luz, 2023; Silva, 2013; Nantes, 2019; Santos, 2022; Silva, 2017).

2 Territory and the organization of the upper and lower circuits of the economy

The territorial formation of Rondônia results from the interaction of various economic agents, both hegemonic and non-hegemonic, even though the state and society tend to privilege actors with greater visibility, resources, and technological tools (Salvador, 2012). In this regard, Santos (1979) emphasizes that space is not produced solely by large corporations (hegemonic agents) and the state, but also by small enterprises, many of which stem from the popular economy. These agents, particularly the most impoverished, mobilize to ensure their own survival by developing production systems that diverge from those tied to the bureaucratic operations of hegemonic actors (Salvador, 2012; Ribeiro, 2023).

Arroyo (2008, free translation) reflects on the relationship between the two circuits of the economy—the hegemonic and the non-hegemonic—and observes that "[…] the upper and lower circuits interact and participate in the movement that unfolds within the same city. It is a single constructed environment, although unequal and fragmented, and a single market, albeit highly segmented"[2]. Complementing this perspective, Ribeiro (2023) illustrates how rural and urban dynamics intersect in cities, with flows of capital, labor, and goods at their core.

The theory of urban circuits of the economy, proposed by Milton Santos (1979), analyzes the organization of cities based on the upper and the lower circuits of the economy. The former is structured around the intensive use of resources and technology, whereas the latter operates with limited resources and a high degree of labor precarization. According to Silva (2012, free translation), "due to the existence of permanent and well-paid work on one side, the upper circuit emerges; on the other, the existence of poorly paid and intermittent work demands the creation of survival strategies by a large portion of the population"[3].

Cities express these two circuits through "opaque places" and "luminous places," understood as polarities but not as dualisms (Silva, 2012). Building

[2] In the original: "[…] os circuitos superior e inferior interagem e participam do movimento que se desenvolve dentro da mesma cidade. Trata-se de um único meio construído, embora desigual e fragmentado, e de um único mercado, embora fortemente segmentado".

[3] In the original: "em função da existência de trabalho perene e bem pago de um lado, surge o circuito superior; por outro, a existência de trabalho com baixa remuneração e intermitente demanda a criação de formas de sobrevivência por grande parte da população".

on these conceptual foundations, the discussion can be further advanced by proposing that the concept be applied not only to cities but also to both urban and rural settings, as similar dynamics are also present in the latter, for example, the contrast between large-scale landholdings and family farming. As in urban spaces, rural areas involve the production and reproduction of labor by many individuals operating with limited capital.

Rondônia's geographic landscape reveals a stark contrast between the richness of its remaining forest—home to abundant natural resources and traditional populations coexisting sustainably with the environment—and the migratory expansion that began in the 1970s, driven by agricultural production and settlement initiatives. This process elevated Rondônia from a relatively marginal territory in national terms to a region marked by high rates of deforestation, including in protected areas and Indigenous Lands subjected to intense pressure (Andrade, 2022).

Deforestation data reveals the extent of this transformation: in the 1970s, deforested land accounted for only 1.8% of the state's territory, concentrated along BR-364 and near the municipalities of Porto Velho and Guajará-Mirim. In the 1980s, deforestation expanded exponentially, with annual growth rates of 16%, driven by agricultural colonization policies and increasing migration. In the 1990s, deforestation reached 2.9% of the state's area, increasing to 12.6% in the 2000s, fueled by agricultural and livestock activities and infrastructure projects. In the 2010s, the rate rose to approximately 22%, reaching 26.5% in the 2020s, and by 2024, it had reached 28.3% (INPE, 2024).

In regional comparison, accumulated data through 2024 shows Pará as the state with the highest accumulated deforestation across the Legal Amazon (34.7%), followed by Mato Grosso (31%) and Rondônia (13.5%). Next are Amazonas (7.3%), Maranhão (5.4%), Acre (3.7%), Roraima (2.0%), Tocantins (1.8%), and Amapá (0.3%) (INPE, 2024).

3 Traditional populations

Traditional populations are culturally distinct groups that maintain close ties to their territories and the environment, engaging in economic practices that exert low pressure on natural resources and promote a harmonious relationship with nature. Their practices include subsistence hunting and fishing to meet nutritional needs, with production not aimed at surplus accumulation, thus generating little waste and minimal environmental impact. In this context, these communities are

said to engage in forms of sustainable development.

