Revista Brasileira de Ciências Ambientais
Brazilian Journal of Environmental Sciences

Ratification of tenure and the conversion of land use in the most impacted Indigenous territories of the Brazilian Legal Amazonia region, between 1985 and 2022

Regularização fundiária e conversão do uso do solo nos territórios indígenas mais impactados da região da Amazônia Legal, entre 1985 e 2022

Tatiana Raquel Alves Vilaça[1], *Ana Carolina do Couto Andrade*[1], *Fausto Miziara*[1], *Karla Emmanuela Ribeiro Hora*[1]

ABSTRACT

In Brazil, the demarcation of Indigenous lands guarantees the dominion of native peoples over their traditional territories. Recent studies have shown that, in addition to protecting the rights of Indigenous peoples, these lands contribute decisively to the conservation of natural environments by forming a barrier to the advance of deforestation. This conflicts with the expansion of agricultural frontiers, logging, and squatting, which are the principal increasing anthropogenic pressures on these areas. Other, less well-documented factors may also affect deforestation patterns on Indigenous lands. In this context, the present study aimed to assess the influence of the advances in the ratification of the tenure of Indigenous lands on the rates of conversion of land use (from natural vegetation to anthropogenic cover) in the five Indigenous lands in the Brazilian Amazonia that were subject to the highest rates of cumulative deforestation in 2023. The hypothesis tested here is that the publication of official acts related to the land tenure ratification process is associated with an increase in environmental degradation, which may reflect a conscious initiative to revert the measures or retaliate against the demarcation process. The study was based on the analysis of data on land conversion between 1985 and 2022, using the DBEST algorithm to identify changes and trends associated with the periods when the federal Brazilian government published official decrees related to Indigenous lands tenure. The results of the analysis indicated that an association indeed exists between the publication of decrees related to the land tenure process and the conversion rates in the Indigenous lands studied here, supporting the proposed hypothesis. These findings should contribute to the development of more effective public policy for the protection of Indigenous territories.

Keywords: territorial rights; traditional peoples; land use.

RESUMO

No Brasil, a demarcação das terras indígenas visa conferir a esses povos a garantia de seu direito territorial originário. Estudos têm demonstrado que, além de proteger os direitos dos povos indígenas, esses territórios contribuem decisivamente para a conservação dos ambientes naturais, formando uma barreira contra o avanço do desmatamento. Em contrapartida, a expansão agropecuária, a exploração madeireira e a grilagem de terras têm sido apontadas como vetores antrópicos de pressão crescentes nessas áreas. Há, também, outros fatores menos documentados que podem influenciar a dinâmica do desmatamento nas terras indígenas. Nesse contexto, este estudo objetivou analisar a influência do avanço do processo de regularização fundiária das terras indígenas sobre as taxas de conversão de uso de solo (da vegetação natural para uso antrópico) nas cinco terras indígenas mais desmatadas em 2023. A hipótese deste estudo é que a publicação de atos oficiais do processo fundiário está associada ao aumento da degradação ambiental, possivelmente como estratégia para reverter e/ou retaliar o procedimento demarcatório. O estudo baseou-se na análise dos dados de conversão do uso de solo no período de 1985 a 2022, e, com uso do algoritmo DBEST, identificou as mudanças e tendências relacionadas ao período de publicação dos atos do rito sumário de reconhecimento das terras indígenas. Os resultados da análise indicaram a existência de associação entre a publicação dos atos do procedimento fundiário e as taxas de conversão do uso de solo para as terras indígenas estudadas, corroborando a hipótese apresentada. Esses resultados obtidos devem contribuir para o direcionamento de políticas públicas mais efetivas para a proteção dos territórios indígenas.

Palavras-chave: direito territorial; povos originários; uso da terra.

[1]Federal University of Goiás – Goiânia (GO), Brazil.

Corresponding author: Tatiana Raquel Alves Vilaça – Universidade Federal de Goiás – Chácaras Califórnia, CDIM – CEP: 74045-155 – Goiânia (GO), Brazil. E-mail: tatianarav@gmail.com

Conflicts of interest: the authors declare no conflicts of interest.

Funding: Academic Excellence Program of the Coordination for the Improvement of Higher Education Personnel - Post Graduate Program in Environmental Sciences (Proex/Capes/PPG CIAMB), process 88887.847802/2023-00

Received on: 02/06/2024. Accepted on: 06/06/2024.

https://doi.org/10.5327/Z2176-94782000

Introduction

The various Brazilian federal constitutions promulgated since 1934 guarantee Indigenous peoples' rights to dominion over their traditional lands, which are currently administered by themselves and the National Foundation for Indigenous Peoples (*Fundação Nacional dos Povos Indígenas* [FUNAI]), the federal organ responsible for Indigenous affairs. In 2023, the Brazilian federal government created the Ministry for Indigenous Peoples, which further reinforced the actions of the government in this important legislative field.

The concept of an Indigenous Land (*Terra Indígena* [TI]) is defined in Article 231 of the Brazilian federal constitution of 1988 as "lands occupied traditionally by Indigenous peoples and inhabited permanently, being used for productive activities, being essential for the preservation of the natural resources necessary for their wellbeing, and being necessary for their physical and cultural reproduction, according to their uses, customs, and traditions" (Brasil, 1988).

The FUNAI was created by Brazilian federal law no. 5371 of December 5, 1967, to substitute the Indian Protection Service (*Serviço de Proteção ao Índio*), which was founded in 1910. Its mission is to protect and promote the rights of Indigenous peoples (FUNAI, 2024). One of FUNAI's principal responsibilities is the identification, delimitation, demarcation, and protection of TIs.

In contrast with the legal proviso, Seeger and Viveiros de Castro (1979) argued that the concept of territory for Indigenous people would not, necessarily, be associated with a specific, delimited space. Dominique Gallois (2004) clarified that the concepts of land and territory should not be confused, given that the former is related to the political-judicial process installed by the State, whereas the latter refers to the experiences of a specific society in relation to its territorial home, which may be culturally variable.

Senra (2021), in turn, pointed out that European colonization introduced Indigenous peoples to different concepts of territory, including the notion of a fixed territorial home. In general, the establishment of physical territories to be occupied by Indigenous peoples does not reflect the varied concepts of territoriality held by these peoples.

The process through which TIs are recognized and their tenure is regulated is defined by federal decree no. 1775/1996 (Brasil, 1996). This process goes through many different stages of the executive power and tends to be long, slow, and often the subject of extensive contestation. The legislation makes FUNAI responsible for the publication of ordinances on the identification and delimitation of TIs, a process supported by specific anthropological studies. Once published, the process must be submitted to the Ministry of Justice and Public Security (*Ministério da Justiça e Segurança Pública* [MJSP]) for analysis and, if the consistency of the study is confirmed, the declaratory ordinance of the TI is published. This ordinance permits the implementation of the payment of compensation for the infrastructure and other investments by the legal occupants of the land. The process is then submitted to the office of the President of the Republic for the publication of the decree of ratification, which recognizes definitively the traditional occupation of the territory, after which, the TI is registered at a public register (Figure 1). Political pressures are also invariably a feature of this process, which must overcome a long series of legal obstacles, and is often fraught with judicial actions that attempt to paralyze the process or even alter the limits of the territory to be demarcated. One other potential legal mechanism is the publication of ordinances of restriction of use, which limit the access of third parties to the areas inhabited by Indigenous peoples in voluntary isolation, independently of the phase of the demarcation process. Some older demarcation processes, from the 1980s and 1990s, adopted an ordinance of interdiction, during the initial phase of the procedure, which is deployed to protect and preserve the target area.

