The threat of transnational organized crime to the protection and sustainable future of the Brazilian Amazon

A ameaça do crime organizado transnacional à proteção e ao futuro sustentável da Amazônia brasileira

La amenaza del crimen organizado transnacional a la protección y al futuro sostenible de la Amazonía Brasileña

La menace du crime organisé transnational sur la protection et l'avenir durable de l'Amazonie Brésilienne

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Abstract
This article analyzes the impacts of transnational organized crime (TOC) on the protection and sustainable future of the Brazilian Amazon. It argues that the presence of criminal organizations in the region has intensified illegal deforestation, facilitated by logistical networks, institutional corruption, and violence against communities and environmental agents. By integrating geospatial data from PRODES/INPE with records of criminal organizations' activities, the study conducts a quantitative and qualitative analysis of municipalities within the Legal Amazon. The findings reveal a significant territorial correlation between the presence of criminal organizations and accumulated deforestation levels. It concludes that TOC poses a direct threat to national sovereignty and the environmental integrity of the region, demanding integrated responses through security, defense, and sustainable development policies.

Keywords: Brazilian Amazon; transnational organized crime; deforestation.

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Resumo
Este artigo analisa os impactos do crime organizado transnacional (COT) sobre a proteção e o futuro sustentável da Amazônia brasileira. Argumenta-se que a presença de facções criminosas na região tem ampliado o desmatamento ilegal, facilitado por redes logísticas, corrupção institucional e violência contra comunidades e agentes de fiscalização. A partir da integração de dados geoespaciais do PRODES/INPE e registros da atuação de organizações criminosas, realiza-se uma análise quantitativa e qualitativa dos municípios da Amazônia Legal. Os resultados indicam uma correlação territorial relevante entre a presença de facções e os níveis de desmatamento acumulado. Conclui-se que o COT representa uma ameaça direta à soberania nacional e à integridade ambiental da região, exigindo respostas articuladas entre políticas de segurança, defesa e desenvolvimento sustentável.

Palavras-chave: Amazônia brasileira; crime organizado transnacional; desmatamento.

Resumen
Este artículo analiza los impactos del crimen organizado transnacional (COT) sobre la protección y el futuro sostenible de la Amazonía brasileña. Se sostiene que la presencia de facciones criminales en la región ha intensificado la deforestación ilegal, facilitada por redes logísticas, corrupción institucional y violencia contra comunidades locales y agentes de fiscalización. A partir de la integración de datos geoespaciales del PRODES/INPE y de registros sobre la actuación de organizaciones criminales, se realiza un análisis cuantitativo y cualitativo de los municipios de la Amazonía Legal. Los resultados muestran una correlación territorial significativa entre la presencia de facciones y los niveles de deforestación acumulada. Se concluye que el COT representa una amenaza directa a la soberanía nacional y a la integridad ambiental de la región, lo que exige respuestas articuladas entre las políticas de seguridad, defensa y desarrollo sostenible.

Palabras clave: Amazonía brasileña; crimen organizado transnacional; deforestación.

Résumé
Cet article analyse les impacts du crime organisé transnational (COT) sur la protection et l'avenir durable de l'Amazonie brésilienne. Il soutient que la présence de factions criminelles dans la région a intensifié la déforestation illégale, facilitée par des réseaux logistiques, la corruption institutionnelle et la violence dirigée contre les communautés locales et les agents de contrôle. En intégrant des données géospatiales du PRODES/INPE et des registres relatifs aux activités des organisations criminelles, l'étude réalise une analyse quantitative et qualitative des municipalités de l'Amazonie légale. Les résultats révèlent une corrélation territoriale significative entre la présence de factions et les niveaux de déforestation accumulée. L'article conclut que le COT constitue une menace directe à la souveraineté nationale et à l'intégrité environnementale de la région, exigeant des réponses coordonnées entre les politiques de sécurité, de défense et de développement durable.

Mots-clés : Amazonie brésilienne ; crime organisé transnational ; déforestation.

1 INTRODUCTION

Organized crime has increased its presence in the Amazon over time, particularly in the second decade of the 21st century (Couto, 2023, p.47). In 2023, 22 criminal groups were present in 178 municipalities (Fórum Brasileiro de Segurança Pública, 2024, p.71). In 2024, despite having decreased to 19, these criminal organizations were established in 260 municipalities (Brazilian Forum on Public Safety, 2024, p.71), out of the 773 existing in the Legal Amazon (Brazilian Institute of Geography and Statistics, IBGE, 2025), denoting activity in about 34% of the Amazon region's territory.

Organized crime is not limited to the Brazilian Amazon. On the contrary, its activities extend throughout the Pan-Amazon region (Lima, 2023), reaching countries such as Bolivia, Colombia, Ecuador, Guyana, French Guiana, Peru, Suriname, and Venezuela. In Peru, for example, studies show that organized crime has caused about 20% of the forest's deforestation due to the cultivation of coca leaves. According to the United Nations Office on Drugs and Crime (UNODC), drugs produced in Peru, as well as those from Colombia and Bolivia, enter Brazilian territory to reach domestic users and to be exported to Europe or Africa (UNODC, 2023, pp. 70 and 81). In addition, other illegal activities carried out by transnational organized crime (TOC), such as mining and illegal exploitation of forest resources (UNODC-DEVIDA, 2024), have threatened the forest and biodiversity of the region.

The Global Initiative Against Transnational Organized Crime (2023, p.5) contends that shipments of cocaine, precious minerals, and timber – moving along Amazonian rivers and clandestine airstrips – fuel the growing global demand and contributes directly to deforestation. The organization also highlights that transnational organized crime poses an existential threat to the most biodiverse region on the planet.

The Brazilian Forum on Public Security (2023, p.11) emphasizes that it is impossible to design policies and strategies to preserve the Amazon rainforest without addressing the threats that crime represents to the Amazon region. Given the seriousness of the issue, the leaders of the States Parties to the Amazon Cooperation Treaty (ACT), participating in the 2023 Amazon Summit, agreed to convene a Meeting of Ministers of Public Security to assess criminal dynamics and transnational organized crime in the Amazon, as well as to promote the information-sharing and strengthen police cooperation against illicit activities and environmental crimes in the area (Brasil, 2023).

Given this complex scenario, the guiding question for this article was: how does transnational organized crime impact illegal deforestation rates, with potential negative consequences for the protection and sustainable future of the Brazilian Amazon? The core objective is to identify the impacts that the threat of transnational organized crime poses to the Amazon in terms of illegal deforestation. The relevance of this investigation lies in the centrality of the Amazon to global climate dynamics – dependent on the maintenance of forest cover – and in the multifaceted threats that TOC represents to national security and environmental integrity.

