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Amazon Dams and Waterways: Brazil's Tapajós Basin Plans

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Abstract
Brazil plans to build 43 "large" dams (> 30 MW) in the Tapajós Basin, ten of which are priorities for completion by 2022. Impacts include flooding indigenous lands and conservation units. The Tapajós River and two tributaries (the Juruena and Teles Pires Rivers) are also the focus of plans for waterways to transport soybeans from Mato Grosso to ports on the Amazon River. Dams would allow barges to pass rapids and waterfalls. The waterway plans require dams in a continuous chain, including the Chacorão Dam that would flood 18 700 ha of the Munduruku Indigenous Land. Protections in Brazil's constitution and legislation and in international conventions are easily neutralized through application of "security suspensions," as has already occurred during licensing of several dams currently under construction in the Tapajós Basin. Few are aware of "security suspensions," resulting in little impetus to change these laws.

Keywords:
Amazonia; Brazil; Dams; Hydropower; Hydroelectric dams

1.) Introduction

The Amazon Basin, roughly two-thirds of which is in Brazil, is the focus of a massive surge in hydroelectric dam construction, with plans that would eventually covert almost all Amazon tributaries into chains of reservoirs (e.g., Fearnside 2014a; Finer and Jenkins 2012; Kahn et al. 2014; Tundisi et al. 2014). Dams in tropical areas like Amazonia have a wide range of environmental and social impacts, including loss of terrestrial and aquatic biodiversity (Santos and Hernandez 2009; Val et al. 2010), greenhouse-gas emissions (Abril et al. 2005; Fearnside and Pueyo 2012; Kemenes et al. 2007), loss of fisheries and other resources that support local livelihoods (Barthem et al. 1991; Fearnside 2014b), methylation of mercury (rendering the poisonous to animals, including humans) (e.g., Fearnside 1999; Leino and Lodenius 1995), and population displacement (Cernea 1988, 2000; McCully 2001; Oliver-Smith 2009, 2010; Scudder 2006; WCD 2000). Dam projects throughout the tropics have followed a pattern of systematic violation of human rights, including violence and murder, especially involving indigenous peoples. Recent examples of murders of indigenous leaders opposing dams include Miguel Pabón in 2012 at the Hidrosogamoso Dam in Colombia and Onesimo Rodriguez in 2013 at the Barro Blanco Dam in Panama (Ross 2012; Yan 2013). The murder of two children (David and Ageo Chen) in 2014 at the Santa Rita Dam in Guatemala when the gunmen were unable to locate the leader they had been hired to kill has become an emblematic case (e.g., Illescas 2014). Ironically, all of these dams have projects for carbon credit approved by the Clean Development Mechanism and supposedly represent "sustainable development." In Brazil, the killing of Adenilson Kirixi Mundurku by police in November 2012 is the emblematic case for indigenous peoples impacted by hydroelectric dams in the Tapajós River Basin (e.g., Aranha and Mota 2014). The Tapajós is a north-flowing Amazon tributary with a 764 183-km^2 drainage basin. Brazil's portion of the Amazon Basin is roughly the size of western Europe, and the Tapajós Basin is about the size of Sweden and Norway together. Many of the challenges exemplified by the Tapajós plans apply throughout the world. As will be illustrated by development plans in Brazil's Tapajós River Basin, the decision-making process in Brazil and the legal system surrounding the country's dam-building frenzy are stacked against the environment and the traditional Amazonian inhabitants.

The present paper concentrates on a little-discussed aspect of decision-making and licensing for major development projects: the legal tools employed to neutralize protections for the environment and for human rights. Many other topics also require change to reduce the impacts and improve the benefits of developments such as those in Brazilian Amazonia. These include reform of energy policy and of the environmental impact assessment system, creation of mechanisms to prevent conflicts of interest for those who evaluate and decide on proposed infrastructure such as dams, and containing corruption both in its simple financial form and in its even more perverse political forms, including both illegal payoffs and legal campaign contributions (see Fearnside 2014a).

The theoretical framework used in the present study follows the pattern of identifying a limited set of objectives and then examining the critical points that prevent the objectives from being achieved. Frameworks that follow this principle are efficient in indicating priorities for change (e.g., Mermet 2011; Ostrom 2011). In this case the objectives are both maintenance of Amazonian ecosystems (together with their environmental services) and maintenance of traditional populations (including indigenous peoples). Conflicts between hydroelectric plans and different kinds of protected areas, including indigenous lands, are documented. Other important aspects of Brazil's development decisions, such as alternative means of providing the benefits of electricity to country's population, are discussed elsewhere (e.g., Moreira 2012).

2.) The Tapajós dams

A total of 43 "large" dams are either planned and under construction in Brazil's Tapajós River Basin (Figures 1 and 2). "Large" dams in Brazil are defined as those with more than 30 megawatts (MW) of installed capacity. Nearly all of the planned dams are much larger than 30 MW. Three of these would be on the Tapajós River itself and four on the Jamanxim River (a tributary of the Tapajós in the state of Pará) (Table 1). On Tapajós tributaries in the state of Mato Grosso six dams are planned in the Teles Pires River Basin (Table 2) and 30 in the Juruena River Basin (Table 3). There are also plans for numerous "small hydropower plants" (PCHs), meaning dams with installed capacity ≤ 30 MW that are exempted from the federal government's Environmental Impact Study-Environmental Impact Report (EIA-RIMA).

[Figures 1 & 2 & Tables 1, 2 & 3 here]

Brazil's Second Program for the Acceleration of Growth (PAC-2), covering the 2011-2015 period, includes six dams on the Tapajós and Jamanxim Rivers and five dams on the Teles Pires River (Brazil, PR 2011). Priorities and schedules for dams have been evolving continuously, as indicated by the Ten-Year Energy Expansion Plans (PDEs) launched every year by the Ministry of Mines and Energy, containing the dams planned for the succeeding ten years. For example, the dams on the Jamanxim River appeared in the PDEs through the 2011-2020 Plan but disappeared from subsequent plans, meaning that they were postponed to beyond the ten-year horizon. They were replaced by the São Simão Alto and Salto Augusto Baixo mega-dams on the Juruena River, plus smaller dams such as Castanheira, on the Arinos River, which is a tributary of the Juruena and the location of one of the ports planned for loading soybeans onto the barges that would descend the Tapajós Waterway (Brazil, MME 2013). These changes favor dams that comprise the waterways that are planned to transport soybeans and postpone the dams

that are not part of these routes. The Ministry of Mines and Energy does not build locks, its contribution to the waterways being limited to reserving space for this purpose next to each dam and locks being the purview of Ministry of Transportation. Although the two ministries are not always in agreement on priorities, the final word lies with the "Civil House" (*Casa Civil*) of the president's office.