In Brazil, traditional populations include:

> […] Indigenous peoples; the remaining quilombo communities; artisanal fishers; riverside dwellers; Romani communities; practitioners of Afro-Brazilian religions; Pantanal inhabitants from Mato Grosso and Mato Grosso do Sul; *faxinalenses from Paraná (who combine yerba mate cultivation with pig farming and pine nut extraction); fundos de pasto (grazing land) communities in Bahia (who practice goat herding on communal lands); caiçaras (maritime fishers and extractivists with shared-use areas in São Paulo, Rio de Janeiro, and Espírito Santo); geraizeiros; and evergreen flower gatherers*[4] (MPMG, 2022, p. 15, free translation).

The concept of "traditional populations" in Brazil emerged from struggles to reaffirm territorial rights and cultural identities, supported by sectors of civil society, including academia and non-governmental organizations. The socio-environmental significance of these populations is evident in two key aspects: (i) the pursuit of economic activities with minimal or no adverse environmental and social impacts, as resource use occurs sustainably and without depleting natural assets; and (ii) minimal labor exploitation, since the expanded reproduction of capital does not constitute the structural foundation of these communities' productive practices.

The primary vulnerability of such communities is exogenous in nature, as they exist in enclaves surrounded by unsustainable economic activities such as deforestation, predatory fishing, extensive cattle ranching, and monoculture farming. The survival of traditional populations depends on the implementation of protective measures, including the legal recognition of designated protected areas such as Conservation Units, Indigenous Lands, Strict Protection Areas, and Sustainable Use Areas.

4 Studied communities

Rondônia is home to more than 50 Indigenous ethnic groups, as well as quilombola and riverside communities. In addition to these traditional populations, the state displays a high degree of racial and cultural diversity, directly resulting

[4] In the original: "[…] Indígenas, as comunidades remanescentes de quilombos, os pescadores artesanais, os ribeirinhos, os povos ciganos, os povos de terreiro, os pantaneiros (Pantanal de Mato Grosso e Mato Grosso do Sul), os faxinalenses do Paraná (que consorciam o plantio de erva-mate com a suinocultura e com o extrativismo do pião), as comunidades de fundos de pasto da Bahia (que praticam a caprinocultura em território de uso comum), os caiçaras (pescadores marítimos e extrativistas com áreas comuns em São Paulo, Rio de Janeiro e Espírito Santo), geraizeiros e os apanhadores de flores sempre-vivas".

from intense domestic and international migratory flows. The construction of the Madeira-Mamoré Railway in the early 20th century contributed to the formation of this population mosaic by attracting workers from a range of national backgrounds, including Antilleans, Barbadians, Chinese, Cubans, Grenadians, Spaniards, Indians, Italians, Lebanese, Mexicans, North Americans, Norwegians, Poles, Puerto Ricans, Russians, Syrians, and Tobagonians. Many of these migrants had previously worked on the construction of the Panama Canal before settling in Porto Velho.

In recent decades, domestic migration has also been significant, particularly with the arrival of people from the Northeast and South of Brazil, though individuals from all regions of the country can now be found in the state. The riverside communities of Porto Velho reflect this historical and social process, delivering considerable cultural diversity. Most residents are descendants of the economic activities that drove settlement and migration to the region, such as latex extraction, government land distribution programs for agricultural purposes, and gold rush cycles.

4.1 Cujubinzinho

The community of Cujubinzinho consists of approximately 60 families. However, its infrastructure functions as a service hub for neighboring communities, ultimately benefiting around 300 families in total. Located nearly 28 miles (45 km) from Porto Velho (RO), the community is accessible year-round by both land and river. The road leading to the area is mostly unpaved but remains in good driving condition. Its maintenance is the responsibility of the municipal government of Porto Velho.

Regarding educational infrastructure, the community has one school that offers primary education. For higher levels of schooling, students must travel to institutions in urban Porto Velho. School transportation is provided by the municipality and carried out by bus. However, class attendance is frequently affected by transportation issues, as pointed out by Silva (2017), who highlights the educational challenges faced by communities affected by the Santo Antônio hydroelectric power plant (HPP).