The article is organized as follows: the introduction contextualizes the problem of transnational organized crime in the Amazon and sets out the research objective. The second section presents a qualitative analysis of the phenomenon, examining organized crime and its relationship with illegal deforestation. The third section addresses the quantitative analysis, based on the available statistical data, assessing the connection between TOC and illegal deforestation. The fourth section discusses the findings of the two previous sections. Finally, the conclusion highlights the implications for public policy formulation and suggests avenues for future research.

2 METHODOLOGY AND MATERIALS

For this article, an applied quali-quantitative research methodology was adopted, structured along two complementary methodological axes.

The first axis consisted of qualitative, bibliographic research aimed at identifying the connections between criminal organizations and illegal deforestation, as well as other illicit economic activities that contribute to it – such as money laundering, unlawful acquisition of land for agricultural purposes, and illegal mining. This bibliographic review drew on scientific articles available on digital platforms such as Google Scholar and EBSCOhost. Sources were selected based on thematic alignment, relevance to the research question, and their quality and currency.

The second axis comprised: (1) a comparative statistical analysis of deforestation between 2000 and 2023 involving municipalities in the Legal Amazon[1] – with and without

[1]Legal Amazon in data

the presence of criminal organizations – which included the production of graphical outputs; (2) application of the Welch's t-test[2] to determine whether the differences between the samples are statistically significant; (3) a multivariate logistic regression with "deforestation" as the dependent variable – with the purpose of assessing the probability of influence exerted by criminal organizations on deforestation—and the following independent variables[3]: a) extent of deforested areas; b) presence of TOC organizations; c) size of arable land in the Legal Amazon; d) number of cattle per municipality; e) municipal area; f) presence of conservation units within municipalities; g) presence of Indigenous lands within municipalities; h) length of highways within the states (given their probable impact on illegal logistics flows); i) Federal Police operations in the area; and j) deforestation rates; (4) the Mann–Whitney U test, a non-parametric statistical test used to verify whether the difference between municipalities with and without criminal organizations is significant; and (5) finally, using PRODES/INPE deforestation rate data and applying ARIMA (autoregressive integrated moving average) time-series modeling to forecast possible future values, the study sought to outline the prospective deforestation scenario.

The databases used were: (1) PRODES Deforestation, from INPE (2000–2023); (2) TerraBrasilis – PRODES (Deforestation), 2000–2023; (3) Legal Amazon, from IBGE (2025); (4) Brazilian Forum on Public Security (2024), for identifying the presence of criminal organizations in the municipalities and police operations carried out in the Amazon against crimes associated with deforestation; (5) the IBGE Automatic Recovery System (2025) for agricultural and livestock data; (6) IBGE (2025) for data on the municipal road network, which facilitates the illegal transport logistics of timber; (7) FUNAI (2025) for identifying Indigenous lands within municipalities; and (8) the Ministry of the Environment (2025) for identifying conservation units present in the municipalities.

[2] Welch's t-test is a variation of the Student's t-test used to compare the means of two independent groups when their variances and/or sample sizes differ. It is the standard test when the assumption of equal variances is not plausible. Since the p-value was lower than 0.05, the hypothesis that deforestation in areas where TOC occurs by chance is rejected.

[3] The independent variables used in the multivariate logistic regression were defined based on their relevance and their hypothesized correlation with deforestation in areas with or without the presence of TOC, namely: (1) the extent of deforested areas, the presence of factions, the size of arable land, the number of cattle per municipality, the municipality's area, the presence of conservation units, the presence of Indigenous lands, the length of highways, and the number of Federal Police operations in the municipality. It is worth noting that the selected variables yielded a statistically predictive model.

3 RESULTS

3.1. QUALITATIVE ANALYSIS

The purpose of this section is to conduct a qualitative analysis of the relationship between criminal organizations and deforestation in the Legal Amazon.

According to Margulis (2003, p. 11), in the 1970s and 1980s, deforestation in the Amazon was primarily driven by the economic occupation of the territory, induced by government incentives and policies. In the 1990s, the increase in deforestation was caused by private-sector activities, particularly cattle ranching. At the time, Margulis warned that the financial viability of medium- and large-scale cattle ranchers functioned as the engine of deforestation (p. 14), while agricultural activity did not compete with ranching because it faced geo-ecological constraints, such as the region's high rainfall (p. 15). In that study, cattle-raising activities accounted for roughly 75% of deforested areas in the Amazon (p. 15). It is worth noting that until 1970, agricultural censuses indicated that only about 3% of Amazonian land had been cleared up for agricultural purposes, but by 2003 this share had surpassed 10% (p. 28). By 2020, 2% of all properties in the Amazon and Cerrado were responsible for 62% of all potentially illegal deforestation, and 17% of beef exports from both biomes to the European Union could be linked to illegal deforestation (Rajão *et al*., 2020).

With the expansion of TOC activity in the Amazon beginning in the 2010s, the dynamics of illegal deforestation shifted from being driven solely by economic pressures – combined with weak state oversight – to incorporating the influence of criminal organizations. According to the Igarapé Institute (2024, p. 3), a significant share of deforestation in the Amazon region results from illegal activities sustained by national and transnational criminal networks. The Institute highlights that deforestation is propelled by a set of illicit economic practices, such as land grabbing and cattle ranching with illegal practices in the supply chain, illegal logging, and illegal mining[4] (p. 4). Carneiro and Rosas (2025, p. 6) note that failures in land registration systems in the Amazon facilitate land grabbing, and shortcomings or gaps in environmental legislation encourage illegal timber exports and illegal gold mining, creating numerous opportunities for criminal organizations.

[4] According to the Global Initiative (2023, p. XXX), illegal gold extraction in the Amazon increased by 94% between 2016 and 2021, making it one of the main drivers of deforestation in the region.

According to Brombacher and Santos (2023, p. 15), the direct impact of drug cultivation on deforestation is limited, but there is evidence that the "drug economy"[5] drives the expansion of the agricultural frontier, as well as cattle ranching and mining activities that have the potential to increase deforestation in the Amazon. UNODC refers to this connection and overlap of illegal activities that affect the environment as "criminal convergence," which encompasses corruption, money laundering, fraud, extortion, violence, and other illicit activities (UNODC, 2023, p. 91). This concept is consistent with what Carneiro and Rosas (2025, p. 7) describe as a form of articulation of multiple illicit activities developed through networks of cooperation and facilitation involving drug trafficking, illegal logging, illegal mining, land grabbing, and money laundering.