Of the 43 planned dams planned in the Tapajós Basin, ten are included in the 2013-2022 PDE: two on the Tapajós River itself, five in the Teles Pires Basin and three in the Juruena Basin (Tables 1, 2 and 3). The dams have multiple impacts, including damage to indigenous lands ("*terras indígenas*", or "TIs") (Figure 3) and flooding in conservation units (CUs) (Figure 4). Note that in Brazil "conservation units" refer to protected areas of types included in the National System of Conservation Units (SNUC) (Brazil, PR 2000). Other types of protected areas, such as indigenous lands, are also important for maintaining Amazonian forest. Dams expel riverside populations and drive deforestation in various ways.

[Figures 3 & 4 here]

Flooding of land in protected areas is one of the environmental impacts of planned dams in the Tapajós Basin. The Brazilian government has degazetted parts of several conservation units even before the planned dams have been evaluated and licensed. Part of Amazonia National Park has already been degazetted (removing legal protection) by means of a provisional measure (No. 558/2012), subsequently converted into law (No. 12 678/2012). This was done explicitly to make way for the reservoir of the São Luiz do Tapajós Dam (e.g., IHU 2012; WWF Brasil 2012). The federal government also removed part of the Juruena National Park to make way for the São Simão Alto and Salto Augusto Baixo Dams on the Juruena River (WWF Brasil 2014). The planned dams would inundate 15 600 ha of Amazonia National Park, 18 515 ha of Jamanxim National Park, 7352 ha of Itaituba-I National Forest, 21 094 ha of Itaituba-II National Forest and 15 819 ha of the Tapajós Environmental Protection Area (APA), or a total of 78 380 ha in protected areas.

In the case of the Tapajós River Basin, the impact of many dams and the Tapajós Waterway, including its branches on the Teles Pires and Juruena Rivers, is much larger than the damage that usually comes into discussion for any specific project, such as the first planned dam: São Luiz do Tapajós (CNEC Worley Parsons Engenharia, S.A. 2014a, b). The waterway has a key role in ensuring construction of all dams required to make the route navigable, including the most damaging dam: Chacorão.

3.) The Tapajós Waterway

Dams flood rapids that impede navigation and the locks associated with the dams allow the passage of barges. Brazil has extensive plans for inland navigation (Fearnside 2001, 2002; Brazil, PR 2011). These dams would allow the Tapajós Waterway to carry soybeans from Mato Grosso to ports in Santarém, Santana and Barcarena, thus giving access to the Amazon river and the Atlantic Ocean (Brazil, PR 2011; Millikan 2011).

Completion of the waterway would require an additional dam that is not mentioned in the "energy axis" of PAC-2. This is the Chacorão Dam on the Tapajós River in the state of Pará (e.g., Millikan 2011). Chacorão also does not appear among the dams listed in

the PDEs for 2011-2020, 2012-2021 and 2013-2022 (e.g., Brazil, MME 2013). On the other hand, Chacorão appears in the feasibility study for the São Luiz do Tapajós Dam (CNEC Worley Parsons Engenharia, S.A. 2014a). It also appears in the Integrated Environmental Assessment (AAI) for the Tapajós dams (Grupo de Trabalho Tapajós and Ecology Brasil 2014, p. 60). The locks associated with Chacorão are listed as a "priority" in the National Waterways Plan (Brazil, MT 2010, p. 22). The reservoir behind the dam would allow barges to cross the Chacoráo rapids.

Chacorão would inundate 18 700 ha of the Munduruku Indigenous Land (Millikan 2011). In the case of the São Luiz do Tapajos and Jatobá Dams, the reservoirs would flood Munduruku tribal lands that have not been officially designated as an "indigenous land" (Lourenço 2014; Ortiz 2013). Creation of new indigenous lands in Brazil has been "paralyzed" for several years, reportedly due to orders from above that the National Indian Foundation (FUNAI) does not deny (e.g., CIMI 2014). This "paralyzation" appears to represent a policy to facilitate the flooding of areas inhabited by indigenous populations where indigenous lands have not yet been created, such as the Munduruku populations in the areas that would be flooded by the planned São Luiz do Tapajós and Jatobá Dams. This is clear in a video of Maria Augusta Assirati, the "president" (head) of FUNAI, in tears as she tries to explain to a group of Mundurku in September 2014 that the paperwork for creating their reserve was completely ready for her signature and had been sitting on her desk for a year, but that "other government agencies began to discuss the proposal" because of the hydroelectric plans (Amigos da Terra-Amazônia Brasileira 2014). She was replaced as head of the agency nine days later with the paperwork still unsigned and, later, she confirmed the interference (Aranha 2015).

Implementation of the Tapajós Waterway would encourage future deforestation for soy in the northern part of Mato Grosso, which would be served by this infrastructure complex. The waterway would also encourage soy plantations in the cattle pastures that currently dominate land use in areas that have already been cleared in this part of Mato Grosso. Such a conversion causes deforestation indirectly in other places: both the cattle and the ranchers who sell their land to soy planters ("*sojeiros*") move from Mato Grosso to Pará (Fearnside 2001). The effect on deforestation in Pará from advancement of soy in pastures in Mato Grosso has been shown statistically (Arima et al. 2011). This effect has been denied by Brazilian diplomats, who were successful in getting mention of it removed from the summary for policy makers of the Fifth Assessment Report (AR-5) of the Intergovernmental Panel on Climate Change (IPCC) in March 2014 (Garcia 2014). Stimulus to deforestation by the Tapajós Waterway is not included among impacts considered in environmental licensing and in evaluating greenhouse-gas emissions of projects for generating carbon credits from dams in the Tapajós Basin, as in the case of the Teles Pires Dam (Fearnside 2013).

