

Legal Amazon, sustainable use and environmental surveillance “systems”: historical legacy and future prospects

A Amazônia Legal, uso sustentável e “sistemas” de vigilância ambiental: legado histórico e perspectivas futuras

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ABSTRACT

Tropical rainforests are among the most endangered biomes on the planet. They have become the new frontiers for capital expansion, both for the production of agricultural commodities and the exploitation of their natural resources. This article seeks to analyze how the command and control system is being practiced on one of such tropical rainforests, namely the Brazilian Amazon. To achieve the objectives set in the research, exploratory/descriptive methods of qualitative and quantitative approach were carried out through field research and literature review on the subject. In addition, we evaluated the publications that best described the “state of the art” of the theme, always aiming at the quality and comprehensiveness of research by bibliometric mining and field survey through questionnaires administered to military police corporations. While examining the environmental protection agencies and law enforcement agencies, both from Union and the states that make up the Legal Amazon, the conclusion was that all of them devote very little material resources to effective forest protection, and that human resources are infinitely smaller than those recommended by other international nature protection organizations. Moreover, the structure in charge of investigating environmental crimes in the states is either poor or non-existent, and distant from the main regions of deforestation and other environmental crimes, something which favors impunity. It is concluded that the lack of structure of command and control bodies in the Amazon threatens the sustainability of the ecosystem, the economy and the society on local, regional, and global levels.

Keywords: military police; environmental security; environmental inspection; command and control; public policies.

RESUMO

As florestas tropicais úmidas estão entre os biomas mais ameaçados do planeta. Elas se tornaram as novas fronteiras de expansão do capital, tanto para a produção de *commodities* agrícolas quanto para a exploração de seus recursos naturais. Este artigo procura analisar como está sendo praticado o sistema de comando e controle sobre uma dessas florestas tropicais úmidas: a Amazônia brasileira. Para alcançar os objetivos traçados na pesquisa, foram empregados métodos exploratórios-descritivos de abordagem qualitativa e quantitativa, realizados por meio de pesquisa de campo e revisão da literatura sobre o assunto. Ainda se avaliou as publicações que melhor descrevessem o “estado da arte” do tema, sempre visando a qualidade e abrangência das pesquisas por mineração bibliométrica e levantamento de campo por meio de questionários administrados às corporações policiais militares. Examinando-se as agências e organizações policiais responsáveis pela proteção ambiental da União quanto aos estados que integram a Amazônia Legal verificou-se que todas elas dedicam poucos recursos materiais para uma proteção efetiva da floresta, bem como os recursos humanos são infinitamente menores do que o recomendado por organizações internacionais de proteção na natureza. Além disso, a estrutura responsável por investigar nos estados os crimes ambientais é pobre ou inexistente e distante das principais regiões de desmatamento e outros crimes ambientais, o que favorece a impunidade. Conclui-se que a falta de estrutura dos órgãos de comando e controle na Amazônia ameaça a sustentabilidade do ecossistema, da economia e da sociedade local, regional e global.

Palavras-chave: polícia militar; segurança ambiental; fiscalização ambiental; comando e controle; políticas públicas.

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Introduction

Tropical rainforests are the most ecologically diverse biomes on the planet. They are found in more than half of all species of biomes in the world, although they comprise only 7% of the Earth's surface. They are distributed around 10° latitude north and south of Ecuador and are found in three main regions: the Indo-Malaysian regions of Borneo and New Guinea; the Congo, Niger, and Zambezi watersheds in Central Africa; and the Amazon and Orinoco watersheds in South America (KORMONDY; BROWN, 2002; ODUM; BARRETT, 2007).

These biomes are among the oldest on Earth and have global ecological importance. Rainforests do not merely influence the climate through ecoclimatic teleconnections, but are also responsible for capturing and storing huge amounts of carbon dioxide and other greenhouse gases, as well as other air pollutants. However, researchers have indicated that such capture capacity has declined by around 30% in recent decades (BRIENEN *et al.*, 2015; GARCIA *et al.*, 2016).

In addition, they are potential sources of new types of foods, materials, active medicinal ingredients, among others yet to be learned. However, rainforests are being threatened by the new frontiers of capital expansion. Vast areas are cleared for the implementation of large agricultural and livestock production projects (KORMONDY; BROWN, 2002; FARIA; ALMEIDA, 2016). In the last 20 years, the planet's rainforests have lost 10% of their areas, mainly in the Amazon and Central Africa (WATSON *et al.*, 2016).

Economic pressures for new agricultural commodities, however, are not the only vectors that threaten tropical forests. Environmental damage and crime are also serious threats to humanity. Environmental degradation and climate change may increase competition over natural resources, accentuating economic inequalities, worsening social dissatisfaction, and promoting human displacement within and between nations, thus impacting human security (COATS, 2019).

Environmental crimes are also transnational. Associated with them are other crimes such as poaching and illegal trafficking of animals, predatory fishing, as well as illegal mining, consequently causing water contamination, and deforestation. There are crimes related to falsifying public documents, corruption, and usurpation as well. These associated crimes promote the evasion of currency from the very same states where such crimes occur, as well as damage to the environment. Such crimes were formed in a branch of an extensive network of organized crime, to the extent of becoming the fourth largest illegal activity in the world, trading between \$ 91 and 258 billion (US dollar) per year (NELLEMANN, 2016; COATS, 2019).

The main objective of the research was to evaluate how the command and control system is being exerted on one of these tropical rainforests, namely the Brazilian Amazon. It is conjectured that the personnel deployed for command and control are undersized, and that the several existing bodies act in an uncoordinated, disconnected, and discontinued manner. The study was limited to the analysis of the military police of Legal Amazon's states, whose mission is to prevent envi-

ronmental crimes from being committed in this biome and to ensure that its resources are exploited sustainably.

Methodology

The methodological aspects were underpinned by an exploratory research through a census conducted among the environmental military police (PMAM for its acronym in Portuguese) of the Legal Amazon states, in which we ran a questionnaire with open, closed and dependent questions, between January and February 2019.

The questionnaire focused on the following: the number of headquarters and sub-offices that the environmental military police had; what they were called; the staff of each headquarters and sub-offices; how many police stations specialized in the investigation of environmental crimes the state counted on, what they called themselves, where they were located, and what their opening hours were; if the PMAM employed remote sensing or other geotechnology in order to monitor crimes against the flora, and, in doing so, who performed this processing and where it was carried out (in the headquarters itself or in the headquarters of another body); in the case of employing another geotechnology different from remote sensing, what would be the other one, and for what purpose it was employed; if there was some kind of official technical cooperation agreement between the state environmental agency and the PMAM, and if so, what it covered, what the counterparts would be and what their duration was; and finally, what was the opinion of the PMAM in relation to the state environmental agency in order to exercise its responsibility for environmental protection and supervision effectively.