In terms of transnational criminal organizations operating in the Amazon, the most prominent are *Comando Vermelho* (CV) and *Primeiro Comando da Capital* (PCC) (Cardoso, 2020, p. 15). Within the broader conception of criminal networks, in addition to PCC and CV, the following criminal organizations (ORCRIM) also operate in the Amazon and maintain, in various ways, connections with those two major groups: *Bonde dos 13, Bonde dos 40*, *União Criminosa do Amapá*, *Família Terror do Amapá, Os Crias, Piratas do Solimões, Família do Norte, Primeiro Comando Panda, Trem de Arágua, Trem da Guayana, Sindicato*, among others. Moreover, dissident elements of the FARC or members of the Shining Path maintain ties with Brazilian criminal organizations (Parente, 2020, p. 22–23).

These criminal groups are motivated by profit and power, employ business-style planning practices, and co-opt state agents to facilitate illegal activities (Mingardi, 2007, p. 56). Environmental crimes, for instance, generate between US$110 and US$281 billion annually (Igarapé Institute, 2024, p. 4). As a result, criminal organizations seek to launder proceeds from the drug market by reinvesting their profits in the legal and illegal acquisition of land (including land grabbing), deforestation for pasture creation, and other agricultural activities, thereby producing narco-deforestation[6] (UNODC, 2023, p. 67).

Criminal organizations possess multiple capabilities for committing illicit activities, such as: (1) territorial control for establishing drug-trafficking routes (Funari, 2024, p. 5); (2)

[5] The drug economy encompasses production, distribution, and consumption, as well as the profits generated, the social and financial impacts, and the social costs it produces.

[6] According to the World Drug Report, narco-deforestation consists of deforestation carried out for real estate speculation or to serve the agribusiness sector, which in fact conceals the laundering of drug trafficking proceeds (UNODC, 2023, p. 61).

construction of illegal airstrips and clandestine roads (Couto, 2000, pp. 10 and 12); (3) access to firearms (Brazilian Forum on Public Security, 2023, p. 10); (4) recruitment of new members, including Indigenous individuals (Lima, Ambrósio and Farias, 2025, p. 3); (5) generating profits through drug and arms trafficking, deforestation, land grabbing, and illegal mining (Guaraldo, 2025); (6) money laundering from illegal mining and agribusiness activities (Júnior and Costa, 2023, pp. 153–155); (7) establishing financial networks to move and conceal illicit transactions (Muller, 2024, p. 21); (8) corruption of public officials to facilitate operations and ensure impunity (Igarapé Institute, 2024, p. 25); (9) control over local communities (Costa, Almeida and Oliveira, 2024, p. 310); (10) intimidation of locals, environmental activists, and authorities (Araújo, 2024, p. 29); (11) expansion into new municipalities (Couto, 2023, p. 63); and (12) formation of strategic alliances (Couto and Netto, 2025, p. 38).

According to Waisbich *et al.* (2022, p. 8), illegal deforestation results from four illicit activities: (1) land grabbing; (2) illegal logging; (3) illegal mining; and (4) agriculture and cattle ranching linked to environmental illegality. To substantiate this assessment, data from 369 Federal Police operations (p. 11) conducted between 2016 and 2021 were analyzed, which revealed the following:

Table 1 – Relationship between deforestation and other illicit economic activities

		Relationship with the main target				
Number of Operations	Main Target	Illegal logging	Land grabbing of public lands	Ilegal mining	Agribusiness with illegal environmental practices	Ilegal deforestattion
100	Ilegal deforestattion	32%	66%	21%	13%	-
53	Land grabbing of public lands	11%	-		7%	35%
151	Illegal logging	-	32%	3%	27%	49%
170	Ilegal mining	3%	7%	-	13%	21%
15	Agribusiness with illegal environmental practices	3%	19%	1%	-	13%

Source: Author's elaboration, based on data from Waisbich *et al.* (2022, p. 11).

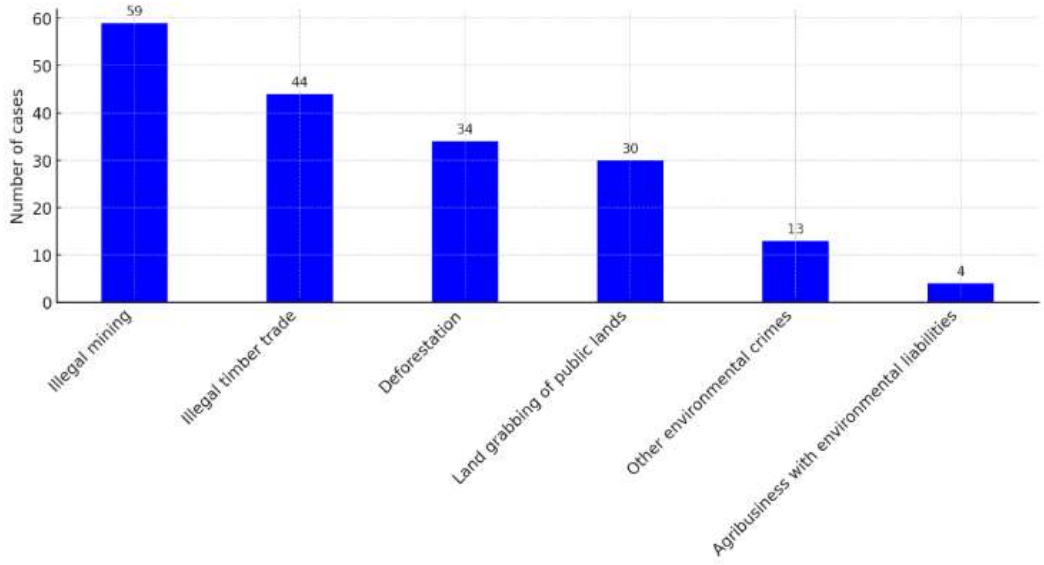
The data show that deforestation almost never occurs in isolation; there is a significant connection between deforestation, land grabbing on public lands, and illegal logging. By

contrast, the relationship between illegal deforestation and mining or agricultural activities that harm the environment appears to be less pronounced. Even so, according to the report *Contemporary Issues on Drugs* (UNODC, 2023, p. 63), there is evidence that drug traffickers finance logistical support for certain illegal mining operations, expanding their activities into illegal logging.

According to the Brazilian Forum on Public Security, Pará has been the state with the highest number of recorded cases of illegal deforestation (2023, p. 99). The organization also highlights the main drivers of deforestation across Amazonian states, as follows: (1) logging and cattle ranching intensify deforestation in northern Mato Grosso, Rondônia, and Acre; (2) logging and illegal mining affect southern Amazonas and the state of Roraima; (3) logging, agriculture, and cattle ranching catalyze deforestation in Mato Grosso and Mato Grosso do Sul; (4) logging, illegal mining, agriculture, and cattle ranching impact Pará; and (5) agriculture and illegal mining accelerate deforestation in Maranhão (2023, p. 103).