On April 25, 2014, Bunge, a multinational company currently responsible for 25% of Brazil's soy production, opened a port for export of soybeans in Barcarena, at the mouth of the Amazon River. The company expects Brazil's exports to double by 2024, mainly targeting China (Freitas 2014). Soybeans for the first vessel loaded at the port of Vila de Conde (in Barcarena) came from Mato Grosso in trucks to the port of Miritituba (on the lower Tapajós River), and from there proceeded to Barcarena in barges operated by Navegações Unidas Tapajós Ltda. (Unitapajós), a joint venture between the Amaggi and Bunge companies. In the future, it is expected that the soybeans exported from

Barcarena will travel all the way from Mato Grosso on barges descending the Tapajós Waterway, starting with the branch of the waterway on the Teles Pires River.

The portion of the waterway in the state of Mato Grosso will fork, with one branch on the Teles Pires River and the other on the Juruena. The first branch of the Tapajós Waterway to be built would make the Teles Pires River navigable as far as Sinop, and, subsequently, to Sorriso. The Teles Pires branch requires a series of five dams, three of which (Colider, São Manoel and Sinop) are already under construction. The São Manoel Dam is less than 1 km from the Kayabi Indigenous Land and already has provoked conflicts with the tribe (ISA 2013). The Foz do Apiacás Dam is located only 5 km from the same indigenous area. Interministerial Ordinance 419/2011 considers that indigenous areas are affected by any hydroelectric plant within 40 km.

For the second branch of the waterway, which would be built on the Juruena River, soybeans would reach the two planned ports via roads from the south, including a new road (MT-319) that would connect Juína, Mato Grosso, with Vilhena, in eastern Rondônia, bisecting two indigenous areas: TI Enawenê Nawê and the Aripunã Indigenous Park (Macrologística 2011). The Juruena River branch of the waterway requires six dams to reach the proposed ports, and three of the reservoirs would flood in indigenous lands: the Escondido and Erikpatsá Dams would flood in TIs with the same names, and the Tucumã Dam would flood part of TI Japuira (CNEC Worley Parsons Engenharia, S.A. 2014a, Illustration 3.5/1). Sixteen more dams are planned on the tributaries in the headwaters of the Juruena above the portion of the river to be made navigable (Brazil, ANEEL 2011). Of the 16 "large" dams in the headwaters of the Juruena, four affect TI Nambikwara (Poçilga, Jacaré, Foz do Formiga Baixo and Nambikwara), and two affect TI Tirecatinga (Salto Utiariti and Foz do Sacre) (CNEC Worley Parsons Engenharia, S.A. 2014a). A number of "small hydropower plants" (PCHs) are also planned, several of which affect indigenous areas (CNEC Worley Parsons Engenharia, S.A. 2014a, Illustration 3.5/1; de Almeida 2010; Fanzeres 2013).

4.) Laws overriding protection

Legal treatment of licensing, and especially of impacts on indigenous peoples, provides a clear illustration of the barriers preventing implementation of protections specified in Brazil's constitution and legislation. This also applies to international agreements such as Convention 169 of the International Labor Organization (ILO-169), under which indigenous peoples impacted by development projects have the right to "consultation." Unfavorable decisions on dam construction in Brazil are routinely reversed by invoking a "security suspension" ("*suspensão de segurança*") that allows construction to continue regardless of any social or environmental violations if halting the project would cause grave damage to the "public economy." A law originating from Brazil's military dictatorship authorizes

> the President of the Court to **suspend** the execution of **injunctions** and rulings on claims against public authorities and their agents in order **to avoid serious injury to the** public **economy** (Law No. 4348 of 26 June 1964; replaced by Law 12 016 of August 7, 2009). [emphasis added]

After Brazil's 1988 Constitution created the Public Ministry (a public prosecutor's office charged with defending the interests of the people), applicability of security suspensions was reconfirmed by clarifying that

> it is the responsibility of the President of the Court, to whom an appeal ["*recurso*"] is submitted, **to suspend**, by means of a substantiated order, the execution of **injunctions** in claims against public authorities or their agents, at the request of the Public Ministry or of any concerned legal entity governed by public law, in the event of manifest public interest and blatant unlawfulness, and **to avoid serious injury to the** public order, health, safety and **economy** (Art. 4 of Law 8437 of June 30, 1992). [emphasis added]

It was clarified that no subsequent appeal ("*agravo"*) could have the effect of temporarily reverting a security suspension:

> When, at the request of an interested legal entity governed by public law or the Public Ministry, and **to avoid serious injury to the** public order, health, security and **economy**, the President of the Court to which the respective appeal ["*recurso*"] is submitted **suspends**, by means of a substantiated decision, the execution of **the injunction** and the sentence, this decision is **subject to** interlocutory **appeal** ["*agravo"*], **without any suspensory effect**, within five days, which will be judged in the session following its filing (Art. 15 of Law 12 016 of August 7, 2009). [emphasis added]

Of course, any hydroelectric dam has economic importance, thus effectively negating all protections of the environment and of impacted peoples (e.g., Prudente 2013, 2014).

In the case of the Teles Pires Dam, use of the security suspension was denounced before the Inter-American Commission on Human Rights (IACHR) of the Organization of American States (OAS), on March 28, 2014 (ISA 2014). The Teles Pires Dam affects three indigenous tribes (Kayabi et al. 2011). Loss of fishing will affect the Kayabi's nutrition. The group will also lose sacred sites associated with waterfalls to be flooded. The licensing process contained a variety of irregularities (Millikan 2012). Successive legal attempts to stop the dam were reversed, usually in just two or three days. The speed with which decisions are reversed despite extensive documentation of impacts and of violations of laws is probably due to the fact that a security suspension is independent of arguments concerning the impacts and legality of a project, depending only on demonstrating the project's economic importance. The Teles Pires Dam was suspended on December 14, 2010 (Kayath 2010), on March 27, 2012 (Lessa 2012; MPF/PA 2012), on April 9, 2012 (Menezes 2012a) and on August 1, 2012 (see Fiocruz and Fase 2013), and on October 9, 2013 (TRF-1 2013). On November 11, 2014, for the 12th time in the case of the Tapajós Dams, a security suspension was granted. This allowed the Brazilian Institute of the Environment and Renewable Natural Resources (IBAMA) to issue an operating license to the Teles Pires Dam without the dam consortium having complied with many of the conditions that IBAMA had previously established (Palmquist 2014).