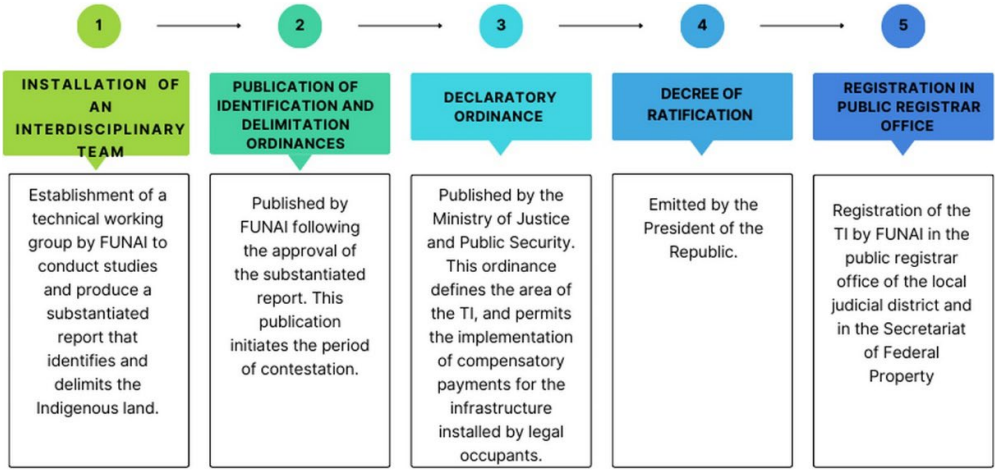

Figure 1 – Flowchart of the demarcation process of Indigenous lands, as regulated by Brazilian federal decree 1775/1996.
FUNAI: Brazilian National Foundation for Indigenous Peoples; TI: *Terra Indígena*.

The recent promulgation of federal law no. 14,701 of October 20, 2023 (Brasil, 2023) raised further difficulties for the demarcation of Indigenous territories by establishing a "Time Mark", which imposes the need for proof that the territory claimed by the Indigenous people was occupied on the date of the promulgation of the current federal constitution (October 5, 1988). This requirement totally ignores the long history of violence and forced migrations imposed, not only by the Brazilian State itself but also by many other sectors of Brazilian society on the country's Indigenous peoples, and represents nothing more than an additional obstacle to the regulation of their land tenure rights.

According to FUNAI (2024), Brazil had a total of 736 TIs in 2022, of which approximately 23% were located in the Amazon region. These lands cover a total area of 115,344,445 ha and are home to around 180 different ethnic groups (ISA, 2024).

In addition to the recognition of the territorial rights of native peoples, which was ratified in Convention 169 of the International Labour Organization and included in the Brazilian constitution of 1988, the demarcation of TIs has been adopted as a strategy for the reduction of deforestation in the Legal Amazonia region (Begotti and Peres, 2020). Qin et al. (2023) emphasized that TIs act as barriers to the advance of deforestation in Brazilian Amazonia, while Schuster et al. (2019) and Gonçalves-Souza et al. (2021) indicated that these territories contribute to the maintenance of sociobiodiversity. TIs also have lower greenhouse gas emissions than outside areas (Walker et al., 2020), and provide important carbon stocks for the combat of climate change. Given this, the regulation of land tenure and the recognition of the TIs also have a positive impact on the environmental agenda, including the deceleration of deforestation rates.

From this perspective, Menezes (2015) also concluded that the implementation of public policies intended to regulate land tenure also tends to favor the environmental agenda, as well as providing rural producers with greater security, given that it reduces the pressure from the land-grabbing market and habitat degradation. However, this author added that the distortion of the objectives of these policies favors deforestation and permits the expropriation of traditional communities.

In his analysis of the vectors that drive deforestation, Reydon (2011, p. 147) concluded that "the principal catalyzer of deforestation is a combination of the value accrued from the conversion of forest into productive land, associated with the profits from logging and the cattle raised on this land". Reydon also noted that the profit from the conversion of forest is higher in the case of vacant land, where the usurpation of public property permits the multiplication of profits. Squatting on Indigenous territory, even when recognized formally, also permits the replication of these practices, given that, like vacant land, these areas can be exploited without paying for the land, which guarantees greater profits.

Despite the perspective of these studies, which highlight the role of TIs in the combat against deforestation, the implementation and progress of the process that regulates land tenure do not appear to be sufficient to deter an increase in land conversion, based on the suppression of natural vegetation. As this legal process is extremely slow and lengthy, prospective TIs tend to be under constant pressure from outsiders, not only for access to their natural resources but also for repeated attempts to revise the limits of the demarcation. Given this scenario, the present study verified whether advances in the process of the land tenure regulation of the five TIs in the Brazilian Legal Amazonia region with the highest cumulative deforestation rates up until 2023 affected the land conversion rates of these areas, considering the historical data from 1985 to 2022. The hypothesis investigated here is that land conversion rates, from natural vegetation to anthropogenic habitats are being employed as a strategy of retaliation for the demarcation process, with the aim of reversing this process, either partially or completely.

Methods

The present study adopted the constitutional concept of TIs for the analysis of the process of their implementation, and the possible relationship between the regulation of TIs tenure and the conversion of land use within Indigenous area. The TIs selected for this study were the five areas with the highest accumulated deforestation rates in 2023, based on data from the Brazilian National Space Research Institute (*Instituto Nacional de Pesquisas Espaciais* [INPE]). Four of these TIs—TI Apyterewa, TI Cachoeira Seca do Iriri, TI Ituna/Itatá, and TI Trincheira Bacajá — are located in the Brazilian state of Pará, while the fifth — TI Maraiwatsede — is in Mato Grosso.

The TIs were analyzed individually, given both their unique features and the varying characteristics of the land tenure regulation processes. This analysis focused on the legal acts that mark the different phases of the legal process, that is, the study, delimitation, declaration, and ratification of the TIs, as well as the restriction of use ordinances, which are typically applied in cases where Indigenous peoples are present in the target area under the condition of voluntary isolation. Any acts that were emitted and subsequently annulled were also considered in this analysis, given that they likely provoked a certain reaction when initially published, and should be verified in the complete analysis presented here. A search and analysis of the documentary evidence were necessary for the verification of the procedural process, through the identification of publication dates of each administrative act related to the process of land tenure regulation of TIs, as established in decree no. 1775 of January 8, 1996, which defines the procedure. The information on the legal acts was obtained from public databases, accessed through the following sites: the Official Journal of the Union, the gazette of the Brazilian government (*Diário Oficial da União* [DOU]; https://www.in.gov.br/inicio), FUNAI (https://www.gov.br/funai/pt-br), and the Socioenvironmental Institute (*Instituto Socioambiental* [ISA]; https://www.socioenvironmental.org/pt-br). While it is an NGO (Non-Governmental Organization), the ISA develops studies using both public and private funds and provides free access to its data, which contributes to the understanding and moni-

toring of land tenure processes, including those of TIs. Complementary data were compiled on the judicial processes related to the demarcation procedures of the TIs selected for analysis here, which were available on the World Wide Web.