According to the Igarapé Institute, between 2016 and 2022, the Federal Police (PF) recorded the following environmental crimes:

Graphic 1 – Cases of environmental crimes recorded by the Federal Police, 2016–2022

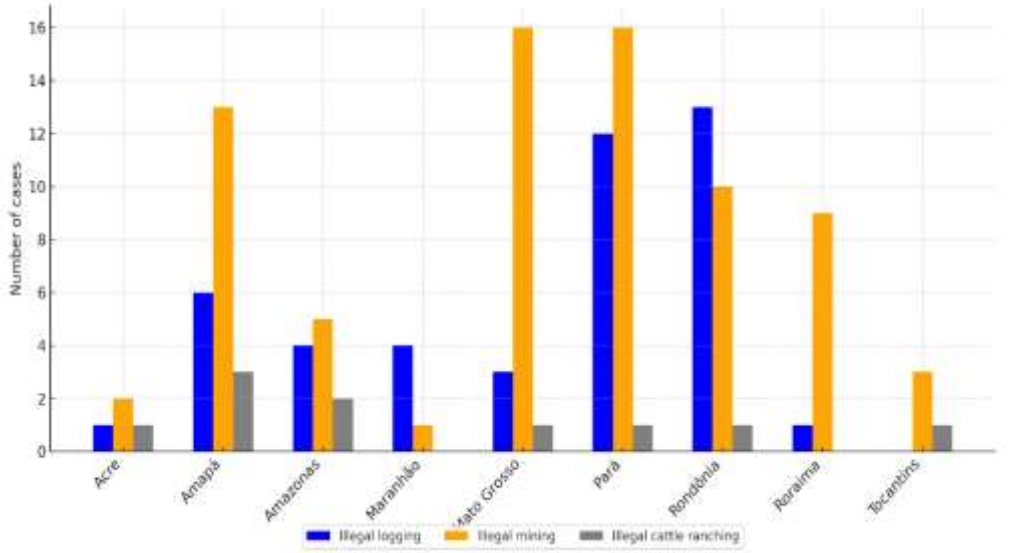


Source: Author's elaboration, based on data from the Igarapé Institute (2024).

It is evident that there is a portfolio of environmental crimes that are interconnected, such as deforestation and the illegal timber trade, or deforestation carried out for the creation

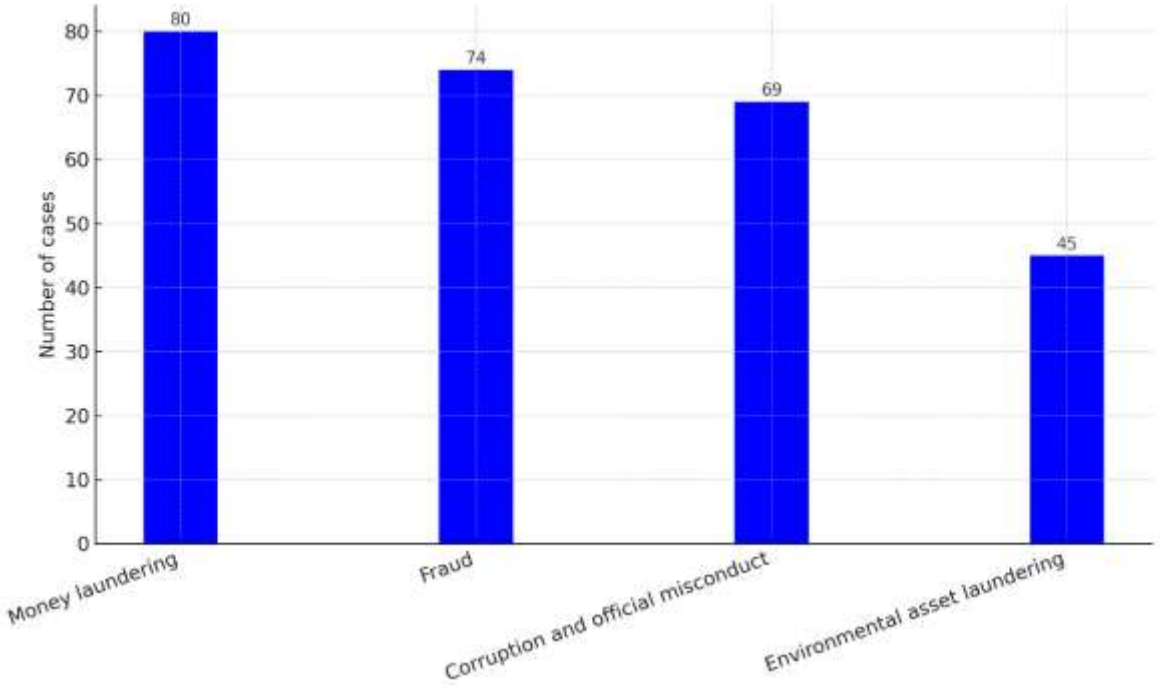
of pastures. The crimes mapped by the Federal Police were geographically distributed as follows:

Graphic 2 – Number of environmental crimes recorded by the Federal Police, 2016–2022



Source: Author's elaboration, based on data from the Igarapé Institute (2024).

Graphic 3 – Cases mapped by the Federal Police of economic offenses linked to environmental crimes between 2016 e 2022



Source: Author's elaboration, based on data from the Igarapé Institute (2024).

The records of environmental crimes and related economic offenses demonstrate criminal convergence and their connection to the illegal deforestation carried out by criminal organizations.

3.2 QUANTITATIVE ANALYSIS

This section presents the quantitative assessment of the relationship between organized crime and illegal deforestation in the Brazilian Amazon, drawing primarily on data from the region's monitoring systems: PRODES/INPE (2000–2023) and TerraBrasilis (2000–2023).

Acre stands out with 100% of its municipalities reporting the presence of criminal organizations (ORCRIM), indicating broad territorial dominance—most notably by *Comando Vermelho* (CV), which operates in 18 municipalities. Roraima follows, with criminal organizations present in 93% of its municipalities. Pará is the state with the highest number of criminal groups, followed by Maranhão. In Amazonas, 21 of 62 municipalities report the presence of organizations. Maranhão registers 48 municipalities with ORCRIM (48 out of 181), representing approximately 27% of its territory. CV also dominates 23 municipalities (out of 142) in Mato Grosso, a state in which agricultural and cattle ranching activities predominate. In Pará, 73 municipalities host criminal organizations, corresponding to roughly 51% of its 144 municipalities. The lowest levels of criminal organization presence are found in Tocantins and Amapá.

It is observed that *Comando Vermelho* holds dominance in approximately 49% of the municipalities where criminal organizations are present, with particular prominence in Acre (AC), Amazonas (AM), Maranhão (MA), and Pará (PA).