In terms of communication, the community lacks both landline and mobile phone coverage. To mitigate this limitation, residents use adapted antennas to connect to mobile reception from nearby localities. Additionally, the community does not have internet access.

Most homes are situated between the Madeira River and the access road. Some of these homes are located on elevated ground above the road, indicating that flooding is a recurring issue in the area. Nonetheless, most houses remain level with the road, a decision residents attribute to the historical behavior of the river, which, according to them, had never surpassed the embankment height of approximately 32,8 feet (10 m).

Geographically, on the right side of the road (heading from Cujubim Grande—the first riverside community—toward Cujubinzinho) lies Lake Cujubim. This body of water is not used by the residents of Cujubinzinho, but rather by those living on the opposite bank, where the land is privately owned and surrounded by farms that have constructed docks for boats. The channel connecting the Madeira River to the lake is not located near the community. The use and oversight of the lake are under the jurisdiction of the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA). According to residents, the lake is home to a significant population of alligators and anacondas, as well as abundant fish stocks. However, fishing—even if for subsistence purposes—is prohibited by the environmental agency.

The installation of HPPs on the Madeira River subjected the community of Cujubinzinho to three distinct periods of territorial transformation: the first, up to 2012, prior to dam construction; the second, from 2012 to 2013, during the construction phase; and the third, after 2013, when the region was severely affected by a major flood that led to profound socio-environmental changes. It can thus be stated that the territory underwent a sudden and transformative intervention.

4.1.1 First period: up to 2012

During this period, the community of Cujubinzinho enjoyed economic abundance and the absence of hindrances. Economic activities centered on fishing and fruit harvesting (coconut, banana, açaí, cupuaçu, cajá, acerola, and guava). Floodplain cultivation was particularly valuable, as during the dry season, deposited sediment created large, fertile areas that enabled the production of beans, watermelon, and melon until the river's rise ended the growing season. Economic activity on higher ground supplemented household income through perennial crops (banana, corn, cupuaçu, cacao).

Most of the community's production was transported by truck, with logistical support from the Porto Velho municipal government, and sold at farmers' markets

in the capital. On designated days of the week, trucks circulated through the community collecting goods. A portion of the fruit harvest was processed at a privately owned agroindustry in Cujubim Grande (owned by Mr. Valdeci), which absorbed a significant share of the added value, as the community association lacked the equipment and infrastructure needed to process the produce locally and retain that value within the community. The agroindustry paid cash upon delivery, and the fruit production (cupuaçu, cajá, acerola, and guava) was directed to the *Programa de Aquisição de Alimentos (PAA – Food Acquisition Program).*

Cujubinzinho was a strictly riverside/agricultural community, alternating between two complementary activities: cultivation in floodplain and upland areas. Its economic activities differed from those of other riverside communities along the Madeira River, which are typically centered on cassava flour production.

4.1.2 Second period: 2012-2013

The second period corresponds to the post-operation phase of the Madeira HPPs and was marked by economic decline in the community of Cujubinzinho. Floodplain agriculture was completely eradicated, dismantling the community's primary subsistence base. Access to water for consumption became inadequate and insufficient, further deteriorating living conditions. Adding up to these issues, there was a significant decline in fish stocks—an essential component of both food security and household economies.

The *Associação Comunitária dos Moradores Produtores(as) Rurais, Extrativistas da Comunidade de Cujubim Grande e Entorno* (Ascomopre – Community Association of Rural Producer-Residents and Extractivists of Cujubim Grande and Surroundings) received an artesian well and was tasked with managing the community's water supply; however, several residents reported that the water was unsuitable for consumption. During a field visit in November 2013, the water reeked. Given the access issues, water began to be delivered by tanker trucks. Nevertheless, residents living in more remote areas of the community were not served by the water trucks and had to fetch water from distant sources, using well water or drawing it directly from the Madeira River. During the dry seasons between 2011 and 2013, the lack of potable water caused health problems in the community, particularly intestinal illnesses affecting children and the elderly.