The present study was based on a quantitative analysis of the annual land conversion data obtained from the transition database of the MapBiomas Brasil project (Collection 8.0) for TIs between 1985 and 2022. This analysis was based on the changes from the natural vegetation category to the anthropogenic use category, which includes the subcategories agriculture, mining, silviculture, pasture, and urban infrastructure (Projeto MapBiomas, 2023).

The changes in land use were identified automatically, using the DBEST (Detecting Breakpoints and Estimating Segments in Trend) algorithm (Jamali et al., 2015; R Core Team, 2021), which detects breakpoints in time series. This method provides both segments of general trends and estimates of the parameters of abrupt events and long-term processes (Jamali and Tomov, 2017).

Results and Discussion

The present work identified more than 30 legal acts related to the land tenure regulation process of the five TIs that were the focus of this study (Table 1). In most cases, one type of act was issued on multiple occasions for the same TI, which is related to the review or complementation of previous acts.

Table 1 – Indigenous lands that were the focus of the present study and the administrative acts published during the land tenure regulation process of each area.

Indigenous land	Year of publication	Type of government act
Apyterewa	1987	Ordinance of interdiction
	1992, 1996, 2002, 2004, 2005, 2006, 2006, 2006	Declaratory ordinances
	2007	Decree of Ratification
Cachoeira Seca	1985	Ordinance of interdiction
	1992	Ordinance of delimitation
	1993, 1994	Declaratory ordinances
	2007	Ordinance of delimitation
	2008	Declaratory ordinance
	2016	Decree of ratification
Ituna/Itatá	2011, 2013, 2016, 2019, 2022, 2022, 2023	Restriction of use ordinances
Maraiwatsede	1992	Ordinance of delimitation
	1993, 1998	Declaratory ordinances
	1998	Decree of ratification
Trincheira Bacajá	1989	Ordinance instituting the working party (under study)
	1992	Ordinance of delimitation
	1993	Declaratory ordinance
	1996	Decree of ratification

The Indigenous lands analyzed in the present study

All five TIs selected for analysis in the present study have the highest cumulative deforestation rates recorded by INPE (2023). These TIs are TI Apyterewa, TI Cachoeira Seca, TI Ituna/Itatá, and TI Trincheira Bacajá, in the Brazilian state of Pará, and TI Maraiwatsédé, in the state of Mato Grosso (Figure 2). Pará is the Brazilian state with the highest rate of deforestation, followed by Mato Grosso (INPE, 2023). Table 2 shows the cumulative deforestation in each study TI by 2023 (INPE, 2023).

Apyterewa Indigenous land (*Terra Indígena* Apyterewa)

The tenure of the TI Apyterewa is now almost completely regulated, having passed through all the necessary administrative acts, including registration in a public register (Table 1). Even so, the area has been subject to several unsuccessful processes of eviction (the removal of non-Indigenous occupants to guarantee the exclusive rights of use of Indigenous people), the latest of which is ongoing. During the attempted evictions in 2016 and 2017, 503 notifications were issued, and more than 50,000 head of cattle were removed from the TI (FUNAI, 2024). In 2017, however, despite two judgments from the Federal Supreme Court (*Supremo Tribunal Federal* [STF]) that upheld the decision to conclude the eviction, these efforts were neutralized by changes in the implementation of the actions, which coincided with the changes in the federal government that resulted from the impeachment of ex-president Dilma Rousseff. Since this time, land conversion in the TI Apyterewa has tended to increase, peaking between 2019 and 2022, a pattern observed in many other protected areas in Amazonia Legal, as a result of the de-structuring of the government's environmental organs and other actions within the federal government that weakened the effective protection available for these areas (Ferrante and Fearnside, 2019; Vale et al., 2021; Silva-Júnior et al., 2023; Nunes et al., 2024).

The data on land conversion indicate three breakpoints, in 1998, 2003, and 2016, which coincide — in the first two cases — with the timing of the declaratory ordinances issued in 1996 and 2002, and, in 2016, with the eviction process. It is important to note here that a number of administrative acts were also issued between 2002 and 2007, when the TI was ratified, through the decree of April 19, 2007. During this period (2002–2007), land conversion rates fluctuated considerably (Figure 3), reflecting the dynamics of the reactions to the administrative acts issued prior to the ratification of the area.

The TI Apyterewa is inhabited by the Parakanã people and is located in São Félix do Xingu, which is the Brazilian municipality that most produces beef, with a total herd of 2.5 million head of cattle, according to data from the Brazilian Institute of Geography and Statistics (*Instituto Brasileiro de Geografia e Estatística* [IBGE], 2022). In this municipality, deployments of the federal Public Prosecutor's Office (MPF, *Ministério Público Federal*), together with environmental organs, have identified the practice of "hotlining" cattle, which involves fattening the animals in unauthorized areas, almost always on public lands, such as the TI Apyterewa, and then using false papers that confirm that the cattle were raised legally, thus covering up the criminal practice (Global Witness, 2020).

