

Removal of vegetation in the state of Mato Grosso: a perspective based on the actions of IBAMA between 1998 and 2016

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Abstract— *The State of Mato Grosso in the Midwest region of Brazil has, in recent decades, become the main area of agricultural production in the country.¹ By positioning itself as the new agricultural frontier, the state has instigated a constant conflict between agriculture and environmental protection. In this context, this study briefly discusses and analyzes deforestation in the region based on data on sanctions issued by the Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (Brazilian Institute for the Environment and Renewable Natural Resources; IBAMA), the Brazilian environmental regulatory and inspection agency, between 1998 and 2016. Annual vegetation removal reached its highest values in 2003 and 2004 (1,109 km²) and then decreased from 2005 to 2008 (4,353 km²) before stabilizing at the lowest level between 2009 and 2016 (1,138 km²).*

Keywords— *Brazil, forest, deforestation, biodiverse, environmental.*

I. INTRODUCTION

The State of Mato Grosso in the Midwest region of Brazil has, in recent decades, become the main area of agricultural production in the country.² By positioning itself as the new agricultural frontier, the state has instigated a constant conflict between agriculture and environmental protection. In this context, this study briefly discusses and analyzes deforestation in the region based on data on sanctions issued by the Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (Brazilian Institute for the Environment

and Renewable Natural Resources; IBAMA), the Brazilian environmental regulatory and inspection agency, between 1998 and 2016. Annual vegetation removal reached its highest values in 2003 and 2004 (1,109 km²) and then decreased from 2005 to 2008 (4,353 km²) before stabilizing at the lowest level between 2009 and 2016 (1,138 km²). A total of 1,593 lawsuit filings were registered, with 70% of the individuals and/or entities receiving a formal notification and 58 individuals receiving two notifications; furthermore, the same individual/entity received 16 notifications. The actions were concentrated in the center and north of the state, with a high concentration of notifications in the municipalities of Cotriguaçu, Querência and Nova Ubiratã, and there was a negative relationship between the number of legal notifications and the total deforested area. Vegetation removal was higher in the areas with fewer notifications, which could have been due to the positive impact of supervision and penalties in reducing deforestation. However, these notifications could also have been associated with the increasing number of areas devoted to large-scale agriculture for export.

II. INSTITUTIONAL CONTEXT, REGULATORY FRAMEWORK AND DEFORESTATION

According to the Ministry of the Environment (2010), Brazil is a “forested country,” with 60.7% of its territory consisting of natural and planted forest, and a significant portion of this forest, especially natural forest, is in the northern region of the country, which is characterized by the Amazonian biome. Although Brazil contains the most biodiverse biome in the world, it has been considered the world leader in deforestation, converting an average of 19 million km² of natural vegetation to agriculture between 1996 and 2005 and emitting between 0.7 to 1.4 Gt of CO₂ into the atmosphere (Nepstad *et al.* 2009).

¹According to CONAB (the National Supply Company), the 2016/2017 estimated grain crop yield for Mato Grosso State was approximately 52.7 million tons.

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It is important to understand the characteristics of the Brazilian productive matrix, the structure of which has changed over time. At the beginning of the 20th century, an essentially coffee-based monoculture export economy was established in the southeast region of the country, particularly in the so-called Planalto Paulista, and throughout the 20th century, especially since the 1950s, there was a strong movement towards industrialization in this region, especially in the state of São Paulo. This economic diversification, until then unprecedented in the country, strongly concentrated income in the southwest region.

From the 1970s onwards, mainly due to technical innovations developed by EMBRAPA,³ the cultivated area strongly expanded to the midwestern region of the country. The traditional cattle production in the area gave way to grain production characterized by the development of crop varieties adapted to local edaphoclimatic conditions. It also involved a high degree of intensive land use, with high technical inputs and the mechanization of production, which, combined with irrigation, resolved the problem of the seasonality of the water supply in the region. This expansion began in the southern part of the midwestern region of the country, near the border between the states of São Paulo and Goiás, and it then gradually expanded towards the northern region to the area called Amazônia Legal. In February 1989, this latter agricultural expansion led to the Brazilian government creating, through Law 7.735, the Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (Brazilian Institute for the Environment and Renewable Natural Resources; IBAMA), which was the combination of four different institutions: the Instituto Brasileiro de Desenvolvimento Florestal (Brazilian Institute for Forest Development; IBDF), the Superintendência de Pesca (Fisheries Superintendency; SUDEPE), the Superintendência da Borracha (Rubber Superintendency; SUDHEVEA), and the Secretaria Especial do Meio Ambiente (Special Environment Secretariat; SEMA).