The construction of the Madeira HPPs (Santo Antônio and Jirau) affected the river and its dynamics in several ways: (i) a decrease in fish availability compared to previous years (notably pirarucu, piraputinga, and branquinha); (ii)

reports from residents that some fish died in the river itself; (iii) disruptions in fish spawning (piracema) since 2013; (iv) the beginning of water flow alterations, with fluctuations in discharge levels of up to six meters overnight without prior warning to riverside users; (v) the instability of the river flow flooded floodplain areas and swept away planted seeds, water pumps, and canoes, as well as damaging perennial crops such as banana; (vi) sediment that was once present in the Madeira River is now retained in the Santo Antônio hydroelectric reservoir (and, after the closure of the Jirau dam, will remain in that reservoir), preventing it from reaching the riverbanks and fertilizing the floodplain soils.

As a result, cultivation of corn, beans, squash, melon, and watermelon in the floodplain is no longer feasible, leading to a decline in both agricultural production and, more critically, income from floodplain farming. The productive complementarity between floodplain and upland farming ended, leaving residents with only perennial crops on limited upland areas, which are insufficient for subsistence farming.

Cujubinzinho was not included by the hydroelectric construction companies among the areas officially recognized as affected by the Madeira River hydroelectric projects, based on the assertion that downstream regions would not be impacted, as the river's dynamics would remain unaltered. However, two critical issues must be highlighted: First, the disregard for existing studies and prior experiences with other hydroelectric projects, which point to significant downstream impacts—particularly on floodplain fertilization. Second, the absence of studies focused on the downstream section of the Santo Antônio dam has resulted in data and information gaps, leading to inconsistencies in the identification and support of affected populations in the context of hydroelectric development (Teixeira; Zhouri; Motta, 2020).

Legal action by the Federal Public Prosecutor's Office compelled the Santo Antônio hydroelectric consortium to commit to installing a fruit-processing agroindustry, as the activity was already well-established in the area. However, to date, the promised facility has not been built.

Thus, the second period is marked by nothing but hopes and promises: promises to establish a cooperative, install a fruit-processing agroindustry, and create a seed bank—and the hope that residents' quality of life would improve.

4.1.3 Third period: 2014–present

This period can be characterized as one of both economic and social destruction for the community. During the 2013–2014 flood, the community of

Cujubinzinho was flooded by the waters of the Madeira River. This would not have constituted a major problem, as similar events had occurred in the past, according to residents, though the intensity recorded in 2014 was unprecedented. However, a serious and previously unseen issue emerged after the waters receded: nearly all of the homes were filled with sediment from the Madeira River. Significantly greater than in previous flood events, the sediment volume was the result of accumulation in the reservoirs of the Madeira HPPs, so when the floodgates were opened in February 2014, part of that sediment was carried downstream and deposited inside the homes.

Moreover, the floodplain as a productive extension of land was lost to sediment accumulation, as the Madeira River has not returned to its normal level, and because the flow of water through the turbines is regulated, meaning that when there is a demand for more electricity, water is withheld, and when less is needed, the sluice gates are closed, causing the water level to drop. It is important to emphasize that this fluctuation in water levels not only makes floodplain agriculture unviable but also fundamentally alters and negatively affects residents' lives.

For descriptive purposes, Chart 1 presents several indicators related to housing, infrastructure, and economic conditions in the community of Cujubinzinho.

Chart 1. Characterization of the Cujubinzinho Community

Indicators	2014	2022
Housing	Destroyed by flooding Taken by sediment deposits	Homes rebuilt using residents' own resources
Infrastructure	School unavailable for all age groups No communication (telephone or internet) Flooding made transportation unviable Health clinic building destroyed	School unavailable for all age groups Communication available Roads repaired by the municipal government Health clinic rebuilt
Economic Situation	Floodplain farming unviable Upland production rendered unviable Disappearance of fish stocks Household income reliant on public assistance programs No employment opportunities available for the population	Only upland production remains viable No fish stocks available

Source: compiled by the authors.

4.2 Mutum-Paraná

The community of Mutum-Paraná emerged under the influence of the now-defunct Madeira-Mamoré Railway and through forest and mineral extraction—in other words, the history of the locality is directly tied to the region's economic cycles. After the railway was decommissioned in 1972—having previously transported rubber, Brazil nuts, charcoal, and grains to the Porto Velho station—the district entered a period of stagnation. In 1978, the discovery of alluvial gold in the Madeira River triggered a migratory influx of garimpeiros (artisanal miners), who operated on rafts and dredges docked near the village (Luz, 2023).

