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Policy Forums

Brazil's Belo Monte license renewal and the need to recognize the immense impacts of dams in Amazonia

Juarez C.B. Pezzuti[a,b], Jansen Zuanon[c,1], Priscila F.M. Lopes[d,e], Cristiane C. Carneiro[f], André Oliveira Sawakuchi[g], Thais R. Montovanelli[h], Alberto Akama[i], Camila C. Ribas[c], Diel Juruna[j], Philip M. Fearnside[c,*]

[a] *Center for Advanced Amazonian Studies (NAEA), Federal University of Pará, Belém, Pará, Brazil*
[b] *Department of Vertebrates, National Museum, Rio de Janeiro, RJ, Brazil*
[c] *National Institute for Amazon Research, Manaus, Amazonas, Brazil*
[d] *Fishing Ecology, Management and Economics Group, Department of Ecology, Federal University of Rio Grande do Norte, Natal, RN, Brazil*
[e] *Research Institute of The University of Bucharest (ICUB), University of Bucharest, Bucharest, Romania*
[f] *Federal Prosecutor's Office, Altamira, Pará, Brazil*
[g] *Institute of Geosciences, University of São Paulo, São Paulo, SP, Brazil*
[h] *Instituto Socioambiental, Altamira, Pará, Brazil*
[i] *Goeldi Museum, Belém, Pará, Brazil*
[j] *Independent Environmental Territorial Monitoring (MATI), Aldeia Mïratu, Pará, Brazil*

HIGHLIGHTS

- Brazil's Amazonian hydroelectric dams are a concern regarding Lula's presidency.
- Lula initiated and still defends the Belo Monte Dam, which has catastrophic impacts.
- The Volta Grande, a 130-km river stretch, has lost over 80% of its natural flow.
- Traditional people, including three indigenous groups, have lost food security.
- Renewal of Belo Monte's operating license tests Lula's socioenvironmental commitment.

GRAPHICAL ABSTRACT

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ABSTRACT

Lula's presidency in Brazil offers great hope for the environment but plans for hydroelectric dams in Amazonia represent an area of concern. The Belo Monte hydroelectric power plant that Lula promoted in his previous administrations and still defends illustrates the contradictions. In 2015 Belo Monte diverted water from the Xingu River through a canal that, since 2019, has left a 130-km river stretch with less than 30% of its natural annual discharge. This has compromised the food security of three Indigenous groups and of traditional non-indigenous river-dwelling people dependent on the river's fish and turtles. Endemic (and threatened) species and unique ecosystems are now being eliminated. The pending

* Corresponding author.
E-mail address: pmfearn@inpa.gov.br (P.M. Fearnside).
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Hydropower
Indigenous peoples
River diversion
Xingu River

renewal of Belo Monte's operating license poses a test for the Lula administration's socioenvironmental commitment. We offer suggestions for improved governance for existing dams like Belo Monte but conclude that no more large dams should be built in Amazonia.

Luiz Inácio Lula da Silva ("Lula") becoming Brazil's president on 1 January 2023 is a relief to all those concerned with the environment, especially given the disastrous record of Lula's predecessor, Jair Bolsonaro. Nevertheless, there are several areas of concern regarding Lula's environmental agenda, including plans for dams in Amazonia (Fearnside, 2023a). The ongoing environmental and human catastrophe of the operation of the Belo Monte hydroelectric power plant lays this contradiction bare. An immediate concern is a pending decision on renewing the operating license for Belo Monte, and what if any changes in its operation will be required.

Belo Monte, which Lula promoted during his previous two presidencies, is not merely a mistake of the past: he still vehemently defends it. During the 2022 presidential campaign he stated that he would build the Belo Monte dam all over again (Lima, 2022) and even claimed that the dam had benefitted the local people because of the money spent on social programs (TV5 Monde, 2022), a claim easily dismissed (Magalhães and da Cunha, 2017). The Movement for Dam Affected People (MAB) estimates that Belo Monte displaced 40,000 people (Sullivan, 2017). Approximately one fourth of the city of Altamira's urban residents, plus a large population of traditional riverside dwellers (*ribeirinhos*), were moved to "collective urban resettlements" (RUCs) on the outskirts of the city, causing severe social impacts (Mayer et al., 2021, 2022; Miranda Neto, 2014).