The primary data from the questionnaires were tabulated and interpreted both qualitatively and quantitatively. Following the analysis, 18 variables were raised, which due to their characteristics, had the power to impact more directly the activities of environmental surveillance by the PMAM.

The analysis variables (Table 1) were organized in four dimensions by their socio-geographic, logistic, geotechnological, and administrative characteristics.

Subsequently, the variables were compared with data from secondary sources obtained from documentary and bibliographic researches, latter by the bibliometric method using the data mining technique. Thus, an indexed search was performed for the keywords of the article (Amazon; military police; environmental security; environmental surveillance) and their thesauri and terms that represented them in English. The keywords were searched individually, and subsequently, a combinatorial analysis was performed two by two, three by three, and finally all together, using the Boolean operators of the Scopus database (Elsevier). The search was limited to the most cited peer-reviewed journals of the last five years (REDONDO *et al.*, 2017).

Finally, the analysis was performed. The data obtained were gathered, tabulated, treated according to statistical principles and related to each other. Furthermore, they were organized according to the

Table 1 – Variables of analyses.

Dimension	Variable	Description	Type	Category / Unit of measure
Socio-geographic	1. State territorial area	shows the territorial area of the state	Discrete quantitative	km ²
	2. Conservation unit area	shows the conservation unit area of the Amazon biome	Discrete quantitative	km ²
	3. PMAm staff	shows the amount of military police officer (PM) in the environmental military police unit	Discrete quantitative	number of PM
	4. Active force of military police corps	shows the active personnel of the state military police corps	Discrete quantitative	number of PM in active service
	5. Brazilian Institute of Environment and Renewable Natural Resources (IBAMA) staff	shows the number of IBAMA agents applied in environmental surveillance	Discrete quantitative	number of IBAMA agents
	6. Chico Mendes Institute for Conservation of Biodiversity (ICMBio) staff	shows the number of ICMBio agents applied in environmental surveillance	Discrete quantitative	number of ICMBio agents
	7. Geospatialization of PMAm's headquarters and sub-offices in the state territory	shows the location of PMAm headquarters and sub-offices in state	Nominal qualitative	headquarters and sub-offices address
Logistics	8. Number of vehicles	shows the number of vehicles that the PMAm had to perform its environmental inspection activities	Discrete quantitative	number of vehicles
	9. Number of vessels	shows the number of vessels that the PMAm had to perform its environmental inspection activities	Discrete quantitative	number of vessels
Geotechnological	10. Use of remote sensing or other geotechnology	shows whether the PMAm used remote sensing or other geotechnology	Dichotomous nominal qualitative	yes / no
	11. Place where monitoring was carried out	shows the address of the geoprocessing sector	Nominal qualitative	address
	12. Purpose of using the data	shows the operational use of geoprocessed information	Nominal qualitative	use of information
Administrative	14. Existence of technical cooperation	shows the existence of official instrument of cooperation between the PMAm and the state environmental agency	Dichotomous nominal qualitative	yes / no
	15. Existing co-responsibility	shows the existing co-responsibilities in the technical cooperation instrument established between the PMAm and the state environmental agency	Nominal qualitative	description of co-responsibilities
	16. Number of police stations specialized in the investigation of environmental crimes	shows the number of police stations specialized in the investigation of environmental crimes	Discrete quantitative	number of specialized police stations
	17. The hours of the police station specialized in the investigation of environmental crimes run	shows the hours which police stations specialized in the investigation of environmental crimes run	Continuous quantitative	run hours
	18. Opinion of the effectiveness of the state environmental agency (sectional) in the protection of nature	shows the PMAm's opinion regarding the state environmental agency's action in order to protect nature	Nominal qualitative	ineffective, low effective, high effective, does not know how to inform

Brazilian state political-administrative division and their frequencies were calculated following the most widely used descriptive measures of central tendency, mean and mode. Therefore, it allowed an accurate analysis of environmental surveillance in the Legal Amazon, as it can be observed in the next section.

Results and discussion

Environmental security and sustainable use of natural resources in Amazon

The colonization of the Amazon

In the early years of colonization, the Amazon was characterized by actions aimed at maintaining Portuguese sovereignty over newly discovered lands. However, this sovereignty was only ensured if the possessor or discoverer colonized the territory. Portugal founded the city of Belém in 1616 after expelling the English, French, and Dutch, thus assuring sovereignty over the entire Amazon River basin and the Brazilian north coast, initiating the process of colonization of the Amazon (PICOLI, 2006; FURTADO, 2007; DEAN, 2007; BECKER, 2016).

In the second half of the eighteenth century, the engine of development was gold mining activities. The discovery of deposits in Minas Gerais, Cuiabá, and Goiás promoted the dream of the discovery of the Brazilian “El Dorado”, also in the Amazon, the place where all the great rivers and forests inhabited by warrior women – the Amazons – originated. The Amazons, who held treasures of precious stones, remained in the imagination of explorers — so-called Bandeirantes. The search for these treasures led the Paulistan Bandeirantes to reach the headwaters of the São Francisco, the Paraguay, and the Amazon rivers, also generating a new European migratory wave for the region (DEAN, 2007).

The nineteenth century was marked not only by the Cabana Revolution, but also by the great migratory waves, the rubber trees latex extractive activities, and the trafficking of their seeds. Large numbers of northeastern peasants migrated to the region fleeing the drought scourge in search of wealth resulting from the exploitation of rubber. In the same period, the British trafficked thousands of rubber tree seeds to London acclimatized them and developed commercial plantations in their colonies in Ceylon, Singapore, and Malaysia, breaking the Brazilian monopoly (PICOLI, 2006; FURTADO, 2007).

Extensive latex production in Asian countries not only caused the price of rubber to fall by more than 80%, but also quickly spread misery. As a result, it turned the rubber tappers to their own most primitive subsistence economy: hunting, fishing, and extrativism, similar to their native forefathers. Rubber was the most sought-after commodity in the world market between the last years of the nineteenth and early twentieth centuries, especially in industrialized countries (FURTADO, 2007).

Although the price of latex has devalued due to oversupply, the region has developed adversely. The major beneficiaries of the profits were the agents of the rubber sector and the large landowners, while the rubber tappers were subjected to a regime of semi-slavery or servi-

tude, which reduced their life expectancy due to exposure to the dangerous and unhealthy forest environment (BECKER, 2016).

Until the early twentieth century, the occupation of the Amazon was shy, since Portuguese colonization concentrated on the Brazilian Atlantic coast. Paradoxical though it may seem, World War II promoted a new cycle of economic development for the Brazilian hylean. Japan ruled over the Malaysian and Burmese rubber groves. As a consequence, the Americans resorted to Brazil as the main source of latex, formerly exploited from the two English colonies. However, production was again compromised by the lack of workforce. The option was once again the northeastern people, who were left with two options: to become “rubber soldiers” in the Amazon or “Brazilian soldiers” on the Italian battlefield during World War II (PICOLI, 2006; BECKER, 2016).