This new institutional framework, created after 1989, came on the heels of the 1988 Constitution, after which a new legal framework emerged with the creation of a significant number of new environmental laws (Table 1) between 1988 and 2012 (Araújo, 2013).

Table.1: Environmental laws created between 1988 - 2012

Law	Theme
Law 7.679/1988	Prohibition of fishing during the

	breeding season
Law 7.754/1989	Protection of vegetation at the headwaters of rivers
Law 7.797/1989	National Environmental Fund Law
Law 7.802/1989	Pesticides Law
Law 7.803/1989	Amendment to the Forest Code
Law 7.704/1989	Amendments to the National Environmental Policy Law (Lei da Política Nacional do Meio Ambiente; PNMA)
Law 7.875/1989	Collection of park entry fees – change in the CF (Federal Constitution)
Law 8.723/1993	Vehicle Pollution Law
Law 9.111/1995	Change in the Wildlife Protection Law
Law 9.433/1997	Water Resources Law
Law 9.605/1998	Criminal and administrative infractions (Environmental Crimes Law)
Law 9.795/1999	National environmental education policy
Law 9.960/2000	Environmental inspection fee – change in the PNMA
Law 9.960/2000	Water pollution by oil
Law 9.974/2000	Post-consumer responsibility – change in the Pesticides Law
Law 9.985/2000	National Conservation Unit System (Sistema Nacional de Unidades de Conservação – SNUC) Law
Law 10.165/2000	Environmental inspection fee – change in the PNMA
Law 10.203/2001	Change in the Vehicular Pollution Law
Law 10.650/2003	Access to information from environmental agencies
Law 11.132/2005	Provisional administrative restriction – change in the SNUC Law
Law 11.284/2006	Public Forest Management
Law 11.428/2006	Protection of the Atlantic Forest
Law 11.516/2007	Adjustments to environmental licensing (and creation of the Chico Mendes Institute)
Law 11.794/2008	Scientific use of animals
Law 11.959/2009	Fishing
Law 12.114/2009	National Climate Change Fund
Law 12.305/2009	National Solid Waste Policy
Law Complemental 140/2011	Environmental cooperation between federated institutions
Law 12.651/2012	New Forestry Law

³Empresa Brasileira de Pesquisa Agropecuária (Brazilian Agricultural Research Company).

Law 12.727/2012	Changes to the New Forestry Law
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Source: Based on Araujo (2013)

Synergies between the 1988 Constitution, the founding of IBAMA in 1989, and the post-1988 consolidation of a clear regulatory framework on environmental issues allowed the country to, for the first time, consider and reorient its growth model based on the newly established environmental policies. However, the profusion of laws in the period between 1988 and 2012 also contributed to a certain level of uncertainty about how agricultural production would be balanced against the role of IBAMA in environmental inspection.

Between 1998 and 2016, IBAMA issued 1,593 legal notifications in the state of Mato Grosso. Of these, 70% of individuals and/or entities received a single notification, but there were cases in which two (58 cases), three (four cases), four (three cases), six (one case) and 16 (one case) citations

applied to the same individual or entity. The National Institute of Colonization and Agrarian Reform (INCRA) received the most notifications in the state, with 16 registered infractions.

The number of notifications increased between 1998 and 2013 followed by a decrease between 2013 to 2016 (Figure 1A). With respect to deforestation, the annual deforested area reached its highest values in 2003 and 2004 (annual average of 11,109 km² deforested), decreased continuously between 2005 to 2008 (annual average of 4,353 km² deforested), and stabilized at its lowest level between 2009 and 2016 (annual average of 1,138 km² deforested) (Figure 1A). This stabilization of deforestation since 2009 may be related, at least partially, to a possible positive impact of the “New Forest Code” (Law 12.651) that was promulgated in 2012 and provided IBAMA with greater control over deforestation in the region.