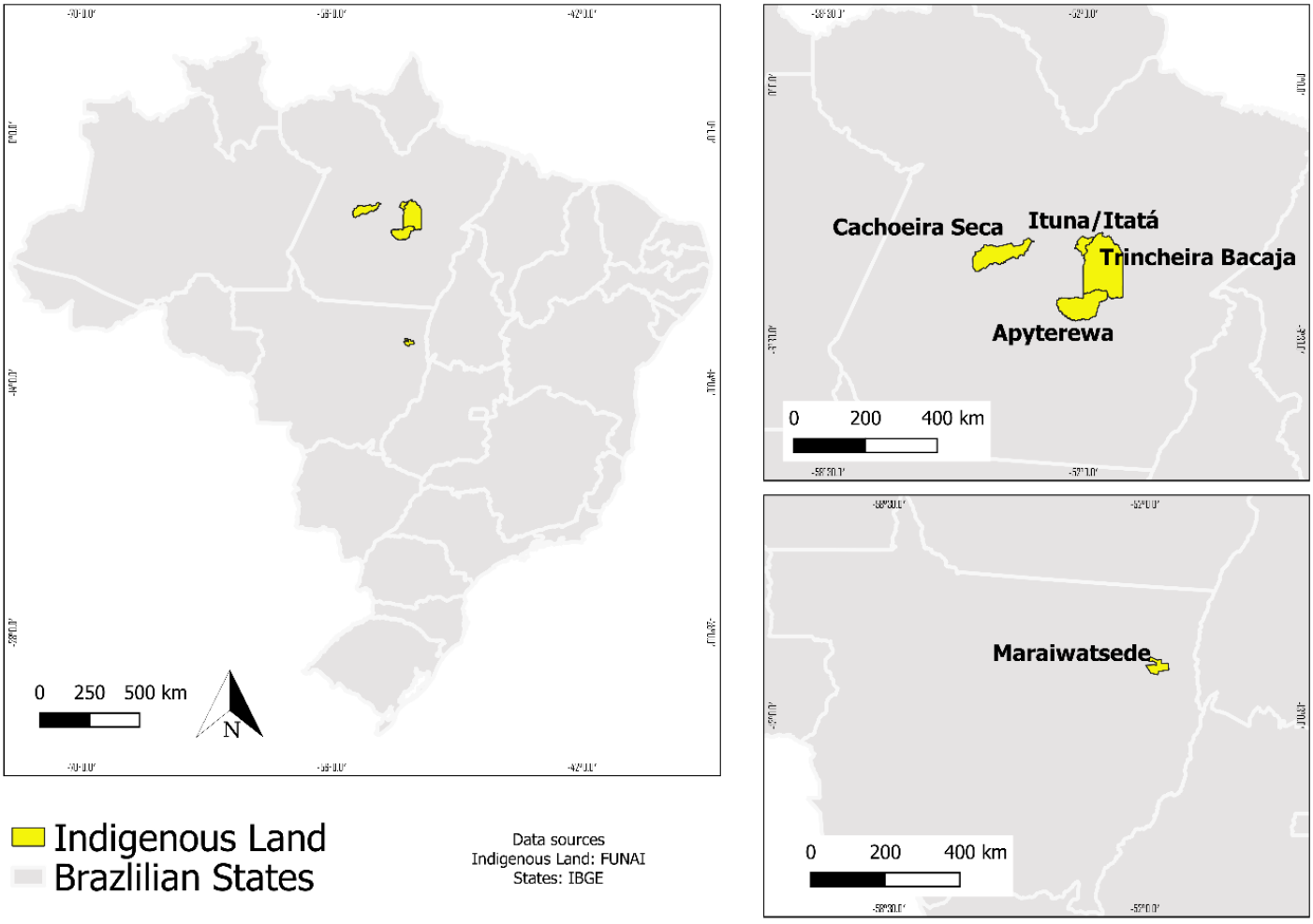

Figure 2 – Location of the Indigenous lands that were the focus of the present study in northern Brazil.

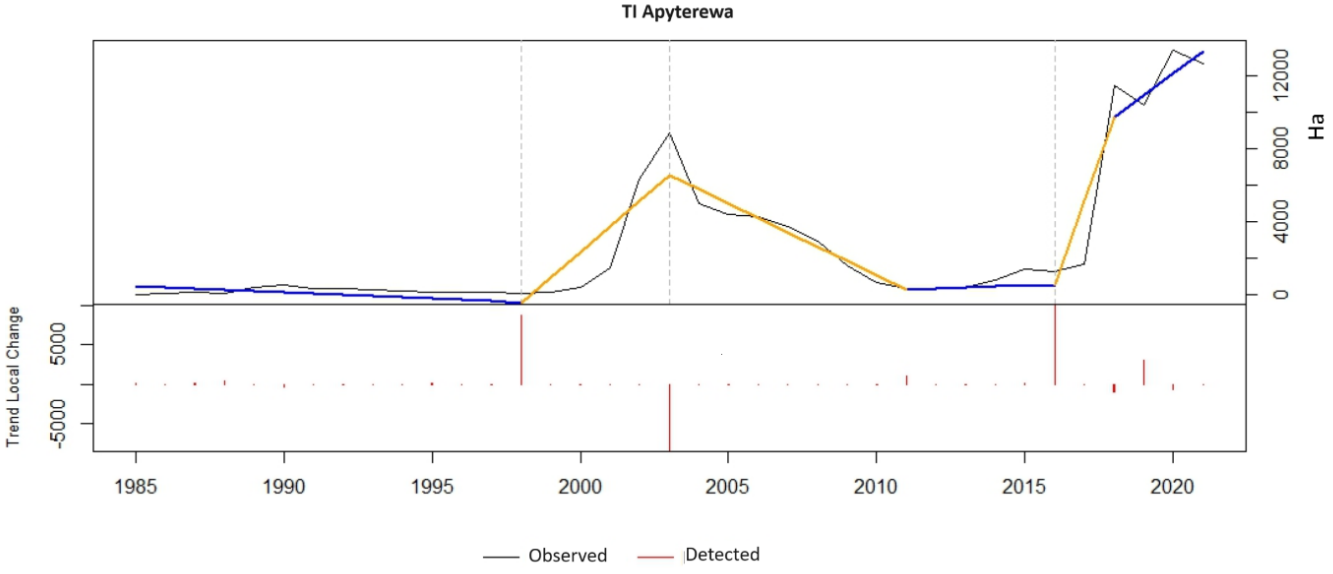

Figure 3 – Timeline of land conversion (hectare) in the *Terra Indígena* Apyterewa, between 1985 and 2022.
Source: Projeto MapBiomas (2023).
TI: *Terra Indígena*.

The difficulties faced by the authorities for the legal consolidation of the TI Apyterewa reflect a movement—in part, political—that has attempted to impede the evictions from the TI, or demonstrate that they are inviable, and thus, achieve the reversal of its TI tenure. In 2021, the STF agreed to an attempt at conciliation (process no. 26.853/STF), for the negotiation of the size of the area destined for occupation by Indigenous people. At the end of this action, however, the court rejected the proposed change due to a "lack of legal or factual conditions for the establishment of a mutually acceptable solution for the litigation on the TI Apyterewa" (Jusbrasil, 2021). If this attempt had been successful, it would have made the TI available for other uses, as well as provided amnesty for the past illegal activities within the area.

Table 2 – Cumulative deforestation in the five Indigenous lands in the Legal Amazonia region, as of November 9, 2023.

Indigenous land	Total area (km²)	Deforestation (km²)	Percentage of the area deforested
TI Apyterewa	7,734.70	476.47	6.2%
TI Cachoeira Seca	7,336.88	425.90	9.9%
IT Ituna/Itatá (restricted use)	1,424.02	240.85	16.9%
IT Maraiwatsede	1,652.41	137.18	8.3%
IT Trincheira Bacajá	16,509.39	134.82	0.81%

Source: INPE (2023).

A new attempt to evict squatters from the TI Apyterewa was initiated in October 2023 but was interrupted the following month, based on a decision from the STF, which subsequently issued a new decision that determined the resumption of the removal of the squatters from the TI (FUNAI, 2024). The conflicting decisions emanating from the STF reflect the tensions of the political scenario created by the eviction process. In this uncertain scenario, the TI Apyterewa has become the TI with the largest cumulative area of deforestation in 2023 (Table 2).

Cachoeira Seca do Iriri Indigenous land (*Terra Indígena* Cachoeira Seca do Iriri)

The TI Cachoeira Seca do Iriri has a total area of 733,688.25 ha and is inhabited by the Arara people. This area was delimited in 1992, following the publication of two declaratory ordinances, in 1993 and 1994. Its delimitation was revised in 2007, however, and a new declaratory ordinance was published in 2008. The TI was ratified only in 2016, through an unnumbered decree issued on April 4, 2016.