Licensing of the São Manoel Dam has produced a spectacular chronology irregularities (Monteiro 2013a, b). Several attempts to prevent construction were legally reversed. A suspension of bidding for construction contracts was reversed on December13, 2013

(Fiocruz and Fase 2013). On April 28, 2014 a judge in Cuiabá suspended work on São Manoel based on legislation guaranteeing the rights of indigenous peoples (Presser 2014). Meanwhile, a public civil suit against São Manoel, which was initiated on September 17, 2013, reached the "concluded for sentencing" stage on July 21, 2014 (TRF-1 2014).

The Sinop, Colíder and Magessi Dams had their construction blocked on December 6, 2011 when a judge in Sinop issued a preliminary injunction based on violation of legislation on environmental licensing (da Silva Neto 2011). Among other irregularities, licensing was being done only by the Mato Grosso Environment Secretariat, while dams such as these require licensing at the federal level by IBAMA (MPF/PA 2011). The dams in question impact indigenous peoples (Monteiro 2011). As early as January 16, 2012 a judge in Brasilia rejected the suit based on a security suspension (Menezes 2012b), allowing construction to continue. As in any country, interpretation of laws varies with individual judges, and some are more prone than others to decide in favor of economic concerns over indigenous rights or environmental impacts. This subset of judges is often sought out by government attorneys in appeals to overturn decisions on dams, even though the judges in question may be located far from the dams in question (see example in Fearnside and Barbosa 1996).

The existence of laws authorizing "security suspensions" is not generally known either to the academic community or to the Brazilian public. Discussion of the need to change these laws is therefore almost nonexistent. The same lack of awareness applies to high-impact projects like the Chacorão Dam, which is omitted from virtually all public discussion of the Tapajós Basin developments despite being a key part of the overall plan. Omitting discussion of the most controversial components of Brazil's hydroelectric plans represents a general pattern, repeating the recent history of licensing the Santo Antônio and Jirau Dams on the Madeira River (Fearnside 2014c) and the Belo Monte Dam on the Xingu River (Fearnside 2006, 2012).

While discussion is invariably concentrated on the pros and cons of each individual proposed project, the way that decisions are made is much more fundamental to the environmental and social conditions that will prevail in the future. The interdependence of project complexes like dams and waterways is a part of this little-debated area. Another is the underlying legal structure, which in the case of Brazil represents a "safety net" for project proponents that provides an ultimate guarantee against environmental and social limitations. Those in the environmental field who have worked long and hard to build the impact-assessment and licensing system usually view the legal system as a given – part of the institutional landscape that must simply be accepted. Fortunately, national laws are not natural laws, and they are subject to change by social decisions. This is true in any country, Brazil providing an example.

5.) Conclusions

The plans for dams and waterways in the Tapajós Basin imply large impacts, both individually and together. These impacts include damage to indigenous lands and to protected areas. The combination of proposals for dams and waterways implies impacts that could otherwise not occur. An example is provided by the Chacorão Dam, which would flood part of the Munduruku Indigenous Land; this dam might not be a priority if it were not part of the route of the Tapajós Waterway. Brazil's environmental licensing

system has been unable to prevent the approval of projects with large impacts, and the legal system has been unable to enforce constitutional and other protections due to the existence of laws authorizing "security suspensions" to allow the continuation of any construction project with economic importance. Public discussion is needed of the laws that currently guarantee completion of any dam or other large infrastructure project irrespective of environmental and social impacts and violations of licensing requirements. Disclosure and democratic debate are also needed on the full range of components comprising basin development plans, including high-impact projects like the Chacorão Dam that are now virtually absent from public view. The immediate policy recommendation arising from the Tapajós experience is obvious: repeal laws or portions of laws (e.g., Article 15 of Law 12016 of August 7, 2009) authorizing "security suspensions" and allow Brazil's existing environmental licensing system to function. On a wider scale, those concerned with environmental and social impacts of development in every country need to work to purge aberrations of this kind from their legal and regulatory systems.

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Figure Legends

Figure 1. Brazil and locations mentioned in the text. **Brazilian states**: MT=Mato Grosso, PA=Pará, RO=Rondônia. **Dams**: 1=São Luiz do Tapajós, 2=Jatobá, 3=Chacorão, 4=Teles Pires, 5=Salto Augusto Baixo, 6=São Simão Alto, 7=Colíder, 8=São Manoel, 9=Sinop, 10=Magessi, 11=Cachoeira do Caí, 12=Cachoeira dos Patos, 13=Jardim de Ouro, 14= Jirau,15=Santo Antônio,16=Belo Monte. **Cities**: 17=Santarém, 18=Cuiabá, 19=Juína, 20=Sinop, 21=Sorriso, 22=Itaituba, 23=Miriticuba, 24=Barcarena, 25=Brasília, 26=Vilhena. Highways: 27=MT-319, 28=BR-230, 29=BR-319, 30=BR-364. **Rivers**: 31=Amazon, 32=Tapajós, 33=Teles Pires, 34=Juruena, 35=Arinos, 36=Jamanxim, 37=Madeira, 38=Xingu.