The construction of BR-364 toward Acre brought renewed momentum to the area by enabling the transport of timber, which began to be intensively exploited in the area, and by the time the Jirau hydroelectric plant was established, the community had approximately 1,800 residents. Access to and from Mutum-Paraná was available via bus and by boats navigating the Mutum-Paraná and Madeira Rivers. Houses were wooden structures with asbestos or tile roofing and wooden floors, and residents relied on wells for water.

However, all residents of Mutum-Paraná were displaced and resettled in the newly constructed village of Nova Mutum-Paraná, which was built specifically to accommodate them due to the formation of the Jirau HPP reservoir, which flooded the area they previously inhabited. The removal and resettlement process happened between 2010 and 2011.

4.3 Nova Mutum-Paraná

Nova Mutum-Paraná (commonly referred to as Nova Mutum) was fully designed and built by the Jirau hydroelectric plant consortium to accommodate the displaced residents of Mutum-Paraná, as well as to house workers employed in the dam's construction.

The community is located along BR-364, approximately 6,2 miles (10 km) from the district of Jaci-Paraná and about 18,6 miles (30 km) from the original placement of Mutum. It was characterized as a sustainable, planned community, equipped with a sewage system, public services, and a commercial center. Nova Mutum symbolized modernity—a new model of urbanization in the region and an aspirational development project.

Territorially, it was an urbanized settlement, perceived as new by both the former residents and the hydroelectric consortium, and regarded as a place of new

opportunities. In addition to the urban core, a rural zone was also established. Of the 1,800 residents who had lived in old Mutum-Paraná, data from the Basic Environmental Plan of the Jirau hydroelectric plant show that approximately 150 families chose collective relocation, while others received housing credits or opted for monetary compensation.

The two communities can be understood as distinct territories: Mutum-Paraná was a stable, extractive, rural community, while Nova Mutum-Paraná began as an unstable, urban settlement and is now caught between abandonment and land conflicts, as many of the families were employed by the Jirau HPP and left once construction was completed (Luz, 2023).

4.3.1 Housing in Nova Mutum-Paraná

The houses are simple (delivered with a laundry sink, kitchen sink, and shower stall, with walls that cannot be drilled due to the concrete construction), with low ceilings and no ventilation features to facilitate airflow.

All 1,800 homes are made of masonry and feature appropriate layouts—two or three bedrooms—with enough space for a bed, wardrobe, and circulation. Nonetheless, there is clear uniformity in the design and appearance of the homes. There is a clear visual distinction between the houses occupied by Jirau hydroelectric plant workers and those inhabited by former residents of Mutum-Paraná: all worker housing is roofed with clay tiles, whereas only a portion of the homes of the former residents has clay tile roofing; the rest are covered with fiber cement tiles, which result in higher indoor temperatures compared to clay tiles. Also, the areas intended for the workers are better maintained—with no water running through the streets, no overgrown vegetation, and adequate public lighting. In contrast, the areas inhabited by former residents of Nova Mutum are markedly different and precarious (Santos, 2022).

4.3.2 Infrastructure in Nova Mutum-Paraná

All streets are paved, in good condition, and clean—except for one remote street, which has open sewage but is not inhabited by workers. The surroundings of the homes of former residents are not well maintained; many are overgrown with tall grass, giving the area an appearance of abandonment, and there is little visible activity, with few people in the streets, many houses closed, and numerous homes externally remodeled with wood and straw. In contrast, the surroundings of the

workers' homes are clean and well-equipped; all homes feature air conditioning, satellite dishes, cars, and washing machines.

In 2014, Nova Mutum-Paraná had two large supermarkets (relative to the locality's size), a commercial center, a public school, a private franchise school from a major Brazilian education network, a police station, administrative offices, restaurants (including a pizzeria and a steakhouse), and a large ice cream parlor (again, relative to the community's scale). Currently, only one supermarket and a few small shops remain open, indicating a downturn following the conclusion of the hydroelectric plant's construction.