Unlike most hydroelectric dams, with a river being blocked by a single dam with a powerhouse at its base where water is released to continue flowing down the river's natural channel, Belo Monte is a run-of-river power plant with two dams. The Pimental Dam impounds the Xingu channel and diverts water through an artificial canal and flooded stream basins (the "Reservoir of the Canals" to the Belo Monte Dam where the main powerhouse is located, thus bypassing a 130-km river stretch known as the "Volta Grande" (meaning "big bend") (Fig. 1). This stretch is now subjected to a discharge regime controlled by Norte Energia, the company that runs the Belo Monte complex. Average flow in the Volta Grande is approximately 70 to 80% lower than the natural discharge, and the timing of water flows is unrelated to the natural flooding cycle, affecting fish and turtle reproduction and all other ecological processes associated with the river.

Prior to the impacts of Belo Monte, fish and turtles from the Volta Grande were the main food source for three Indigenous groups, two of which live beside the Xingu and the third on a tributary (the Bacajá River). Also dependent on these resources were the non-indigenous *ribeirinho*s who had lived for generations along the Volta Grande (Magalhães and da Cunha, 2017). The presence of still-uncontacted Indigenous populations around the Ituna River (another Xingu tributary that enters the Volta Grande) increases the risk of irreversible losses. The loss of fish has severely impacted both men and women in *ribeirinho* families and has affected them in different ways both upstream and downstream of the reservoir (Castro-Diaz et al., 2018; Gonçalves and Pezzuti, 2023).

The operation of the Belo Monte hydroelectric plant threatens the Volta Grande's extraordinary array of endemic species and unique ecosystems. Trophic interactions between aquatic wildlife and the seasonally flooded forest (*igapó*) are no longer taking place, as well as the spawning of numerous fish species. On February 8, 2023, Indigenous monitors who coordinate the Independent Environmental and Territorial Monitoring (MATI) initiative documented mass mortality of the eggs of one of the most important fish species for local subsistence and for commercial fisheries: the curimatá (*Prochilodus nigricans*). Near Mïratu village (Fig. 1) in an area of seasonally flooded forest where these fish normally spawned under the natural flood regime, millions of eggs laid during a temporary flood caused by heavy rains were destroyed after water receded to a very low level because the river discharge was less than 30% of what would be expected for this period of the year (Juruna, 2023).

The South American monsoon system drives rainfall across the Amazon Basin and governs the annual flood pulse of the Xingu River, when the flowing water washes the rocky riverbed of the Volta Grande and invades its extensive areas of *igapó* from November to July. The long-term evolution of the biota is coupled to the seasonal flooding cycle, which sustains freshwater wildlife, including the world's largest assemblages of rheophilic fishes (species that live in fast-flowing water), most of which are endemic (Fitzgerald et al., 2018; Winemiller et al., 2016; Zuanon, 1999). These fish provided an important source of income for Indigenous peoples and *ribeirinhos* through sale of ornamental fish for the aquarium trade (Sabaj-Perez, 2015). Particularly emblematic is the zebra pleco (*Hypancistrus zebra*), a well-known aquarium species that is expected to go extinct in the wild because of habitat loss provoked by the Belo Monte hydroelectric plant (Gonçalves, 2011).

The seasonally inundated habitats evolved as interdependent high-productivity ecosystems, where fish, turtles, otters, manatees and caimans forage. Herbivorous fishes and turtles convert plant matter to animal biomass as part of a complex network of life in the wetlands. Most fish species inhabiting river-floodplain systems also have their annual reproductive events synchronized with the flood pulse, spawning in a diverse mosaic of microhabitats (Castello et al., 2019; Isaac et al., 2016). Fruits from trees in the seasonally flooded forests ripen and fall during the flood pulse, and these fruits feed the reproducing fish and turtle populations. Native peoples have also developed their cultures with an intimate connection to this natural dynamic system, which provides them food and other vital resources (Begossi et al., 2019).