In the second half of the twentieth century, the Amazon benefited from the development of coffee-industrial culture in the Southeast region, which began to absorb all rubber production allowing the opening of new production lines, such as jute (FURTADO, 2007). From this period on, the region has been occupied in three manners:

- through spontaneous colonization;
- government direction through land distribution;
- promotion by private real estate speculation companies (companies of colonization) (PICOLI, 2006).

The process of colonization of The Amazon, however, has intensified within the last 50 years, due to the development of large infrastructure projects, such as the construction of hydroelectric power stations and federal highways. The highways promoted the integration of the Amazon with the rest of the country, becoming the engine of this process (PICOLI, 2006). They have changed the pattern of regional mobility dynamics. The connectivity between the regions, which was previously performed by waterways, is now centred on the road axes (paved roads and roads opened by loggers), facilitating the creation of settlements along these axes (Figure 1). The three main frontiers of colonization in recent times were: the municipality of São Félix do Xingu, in Pará; BR-163, the Cuiabá-Santarém highway further north of Mato Grosso; and the northern part of Mato Grosso and Rondônia towards the southern region in the state of Amazonas (BECKER, 2016).

The pattern of colonization contributed to the increase in deforestation in the region. These works reached an area of influence around 50 km from each bank. In other words, they have impacted even specially protected areas within this distance (BRASIL, 2018c).

More than colonizing expansion fronts, these new frontiers have tended to consolidate settlements due to the significant economic development and technological transformation of *agribusiness*. Soybean and cotton crops grew in production in southern Pará (PA), while agriculture advanced in southern PA and Mato Grosso (MT). The degradation and deforestation that has occurred in the south-southeast-

ern regions of PA, extending to the west through the north of MT and Rondônia (RO), and southern Amazonas (AM) has been so intense that it has become known as “Fire Arch” or “Deforestation Arch” (Figure 2) (BECKER, 2016).

The colonization projects delivered by the government to the private sector were another vector of Amazonian penetration. They were developed on unoccupied Union land that would be primarily intended for land reform. However, colonization companies benefited few rural workers. The criterion of land distribution used was the purchasing power of the interested parties, which favoured those with greater financial resources (PICOLI, 2006; BECKER, 2016).

During the process of land distribution, large numbers of migrants, either unemployed or underemployed workers, moved in search of occupation. However, the process was not peaceful or fair. Invariably, landless workers and squatters arrived after the giant landlords or even after domestic or foreign businesspeople, carrying out an agrarian reform inside out. The tactic used was the expropriation of the lands of their original inhabitants, the Indians, and the squatters, who did not have documentation to legitimize rightful ownership of the land. Holders of capital and political power, farmers and landowners, land grabbers, gunmen and *jagunços* spread terror and violence in the region in order to appropriate land (PICOLI, 2006; TOLLEFSON, 2015).

Projects such as agriculture and the woodworking industry thrived, thanks to the high profitability of the commer-

cialization of rich and noble timber. Moreover, logging was associated with agriculture, since deforested areas quickly became cattle pasture. These activities gave the region a boost and became its economic base until the present day (PICOLI, 2006).

One of the consequences of this process in the Amazon was the slumming of cities. Throughout human history, the cities have been centers of economic and political power. On the one hand, cities were modernizing in structures and services in order to attend necessity demanded by both the ruling economic and political classes. On the other hand, large estates could not absorb all the available labour. Thus, idle labor migrated to large urban centers, giving rise to slums and stilt, the “human clusters of exclusion”, especially in those cities that had rural *commodities* and were export corridors. These spaces became belts of poverty and misery, bringing huge social costs to those who inhabited them. Since the individuals inhabiting these spaces were ostracized and placed in the outskirts of town less supplied by basic public services, they did not create an emotional link with that new territory. In other words, they became *detrterritorialized* (COSTA, 2004, p. 278; PICOLI, 2006; RICHARDS; VANWEY, 2015).

The last decades of the twentieth century brought new challenges to the Amazon. It was the region with the highest urban growth rates in the country, according to the 2000 Census. Although, the cities within the Amazon still lack basic public services despite such growth. Furthermore, environmental awareness has sprouted a sense of unity in

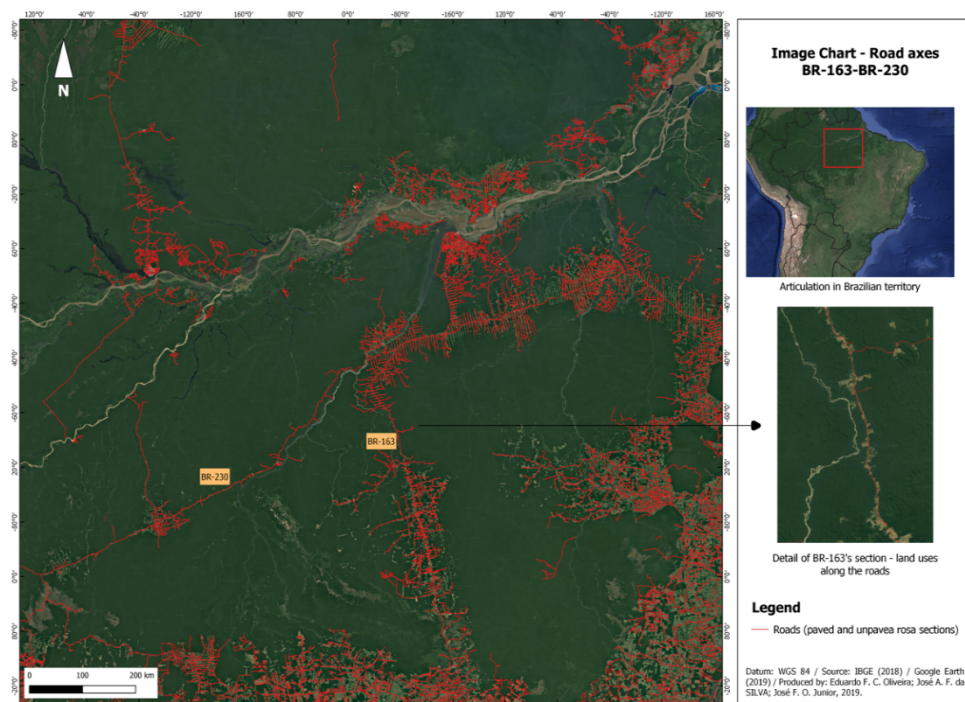


Figure 1 – BR-163 and BR-230 Road Axes.

the world and Brazil, thanks mainly to the advancement of geotechnologies. These conditions were adequate for the proliferation of several civil society organizations. By this time, the environment was already the second biggest concern of young people in big cities (SVIRSKY; CAPOBIANCO, 1997; DEAN, 2007; BECKER, 2016).