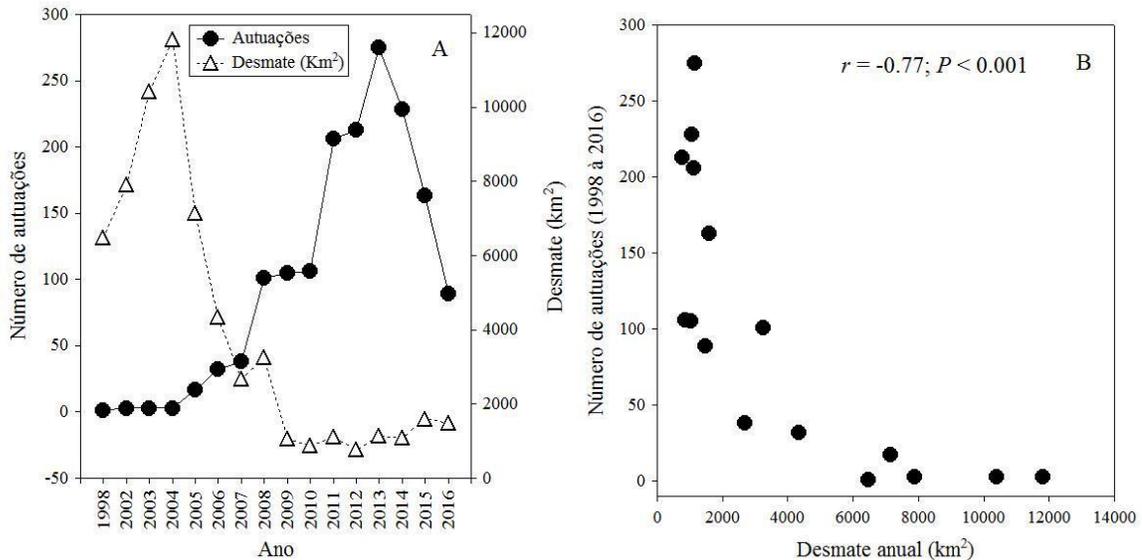


Fig.1: Relationship between deforestation and legal notifications issued in the state of Mato Grosso between 1998 and 2016. (A) Temporal dynamics of the number of notifications and the deforested area. (B) Relationship between the number of notifications by IBAMA and the total annual deforested area (Pearson correlation)

There was a negative relationship between the number of notifications issued by IBAMA and the total deforested area (in km²) in the State of Mato Grosso between 1998 and 2016 ($r = -0.77$; $P < 0.001$) (Figure 1B). Thus, the years with high levels of deforestation were those with a lower number of infractions, indicating a positive effect of the inspection and citations by IBAMA on reducing deforestation as well as the efforts of the federal government to cancel credits to illegal deforesters and to pressure the buyers of products from these areas (Nepstad *et al.* 2009). However, there may be alternative explanations. For

example, it is possible that these notifications apply to large areas devoted to large-scale agricultural production, which, in turn, indicates a large expansion of the agricultural frontier for export-oriented production.

III. CATEGORIES OF INFRACTIONS

The notifications by IBAMA are divided into 52 categories, with only nine accounting for 93% of all fines issued. These nine categories can be divided into two groups: (i) notifications related to deforestation (categories 1 to 4) and

(ii) notifications related to sales and services (categories 5 to 9) (Table 2).