In this context, there are clear breakpoints in the timeline of land conversion in the TI Cachoeira Seca do Iriri in 1998, 2016, and 2017. There were also peaks in the land conversion rate in 1995, and between 2004 and 2007, albeit without the establishment of any major breakpoints (Figure 4).

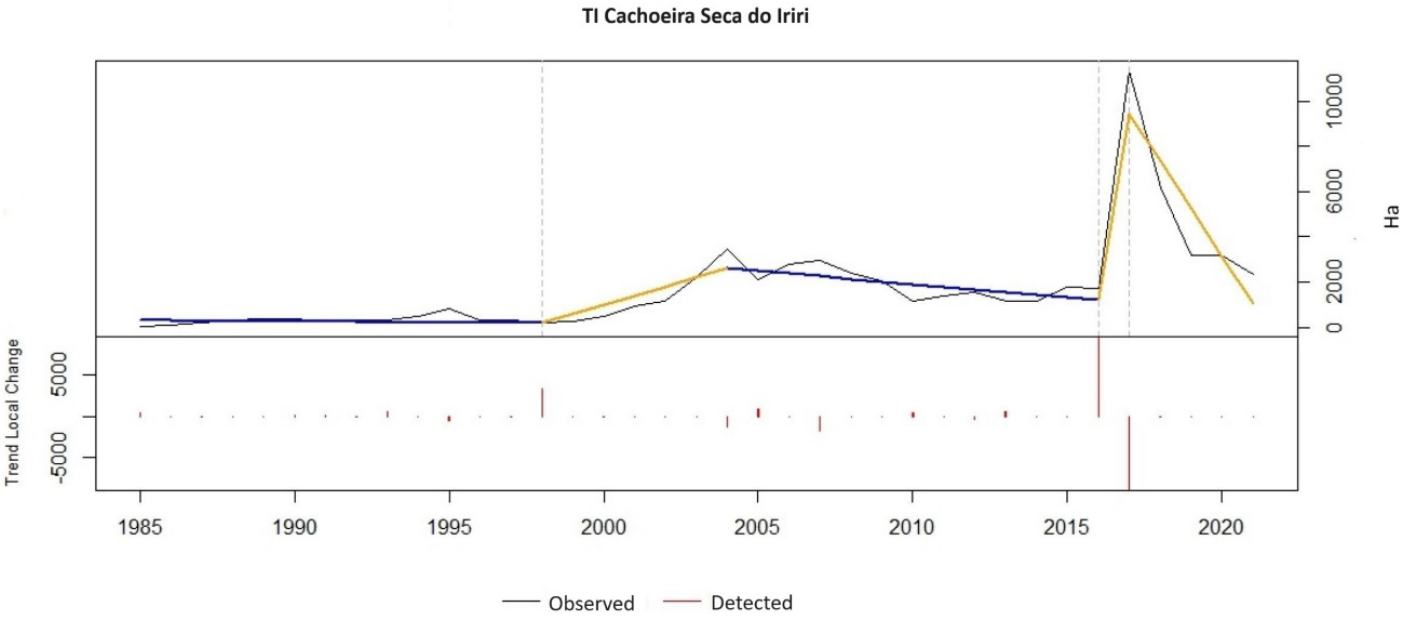

Figure 4 – Timeline of land conversion (hectare) in the *Terra Indígena* Cachoeira Seca do Iriri, between 1985 and 2022.
Source: Projeto MapBiomas (2023).
TI: *Terra Indígena*.

Approximately 76% of the TI Cachoeira Seca do Iriri is located in the municipality of Altamira, with the remaining area situated in the municipalities of Uruará and Placas. Altamira is ranked fourth in the principal beef-producing municipalities of the state of Pará (IBGE, 2022), with more than one million head of cattle, and TI Cachoeira Seca do Iriri is the second most deforested TI in the Amazon (INPE, 2023).

Ituna-Itatá Indigenous land (*Terra Indígena* Ituna-Itatá)

The TI Ituna/Itatá, which covers an area of 142,402.00 ha, is ranked third among the most deforested TIs, according to data from INPE (2023). This territory is currently in the institutional study phase and is under a restriction of use ordinance, which is an administrative act that "prohibits" access to areas occupied by Indigenous peoples in voluntary isolation, intended to restrict the access or transit of third parties (FUNAI, 2024). This type of administrative act does not depend on the installation of an ordinary procedure for demarcation of TIs, and is regulated by decree no. 1775/1996. This scenario is extremely tenuous, given both the presence of Indigenous peoples at the highest level of vulnerability and the fact that the demarcation process, which is extremely slow-moving, is still at a preliminary stage. The first restricted use ordinance was issued for the TI Ituna/Itatá in 2011 (PRES/FUNAI ordinance no. 38, of January 11, 2011), and was renewed in 2013, 2016, and 2019. In 2019, the TI Ituna-Itatá had the largest cumulative deforested area of any Brazilian TI (119.96 km^2; INPE, 2023). The ordinance was renewed most recently in 2022.

The timeline (Figure 5) shows that the interdiction of the Indigenous territory, through the publication and various renovations of ordinances of restricted use coincided with an increase in the land conversion rate. The pressure against the demarcation of TIs employs strategies that alter the characteristics of the environment and consolidate the illegal occupation of the TI, which can delay or even interrupt the demarcation process.

Conceição et al. (2021) discovered that 94% of this TI is included in the Rural Environment Register (*Cadastro Ambiental Rural* [CAR]) as private property, with 33.62% corresponding to plots of more than 1,000 ha. These inscriptions cannot be analyzed or validated by the appropriate environmental organ, given that they indicate the use of deforestation to facilitate squatting, which is a means of hampering or impeding the demarcation of the TI.

The municipality of Senador José Porfírio, in which approximately 63% of the area of this TI is located, is a major producer of beef, with output increasing by almost 60% between 2019 and 2022 (IBGE, 2022). The remainder of this TI is located in the municipality of Altamira.

Maraiwatsede Indigenous land (*Terra Indígena* Maraiwatsede)

The TI Maraiwatsede, which is inhabited by the Xavante people, was delimited in 1992, and had declaratory ordinances published in 1993 and 1998, before being ratified in 1998. However, the non-Indigenous residents of this land were only removed definitively in 2012 and 2013, when the territory was finally handed over to the Xavante (FUNAI, 2024).