In this regard, Becker (2016) noted that the Amazon had become an “urban forest” due to its significant urban growth in the last two decades of the twentieth century. Although this development has generated high social and environmental costs, it was thanks to it that the region has achieved the level of progress it currently has, even with social indicators still lower than the rest of the country. However, socio-environmental conflicts emerged in the 1990s between policymakers and those who wanted to protect the environment, advocating economic development through the sustainable exploitation of the forest and its natural resources. The defence of the forest and its resources killed in Brazil about 622 activists between 2002 and 2017 (MIDDELDORP; LE BILLON, 2019).

Today, the Amazon is no longer a frontier for migratory expansion, but a region with its production structure and multi-stakeholder projects. Civil society is a key player in this movement, both in rural and urban areas. Faced with the economic and political crisis of the central government, the Amazon states assumed the political responsibility to develop their own regions. These states adopted different strategies, such as extensive land use in the cases of Mato Grosso and Pará, and in-

dustrial development, as was the case of Amazonas, with the establishment of the “Manaus Free Zone” (BECKER, 2016; NOBRE *et al.*, 2016).

Forest preservation is directly related to the development of sustainable products that can compete in terms of economic value with livestock and logging. This involves a scientific and technological revolution of the Amazon Forest, based on the techno-productive chain and biodiversity, as well as transforming forest communities into centers of advanced technology (BECKER, 2016).

Geotechnologies and the Geopolitics of the Amazon

According to Becker (2016, p. 16), geopolitics “is a field of knowledge which analyzes relations between power and geographical space”. Thus, the development of geotechnologies remote sensing, brought two important changes in perspectives on the Amazon region.

First, a supported by geotechnologies. Satellite imageries have heightened awareness of the Amazon by highlighting the role it plays as a forest in capturing and storing greenhouse gases, so crucial to mitigating the effects of global warming and preserving biodiversity. The result of this change has been that nature-provided ecosystem services have been re-evaluated and revalued (COSTANZA *et al.*, 2014; BECKER, 2016).

Geotechnologies have made it possible to observe the planet as a whole and in a systemic way, giving rise to a common sense of respon-



Figure 2 – Burn in the Amazon, in the municipality of Altamira (PA).

Source: Figueiredo (2019).

sibility for its protection to a large portion of mankind. However, technological development and popularization in the production of *web* maps have promoted negative externalities, thanks to mobile mapping on portable devices and the development of free and open source software, such as deforestation in smaller areas than satellite imagery could capture (TSOU, 2011; MENEGUETTE, 2012). Therefore, between 2002 and 2009, the amount of small deforestation increased from 30 to 73% of all deforested areas in MT, PA, and RO, which makes remote surveillance difficult (ROSA; SOUZA JR.; EWERS, 2012; BECKER, 2016).

Second, the development of geotechnologies increased the need for governmental presence in the Amazon in order to maintain national sovereignty. From an economic point of view, the different sensors of satellite images facilitated and promoted the discovery of huge mineral riches in the underground of the Amazon, increasing international greed for the region. There was a strategic need for preservation of national sovereignty over the Amazon region by the Brazilian government through the thickening of the military presence in the region with the installation of multiple bases. The consequence of this process was the increase of areas under special protection, such as conservation units (UC for its acronym in Portuguese) and indigenous lands, comprising an area of more than 30% of the Amazon, equivalent to the territory of Spain (BRASIL, 2008b; PICOLI, 2006; BECKER, 2016).

Cunha e Menezes (2015, p. 210) found out that the creation of protected areas was part of this defence strategy, since protected areas “prevent land grabbing, restrict uncontrolled deforestation... direct migratory movements, and encourage development according to pre-conceived vectors”.

The scarcity of the government’s presence in the Amazon has happened for years. While the strategy of creating UC as a tool for maintaining sovereignty, seemed to be good in theory, on the other hand, it has been proven ineffective in recent years. Between May 2017 and May 2018, deforestation in the Amazon advanced 73%. Most of them in areas under the special protection regime, such as UC (30%), land reform settlements (13%), and indigenous lands (1%) (FONSECA *et al.*, 2018). The impunity of criminals is also associated with deforestation in the areas that they operate. Only 10% of all administrative fines imposed by federal command and control agencies were paid (BARRETO *et al.*, 2009). The creation of UC and the installation of military bases were not enough to stop the environmental crimes that plagued the Amazon.

Environmental security in the Amazon

Environmental security is the branch of scientific knowledge that studies how dynamics and connections between the environment, society and the economic engines influence the stability both local and regional. Yet it analyzes the role that natural resources play in promoting, preventing, mitigating, and resolving conflicts in all its dimensions. For this reason, environmental security plays a key role in the promotion and preservation of national security of any country (UNITED

NATIONS ENVIRONMENT PROGRAM, 2009; INSTITUTE FOR ENVIRONMENTAL SECURITY, 2019).

The Legal Amazon has its largest portion inserted in the Brazilian northern region. In addition, this region was the most vulnerable from environmental monitoring by the environmental military police (PMAM for its acronym in Portuguese). Although it has the largest territorial extension, it has the smallest contingents of environmental military police and the smallest number of vehicles and vessels intended for surveillance. The region also uses less technological resources, such as aircraft and drones, and it is the region that employs least geotechnologies for remote sensing (CABRAL DE OLIVEIRA, 2018).

Environmental problems in the Amazon are not limited to deforestation; in reality, they have only become another branch of organized crime. There was a wide variety of crimes connected to a well-organized chain of diverse actors, from the humblest individual doing manual work to the leaders with great economic and/or political power, as well as public officials. In addition to deforestation, they included crimes such as hunting, for sporting purposes, meat consumption, and the capturing of animals for trafficking; illegal mining activities; tax evasion; predatory fishing and catching ornamental fish for export; drug trafficking; smuggling of forest and biological products; money laundry; active and passive corruption, etc. (VAN VLIET *et al.*, 2015; BECKER, 2016; UNGAR, 2017).

There were several negative externalities associated with these crimes. Among them, we could cite loss of soil productivity, changes in the hydrological system, loss of biodiversity, global warming, acculturation of indigenous and traditional communities, tax evasion, water and soil pollution, siltation of watercourses, and violence (UNGAR, 2017).

The interconnection between violence and environmental crimes in the Amazon has never been so clear. Following the work of Waiselfisz (2015) concerning the outbreaks of violence by municipalities, he identified that in addition to those outbreaks already traditionally located in urban centers and metropolitan regions, new ones appeared. Among them, the municipalities that make up the Amazon “Deforestation Arc”, which accounted for about 65% of all deforested areas in the Amazon in 2016 (BRAZIL, 2018c). Especially in these places, crimes are associated with slave labour, illegal logging, land grabbing, the extermination of indigenous communities or the appropriation of their land, and large unproductive landlords — all with the goodwill of politicians and financial groups.