Choking off the flow of the river has unleashed a biological, social and human-rights catastrophe (Fearnside, 2021; Palmquist, 2023; Pertille and Albuquerque, 2020; Pezzuti et al., 2022; Sarmento and Rocha, 2021; Zuanon et al., 2019). The decision to divert most of the water from the Volta Grande to prioritize the full generating capacity of Belo Monte's main powerhouse is part of the original engineering plan that was drafted during Lula's previous administrations (2006–2010) and now poses a test of his promised socioenvironmental agenda. The legality of the licensing process for Belo Monte is contested in 22 lawsuits filed by the Public Prosecutor's Office. On 1 September 2022 the head of Brazil's Federal Supreme Court ruled that Belo Monte had violated Brazilian law by failing to carry out consultations with the Indigenous and other traditional peoples of the Volta Grande as required by International Labour Organization (ILO) Convention 169 (de Moraes, 2022); however, the decision will need to be ratified by the full court before it takes effect (MPF-PA, 2022).

Dam construction began in 2011, water diversion started in September 2015, and the installation of all 18 turbines of the main powerhouse was concluded in November 2019, causing the water diversion to reach its maximum. The highly seasonal flow of the Xingu River had long been known to be insufficient to justify the 11,000 MW installed capacity of the main powerhouse (Fearnside, 2006), and the systematic use of disinformation characterized the licensing process and the political promotion of the dam project (Fearnside, 2017a, b). In February 2021 Norte Energia signed a "*termo*" (a sort of memorandum of understanding) proposing a