Figure 2. Large dams (> 30 MW) planned in the Tapajós Basin: 1=Roncador, 2=Kabiara, 3=Parecis, 4=Cachoeirão, 5=Juruena, 6=Chacorão, 7=Jatobá, 8=Cachoeira do Caí, 9=Cachoeira dos Patos, 10=Jardim de Ouro, 11=São Luiz do Tapajós, 12=Jamanxim, 13=Tucumã, 14=Erikpatsá, 15=Salto Augusto Baixo, 16=Escondido, 17=Apiaka Kayabi, 18=Jacare, 19=Pocilga, 20=Foz do Sacre, 21=Foz do Formiga Baixo, 22=Salto do Utiariti, 23=Castanheira, 24=Paiaguá, 25=Nambiquara, 26= São Simão Alto, 27=Barra do Claro, 28= Travessão dos Índios, 29=Fontanilhas, 30=Enawene Nawe, 31=Foz do Buriti, 32= Matrinxã, 33=Tapires, 34=Tirecatinga, 35=Água Quente, 36= Buriti, 37=Jesuíta, 38= Colíder, 39= Foz do Apiacás, 40=São Manoel, 41=Sinop, 42=Teles Pires, 43=Magessi. TI=Indigenous Land ("*Terra Indígena"*); CU=Conservation Unit; IP= Integral Protection; SU= Sustainable Use.

Figure 3. Indigenous Lands (*Terras Indígenas:* TIs) in the Tapajós Basin: 1= Manoki, 2= Ponte de Pedra, 3= Uirapuru, 4= Estação Parecis, 5= Menkú, 6= Batelão, 7= Maró, 8= Munduruku-Taquara, 9= Bragança-Marituba, 10= Apiaká do Pontal e Isolados, 11=Praia do Índio, 12= Praia do Mangue, 13=Apiaká/Kayabi, 14= Bakairi, 15= Enawenê-Nawê, 16= Erikpatsá, 17= Escondido, 18= Irantxe, 19= Japuira, 20=Juininha, 21= Cayabi, 22= Menkú, 23= Munduruku, 24= Nambikwara, 25= Panará, 26= Paresi, 27= Parque do Aripuanã, 28=Pirineus de Souza, 29= Rio Formoso, 30= Sai-Cinza, 31= Santana, 32= Tirecatinga, 33=Utiariti. CU=Conservation Unit; IP= Integral Protection; SU= Sustainable Use.

Figure 4. Conservation Units (UCs) in the Tapajós Basin. 1=Águas do Cuiabá State Park, 2= Igarapés do Juruena State Park, 3=Sucunduri State Park, 4= Cristalino State Park, 5= Peugeot-ONF-Brasil Private Reserve of Natural Patrimony (RPPN), 6=Área de Proteção Ambiental do Salto Magessi, 7=Reserva Particular do Patrimônio Natural Cristalino-I RPPN, 8=Cristalino-III RPPN, 9= Fazenda Loanda RPPN, 10=Cabeceiras do Rio Cuiabá Environmental Protection Area (APA), 11=Bararati Sustainable

Development Reserve, 12=Apuí State Forest, 13= Sucunduri State Forest, 14=Amazonia National Park, 15=Juruena National Park, 16=Jamanxim National Park, 17= Nascentes Serra do Cachimbo Biological Reserve, 18= Iquê Ecological Station, 19=Rio Novo National Park, 20=Tapajós National Forest, 21=Amaná National Forest, 22=Crepori National Forest, 23=Riozinho do Anfrísio Extractive Reserve, 24=Tapajós Arapiuns Extractive Reserve, 25=Tapajós APA, 26=Itaituba-II National Forest, 27=Altamira National Forest, 28=Jamanxim National Forest, 29=Itaituba-I National Forest, 30=Trairão National Forest. TI=Indigenous Land (*Terra Indígena*); IP= Integral Protection; SU= Sustainable Use.

Table 1 –Planned dams on the Tapajós and Jamanxim Rivers

No. in Figure 2	Name	Code	River	Power [MW] [a, b]	Reservoir Area (km^2) [b]	Status	Inclusion in waterway	Inclusion in PDE 2013-2022[a]	Indigenous areas affected	Conservation units affected
7	Jatobá	TPJ-445	Tapajós	2338	646	Planned	Yes	Yes	Munduruku areas not officially recognized [c]	Amanã National Forest
6	Chacorão	TPJ-685	Tapajós	3336	616	Planned	Yes	No	TI Munduruku	
8	Cachoeira do Caí	JMX-043	Jamanxim	802	420	Planned	No	No		Itaituba-II National Forest
9	Cachoeira dos Patos	JMX-166 [J]	Jamanxim	528	117	Planned	No	No		Parque Nacional do Jamanxim, Jamanxim National Forest
10	Jardim de Ouro	JMX-257	Jamanxim	227	426	Planned	No	No		Jamanxim National Forest
11	São Luiz do Tapajós	TPJ-325	Tapajós	6133	722	Planned	Yes	Yes	Munduruku areas not officially recognized [c]	Amazonia National Park, Itaituba-I National Forest, Itaituba-II National Forest
12	Jamanxim	JMX-212	Jamanxim	881	75	Planned	No	No		Jamanxim National Park

(a) Brazil, MME (2013, pp. 84-85).
(b) See Fearnside (2014a).
(c) Ortiz (2013).

Table 2-PLanned dams in the Teles Pires Basin

No. in Figure 2	Name[(a)]	Code	River	Power [MW] [(a)]	Reservoir Area (km^2)[(b)]	Status	Inclusion in waterway	Inclusion in PDE 2013-2022	Indigenous areas affected
38	Colíder	TPR-680	Teles Pires	300	171.7	Under construction	Yes	Yes	
39	Foz do Apiacás (Salto Apiacás)	API-006	Apiacás	230	89.6	Planned	No	Yes	Kaiabí
40	São Manoel	TPR-287	Teles Pires	700	53	Under construction	Yes	Yes	Kaiabí
41	Sinop	TPR-775	Teles Pires	400	329.6	Under construction	Yes	Yes	
42	Teles Pires	TPR-329	Teles Pires		1820	Under construction	Yes	Yes	
43	Magessi	TPR-1230	Teles Pires	53	60	Planned	No	No	