The importance of the Amazon for social and environmental balance

The Amazon and its concepts

The noun “Amazônia” refers to at least three geographically well-defined and diverse concepts. First, the biogeographic features the Amazon within biome perspective, i.e., a large continuous area with similar characteristics to biotic and abiotic (KORMONDY; BROWN, 2002; ODUM; BARRETT, 2007). In this light, the Amazon biome extends beyond Brazilian borders and extends over 7 million km², 60%

of them in Brazil and the rest distributed in eight other countries: Bolivia, Peru, Ecuador, Colombia, Venezuela, Guyana, France (French Guiana), and Suriname. The sheer size of the Amazon has influenced some authors to call it the South American or International Amazon (PICOLI, 2006; SANTOS, 2015).

According to the political-administrative concept, by derivation, it deals with the state of Amazonas as one of the 27 federative units that make up the Brazilian state as well as one of the seven states in the northern region of the country (Brazilian federative units and its abbreviation: Acre – AC, Alagoas – AL, Amazonas – AM, Amapá – AP, Bahia – BA, Ceará – CE, Distrito Federal – DF, Espírito Santo – ES, Goiás – GO, Maranhão – MA, Minas Gerais – MG, Mato Grosso do Sul – MS, Mato Grosso – MT, Pará – PA, Paraíba – PB, Pernambuco – PE, Piauí – PI, Paraná – PR, Rio de Janeiro – RJ, Rio Grande do Norte – RN, Rio Grande do Sul – RS, Rondônia – RO, Roraima – RR, Santa Catarina – SC, Sergipe – SE, São Paulo – SP, and Tocantins – TO).

Finally, the third approach defines the Amazon under the socio-economic aspect. This approach was defined as of 1953 with the creation of the “Amazon Economic Recovery Plan” (BRASIL, 1953). However, the term “Legal Amazon” was only adopted from 2009 when the government attempted to regularize land occupations on land under the Union’s domain and was later adopted in more recent legislation (BRASIL, 2009). Currently, the Legal Amazon comprises the area corresponding to the states of Acre (AC), Amazonas (AM), Amapá (AP), Mato Grosso (MT), Pará (PA), Rondônia (RO), Roraima (RR), Tocantins (TO), and part of Maranhão (MA) (BRAZIL, 2007). Figure 3 presents geographically the various concepts of the word “Amazon”.

The Amazon as a biome, nonetheless, has its survival threatened firmly in its strengths: the forest, biodiversity, and water resources. It is estimated that around 20% of all vegetation in the Amazon rainforest has already been destroyed (NOBRE, 2014). The realization of these threats can impact Brazil and the world in several ways: on climate change at local, regional, and global levels; in the economy; and on biodiversity. These are the topics that will be covered in the next sections.

The Amazon and the climate change

The international community has drawn its attention to the Amazon, and the importance of this broad region is getting known around the world. If the Amazon were a country, it would be the 9th largest in the world. Since it comprehends a large mass of land, it has implications for the survival of *homo sapiens*, who as a species relies fundamentally on the preservation of the forest. It captures and stores 120 tons of carbon year⁻¹, mainly by large trees (diameter at breast height - dap ³ 60 cm), which accumulate almost half of all aboveground biomass. This represents more than 17 times the amount of carbon that the United States expels annually (SIST *et al.*, 2014; UNGAR, 2017). Thus, the Amazon plays a key role in global warming, capable of enhancing or mitigating its effects according to its use (BECKER, 2016; PHILLIPS; BRIENEN; THE RAINFOR COLLABORATION, 2017).

Moreover, rainforests promote life-critical ecosystem services. Approximately 90% of all moisture that reaches the atmosphere from terrestrial ecosystems did so through evapotranspiration (JASECHKO *et al.*, 2013). The recycling of water that the Amazon performs is essential for the water balance of the entire South American continent. It is estimated that only the Amazon transpires somewhere around 20 trillion litres of water a day⁻¹, forming true “flying rivers”. These “rivers” are responsible for moisture in the Southeastern and Southern regions of Brazil, the Pantanal, the Chaco, and the agricultural areas of Bolivia, Paraguay, Uruguay, and Argentina, where it is discharged by rain, which also promotes an energy gradient, reducing atmospheric pressure and accelerating ocean winds inland.

Other factors that favour the occurrence of the “flying rivers” are the atmospheric circulation combined with the geological formation of the Americas. The distribution of deserts and wetlands on Earth are established by the largest latitudinal climate belts. They ensure that there is not merely a predominance of forests along equatorial latitude, but also the dominance of arid regions around the Tropics of Cancer and Capricorn. This phenomenon is known as Hadley’s circulation. However, the geological formation of the Americas has caused the Andes to dominate the entire western portion of the continent, forming a barrier that directs the “flying rivers” to its south-central portion. This combination of factors caused the region to become an exception to the rule. Otherwise, it would be a true desert, such as those of Atacama, on the other side of the Andes; Namibia and Kalahari in southern Africa; and the Great Victoria Desert in Australia; all at the same latitude (NOBRE, 2014; RICKLEFS; RELYEA, 2014). Thus, decimating the Amazon forest would incur the interruption of this supply of moisture.

These true “Wooden geysers” not only perspire water, but also the evapotranspiration carry biogenic volatile organic compounds (BVO-Cs for its acronym in Portuguese), such as isoprene and monoterpenes, are essential for formation of clouding nuclei and rainfall production (SINDELAROVA *et al.*, 2014; CSETTKEY, 2015; WANG *et al.*, 2016). However, such phenomena neither are completely known, nor is synergy between them entirely understood. Also, forest evaporation and transpiration occur even during drought periods, although in pastures, the volume is much lower than those produced by forests (LOVEJOY; NOBRE, 2018).

Another worrying and little-known fact are how climate change and the indiscriminate use of fire to clean and eliminate trees, grass, and weeds can contribute to changes in the hydrological cycle. This concern worsens even more during the occurrence of the La Niña phenomenon, when the risk of fire is increased (SODRÉ *et al.*, 2018). The first mathematical models presented as a forest tipping point a deforestation rate of 40%. When the variables of climate change and indiscriminate use of fire are added, computer modelling indicated an even lower tipping point, around 20–25% of deforestation.

These changes would promote “savannization” of the region, with canopy loss, grass invasion and biomass loss, as well as it has already occurred

in some areas of the same latitude. Scientists have suggested that severe droughts in 2005, 2010, and 2015-16 were the first signs of these changes in the region's hydrological cycle (BRANDO *et al.*, 2014; DOUGHTY *et al.*, 2015; ROWLAND *et al.*, 2015; LOVEJOY; NOBLE, 2018).

However, these same scientists stressed that developing the Amazon can transform the paradigm of development worldwide.