Primeiro Comando da Capital (PCC) operates in 11% of the municipalities with criminal organizations, especially in Rondônia (RO) and Roraima (RR).

There are 44 records of the coexistence of CV and PCC within the same municipalities, a situation that may give rise to disputes between the organizations or to some form of arrangement enabling them to jointly carry out their illegal activities profitably.

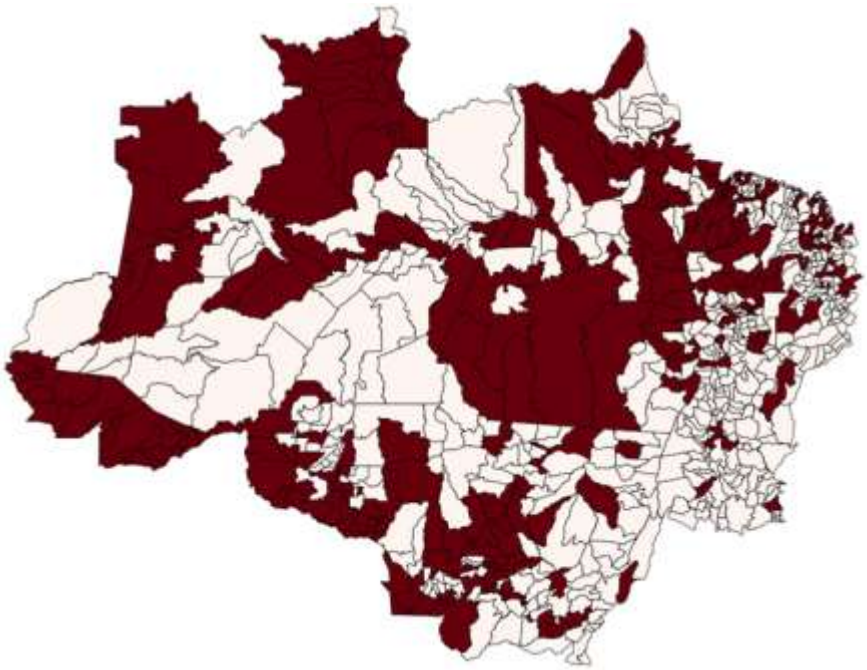
Table 2 – Presence of Organized Criminal Groups in the Amazon Region

STATE	NUMBER OF MUNICIPALITIES	MUNICÍPIOS COM FACÇÕES CRIMINOSAS	PRESENCE OF CV	PRESENCE OF PCC	PRESENCE OF TWO OR MORE CRIMINAL ORGANIZATIONS OR DOMINANCE OTHER THAN CV OR PCC
AC	22	22	18	-	4
AM	62	21	10	-	11
AP	16	5		1	4
MA	181	48	11	3	34
MT	142	42	23	1	18
PA	144	73	60	3	10
RO	52	26	3	13	10
RR	15	14	1	6	7
TO	139	9	1	2	6

Source: Author's elaboration, based on data from the Brazilian Forum on Public Security (2024).

Geographically, the distribution of municipalities in the Legal Amazon with the presence of criminal organizations is as follows:

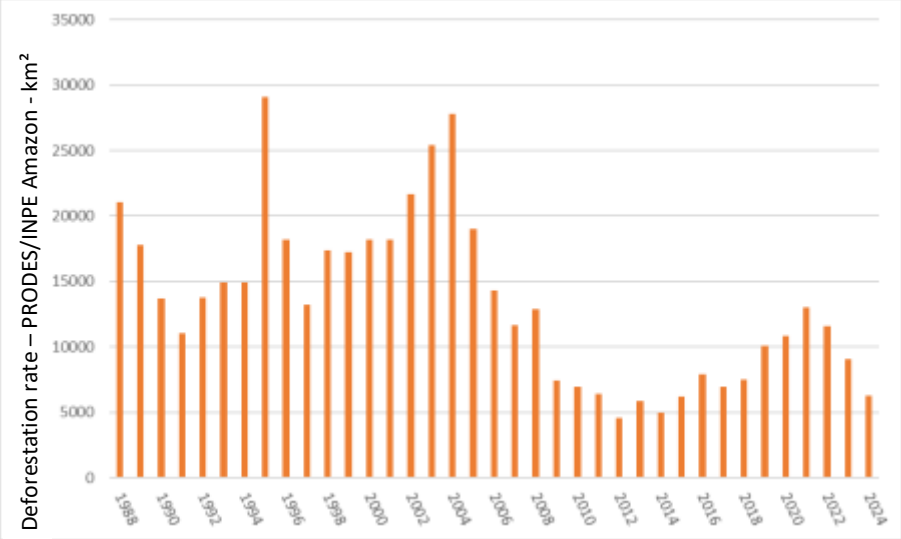
Figure 1 – Municipalities in the Amazon with the presence of criminal organizations



Source: Author's elaboration, based on data from the Brazilian Forum on Public Security (2024).

According to PRODES/INPE data (2000–2023), the deforestation rate in the Amazon over time has evolved as shown in the graph below:

Graphic 4 – Deforestation rate – PRODES/INPE Amazon - km²



Source: Author's elaboration based on PRODES data (2025).

Of the 260 municipalities with the presence of criminal organizations (out of the 773 that make up the Legal Amazon), deforestation data are available for 233. For the 513 municipalities without the presence of criminal organizations, data were identified for 323 cities. The absence of data for 190 municipalities may be due to the lack of continuous deforestation patches larger than 6.25 hectares between 2000 and 2023.

When comparing deforestation across municipalities in the Legal Amazon, it was found that the average deforestation rate in municipalities with the presence of criminal organizations is approximately 1.39 times higher than in municipalities without criminal groups. When assessing the median, municipalities with criminal organizations show values 1.26 times higher than the others.