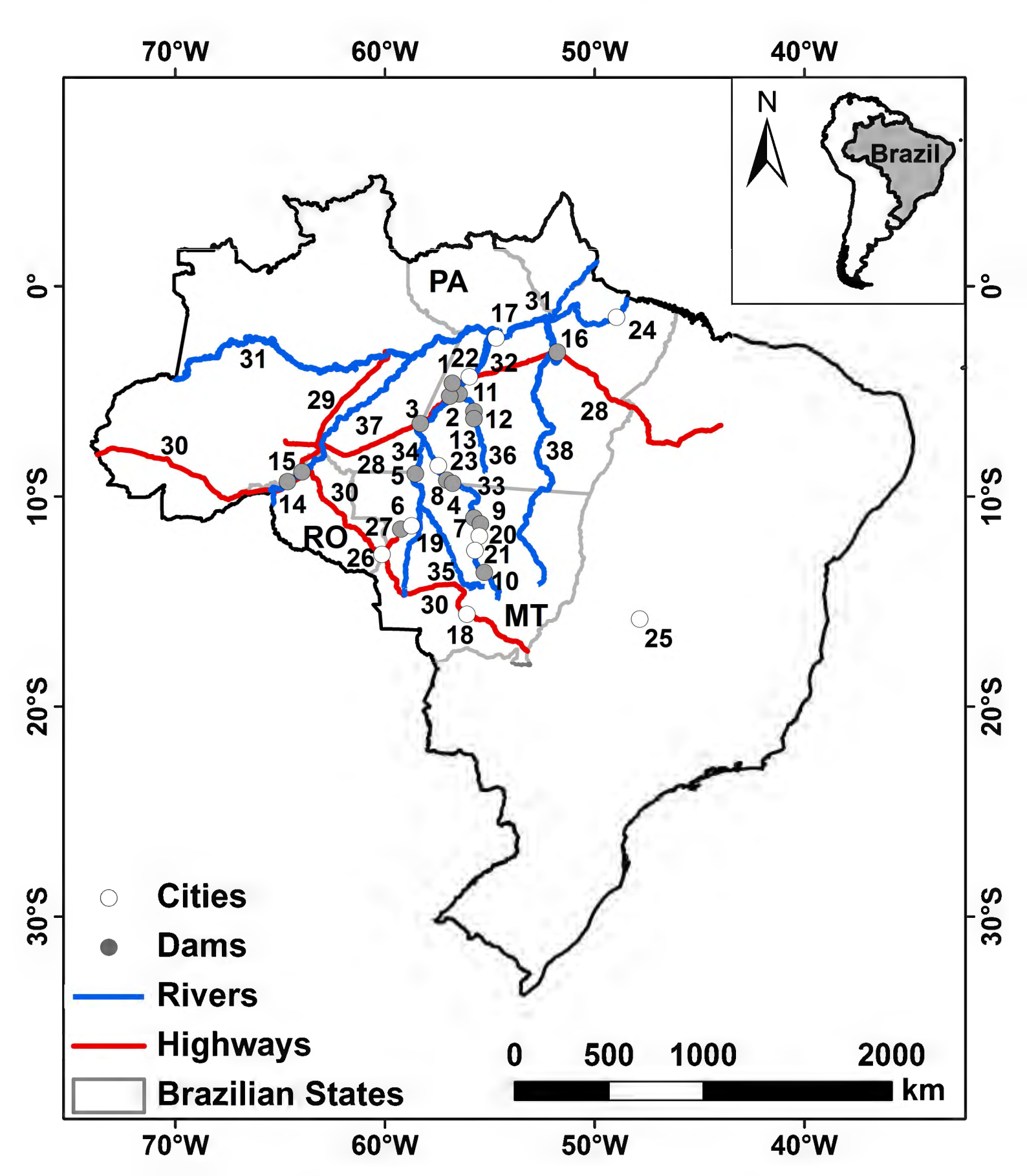
(a) Dams, installed capacities and inclusion in the Ten-Year Energy Expansion Plan (PDE) from Brazil, MME (2013, pp. 84-85).
(b) Areas of reservoirs: see Fearnside (2014a).

Table 3-Planned dams in the Juruena Basin

No. in Figure 2	Name[a, c]	Code	River	Power [MW] [a]	Inclusion in waterway	Inclusion in PDE 2013-2022[b]	Indigenous areas affected[c]
1	Roncador		do Sangue	134.0	No	No	TI Manoki
2	Kabiara		do Sangue	241.2	No	No	TI Erikpatsá
3	Parecis		do Sangue	74.5	No	No	TI Manoki
4	Cachoeirão		Juruena	64.0	No	No	
5	Juruena		Juruena	46.0	No	No	
13	Tucumã	JRN-466	Juruena	510	Yes	No	TI Japuira
14	Erikpatsá	JRN-530	Juruena	415	Yes	No	TI Erikpatsá
15	Salto Augusto Baixo	JRN-234b	Juruena	1461	Yes	Yes	
16	Escondido	JRN-277	Juruena	1248	Yes	No	TI Escondido
17	Apiaká-Kayabi	PEX-093	dos Peixes	206	No	No	
18	Jacaré	JUl-048	Juína	53	No	No	TI Nambikwara
19	Pocilga	JUl-117	Juína	34	No	No	TI Nambikwara
20	Foz do Sacre	PPG-147	Papagaio	117	No	No	TI Tirecatinga
21	Foz do Formiga Baixo	JUl-029b	Juína	107	No	No	TI Nambikwara
22	Salto Utiariti	PPG-159	Papagaio	76	No	No	TI Tirecatinga
23	Castanheira	ARN-120	Arinos	192	Yes	Yes	
24	Paiaguá		do Sangue	35.2	No	No	TI Manoki; TI Ponte de Pedra
25	Nambiquara	JUl-008	Juína	73	No	No	TI Nambikwara
26	São Simão Alto	JRN-117a	Juruena	3509	Yes	Yes	
27	Barra do Claro		Arinos	61.0	No	No	
28	Travessão dos Índios		Juruena	252	No	No	

29	Fontanilhas	JRN-5771	Juruena	225	No	No	
30	Enawenê-Nawê	JRN-7201	Juruena	150	No	No	
31	Foz do Buriti	PPG-1151	Papagaio	68	No	No	
32	Matrinxã	SAC-0141	Sacre	34.5	No	No	
33	Tapires	SAN-0201	do Sangue	75	No	No	
34	Tirecatinga	BUR-0391	Burití	37.5	No	No	
35	Água Quente	BUR-077	Burití	42.5	No	No	
36	Buriti	BUR-0131	Burití	60	No	No	
37	Jesuíta		Juruena	22.3[(d)]	No	No	