Table.2: Main categories of infractions registered by IBAMA in the state of Mato Grosso between 1998 and 2016

Notifications related to deforestation	Notifications related to sales and services
<ol style="list-style-type: none"> 1. Non-authorized destroying, deforesting, or damaging of forests or any native vegetation or planted native species in a specially protected public or private legal reserve or forest easement. 2. Flora infraction (non-classified - mobile). 3. Destroying or damaging forests or other forms of vegetation in specially protected areas under Art. 225 of the Federal Constitution/1988 (Amazônia Legal Region), Art. 50 of Law number 9.605/98, and Art. 37 of Decree number 3.179/99. 4. Destroying or damaging forests or cutting trees or other types of natural vegetation in permanently protected areas or involving species under special protection without authorization from the competent authority or in violation of their instruction. 	<ol style="list-style-type: none"> 5. Building, renovating, expanding, installing, or operating potentially polluting works or services or natural resource use without license or authorization from the competent environmental agencies or in violation of the license obtained. 6. Environmental quality infraction (non-classified - mobile). 7. Selling, offering for sale, warehousing, transporting, or storing timber, firewood, charcoal or other products of plant origin without a valid license for the entire transportation or storage period granted by the competent authority. 8. Harvesting or damaging forest or any type of native vegetation or planted native species located outside a public or private legal nature reserve without the prior approval of the competent environmental agency. 9. Carrying out potentially environmentally degrading activity without an environmental license.

Among the main types of notifications, the most common were in categories 1 and 2 (Table 2), which accounted for 51% and 30% of all cases, respectively (Figure 2A). Therefore, the high level of notifications by IBAMA can be considered a result of the activities in group 1

(deforestation). In addition, there was a high concentration of infractions in the municipalities of Cotriguaçu and Querência, which incurred more than twice as many citations as Nova Ubiratã, the municipality with the third most notifications (Figure 2B).

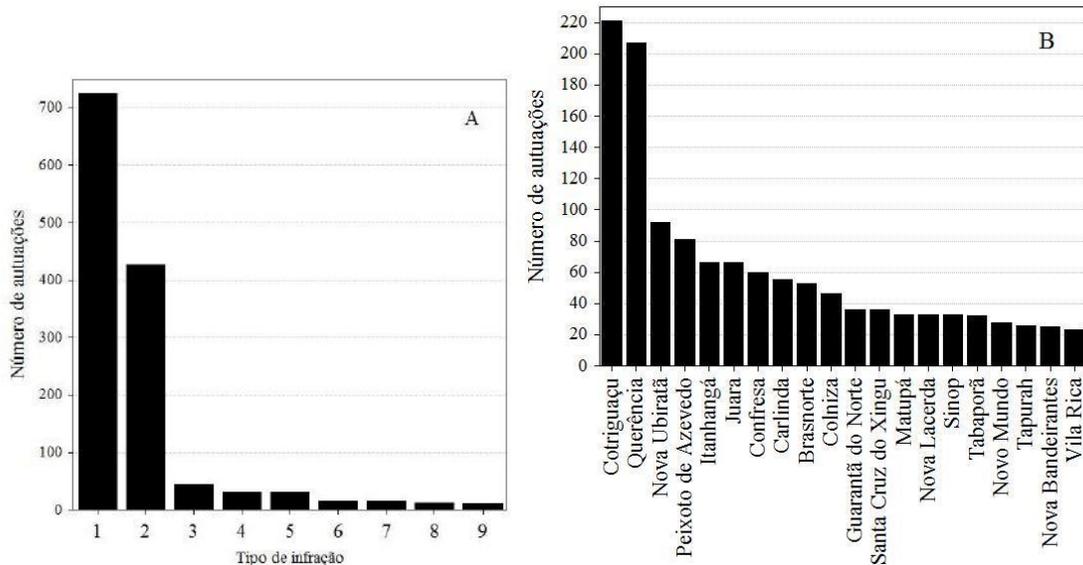


Fig.2: Main categories of infractions (A) and the municipalities where infractions occurred (B) as recorded by IBAMA between 1998 and 2016 in the state of Mato Grosso

IV. SPATIAL DISTRIBUTION

The number of notifications were concentrated in the north-central part of the state of Mato Grosso, a region popularly known as the “arc of deforestation” (Figure 3A). The number of notifications increased significantly in the center of the state, in the transition area between the cerrado and Amazon biomes, and the volume of deforestation increased closer to the Amazon biome. Notably, in the region bordering the state

of Pará, in the cities of Alta Floresta, Paranaíta, Novo Mundo, Guarantã do Norte, and Vila Rica, deforestation reached 40% to 86% of the municipal area. In contrast, municipalities such as Nova Bandeirantes, Cotriguaçu, Peixoto de Azevedo, Santa Cruz do Xingu, and Matupá had levels of deforestation below 40% (Figure 3A).