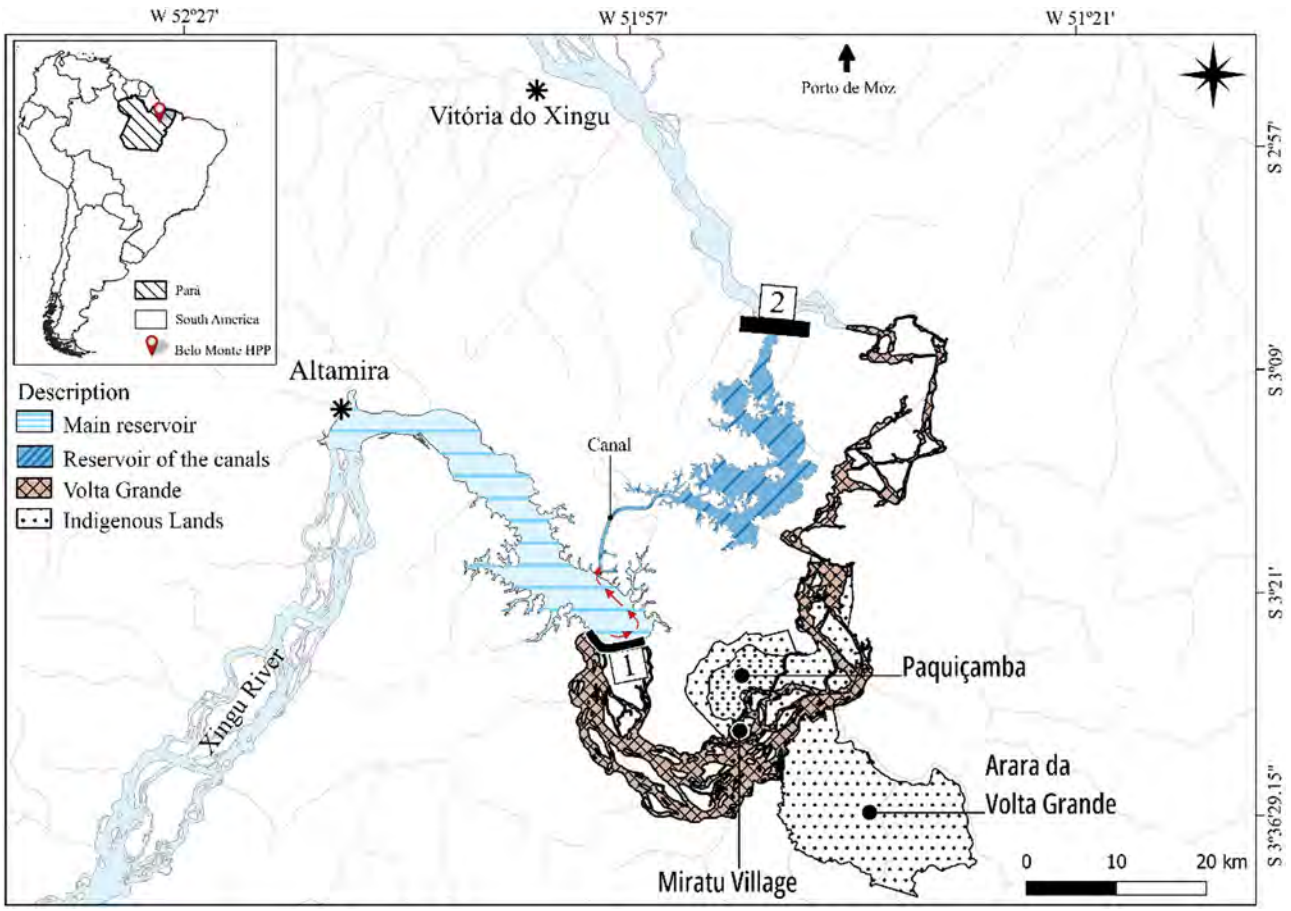

Fig. 1. Brazil's Xingu River and the Belo Monte Hydroelectric Power Plant. The Xingu River was impounded by the Pimental Dam [**1**] to divert water to an out-of-channel reservoir formed by the Belo Monte Dam [**2**].

budget of 157 million Brazilian reais (roughly US$ 30 million) to mitigate impacts of low water flow in the Volta Grande; although lacking detail, the funds would be employed in a series of monitoring measures (Brazil, IBAMA, 2021; Menegassim, 2021). Most of these measures were already required as specified in the licenses for building and operating Belo Monte (Rede Xingu Mais, 2023). New items feature experimental actions that are unlikely to be effective, including collecting fruits and other food items to be made available to aquatic animals on artificial feeding platforms at points along the 130-km Volta Grande stretch, raising fish of some species in aquaculture ponds for restocking the river, and producing seedlings of floodplain trees for reforestation in the areas that will no longer be flooded by the river - and that therefore will never again sustain floodplain vegetation that is adapted to the flooding cycle (e.g., Higgins, 2021). These small-scale experiments are presented by the entrepreneur as a robust mitigation program that would allow the dam to divert over 70% of the discharge without significant impacts on the socioenvironmental system. However, the costs, logistics and justification for supposed effectiveness of these strategies were not presented in the agreement.

The Juruna (or Yudjá, as they self-denominate), one of the Indigenous groups in the now-dewatered Volta Grande stretch, is an emblematic example of the riverine inhabitant's lifestyle and culture. Fish consumption is vital to the food security of Indigenous populations such as this (Begossi et al., 2019; Lopes et al., 2024). The Juruna's close association with the river is reflected in their being referred to as the "owners of the river" and the people with "canoes instead of feet" (Pezzuti et al., 2018). This livelihood is now disrupted by the Belo Monte hydroelectric complex, despite Brazil's 1988 Constitution guaranteeing that both Indigenous and *ribeirinho* families have the right to maintain their lifestyles. Article 231 of Brazil's Constitution states that use of water resources in Indigenous lands must be previously authorized by the National Congress, which authorized proceeding with the Belo Monte project in 2005 based on the argument that Indigenous territories would not be flooded, ignoring the fact that these territories would lose their vital water resources because of the river diversion (Fig. 2), an argument that continues to be used by Norte Energia, the dam's administrator. The diversion of water prevents the seasonal inundation of 86% (30,748 ha) of the total area (35,600 ha) originally covered by seasonally flooded vegetation in the Volta Grande. Consequences include declines in biological productivity and fishery yields, loss of flood-adapted vegetation and of biodiversity in general, increased risk of biological extinction of various endemic species, loss of connectivity along the river channel, changes in sedimentation patterns affecting habitat stability and water quality, degradation of cultural repertoires and the loss of food security for the riverine human populations. In short, a collapse of the regional socioecological system is underway.