The economic importance of the Amazon

The Amazon region has riches still little explored. The mapping of the Amazon underground demonstrated a potential that can raise Brazil to a new economic level in the region and the world. Globalization and the fall of most trade barriers have aroused concerns about the need to maintain sovereignty over this territory (CUNHA; MENEZES, 2015).

However, the challenge is how to exploit this potential under a new sustainable development paradigm. This can be accomplished through the combined use of digital, biological, and material technologies from the 4th Industrial Revolution, thereby creating high value-added advanced products, services, and platforms (BECKER, 2016; NOBRE *et al.*, 2016).

Becker (2016) noted in his research the existence of three challenges that science and technology must overcome to reconcile economic development and conservation of natural resources:

- the new global geopolitical significance of the Amazon as a vast natural capital frontier;
- the new role of the Amazon in Brazil;
- the urgency of a new development policy and basic strategies for implementing them.

However, at the regional level, it is necessary for this development to be inclusive, sustainable, and sustained, and based on five pillars: social, environmental, territorial, economic, and political (SACHS, 2008).

From a national perspective, the Amazon has a major impact on the water sustainability of other Brazilian regions, particularly the South and Southeast. Both are those with the highest economic potential, accounting for 20 and 50% of Brazilian GDP, respectively (IBGE, 2019). At this point, a controversial idea arises: does it seem likely that a severe change in the hydrological cycle of these regions would have the potential to promote political, social, and economic consequences such as migration, conflict over natural resources, and loss of productive capacity? The answer is yes. The depletion of resources can lead to a social and public order collapse of the Amazon region, Brazil, and the planet in the short term.

The Amazon on a global scale is a huge carbon store, notably 120 tons of carbon a year⁻¹. Conservation of the region is essential to an effi-

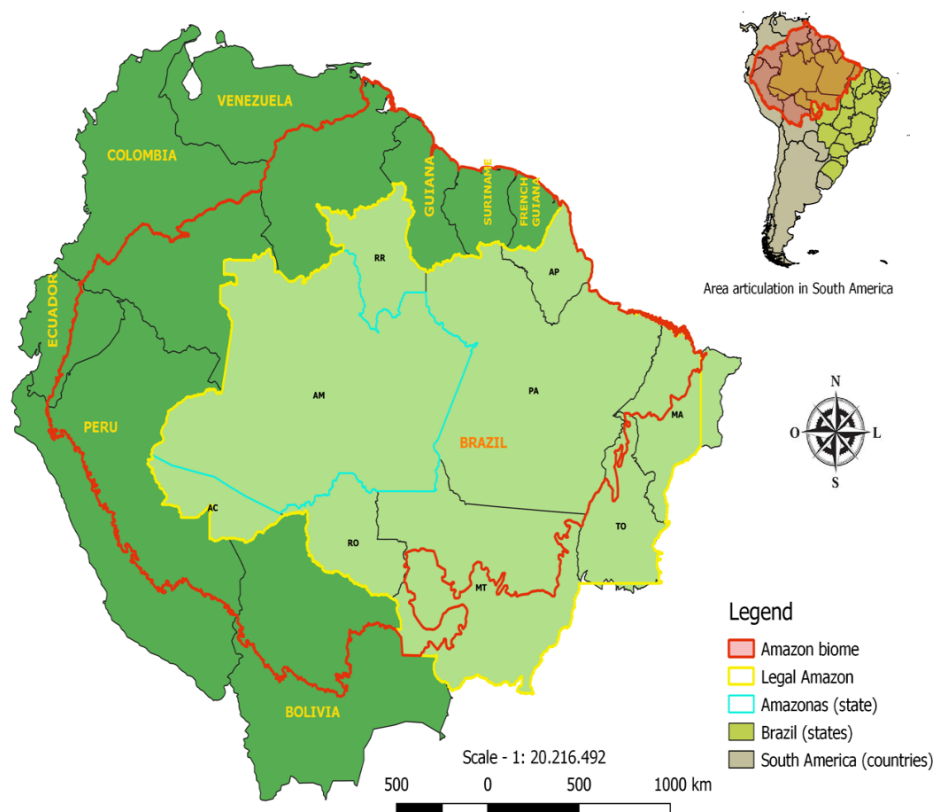


Figure 3 – The geospatialization of the various concepts of the word “Amazon”.

cient global carbon cycle for its ability to store carbon, thereby mitigating the effects of global warming by reducing the amount and intensity of extreme climate phenomena, which affects contemporary humanity, endangers the climate and human security, and its biodiversity (ABRIL *et al.*, 2014; UNGAR, 2017).

Amazon biodiversity

Brazil is considered to be the most biodiverse country on the planet, having in its different biomes 13% of all species of living beings. Hence, Brazil is recognized as the most megadiverse nations in the world. The Amazon is not simply the largest biome and the most extensive tropical rainforest in the world, but also the biome with the largest number of fauna species, totalling 5,250 taxa (BRASIL, 2018b).

Nevertheless, this megadiversity is associated with the current intangibility of some of its areas. The westernmost portion of the Amazon biome is the least inhabited, the best-preserved, and where the largest border strip in the country is located (BECKER, 2016). This part of the biome is among the last five wilderness regions on the planet. The Amazon, along with the forests of northern Russia, the boreal forests of Canada, the arctic tundra in Alaska, and the Australian desert, make up 70 percent of all the world's wilderness (WATSON *et al.*, 2018).

However, all these biological heritages are threatened. Worldwide 3.3 million km² of all wildness areas have already been lost, 30% of them in the Amazon (WATSON *et al.*, 2016). Like other tropical forests, the sustainability of the Amazon biome is being threatened through activities that are potentially harmful to the environment. Some of them are associated with organized crime, which compromises the sustainability of the use of its natural resources, expropriating resources of its population, sometimes with the use of violence, as well as plundering the government of taxes and fees on the exploitation of natural resources.

Deforestation, burning, damming of watercourses for power generation, waterways, predatory fishing, mining, and pollution are among the main vectors that endanger the sustainability of the Amazon as a biome (NEPSTAD *et al.*, 2014). Furthermore, these anthropogenic interventions can double the loss of biodiversity in the region, including ichthyological fauna (LOBÓN-CERVIÁ *et al.*, 2015; BARLOW *et al.*, 2016; BETTS *et al.*, 2017). Some social and environmental initiatives have been taken to reduce deforestation and protect biodiversity. The creation of the Amazon Fund was one of them.

Amazon Fund

The Amazon Fund was an initiative by The United Nations aiming at reducing greenhouse gas emissions from deforestation in the Amazon biome. It is regulated by Decree No. 6,527/2008 (BRASIL, 2008a) and raised between 2009 and 2017 more than R\$ 3 billion (three billion reais), being 93.3% of this amount from the Norwegian government, 6.2% of the German government, and 0.5% of Petrobras, a Brazilian oil company. During this period, 95 projects were financed for a to-

tal amount of more than R\$ 1.5 billion (one and a half billion reais). Most of the projects (52) involved third sector organizations, which absorbed 38% of these resources, followed by the Legal Amazon states that benefited from 34% of that amount. The Union was the third most benefited from the use of 24% of the fund values in eight projects (BRASIL, 2018a).