(a) Source of data on dams: Brazil, ANEEL (2011); several of the installed capacities listed reflect downward revisions by ANEEL as compared to initial proposals.
(b) Ten-Year Energy Expansion Plan (*Plano Decenal de Expansão de Energia*: PDE) 2013-2022: Brazil, MME (2013, pp. 84-85).
(c) CNEC Worley Parsons Engenharia, S.A. (2014a, Fig. 35-1. Illustration 3.5/1).
(d) Listed as a large dam, but with currently expected installed capacity < 30 MW.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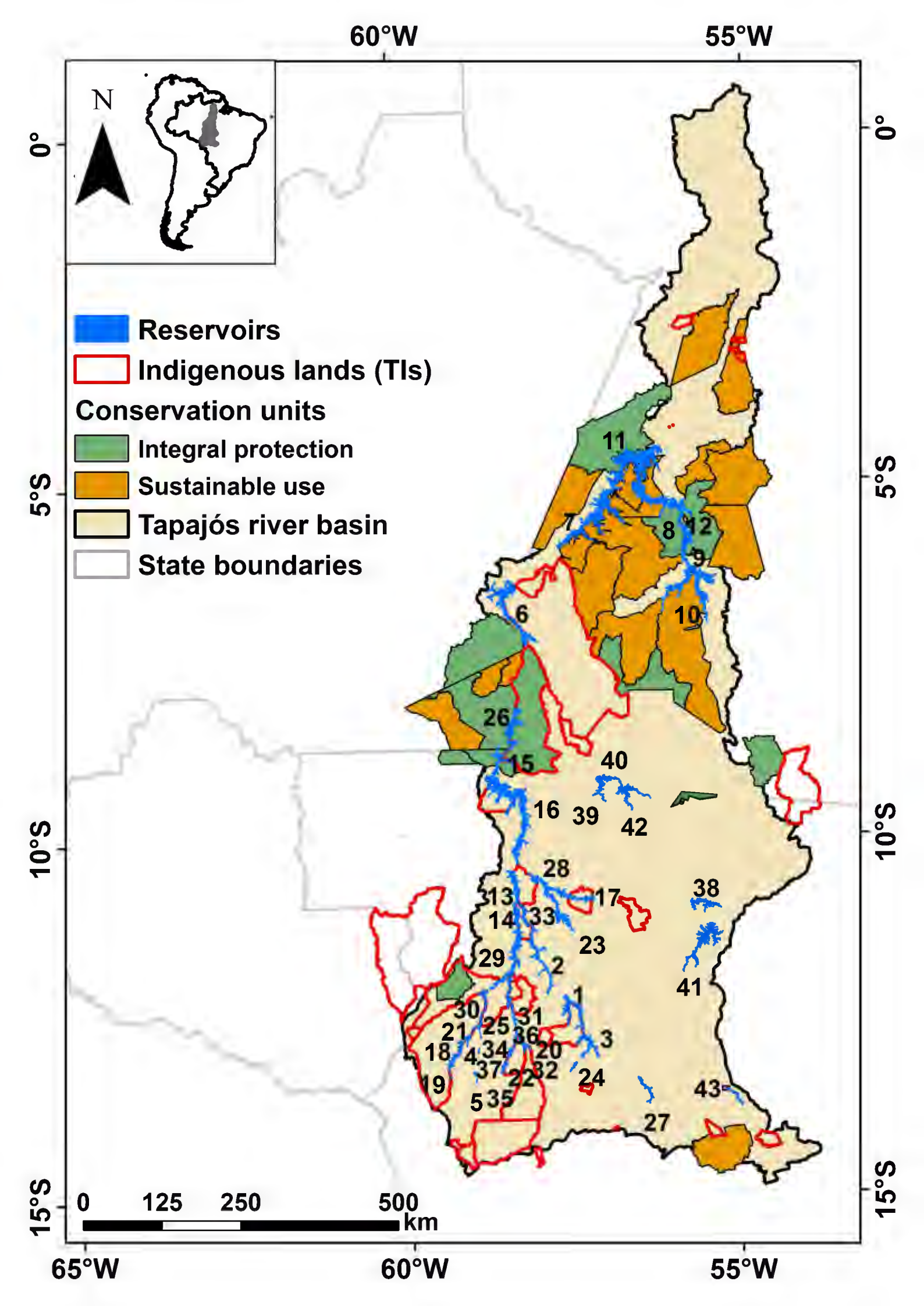
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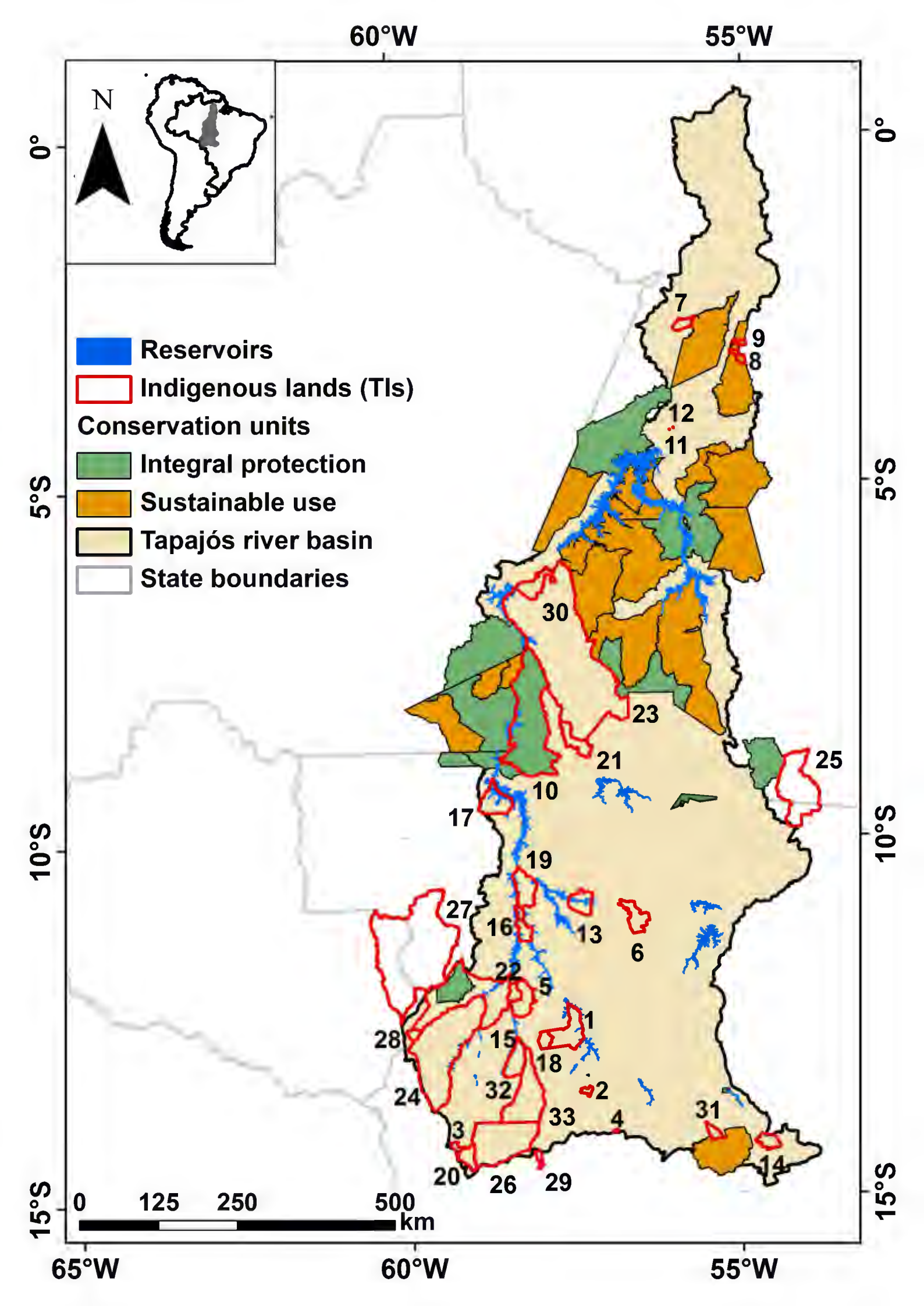
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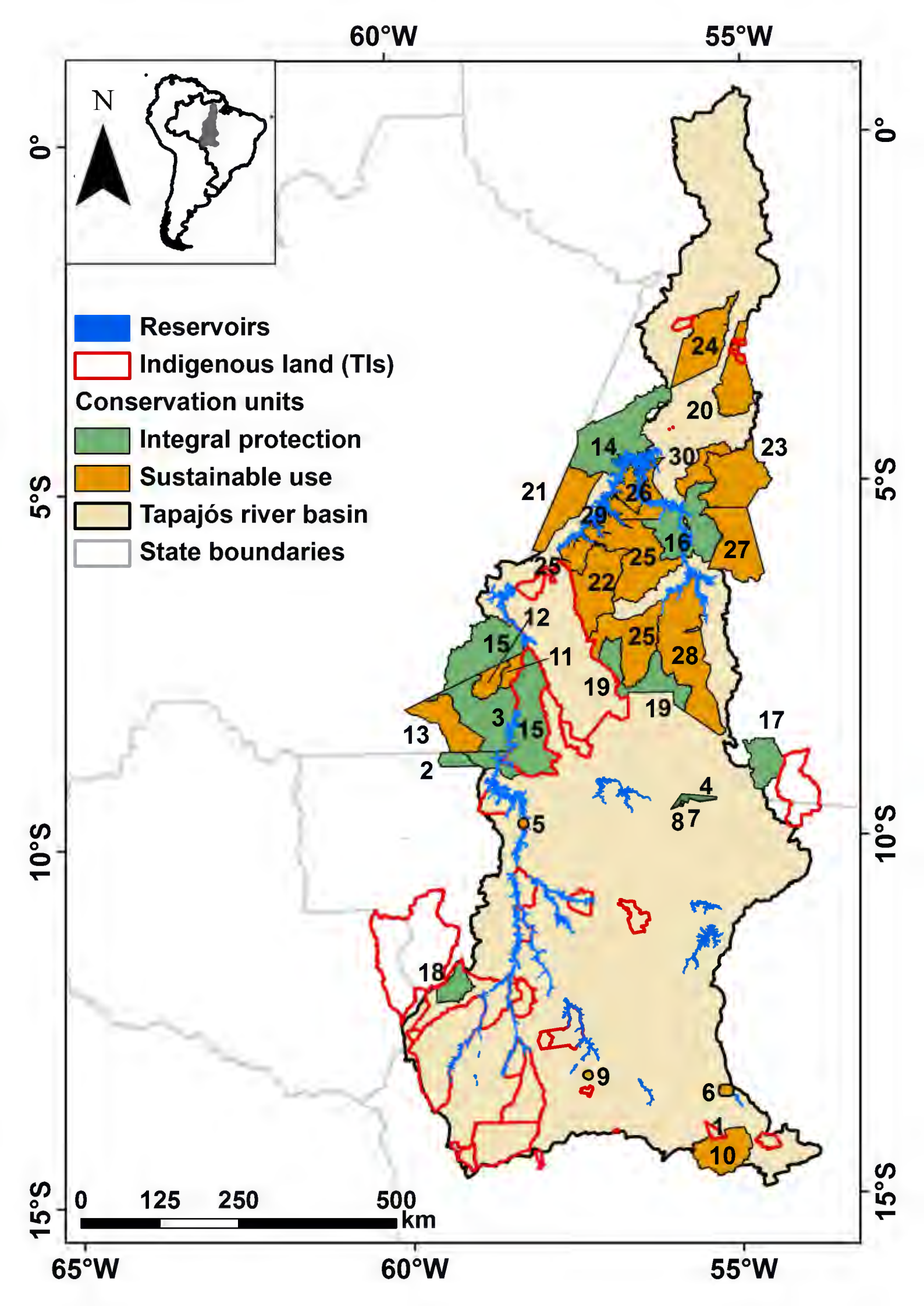
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Reservoirs
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