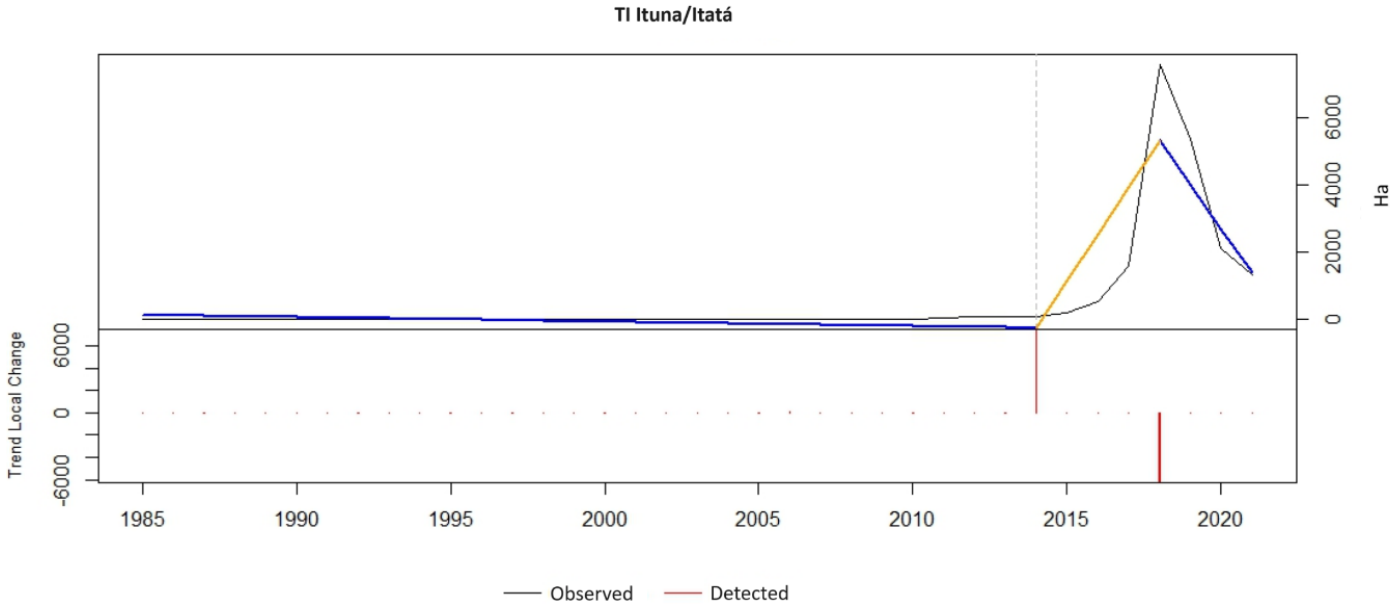

Figure 5 – Timeline of land conversion (hectare) in the *Terra Indígena* Ituna/Itatá, between 1985 and 2022.
Source: Projeto MapBiomas (2023).
TI: *Terra Indígena*.

The data on the conversion of land use analyzed here (Figure 6) revealed that, since the early 1990s, when the area was still being delimited, there was an increase in the rate of land conversion, with a growing trend that continued until 2003 (Figure 6). Between 1992 and 1998, in addition to the ongoing administrative processes, a judicial action was implemented, which aimed to block the ratification of the TI, although, in May 1995, a decision was taken in favor of the Indigenous population. Even so, this process persisted, and only in 1999 the STF judged in favor of the Indigenous tenure of the territory, which was in fact shortly after the promulgation of the decree of November 11, 1998, which ratified the TI (ISA, 2024).

New legal actions were filed, and it was only in 2007 that the courts decided to authorize evictions from the TI Maraiwatsede, with a subsequent trend of a decrease in the land conversion rate. However, new legal actions continued to affect the TI, and the extreme fluctuations in the land conversion rates only stabilized from 2015 onward, when the TI was already under the permanent tenure of the Xavante people (Figure 6).

It is nevertheless interesting to note that, during the eviction period, which ended in January 2013, the number of heat spots identified in the TI Maraiwatsede increased atypically, with this TI advancing from 26th to second place in the TIs with the most heat spots in Brazil in 2012, although in 2014, a year after the eviction, it had fallen into seventh place (INPE, 2023). While fire is employed widely by the Xavante in their land management practices, there was not only an abnormal increase in the number of heat spots in 2013 but forensic analyses conducted by the Brazilian Institute of the Environment and Renewable Natural Resources (*Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis* [IBAMA]) in the area indicated the occurrence of arson (ISA, 2024).

The TI Maraiwatsede is located in the municipalities of São Félix do Araguaia, Bom Jesus do Araguaia, and Alto Boa Vista, in the Brazilian state of Mato Grosso. However, more than 70% of the TI is located in Alto Boa Vista, within a region dominated economically by the production of grain, in particular, soybean (IBGE, 2022).

Trincheira Bacajá Indigenous land (*Terra Indígena* Trincheira Bacajá)

The TI Trincheira Bacajá is inhabited by the Xikrin Mebengôkre and Mebengôkre Kayapó peoples and is ranked fifth among the TIs most deforested in 2023. This territory was demarcated in 1922, declared in 1993, and ratified in 1996.

The timeline of land conversion in this area (Figure 7) shows that the rates were low during the period in which the administrative acts were being processed, even though there was a slight rise between 1993 and 1997. The principal deviation from the historical pattern, nevertheless, occurred in 2017, and may be associated with the increase in land grabbing following the suspension of the eviction operation in the neighboring TI Apyterewa. In 2019, FUNAI decided on the repossession order (electronic judicial process [PJE] no. 1000108-11.2019.4.01.3903) of the area in favor of the Xikrin people, which was executed by the Federal Police, and coincided with a reduction in the land conversion rate in the TI Trincheira Bacajá.

The TI Trincheira Bacajá is located in some of the municipalities mentioned above, i.e., Altamira, São Félix do Xingu, Anapu, and Senador José Porfírio, in which cattle ranching is still expanding (IBGE, 2022).

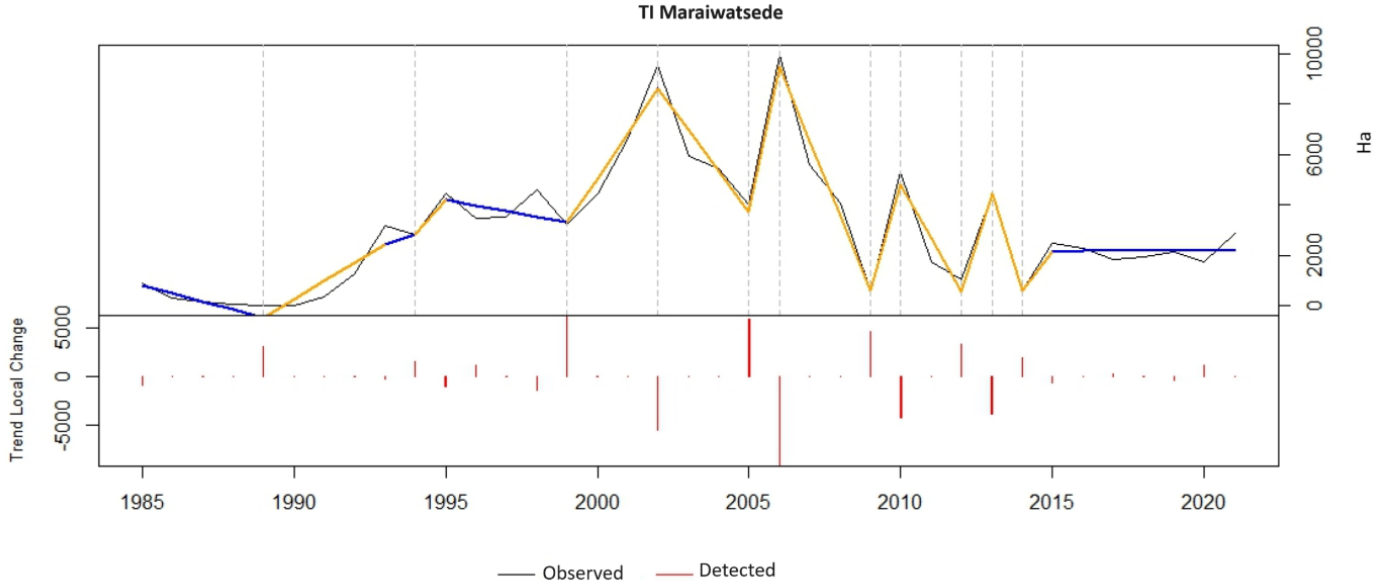

Figure 6 – Timeline of land conversion (hectare) in the *Terra Indígena* Maraiwatsede, between 1985 and 2022.
Source: Projeto MapBiomas (2023).
TI: *Terra Indígena*.