How a project with such foreseeable socioecological impacts and that violates Indigenous and other traditional peoples' rights was conceived and carried out may seem intriguing at first (Fearnside, 2006, 2017c). Under the Brazilian licensing system, the entrepreneurs are responsible for all environmental impact assessments and subsequent mitigation and compensatory programs. In government environmental agencies the staff has long been subjected to pressure when analyzing the reports provided by the consultants hired by the entrepreneur (Zuanon et al., 2019).

Fig. 2. Reduced water flow in the Volta Grande of the Xingu River, a 130-km stretch between the two dams that comprise the Belo Monte Hydropower Plant, decimates aquatic and seasonally flooded ecosystems, deprives traditional populations of fish and impedes transportation. Photograph: Fábio Erdos/*The Guardian* (Watts, 2019).

In addition, protocols for impact assessment studies have not yet been developed for the severe changes to complex and interconnected Amazonian rivers and associated flooding cycles, which impact specific habitats and species and can affect extensive seasonally flooded areas downstream of dams (e.g., Gerlak et al., 2020; Latrubesse et al., 2017; RTAC/USAID, 2020; Schöngart et al., 2021). The protocols employed by staff hired by Norte Energia systematically fail to find any significant impacts, despite the disruption being obvious to local people and to independent researchers (Pezzuti et al., 2018; Zuanon et al., 2019). The environmental impact assessment for Belo Monte (Brazil, ELETROBRÁS, 2009) severely underestimated virtually all impacts of the project (Magalhães and Hernandez, 2009; Ritter et al., 2017). In addition to environmental impacts, multiple violations of human rights were committed in implementing the dam project (e.g., AIDA, 2018). Brazil's press coverage of Belo Monte and other dams has been found to downplay or ignore social and environmental impacts and to emphasize the narratives of the hydroelectric industry asserting that these dams are needed for economic progress (Mourão et al., 2022).

Consultant specialists hired by Norte Energia to conduct the licensing process and to implement monitoring and conservation actions sign contracts with confidentiality clauses, forfeiting their independence and preventing their findings from being fully known. Although the currently observed impacts in the Volta Grande were predicted by scientific assessments that relied on six decades of studies on the ecology and hydrology of the Amazon Basin, most were overlooked, thus favoring approval of the dam project. Impacts on the biota and on riverine families were grossly understated by the entrepreneur's consultants (Zuanon et al., 2019). This was evident during the construction phase (2011–2015) and during the phase with partial operation of the turbines (2016–2019), when the duration of the flood pulse decreased progressively from six to three months and its amplitude decreased severely. The Brazilian Institute of the Environment and Renewable Natural Resources (IBAMA), the federal agency in charge of licensing, has highly qualified technical personnel who were rendered powerless by uninterrupted political pressure during Lula's previous administrations (Fearnside, 2006, 2017c). This pressure was further accentuated under the 2019–2022 Bolsonaro presidential administration (Zuanon et al., 2019).

With the dam in operation, local communities and independent researchers have been conducting autonomous environmental monitoring and consistently documenting the impacts of water diversion on the ecosystems of the Volta Grande (Pezzuti et al., 2018). These negative effects have been recognized by IBAMA (Brazil, IBAMA, 2019). The victims of Belo Monte are demanding that the Lula administration guarantee that an adequate quantity of water be left to flow through the Volta Grande in a way that nearly reproduces the duration of the seasonal flood pulse with an amplitude sufficient to maintain the Volta Grande's aquatic and flooded ecosystems. The dam company's record in keeping past promises is poor: as of June 2022, IBAMA found that only 13 of 47 conditions in the dam's operating license had been met and eight had been partially met (ISA, 2022; see also ISA, 2019; Palmquist, 2023). Changes are clearly needed in Brazil's governance system to assure accountability for failure to fulfill promises like these.

The dispute over the Xingu's water (Sabaj-Perez, 2015) is far from over, especially because several major impacts are cumulative and will continue to worsen if the present large diversion of river flow continues. Various species will disappear, and others will survive in extremely reduced populations and biomass, further increasing their extinction risks. Conflict will be exacerbated as water becomes scarcer, especially during the low-flow season, due to climate change (Sorribas et al., 2016). More frequent extreme droughts are expected with continued global warming (Fearnside and Silva, 2023; Latif et al., 2015), and Belo Monte's power output would further decrease as deforestation continues in its headwaters (Stickler et al., 2013).