The projects also favoured some federal and state operative command and control agencies. the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA for its acronym in Portuguese) was awarded funds for renting cars and helicopters (R\$ 56 million) and to structure the National Center for Forest Fire Prevention and Fighting (Prevfogo for its acronym in Portuguese) and environmental education (R\$ 14 million). The Mato Grosso Military Fire Department funded the installation of a forest fire fighting airbase, as well as the acquisition of aircrafts (R\$ 12.5 million). The National Force of Public Security (FNSP for its acronym in Portuguese) structured its company of environmental operations with those resources (R\$ 30 million). The state of RO acquired equipment for the installation of the Air and Ground Operations Base of its Military Fire Department in Porto Velho, its capital (R\$ 15 million) (BRASIL, 2018a).

However, the vast majority of PMAMs of the Legal Amazon's states has never directly benefited from resources of this fund. It was not known whether for lack of submission of projects or their non-approval, and the only exception was the MT PMAM. The Amazon Fund supported the construction of an integrated center for environmental operations in the northern municipality of Colniza. This center would be attended not only by PMAM from MT, but also by members of FNSP, Federal Police (PF for its acronym in Portuguese), and IBAMA. The goal would be to increase the presence of state command and control agencies to prevent deforestation in a region where it occurs most intensely (BRASIL, 2016). Even though this center has already been built, PMAM of MT has not yet integrated it due to a lack of staff.

Future prospects of environmental protection in the Amazon

The strategy of promoting the thickening of the military presence in the Amazon to guarantee Brazilian sovereignty over the region seems to have been successful. That is more that can be said of the creation of areas under special protection, such as indigenous lands and UC. Although these areas would be under a stricter special protection regime than in other areas, they were the ones that suffered the most from illegal deforester actions. Approximately 45% of all deforestation in the Amazon between May 2017 and May 2018 occurred in UC (30%), land reform settlements (13%), and indigenous lands (1%) (FONSECA *et al.*, 2018).

Moreover, what prevailed in the practice of these environmental crimes was impunity. Only 10% of all administrative fines imposed by IBAMA to environmental offenders in protected areas were received (BARRETO *et al.*, 2009), as well as those applied only for deforesta-

tion had a payment rate of around 1% (UNGAR, 2017). These data support the case study conducted in Rio de Janeiro that found that only 4% of all environmental criminals arrested by PMAm in that state in 2014 were convicted in court (CABRAL DE OLIVEIRA; ALVES; FERREIRA, 2018).

Concerning UC, the data collected suggest that they are unprotected. The Chico Mendes Institute for Conservation of Biodiversity (ICM-Bio for its acronym in Portuguese), for example, had around 288 inspectors to oversee 118 conservation units in the Legal Amazon, which together amounts to about 605,000 km² (CABRAL DE OLIVEIRA, 2018; ICMBIO, 2019). The UCs of the Legal Amazon are unprotected, not merely owing to the absence of inspection agents, but also because of the validity of a Forest Code (BRASIL, 2012) much less rigid in the preservation of natural resources than the previous one (NICOLAU *et al.*, 2018).

The PMAmS of the member states of the Legal Amazon together total 1,229 members and are responsible for a policing area of more than five million km². These amounts are proportional to one inspector per each 2,100 km² block in the case of ICMBio, and one environmental military police officer (PM) per each 4,097 km² block in the PMAm. However, the average ICMBio inspector was calculated, taking into consideration only the area of federal UCs, while in the case of the PMAm, the calculation was based on the area of the entire Legal Amazon region.

In addition, the data maintain that these averages are much lower than those recommended by international nature protection bodies and those practiced in other countries of the Americas. The International Ranger Federation (IRF), for example, proposed that the ideal for adequate protection of an area under special protection regime, such as UC, would be that of a park ranger for a block of 100 km² (1/100). The International Union for Conservation of Nature (IUCN) advised that, according to the risk of extinction of species, the park ranger relationship by km² protected should be even lower, ranging from 1/10 and 1/30 km². Guatemala, Panama, Nicaragua, and the USA have an average of rangers very close to that recommended by the IRF, ranging from 1/74 to 1/125 per km² (EMSLIE; BROOKS, 1999; CUNHA; MENEZES, 2015).

As for the PMAmS, the data found in the survey indicate that the average of environmental military police per km² in the Legal Amazon is also much lower than the national average. While the national average is one environmental military policeman for every 1,173 km², in the Legal Amazon, this ratio has been reduced to one PM for an area of 4,097 km². The averages also vary considerably across states, such as in RO where it is found the best proportion, with an average of 1 PM/914 km², and in AM where the average is 1 PM/11,902 km² (Table 2).

IBAMA agents are responsible for overseeing the entire territorial extension of the states, and in many of them, the proportion of agents per km² was lower than the PMAmS. In the state of PA, for

example, the proportion was from an inspector to an area of 7,998 km², while in AM, this proportion was even lower. In 2014, there were only 47 agents to oversee its more than 1.5 billion km², equivalent to the average of one inspector for every 33,100 km² of the area to be inspected (SEVERIANO, 2014; UNGAR, 2017).

The PMAmS of the states that make up the Amazon have so much diversity among themselves, as its fauna. Take the case of personnel that they devote to environmental policing. The percentage ranges from 1% to almost 5% of its active staff (Table 3).

They also have most of their headquarters and sub-offices concentrated in the capital of their respective states, such as the states of AC, AM, AP, and RR. The state of MT has its headquarters in the capital, Cuiabá, and concentrates its subdivisions on the south. PA does further east and southeast. RO does it close to its borders. MA has its subdivisions located in the capital, São Luís, and one in each of its western and eastern limits. TO is the state with the largest number of nodes between headquarters and sub-offices, with a balanced distribution throughout its territory.

The interaction between the PMAmS and the territory is directly related to this spatialization. In other words, the larger the nodes of this network formed between the headquarters and their subordinate sub-offices, the greater their interaction with the territory, and the greater the effectiveness of environmental overview.

Moreover, they are also different to their socio-geographic characteristics, its logistics structures, the forms as they are used in geotechnology, and finally, the administrative support they receive for environmental policing activities. One of the most striking socio-geographic characteristics that directly influence environmental surveillance is the intentional violent death rate (MVI, for its acronym in Portuguese, refers to the sum of the victims of intentional homicide, murder, bodily injury followed by death, and deaths resulting from police interventions on and off duty, in some cases). They impact these activities since in Brazil, there is a tendency for the higher the MVI rate, the lower the percentage of the staff devoted to environmental policing. Thus, most states show MVI rates above the national average of 30.8 per 100,000 inhabitants (Table 4).