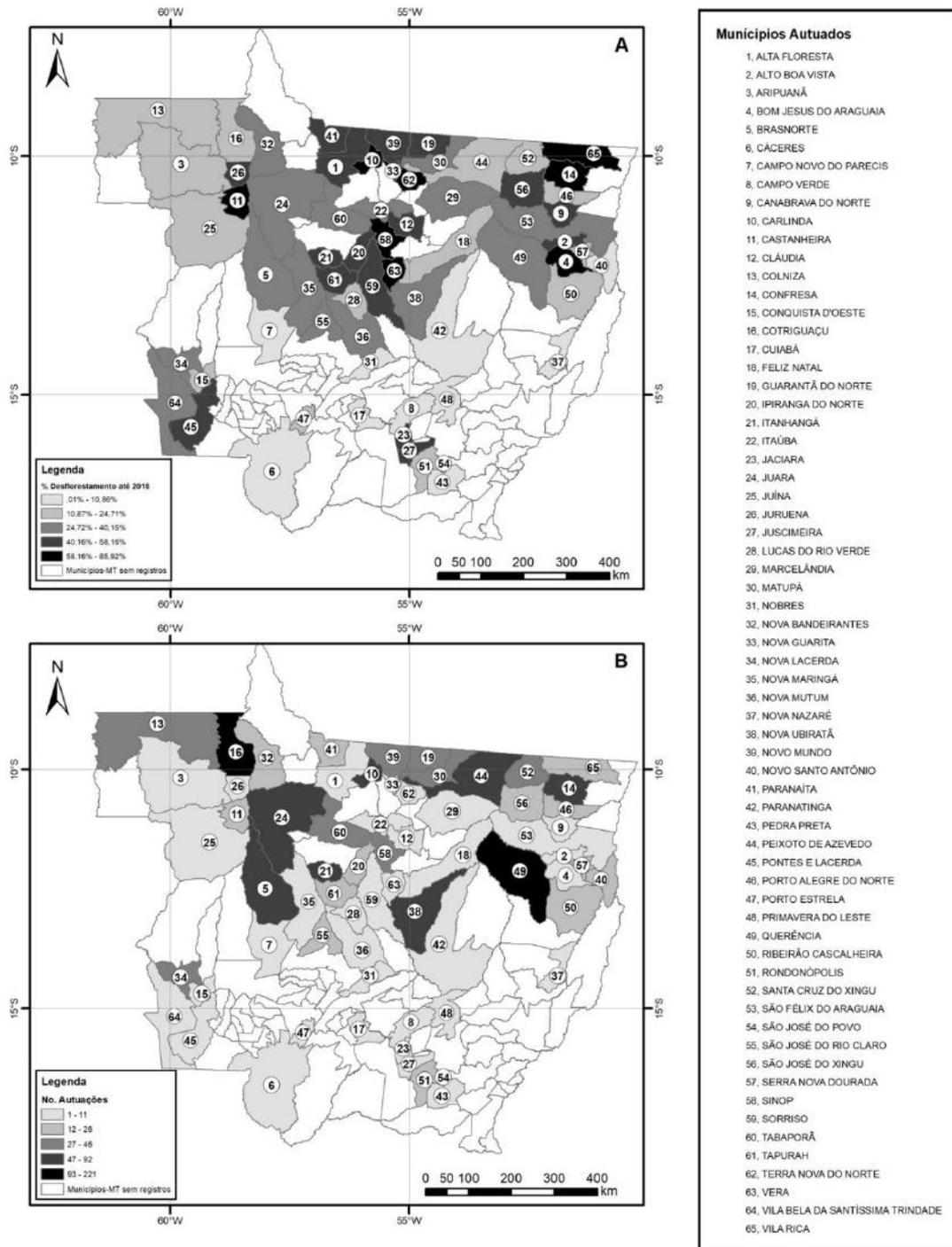


Fig.3: Deforestation (A) and notifications by IBAMA in the state of Mato Grosso up to 2016 (B) by municipality

It is interesting that the municipalities with greater deforestation did not have a significant number of notifications, but the municipalities of Cotriguaçu and Peixoto Azevedo had a high number of notifications (Figure 3B). This partially indicates that the high degree of action by IBAMA through inspections and eventual citations may be reflected in a reduction of deforested area.