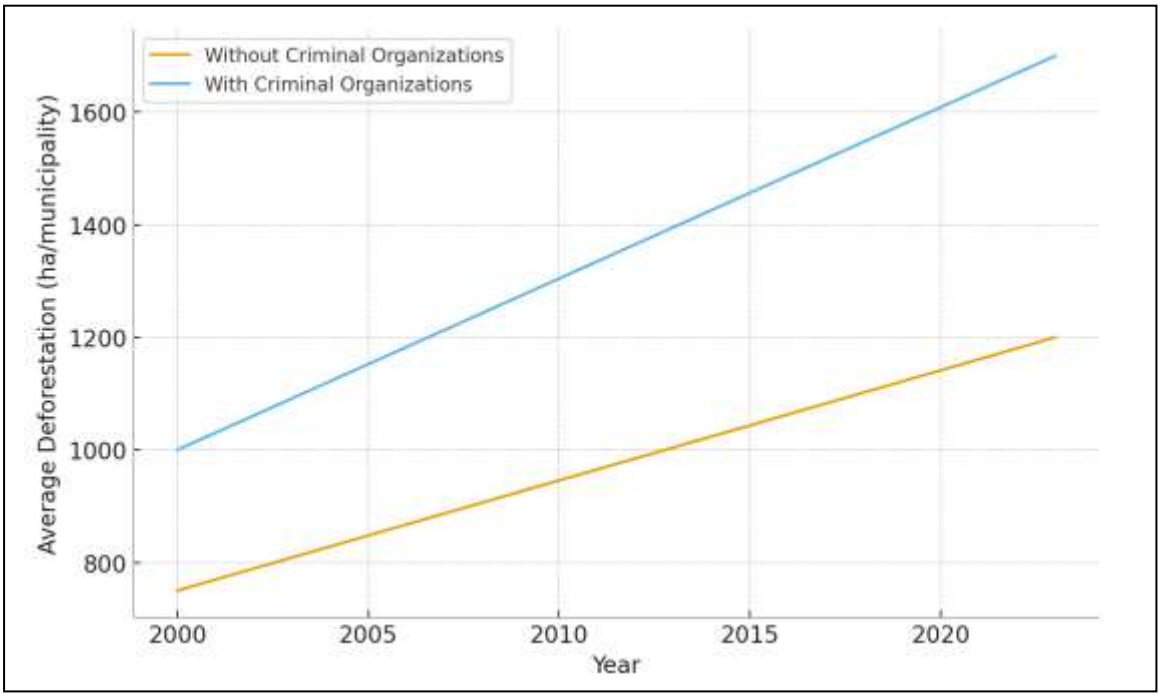
Table 3 – Comparative Descriptive Statistics – Deforestation in the Legal Amazon[7]

INDICATOR	MUNICIPALITIES WITHOUT CRIMINAL ORGANIZATIONS	MUNICIPALITIES WITH CRIMINAL ORGANIZATIONS
N	323	233
Mean annual deforestation (ha/year)	1035.48	1434.27
Median (ha/year)	707.52	894.11
Standard Deviation	1134.33	1817.43

Source: Author's elaboration based on data from PRODES/INPE (2000–2023) and the Brazilian Forum for Public Security (2024).

In order to verify whether the difference in mean deforestation between municipalities with and without criminal organizations is statistically significant, Welch's **t-test** was applied. The test yielded a value of 2.95 and a **p-value of 0.0033 (below 0.05)**, **demonstrating statistical significance**. This result confirms that the presence of criminal organizations contributes to increased deforestation.

Graphic 5 – Average municipal deforestation (2000–2023): municipalities with and without the presence of criminal organizations



Source: Author's elaboration based on PRODES/INPE data (2000–2023) and data from the Brazilian Forum on Public Security (2024).

[7] Values calculated based on the annual average deforestation per municipality for the period 2000–2023, after merging the deforestation data from PRODES (2000–2023) with the criminal group data from the Brazilian Forum on Public Security (2024).

In order to assess the impact of criminal organizations (ORCRIM) on the likelihood of deforestation, a multivariate cross-sectional logistic regression was conducted for the period 2000–2023. The dependent variable was defined as *deforestation* = 1 when the municipality exhibited a total deforested area greater than zero (PRODES/INPE 2025), and *deforestation* = 0 otherwise. The independent variables included: (1) municipal land area (log of area); (2) presence of criminal organizations; (3) extent of arable land within the municipality (log of planted area); (4) number of cattle per municipality (log and density per km²); (5) presence of protected areas (dummy); (6) presence of Indigenous lands (dummy); and (7) extent of the municipal road network (log and density per km²).

The **odds ratio**[8] for the presence of criminal organizations was approximately 2.78 (95% CI: 1.55–4.98; $p < 0.001$)[9]. This means that, holding all other independent variables constant, municipalities with the presence of criminal organizations are about 2.8 times more likely to report some level of deforestation during the period analyzed. In absolute terms, the average marginal effect corresponds to an increase of approximately 15 percentage points in the probability of occurrence.

The estimated impact of organized crime (TOC) on deforestation can be calculated as follows:

$$\text{Relative TOC Impact (\%)} = 100 \times \frac{\text{Deforestation growth with criminal organizations} - \text{Deforestation growth without criminal organizations}}{\text{Deforestation growth without criminal organizations}}$$

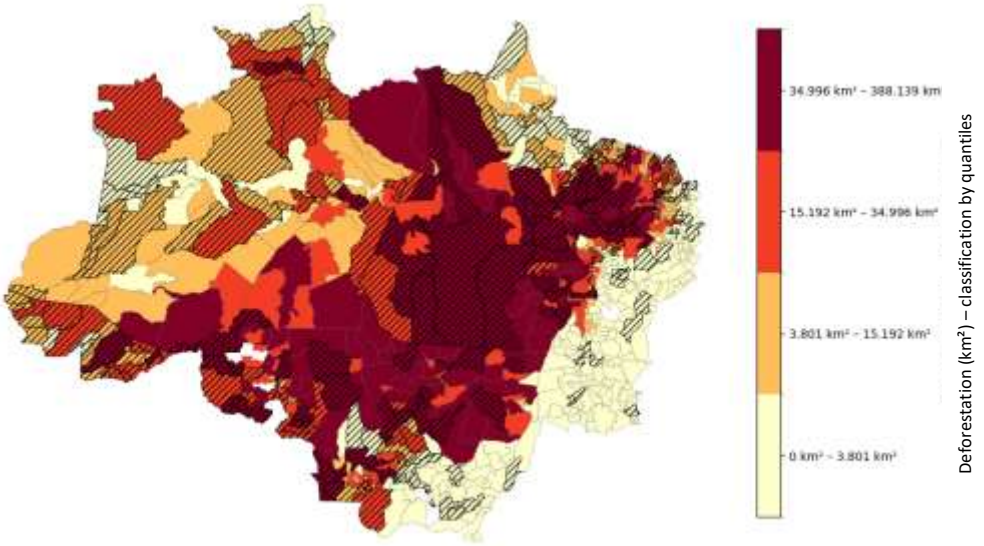
$$\text{Relative TOC Impact (\%)} = \frac{21.80 - 17.49}{17.49} \text{X } 100$$

The estimated relative impact of TOC on deforestation is approximately 24.62%. In the map below, it is possible to observe the overlap between deforestation and the presence of criminal organizations (ORCRIM), allowing the identification of the areas most likely to be affected by organized crime.

[8] The odds ratio (OR) is used to compare two scenarios. When OR > 1, there is an increased likelihood of the event occurring.