In the case of Belo Monte and other already-existing dams in Amazonia, impacts can be minimized by improved monitoring (including involvement of Indigenous peoples and *ribeirinhos*), an end to secrecy of information obtained during monitoring, and new rules for dam operation. Licensing of any modifications must include participation of Indigenous communities. Belo Monte's operating license is now up for renewal (Selibas, 2023), and the licensing agency is under strong pressure from the Ministry of Mines and Energy to approve the license with the current "hydrogram" for water flows in the Volta Grande, which was proposed by the power company over the objections of other stakeholders (Gabriel, 2023). We call on Lula's administration to require that sub-

stantially more of the Xingu's water be allocated to flowing through the Volta Grande.

While strengthening licensing procedures for new dams and the oversight by regulators for existing dams are important priorities, these measures would not be enough to avert future disastrous hydroelectric projects in Amazonia. Instead, building new dams with installed capacity of 10 MW or more must be simply ruled out without exception — as concluded in the 2021 Scientific Panel for the Amazon report (Fearnside et al., 2021). This includes the three dams in the electrical authority's current ten-year plan. An exception for the theoretical "good" dam would open a loophole causing a large net impact by allowing damaging dams to be approved in practice (Fearnside et al., 2021).

The disaster taking place at Belo Monte in one of the world's most socially and biologically diverse places should be a warning of the consequences of Brazil's extensive hydroelectric plans, especially those that would be allowed in Indigenous lands under a bill (PL 191/2020) that was submitted to the National Congress in 2020 by then-president Bolsonaro and is still advancing towards a vote. In addition to dams, the bill would open Indigenous land to agribusiness, mining and logging. Together, these powerful interest groups control sufficient votes in the National Congress not only to pass this law but also to override any presidential veto. In fact, key environmental advances made in the first days after President Lula took office in January 2023 were decreed by "provisional measures", which are executive orders valid for 120 days, and the bills that would enact these changes have now been rejected or gutted by the agribusiness "ruralists" and other interest groups in the National Congress (ClimaInfo, 2023a; Gabriel et al., 2023). This has also occurred in the case of key features a provisional measure that defined responsibilities of both the Ministry of Environment and Climate Change and the Ministry of Indigenous Peoples (ClimaInfo, 2023b).

The questions of how and by whom Belo Monte should be governed need to be addressed, as a project of this magnitude clearly needs a robust governance system. This governance system will need to be designed primarily by the local stakeholders, including Indigenous peoples, *ribeirinhos* and urban residents, in partnership with government technical staff and researchers and technicians from universities, research institutes and the public prosecutor's office. A potential approach is "adaptive management", where the various stakeholders meet periodically and attempt to arrive at agreements (Holling, 1978; Scarlett, 2013; Walters and Holling, 1990). A consensus is not guaranteed, although it is more likely than without the system, and governance measures can evolve over time, both to accommodate changing circumstances and evolving demands of the stakeholders. The system is a topic of research for application to Amazonian dams (Athayde et al., 2019).

The Brazilian government has extensive plans for future Amazonian hydroelectric dams (Brazil, EPE, 2020; Fearnside, 2020), and these plans remain in place (Fearnside, 2023b, 2024). Brazil also plans to become a major exporter of green hydrogen by tapping the huge potential for wind power on the country's coast (Bethônico, 2023), but this potential is also the key both to not building more Amazon dams and to avoiding pressure such as that currently pushing to allow inadequate water flow in the Volta Grande. If green hydrogen is exported to Europe while Brazil's cities receive power from new dams, that hydrogen will not be "green". As a precondition for importing Brazilian hydrogen, European countries should require that Brazil halt all construction of Amazon dams and adopt a better water management system in Volta Grande. The dramatic situation on the Volta Grande should motivate a rethinking of energy and environmental policies in Brazil and in the many other countries that turn a blind eye to the consequences of their plans for hydropower.

Conflict of interest

The authors declare that they have no known conflict of interest.

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