4.3.3 Economy in Nova Mutum-Paraná

There are no economic activities comparable to those once practiced in Mutum, particularly those related to the river. Economic opportunities for residents are limited to employment at the Jirau hydroelectric plant construction site, or in bars, restaurants, supermarkets, or as domestic workers in the homes of HPP employees (Derrosso; Ichikawa, 2014).

Chart 2. Characterization of the Nova Mutum-Paraná Community

Indicators	2014	2022
Housing	Not adapted to the residents' needs Small, hot homes unsuited to the region's climate	Not adapted to the residents' needs Small, hot homes unsuited to the region's climate
Infrastructure	Access to healthcare, private education, and transportation Unsanitary surroundings near resettled residents' homes, including open sewage in some areas	Underequipped health clinic with insufficient medical staff Public education Poor transportation between Nova Mutum-Paraná and Porto Velho
Economic Situation	No economic activities aligned with the skills or livelihoods of remaining residents Lack of employment opportunities for the remaining residents No regular income	No economic activities aligned with the skills or livelihoods of the remaining residents Depopulation of Nova Mutum-Paraná due to lack of work and economic activity No job prospects for young people No vocational training programs

Source: compiled by the authors.

5 Data analysis

The transformations that took place in the territories affected by the construction of the Madeira hydroelectric plants—particularly in the riverside communities impacted by these large-scale projects—"are invariably disregarded in light of the irreversible loss of their conditions for production and social reproduction, determined by the formation of the reservoir"[5] (Bermann, 2007, p. 142, free translation). In other words, once again, large infrastructure projects adopt a triumphalist and immeasurable discourse of growth, progress, and economic development in an attempt to mask the real impact resulting from the primitive accumulation of capital (Alves; Justo, 2010). Santos (2022) highlights that a process of silencing and marginalization took place in the territory of Nova Mutum-Paraná, concealing existing problems and rendering residents virtually invisible. Likewise, Luz (2023) reveals that residents expressed nostalgia for Mutum-Paraná, as the situation in the new territory is not conducive to a dignified life.

In the same vein, Santos (2012, free translation) pointed out that the availability of natural resources generates issues, because capital appropriates those resources:

> "The Curse of Abundance" is an expression used to characterize the risks faced by poor countries where natural resources coveted by international interests are discovered. The promise of abundance stemming from the immense commercial value of these resources and the investments required for their exploitation is so compelling that it begins to shape the country's patterns of economic, social, political, and cultural development[6].

Fearnside (2014, p. 13, free translation) observes that there is inequality between those who benefit and those who bear the environmental and social costs associated with hydroelectric development:

> In addition to the disparity in the magnitude of costs and benefits, there are also major inequalities regarding those who bear the costs and those who reap the

[5] In the original: "são invariavelmente desconsideradas diante da perspectiva da perda irreversível das suas condições de produção e reprodução social, determinada pela formação do reservatório".

[6] In the original: "'A Maldição da Abundância' é uma expressão usada para caracterizar os riscos que correm os países pobres onde se descobrem recursos naturais objeto de cobiça internacional. A promessa de abundância decorrentes do imenso valor comercial dos recursos e dos investimentos necessários para o concretizar é tão convincente que passa a condicionar o padrão de desenvolvimento econômico, social, político e cultural".

> benefits. Local populations often suffer the most significant impacts, while the rewards primarily benefit urban centers […][7].

Regarding the community of São Domingos, an area impacted by the Santo Antônio hydroelectric plant, Ribeiro (2013, p. 116, free translation) stresses that the situation deteriorated after resettlement: "Income declined for 53% of the population, production dropped from 20 to 7 products, the size of the plots makes it unfeasible to raise animals for food, and fishing is no longer viable in the reservoir"[8].

The World Commission on Dams (2000, p. 20, free translation) provided a significant analysis of the economic impacts of large dams, showing that negative consequences tend to fall on the most vulnerable (those in the lower circuit of the economy), while positive outcomes occur unequally and benefit primarily those in the upper circuit of the economy:

> Concerning the social impacts of dams, the Commission found that negative effects are often inadequately assessed or completely overlooked. These impacts are broad in scope, affecting the lives, livelihoods, and health of communities dependent on riparian environments[9].