[9] 95% confidence interval (CI). The presence of criminal organizations increases the likelihood of deforestation by at least 55% and may reach nearly fivefold, with the most likely estimate around 2.8 times. A *p*-value < 0.001 indicates the statistical significance of the study.

Figure 2– Deforestation by municipality and presence of criminal organizations (black hatching)



Source: Author's elaboration, with data from the Brazilian Public Security Forum (2024) and TerraBrasilis (2000–2023).

In the statistical models used to assess the intensity of organized crime's influence (restricted to municipalities that already exhibit deforestation), the effect of criminal organizations was small and statistically insignificant; no evidence emerged of a convincing causal increase attributable to their presence. This outcome arises primarily from the lack of concrete information on when organized crime began operating in each municipality, as well as the absence of objective data directly linking deforestation to criminal organizations (ORCRIM).

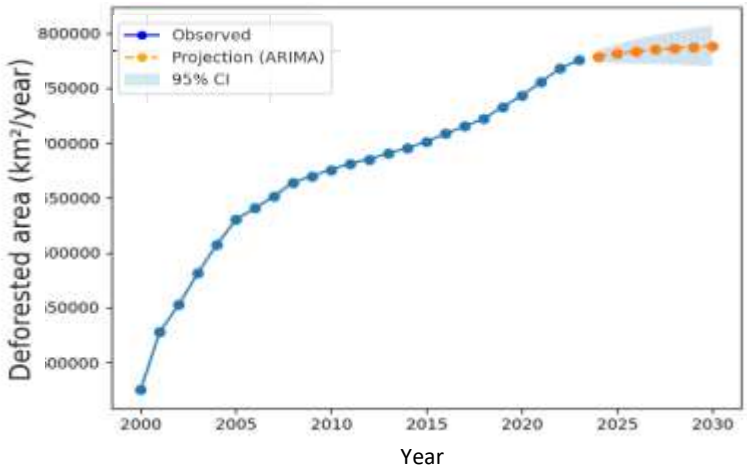
In summary, the presence of criminal organizations increases the likelihood that a municipality will fall into the group that engages in deforestation; however, there is still no evidence that they are the direct cause of the increase in deforestation.

It is important to note the difficulty in measuring data due to the lack of integration of information across the various agencies that deal directly or indirectly with intelligence related to TOC. A significant share of deforestation incidents never comes to the attention of state police forces—either because other institutions become aware of them but do not report them, or because these incidents are not detected by any institution (Forum Brasileiro de Segurança Pública, 2023, p. 100).

Using PRODES/INPE deforestation rate data (2000–2023) and applying an ARIMA (autoregressive integrated moving average) model—i.e., a time-series analysis and forecasting

technique—a projected deforestation scenario was identified with the following characteristics: (1) a trend toward reaching 813,838 km² of accumulated deforested area; (2) a lower-bound estimate of 752,689 km²; and (3) an upper-bound estimate of 874,987 km². The figure below illustrates the possible deforestation scenarios for the Legal Amazon.

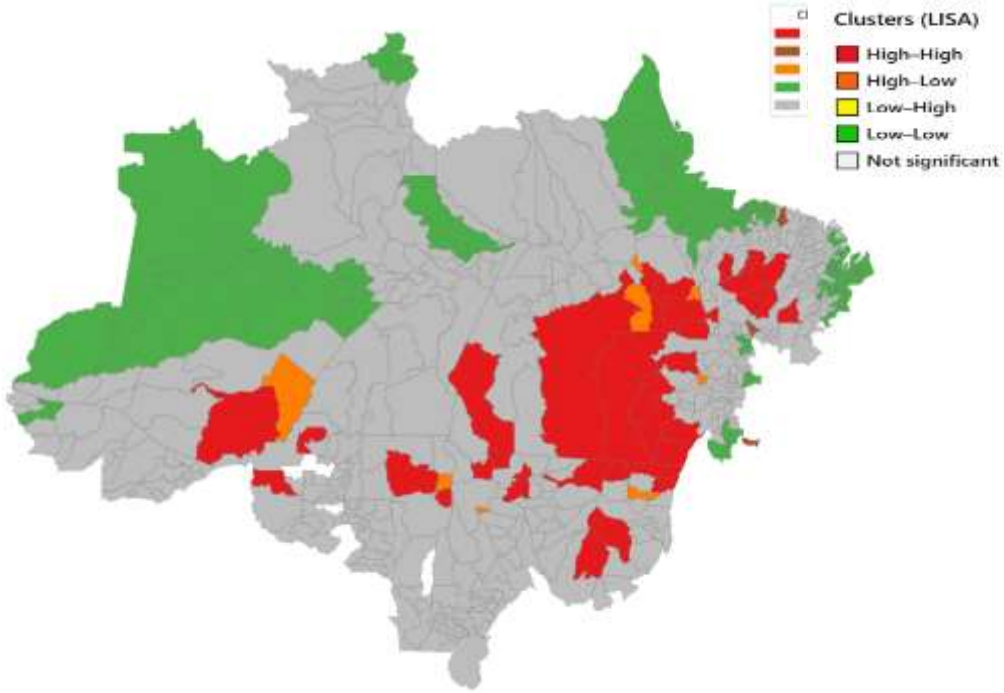
Graphic 6 – Legal Amazon Deforestation: Historical Series and ARIMA Projection



Source: Author's elaboration based on PRODES/INPE Amazon deforestation rate data (2000–2023).

In the map below, produced using the concept of spatial clustering, it is possible to identify the areas with the highest likelihood of increases influenced by TOC.

Figure 3 – Spatial Clustering Map – Mean Deforestation (LISA)



Source: Author's elaboration based on PRODES/INPE data (2000–2023) and Brazilian Forum on Public Security data (2024).

The interpretation of the clustering map is as follows:

Table 4 – Spatial Clustering Results: Deforestation – TOC

CLUSTER	SPATIAL INTERPRETATION	IMPLICATIONS FOR TOC AND DEFORESTATION
High-High	Municipality with high deforestation, surrounded by neighbors also exhibiting high deforestation.	Strong evidence of regional patterns of elevated deforestation, possibly reflecting coordinated TOC influence across contiguous areas. May indicate a consolidated route of illegal exploitation (e.g., timber, cattle, or drug trafficking).
High-Low	Municipality with high deforestation, surrounded by neighbors with low deforestation.	May indicate that TOC is acting in an isolated or recent manner in a specific area, generating a *hot spot* of deforestation outside traditionally affected regions. May represent a new front of expansion.
Low-High	Municipality with low deforestation, surrounded by neighbors with high deforestation.	Potential transition or buffer zone resisting TOC expansion. May involve municipalities with protected areas or stronger state presence, though at risk due to proximity.
Low-Low	Municipality with low deforestation and surrounded by neighbors also with low deforestation.	Area of relative environmental stability and territorial security. May indicate absence or low impact of TOC. Worthy of preservation and preventive policies.