Legal Amazon's PMAmS are among the most logistically deficient. They have the lowest absolute numbers of personnel, vehicles, and vessels when compared to their counterpart of the rest of the country, and they also have poor use of geotechnologies. Only two states use drones (AP and RR), two have a geoprocessing sector at their headquarters (AC and MT), three use remote sensing for environmental surveillance purposes (AC, MT, and AM), and two employ thematic maps for operational planning (AM and TO).

When it comes to administrative support, the differences stand out even more. The states of MT, RO, and RR are the only ones that have a delegation of competence regarding the environmental administrative police power to carry out their activities. The role of the state envi-

ronmental agency (sectional) is considered effective or very effective to only four states (MA, MT, PA, and TO), while others consider the performance to be of little effect or an ineffective body. Interestingly, the PMAMs of the states of MT and PA, even considering the work of the state agency as effective or very effective, is among states with the highest deforestation rates in the region.

Police stations specializing in the investigation and prosecution of environmental crimes also act poorly. Although the states, except AC, have at least one station of this nature, all the others are located in the capitals of their respective states, distant from the main areas of illegal deforestation, and run only on weekdays during business hours or part-time. The lack of adequate investigation, with robust evidence to identify and punish violators of environmental law, favours impunity and inequalities in the Brazilian Amazon region are accentuated.

Without coordinated and integrated action between the command and control bodies and adequate logistical resources, it will be very difficult to achieve effective results in the environmental supervision of a region as vast and complex as the Legal Amazon.

Final considerations

The protection of the Brazilian Amazon demands a tremendous challenge and effort from state command and control agencies, not merely for its continental extent, but also for the inaccessibility of some areas. The colonization of the region took place *sui generis* because it went through periods of long stagnation and successive migratory waves to exploit its natural resources. However, the most striking fact was the tactic of expropriation of the lands of their original inhabitants: the Indians and the settlers. Without documentation assuring them of legal ownership of the land, they were expelled from it by both the dominant political elites and those most economically privileged. Sometimes, these elites were from both categories, and they used land grabbers, gunmen, and *jagunços* to spread fear and cruelty upon the early inhabitants of these lands. This is a tactic that unfortunately endures to the present days.

However, the technological advance brought a new perspective to the Amazon, attracting the attention of the world and giving rise to a sense of oneness and common responsibility for the region. Nonetheless, environmental problems in the Legal Amazon are not just about

Table 2 – Average proportion of environmental military police per km² protected.

State	AC	AP	AM	MA	MT	PA	RO	RR	TO
Average of Environmental Military Police per km ²	1/3,492	1/992	1/11,902	1/3,688	1/5,221	1/5,356	1/914	1/8,627	1/2,222

Source: The Authors (2019).

Table 3 – Percentage of the environmental military police (PMAM) personnel in relation to the active force of the Military Police in 2016.

State	AC	AP	AM	MA	MT	PA	RO	RR	TO
PMAM personnel in relation to the active force of the Military Police in 2016 (%)	1,93	4,28	1,42	1,01	2,19	1,57	4,94	1,36	3,31

Source: adapted from IBGE (2016).

Table 4 – Rate of intentional violent deaths per 100 thousand inhabitants (2017).

State	AC	AP	AM	MA	MT	PA	RO	RR	TO
Rate of intentional violent deaths per 100 thousand inhabitants (2017)	63,9	55,8	31,3	29,4	31,5	53,4	28,1	44,0	26,6

Source: Fórum Brasileiro de Segurança Pública (2018).

agrarian problems and deforestation. The Amazon region has become a stage in an extensive and well-diversified network of organized crime that threatens local, regional, and global environmental security.

Amazonia performs ecosystem services that are not only essential for mitigating the effects of climate change globally, but also for maintaining the water sustainability of the Southern and Southeastern regions and part of the South American cone, as well as for conserving local biodiversity. In this light, command and control bodies play a key role in mitigating these problems.

It was evaluated how these state command and control systems responsible for the protection of the Brazilian Amazon rainforest are developing. This assessment comprised four discussions. The first aimed to identify how many agents (inspector or PM) were designated for this protection. Survey data showed that the average IBAMA, ICMBio, and PMAm agents per km² are infinitely lower than recommended by international nature protection bodies, such as IRF and IUCN. Furthermore, the average of environmental military police officers per km² in the Legal Amazon is about a quarter of the average of the other states of the federation, as well as the percentage of active personnel that each state military police corporation devotes to environmental policing varies greatly.

The second analyzed how the headquarters and subdivisions were geospatialized in the territory of each state. It was found that most of the PMAm have their headquarters and subdivisions located in the capitals of their states. This contributes negatively to the effectiveness of overseeing activities since the more dispersed, the greater their interactions with the territory.

The third discussion was about their socio-geographic characteristics. It was revealed that the higher the state's MVI rates, the lower the percentages of active personnel that military police corporations will devote to environmental policing.

Finally, the fourth argument was about the logistical and administrative structure that PMAm have to perform their services. The information obtained from the research clarified and confirmed that they are among the most deficient, also in terms of the logistic point of view of vehicles and vessels. Moreover, most of them consider the

performance of the state environmental agency to be ineffective or inefficient. Surprisingly, the PMAm of the states of MT and PA consider the performance of those agencies to be effective or very effective, although they are among the states with the highest deforestation rates in the region. Also, the form of policing commonly used in law enforcement is motorized, and deforestation occurs along the axes of paved roads or roads opened by loggers. This fact suggests that motorized policing is not being carried out effectively.

Another fact revealed by the research is that, except for AC, all other states have only one civil police station specialized in the investigation and repression of environmental crimes. However, these public offices are not only located in their state capitals, which are away from areas where illegal deforestation occurs and far from other environmental crimes, as well as these public offices are only open during business hours or part-time.

The lack of structure of the command and control systems and their uncoordinated, disconnected, and discontinued performance compromises the ecosystem, economic, and social sustainability of the Legal Amazon. In the medium to long term local impacts, they will have the same consequences at the regional and global level. Thus, the findings of this paper should be viewed as opportunities for improving environmental inspection in general.

This research also presents the possibility of precious points to be investigated in future research, such as the assessment of how other biomes and their ecosystems are being protected, thus obtaining an overview of the entire national territory. Another research opportunity presented by this study is the possibility of verifying the viability of the use of PMAm in the policing of UCs, which keep relevant and valuable biotic and abiotic representatives of Brazilian nature.

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Cabral de Oliveira, E.F.: Formal analysis, Data curation, Writing – original draft, Investigation, Methodology, Conceptualization, Project administration, Review & editing. Oliveira Júnior, J.F.: Formal analysis, Data curation, Writing – original draft, Investigation, Methodology, Visualization.. Silva, J.A.F.: Formal analysis, Data curation, Writing – original draft, Investigation, Methodology, Supervision, Validation.

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