Ribeiro (2013, p. 47, free translation) advocates that the economic, technical, and territorial dimensions of hydroelectric plants "become factors of social and economic disorganization, followed by a reorganization of the populations that once lived there, and the emergence of new activities established around the enterprise"10. The author underscores that the greatest added value (a term commonly used in economics to denote gains brought by technology to a given territory) of hydroelectric plants lies not in the activity itself, but in the territorial appropriation and, above all, in the reproduction of capital that benefits the upper circuit of the economy.

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[7] In the original: "Además de las disparidades en la magnitud de los costos y beneficios, existen grandes desigualdades en términos de quién asume los costos y quién goza de los beneficios. Las poblaciones locales a menudo han sostenido importantes impactos, mientras que las recompensas son acumuladas particularmente a los beneficiarios de los centros urbanos".

[8] In the original: "a renda piorou para 53% da população, a produção caiu de 20 para 7 produtos, o tamanho dos lotes inviabiliza a criação de animais para a alimentação e a pesca está inviabilizada no lago".

[9] In the original: "Quanto aos impactos sociais das barragens, a Comissão constatou que muitas vezes os efeitos negativos não são adequadamente avaliados ou sequer considerados. A gama desses impactos é considerável – sobre a vida, a subsistência e a saúde das comunidades afetadas que dependem do ambiente ribeirinho".

[10] In the original: "tornam-se fatores de desorganização social e econômica, a qual se segue uma reorganização das populações que aí residiam, e a entrada de novas atividades que se estabelecem no entorno da empresa".

Residents of Cujubinzinho express a clear perception of the damage caused by the territorial intervention:

- Most families move to the city of Porto Velho due to the need to educate their children, typically settling within the urban periphery.
- Public institutions provide training programs, but as residents explain: "We've done several training programs already, what's the point of qualification courses if there are no jobs".
- There is widespread distrust in institutions (Ibama and the Public Prosecutor's Office are explicitly mentioned): "We file petitions but get no response. They're all good for nothing, both the Public Prosecutor's Office and Ibama".
- There is no adequate supply of drinking water: "We used to drink river water, but the children started getting sick, so we switched to bottled water". However, most people rely on well water or water from the Madeira River, which is not safe for consumption.
- "We run out of water in the dry season. People who can't afford to buy it drink brackish water. That's when people start getting sick. The well water smells bad, and sometimes it's undrinkable".
- Today, there is a rural zone with urban habits.
- Fish production has declined by approximately 70%.
- The river no longer behaves normally. With the opening and closing of the floodgates, the surrounding environment changes with no prior warning.

Studies show that resistance to the changes proposed by project developers is anything but easy. It takes courage to oppose something presented as inherently positive, especially when it is backed by a powerful propaganda machine promising job creation, healthcare, education, and basic sanitation. What is promised is an improvement in quality of life and increased income; however, the actual outcomes are negative, as demonstrated by Nantes (2019), who observed a higher incidence of precarious employment in affected areas.

The technical implementation of electricity supply becomes synonymous with economic development, and those who question such policies are labeled "anti-progress" or stigmatized as "backward" or "traditional" (Moret, 2018; Luz, 2023; Santos, 2022). In this context, Parmigiane (2006) notes that such discourse is recurrent in large infrastructure projects, where co-opting individuals is a strategic technique used to secure support for the enterprise. This is significant because, in many cases, these populations rely on basic services that the state has failed to provide, as was the case with the residents of Mutum-Paraná.

Currently, there is growing awareness of the problems caused by displacement

and resettlement:

- Not all residents of Mutum-Paraná opposed relocation due to the construction of the Jirau hydroelectric plant, as some hoped to gain financially from the project.
- Many houses appear to be vacant. Moreover, the lifestyle of resettled individuals indicates they cannot afford the high cost of electricity, which contributes to the apparent "abandonment" of homes.
- Resettled residents received a monthly minimum wage stipend only during the first year of relocation.
- Some individuals living in Nova Mutum-Paraná have no alternative housing options.
- The company's strategy was to pressure the population to accept relocation, subsequently offering housing credits, with monetary compensation being the exception rather than the norm.
- Residents lack income levels comparable to those they previously held in Mutum-Paraná.