Source: Author's elaboration.

4 DISCUSSION

The problem formulated for the development of this article was the following: **how does transnational organized crime impact illegal deforestation rates, with negative implications for the protection and sustainable future of the Amazon?**

The results of the qualitative analysis show that criminal organizations in the Amazon are already present in roughly 34% of the territory. The profitability achieved by transnational organized crime, whether through drug trafficking or the commission of environmental crimes (with estimated profits ranging from USD 110 to 281 billion per year)—enables reinvestment in the region, generating a convergence of illicit activities with a significant impact on deforestation, which becomes narco-deforestation. Federal Police data reveal, for example, a 66% interrelation between illegal deforestation and land grabbing, and a 32% interrelation with illegal logging.

The criminal convergence observed among deforestation, land grabbing, illegal logging and mining, fraud, and other illicit activities aligns with the concept of hybrid governance as exercised by transnational organized crime (TOC) in the Amazon. According to Pimenta *et al.* (2021, p. 7), hybrid governance can be understood as the presence of different sources of authority within the same space, where violence, rules, and moral conduct are administered by both legal and illegal actors. In this sense, TOC coexists and competes with the State, imposing specific rules on social conduct (Ferreira, 2023).

Hybrid governance manifests itself in illegal deforestation when TOC employs corruption to enable the activity, resorting, for example, to: the co-optation of public officials for the falsification of documents such as forest management plans and forest transportation permits (Instituto Igarapé, 2023, p. 11); forest origin documents (p. 12); the fraudulent issuance of artisanal mining permits, land ownership certificates, and other documents related to environmental crimes (p. 15); facilitation of the illegal mineral trade (p. 19); cattle "laundering" through the so-called triangulation process, whereby cattle are moved from illegal areas to legalized ones (p. 22); and enabling the illegal or irregular appropriation of public lands (p. 25), among many other "windows of opportunity."

Moreover, poverty and the lack of lawful economic opportunities – which could otherwise be fostered by the State – lead individuals and communities to align themselves with criminal practices (Marques, 2023, p. 14). Land conflicts, the marginalization of

traditional communities, and population flows further facilitate the commission of criminal acts (Gama; Barboza; Jesus, 2024, p. 9).

Other aspects that facilitate criminal convergence and hybrid governance in the Amazon include: (1) logistical capillarity and armed protection—criminal factions create or finance clandestine airstrips, informal ports, and violent protection networks, thereby reducing costs and risks for illicit environmental activities; (2) land laundering and speculative land accumulation—profits from drug trafficking and other illicit markets are reinvested in land and cattle, enabling land grabbing and the conversion of forests into pasture or cropland; and (3) co-optation and institutional capture—corruption in registries, licensing, enforcement, and notary offices to falsify documents while simultaneously weakening deterrence mechanisms.

From a qualitative perspective, it was observed that, beginning in the 1990s, the deforestation process in the Brazilian Amazon became increasingly linked to economic activities—particularly agricultural and livestock production, which required forest clearing to establish pasture for extensive cattle ranching or large-scale agriculture. This shift created a window of opportunity for criminal organizations operating in the region, especially those involved in drug trafficking, to launder profits derived from cocaine sales.

The results of the quantitative analysis indicate that municipalities with the presence of criminal organizations displayed higher average annual deforestation between 2000 and 2023 compared to those without such presence: approximately 1,434 hectares/year versus 1,035 hectares/year. This difference was found to be statistically significant (Welch's t-test, $p < 0.01$). This finding appears consistent with the qualitative assessment of ORCRIM activity in the Amazon, given the convergence of illicit activities such as deforestation, land grabbing of public lands, illegal logging, and illegal mining.

In the logistic model, the presence of criminal factions is associated with a higher likelihood that a municipality falls into the deforesting group (odds ratio 2.78, 95% CI 1.55–4.98), with an average marginal effect of roughly +15 percentage points, reinforcing the facilitating role of TOC in driving deforestation events.

The quantitative analysis was able to identify the likelihood that ORCRIM exert influence over illegal deforestation, in line with qualitative findings; however, the insufficiency of annual, organization-specific data suggests caution in interpreting the causal direction of this phenomenon.

Taken together, empirical evidence and existing studies support the argument that the presence of ORCRIM acts as a structural amplifier of deforestation risk—particularly where state capacity is low, illicit profitability is high, and logistical corridors reduce opportunity costs. Policies focused on such corridors, illicit revenue streams, and land governance are likely to yield greater returns than isolated sectoral interventions.

5 CONCLUDING REMARKS

Transnational organized crime (TOC) represents a high-impact threat to Brazil, generating concrete harm to Brazilian society—whether through narcotrafficking or through deforestation and its associated illicit activities, which form part of the criminal portfolio operating in the region.

Based on the quantitative study, it was found that, at present, TOC contributes to nearly 25% of the illegal deforestation activity in the Amazon. This impact has the potential to increase, as suggested by the spatial clustering analysis. From the qualitative perspective, "narco-deforestation" appears to result from the reinvestment of profits derived from criminal convergence in the Amazon and from the hybrid governance dynamics—where criminal actors compete with the State—that have become established in the region.

The findings suggest three main axes for addressing this situation: (1) strengthening interagency operations focused on commercial corridors, grounded primarily in financial intelligence and logistical control (airstrips, ports, dredges) along priority axes (Solimões, BR-163, BR-319); (2) reinforcing land governance and traceability—cleaning and verifying land registries, blocking land grabbing, and ensuring supply-chain traceability (cattle–timber–mineral), supported by financial and commercial sanctions; and (3) financial action targeting the flows associated with narco-deforestation (monitoring transactions linked to land, heavy machinery, fuel, and front persons), in coordination with international partners (EU, United States, Andean neighbors).

The data obtained in this study open pathways for future research concerning the extent of transnational organized crime's influence over deforestation in each subregion of the Brazilian Amazon, as well as the relative contribution of each illicit economic activity within the broader framework of criminal convergence.

At a time when the sovereignty of some nations is under threat—such as the kinetic challenge faced by Ukraine, or the rhetorical pressures directed at Denmark (in connection with Greenland)—it is not surprising that the Amazon may soon be framed as a strategic asset under dispute for various reasons: its vast freshwater reserves, its deposits of rare-earth elements, its valuable bioactive compounds, among others. In this context, the narrative of external intervention justified by deforestation and its global climate effects may become a convenient argument for certain international actors, posing risks to the future of the Brazilian Amazon.

Ultimately, it is clear that the protection and sustainable future of the Amazon are at stake, in a contest where those who possess power exercise it with little regard for the more vulnerable or less prepared.

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