Other municipalities in the central part of the state with high deforestation include Sinop, Vera, and Bom Jesus do Araguaia, with deforestation values between 58% to 86%.

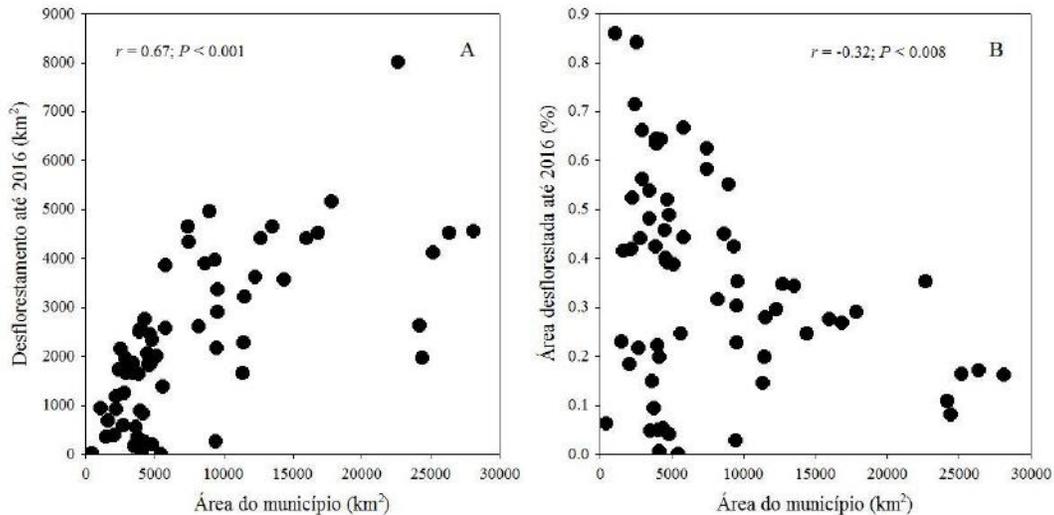


Fig.4: Pearson correlation between municipal area (km^2) and deforested area (in km^2 and as a percentage of municipal area) up to 2016

Additionally, in municipalities with areas up to $6,000 \text{ km}^2$, there was great variability in forest degradation, which ranged from 0.001 to 87% of the area being deforested (Figure 4B), so deforestation is lower in smaller municipalities. On the other hand, larger municipalities also tend to have larger deforested areas. Because this is a trend, this observation cannot be considered out of context; other aspects should be considered, such as being located within the transition area between the cerrado and Amazon biomes.

V. CONCLUSIONS

In conclusion, one of the greatest current challenges is producing sufficient food to meet the needs of an exponentially growing global population with greater longevity and purchasing power (Crist *et al.* 2017, Gerland *et al.* 2014), but human activities, including agriculture, must be carried out sustainably to ensure the preservation of biodiversity and the full functioning of ecosystem services (DeFries and Nagendra 2017, Johnson *et al.* 2017, Steffen *et al.* 2015). In an ideal scenario, agricultural production and environmental conservation should not be in opposition but

However, the number of notifications in these municipalities can be considered low, with Sinop in the range of 12 to 26 notifications and Vera and Bom Jesus do Araguaia in the range of 1 to 11 notifications. Once again, the lack of action by IBAMA tends to increase the amount of deforested area.

There was a positive relationship between municipality size and deforested area, with larger municipalities having larger deforested areas (Figure 4A). However, the proportion of deforested area decreases as the size of the municipality increases (Figure 4B).

be complementary and harmonious activities. If there are conflicts between these two goals, the results of this study show that there are important relationships between the number of environmental notifications by federal institutions, the number of individuals and entities notified, the geography of the areas, the municipalities, and their size. These effects should be considered in the decision making and actions by surveillance institutions, such as IBAMA, that play a fundamental role in performing inspections and ensuring compliance with current legislation.

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