At the end of the construction phase, regional inequalities become evident once again, generating instability as an expression of uneven development (Araujo, 2017), the loss of rights highlighted by Nantes (2019), Araujo and Moret (2016), and Luz (2023), and the production of knowledge that undermines the viability of future projects (Bermann, 2007). Thus, although hydroelectric construction generates temporary benefits (such as increases in GDP and job creation), those do not persist over time, and the promise of development fails to materialize. Still, promotional narratives portray upcoming projects as fundamentally different, promising improvement and fueling a cycle of repetition that exposes the structural roots of regional inequality (uneven geographical development), as without such disparities, the discourse of "development" and "progress" would have little ground on which to spread (Locatelli, 2012).

Conclusions

The construction of hydroelectric plants transforms the territories they impact and introduces greater vulnerability than that which existed prior to the project. Forced displacement negatively alters both social and economic dimensions, as residents lose income, access to the river, and the abundance and diversity of fish species, as well as their neighborhood and kinship ties; the layout imposed by resettlement plans spatially separates households, weakening previous

relationships and complicating collective organization and advocacy efforts.

From the perspective of uneven geographical development theory, the hydroelectric construction process reveals: (i) the dispossession of natural resources; (ii) the emergence of political, social, and class struggles; (iii) the unequal distribution of burdens and benefits, wherein affected local populations bear the costs and receive little or no benefit, while domestic and global spheres benefit from increased energy availability for industrial use; and (iv) the role of the state becomes evident, as the majority of political actors support these projects, aligning with capital rather than with the populations they should be representing.

Understanding territorial impacts from the standpoint of the lower circuit of the economy showcases that large infrastructure projects generate benefits primarily for the upper circuit, while little or nothing reaches the lower circuit, even though public discourse and promotional campaigns attempt to normalize and obscure the existence of this duality. Moreover, not only do benefits fail to reach the lower circuit, but environmental and social impacts affect it more directly and severely, increasing vulnerability and resulting in deteriorated living conditions. In studies of three hydroelectric plants: Jirau (RO), Lajeado (TO), and Chixoy (Guatemala), Moret (2018) observed that the impacts on the lower circuit are not bound to a specific territory.

Therefore, it is evident that hydroelectric plants do not promote local human development, do not positively affect regional disparities, and do not benefit the lower circuit of the economy. As such, hydroelectric plant construction represents a process of capital reproduction in space through the appropriation of natural resources, resulting in unequal income distribution, continued labor exploitation, and increased vulnerability.

A more effective environmental and social adjustment of hydroelectric construction processes requires improvements to environmental licensing instruments, the full implementation of mitigation measures, and better preparation of affected populations to ensure their meaningful participation (Silva, 2013) in decision-making and in negotiating the distribution of burdens and benefits generated in the territory.

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Authors' participation
Neiva Araújo was responsible for the study's conception and the development of its theoretical framework, as well as for coordinating the fieldwork and conducting the qualitative analysis of socio-environmental data. She actively contributed to the manuscript writing, critical revision, and interpretation of the results, particularly regarding the discussion of the socioeconomic impacts of hydroelectric projects on traditional territories. Artur Moret provided overall supervision of the research, guiding methodological choices and theoretical-methodological approaches, contributing to the formulation of the research problem and the structuring of the article. His participation included critical content review, support in the analysis of circuits of the economy, and articulation of the results with the specialized literature, ensuring scientific rigor and conceptual coherence. Mineia Capistrano da Luz played a central role in the collection and organization of empirical data, the analysis of territorial and environmental aspects, and the drafting of the sections addressing local dynamics and the impacts of hydroelectric interventions. She also contributed to the initial writing and revision of the manuscript by integrating the empirical findings with concepts from political economy and critical geography.

How to cite this article (ABNT):
ARAUJO, N.; MORET, A.; LUZ, M. C. Hydroelectric dams and traditional territories in Rondônia: signs of reproduction of the lower circuit of the economy. *Veredas do Direito*, Belo Horizonte, v. 22, e222863, 2025. Available at: http://www.domhelder.edu.br/revista/index.php/veredas/article/view/2863. Access on: Month. day, year.