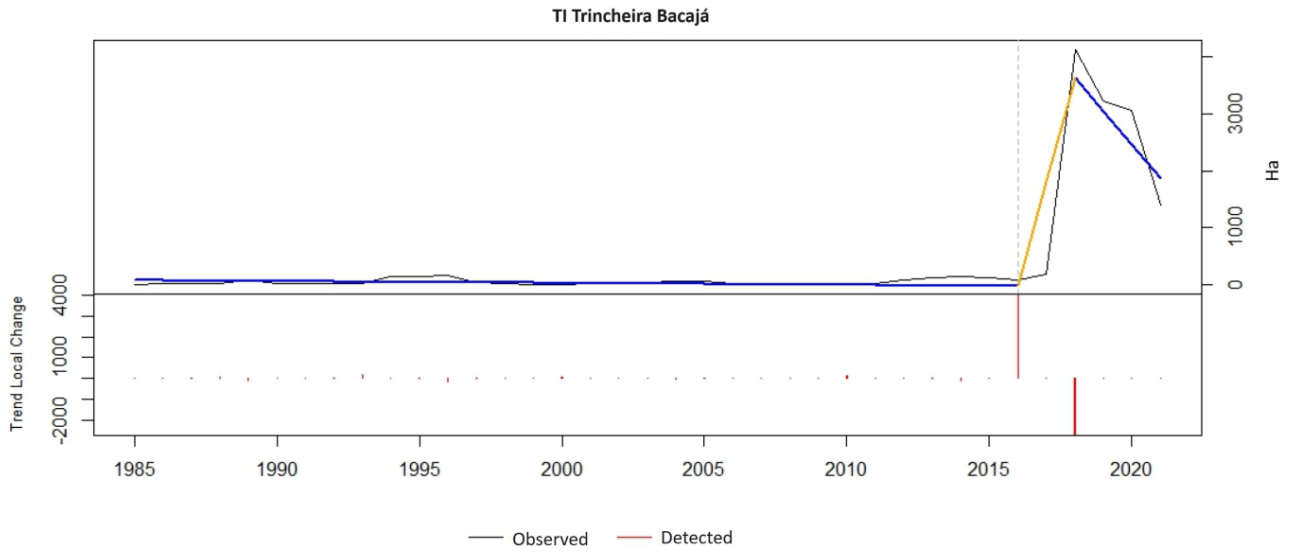

Figure 7 – Timeline of land conversion (hectare) in the *Terra Indígena* Trincheira Bacajá, between 1985 and 2022.
Source: Projeto MapBiomas (2023).
TI: *Terra Indígena*.

Overall, the results of the present study are consistent with the findings of Reydon (2011) and Stabile et al. (2020), who observed that the dynamics of land conversion on TIs, from natural vegetation to anthropogenic uses, are influenced by land tenure processes. Squatting on public land has the potential to generate high profits, not only from the exploitation of its natural resources but also through attempts to legalize land tenure, which drives real estate speculation.

Conclusions

The results of the present study indicate that land conversion is associated with the stages of administrative procedures that regulate the land tenure of TIs and legal judgments relative to this process. Even though not all administrative and legal acts resulted in peaks in land conversion rates, the periods with the highest rates are, in fact, associated with regulatory acts related to the tenure of TIs.

The alterations of the characteristics of the environment and squatting on Indigenous territories in an attempt to consolidate the illegal occupation of public land are strategies that aim to slow down, alter, impede, or even revert the implementation of TIs rights. Attempts to weaken the tenure of TIs favor the creation of a scenario that may permit the annulation of current and valid administrative acts, which may further intensify, rather than resolve, existing land tenure conflicts.

It is important to understand that, while the consolidation of the tenure of TIs is essential for their effective protection, the process is slow-moving and needs to overcome a number of different instances in the executive power, as established by decree no. 1775/1996. This reinforces the need to adopt measures that can guarantee the integrity of the territory until its tenure has been conceded definitively to the Indigenous people.

While protected areas are efficient inhibitors of deforestation, the impacts on their integrity can negatively influence deforestation rates. Baragwanath and Bayi (2020) confirmed the positive influence of the regulation of land tenure on the reduction of deforestation rates on TIs between 1982 and 2016, above all when considering not only the normative act itself but also the relationship between deforestation and the definitive tenure of the land by Indigenous peoples.

If the challenge of reducing deforestation and other environmental crimes in Legal Amazonia is associated with the challenge of regulating and consolidating public lands, above all, the Indigenous territories, the need to deter retaliatory strategies that oppose the consolidation of TIs rights must be systematically considered during the implementation of public policies, including the immediate obstruction of attempts at illegal occupation. Despite the comprehensive nature of the data presented here, further analyses should be undertaken to verify whether the scenario observed in the five most deforested TIs in Legal Amazonia in 2023 reflects more general trends or refers only to specific cases.

Authors' contributions

Vilaça, T.R.A.: conceptualization, data curation, writing – original draft, formal analysis. Andrade, A.C.C.: methodology. Miziara, F.: conceptualization, writing – review & editing. Hora, K.E.R.: conceptualization, writing – review & editing.

References

Baragwanath, K.; Bayi, E., 2020. Collective property rights reduce deforestation in the Brazilian Amazon. Proceedings of the National Academy of Sciences, v. 117 (34), 20495-20502. https://doi.org/10.1073/pnas.1917874117

Begotti, R.A.; Peres, C.A., 2020. Rapidly escalating threats to the biodiversity and ethnocultural capital of Brazilian Indigenous Lands. Land Use Policy, v. 96, 104694. https://doi.org/10.1016/j.landusepol.2020.104694

Brasil, 1988. Constituição Federal, de 05 de outubro de 1988. Diário Oficial da União, Brasília.

Brasil, 1996. Decreto nº 1.775, de 08 de janeiro de 1996. Diário Oficial da União, Brasília.

Brasil, 2023. Lei nº 14.701, de 20 de outubro de 2023. Diário Oficial da União, Brasília.

Conceição, K.V.; Chaves, M.E.D.; Picoli, M.C.A.; Sánchez, A.H.; Soares, A.R.; Mataveli, G.A.V.; Silva, D.E.; Costa, J.S.; Camara, G., 2021. Government policies endanger the indigenous peoples of the Brazilian Amazon. Land Use Policy, v. 108, 105663. https://doi.org/10.1016/j.landusepol.2021.105663

Ferrante, L.; Fearnside, P., 2019. Brazil's new president and 'ruralists' threaten Amazonia's environment, traditional peoples and the global climate. Environmenal Conservation, v. 46, 261-263. https://doi.org/10.1017/S0376892919000213

Fundação Nacional dos Povos Indígenas (FUNAI), 2024. Terras Indígenas (Accessed April 27, 2024) at:. https://www.gov.br/funai/pt-br/atuacao/terras-indigenas.

Gallois, D.T., 2004. Terras ocupadas? Territórios? Territorialidades? In: Ricardo, F. (Ed.), Terras Indígenas & Unidades de Conservação da Natureza. Instituto Socioambiental, São Paulo, pp. 37-41.

Global Witness, 2020. Carne Bovina, Bancos e Amazônia Brasileira (Accessed December 12, 2023) at:. https://www.globalwitness.org/pt/beef-banks-and-brazilian-amazon-pt/.

Gonçalves-Souza, D.; Vilela, B.; Phalan, B.; Dobrovolski, R., 2021. The role of protected areas in maintaining natural vegetation in Brazil. Science Advances, v. 7 (38), eabh2932. https://doi/10.1126/sciadv.abh293

Instituto Brasileiro de Geografia e Estatística (IBGE), 2022. Produção da Pecuária Municipal (Accessed December 18, 2023) at:. https://biblioteca.ibge.gov.br/visualizacao/periodicos/84/ppm_2022_v50_br_informativo.pdf

Instituto Nacional de Pesquisas Espaciais (INPE), 2023. Terrabrasilis - Plataforma de dados geográficos (Accessed December 18, 2023) at:. https://terrabrasilis.dpi.inpe.br/en/home-page/

Instituto Socioambiental (ISA), 2024. Terras Indígenas no Brasil (Accessed April 27, 2024) at:. https://terrasindigenas.org.br/

Jamali, S.; Jönsson, P.; Eklundh, L.; Ardö, J.; Seaquist, J., 2015. Detecting changes in vegetation trends using time series segmentation. Remote Sensing of Environment, v. 156,182-195. https://doi.org/10.1016/j.rse.2014.09.010

Jamali, S.; Tomov, H., 2017. DBEST: Detecting Breakpoints and Estimating Segments in Trend. R package version 1.8 (Accessed February 01, 2024) at:. https://CRAN.R-project.org/package=DBEST.

Jusbrasil, 2021. Supremo Tribunal Federal. Mandado de Segurança MS 26853 DF (Accessed April 27, 2024) at:. https://www.jusbrasil.com.br/jurisprudencia/stf/1345846216/inteiro-teor-1345846221.

Menezes, T.C.C., 2015. A regularização fundiária e as novas formas de expropriação rural na Amazônia. Estudos Sociedade e Agricultura, v. 23 (1), 110-130.

Nunes, F.S.; Soares-Filho, B.S.; Oliveira, A.R.; Veloso, L.V.; Schmitt, J.; Van der Hoff, R.; Assis, D.C.; Costa, R.P.; Börner, J.; Ribeiro, S.M.; Rajão, R.G., 2024. Lessons from the historical dynamics of environmental law enforcement in the Brazilian Amazon. Scientific Reports, v. 14 (1), 1828. https://doi.org/10.1038/s41598-024-52180-7

Projeto MapBiomas, 2023. Projeto de Mapeamento Anual do Uso e Cobertura da Terra no Brasil (Accessed July 10, 2023) at:. https://brasil.mapbiomas.org/estatisticas/.

Qin, Y.; Xiao, X.; Liu, F.; Silva, F.S.; Shimabukuro, Y.; Arai, E.; Fearnside, P.M., 2023. Forest conservation in Indigenous territories and protected areas in the Brazilian Amazon. Nature Sustainability, v. 6, 295-305. https://doi.org/10.1038/s41893-022-01018-z

R Core Team, 2021. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria (Accessed February 01, 2024) at:. https://www.R-project.org/.

Reydon, B.P. 2011. O desmatamento da floresta amazônica: causas e soluções. Política Ambiental, v. 1 (8), 143-155. ISSN 1809-8185

Schuster, R.; Germain, R.R.; Bennett, J.R.; Reo, N.J.; Arcese, P., 2019. Vertebrate biodiversity on indigenous-managed lands in Australia, Brazil, and Canada equals that in protected areas. Environmental Science & Policy, v. 101, 1-6. https://doi.org/10.1016/j.envsci.2019.07.002

Seeger, A.; Castro, E.V., 1979. Terras e territórios indígenas no Brasil. Revista Encontros com a Civilização Brasileira, (12), 79-151.

Senra, E.B., 2021. Da Terra-floresta à Terra Indígena: a construção de um território político Yanomami. Confins, (53). https://doi.org/10.4000/confins.43174

Silva-Júnior, C.H.L.; Silva, F.B.; Arisi, B.M.; Mataveli, G.; Pessôa, A.C.M.; Carvalho, N.S.; Reis, J.B.C.; Silva Júnior, A.R.; Motta, N.A.C.S.; Silva, P.V.M.; Ribeiro. F.D.; Siqueira-Gay, J.; Alencar, A.; Saatchi, S.; Aragão, L.E.O.C.; Anderson, L.O.; Melo, M., 2023. Brazilian Amazon indigenous territories under deforestation pressure. Scientific Reports, v. 13, 5851. https://doi.org/10.1038/s41598-023-32746-7

Stabile, M.C.C.; Guimarães, A.L; Silva, D.S.; Ribeiro, V.; Macedo, M.N.; Coe, M.T.; Pinto, E.; Paulo Moutinho, P.; Alencara, A., 2020. Solving Brazil's land use puzzle: Increasing production and slowing Amazon deforestation. Land Use Policy, v. 91, 104362. https://doi.org/10.1016/j.landusepol.2019.104362

Vale, M.M.; Berenguer, E.; Argollo de Menezes, M.; Viveiros de Castro, E.B.; Pugliese de Siqueira, L.; Portela, R.C.Q., 2021. The COVID-19 pandemic as an opportunity to weaken environmental protection in Brazil. Biological Conservation, v. 255, 108994. https://doi.org/10.1016/j.biocon.2021.108994

Walker, W.S.; Gorelik, S.R.; Baccini, A.; Aragon-Osejo, J.L.; Josse, C.; Meyer, C.; Macedo, M.N.; Augusto, C.; Rios, S.; Katan, T.; Souza, A.A.; Cuellar, S.; Llanos, A.; Zager, I.; Mirabal, G.D.; Solvik, K.K.; Farina, M.K.; Moutinho, P.; Schwartzman, S., 2020. The role of forest conversion, degradation, and disturbance in the carbon dynamics of Amazon indigenous territories and protected areas. Proceedings of the National Academy of Sciences of the United States of America, v. 117 (6), 3015-3025. https://doi.org/10.1073/pnas.1913321117