DATA COLLECTION SURVEY FOR GLOBAL COOPERATION ON FOREST FIRE IN AMAZON BASIN - *BRAZIL*

Final Report

Commissioned by:

Japan International Cooperation Agency (JICA)

Coordinated by:

Nippon Koei Co. Ltd. (NK)

Executed by:

Thiago Oliveira Rodrigues (consultant)

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INFORMAÇÃO PARA SUSTENTABILIDADE

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Introduction

This report is a product of the consultancy **DATA COLLECTION FOR GLOBAL COOPERATION ON FOREST FIRE IN THE AMAZON BASIN - BRAZIL**, commissioned by the Japanese International Cooperation Agency (JICA), coordinated by Nippon Koei and executed by SEIVA Information for Sustainability.

The consultancy took place between September 2021 and February 2022. The research was carried out based on the collection of secondary **data from relevant institutions in the prevention and combat of forest fires in the Amazon biome, in addition to a technical visit to Cuiabá.** In this visit, some key actors were interviewed, in order to improve the understanding of how institutions in the state of Mato Grosso are dealing with the fire problem.

In possession of the data and information, this report was prepared with the purpose of highlighting the environmental and socioeconomic context of forest fires in the Amazon, the regulatory, financial and institutional aspects in the biome and in the state of Mato Grosso and the potential forms of cooperation to the Japanese government.

SEIVA thanks everyone who cooperated with time and provided data and information to carry out this consultancy. We remain at your disposal for any clarification. We are also open to future cooperation.

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Environmental and socio-economic context of forest fires in Amazon basin

Introduction

Forest fires are an important problem that interferes with many aspects of social, environmental and economic dimensions. Despite it being a natural process that occurs periodically all over the world, human activities are increasing their occurrence and impacts. In fact, nowadays forest fires are mainly caused by anthropogenic actions.

A forest fire brings the carbon that was fixed by photosynthesis back to the atmosphere and it increases global warming. On its side, global warming promotes more extreme events such as hot days and droughts, favorable conditions to improve forest fires.

So, **forest fires are one of the main targets in order to break this vicious cycle and to mitigate climate change**. Each year, between 350 and 450 million hectares of forest and grassland are burnt, which implies emissions between 1.75 and 13.5 billion metric tons of carbon (JOHNS *et al.*, 2020). The reduction of their occurrence could help to reduce the advance of global warming.

The Amazon basin is a region with a significant role in the climate change scenario. The rainforest has fixed an amount of 73,000 Mt of carbon (INFOAMAZONIA, 2020). Instead, it has been releasing more CO_2 than capturing (GATTI *et al.*, 2021). It is due to deforestation and forest fires, which has been increasing in the last four years. So, it has changed its role as sinkhole to a **source of CO_2**, a concerning paradox.

This Data Collection Survey for Global Cooperation on Forest Fire in Amazon Basin (Brazil) intends to gather data about the status of forest fire prevention and control at the biome. These data will allow JICA to create the **information** needed to make decisions where it is more adequate to invest efforts to help institutions focused on the mitigation of forest fires in the region.

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The Amazon basin natural environment

The Amazon basin occupies nine states in Brazil and eight more countries: Bolivia, Peru, Ecuador, Colombia, Venezuela, Guyana, Suriname and French Guyana. It covers an area of more than 6,915,000 km². It is mainly in Brazil (59%), where its main river is, the Amazon river. It is born at the Peruvian Andes and after more than 6,500 km and more than a thousand tributaire rivers, it ends in the Atlantic Ocean after 200 km before it melts with salt water (BUTLER, 2020).

The Amazon basin region has a predominantly humid equatorial climate, with an average temperature of 27.9 °C, during the season of lower humidity, and of 25.8 °C, in the season of higher rainfall (INPE).

Figure 1 - Amazon basin representation in Latin-America. Source: Brasil Escola.

Usually it rains from November to March and the dry season is from May to September. The rainfall is more than 2,000 mm.year^{-1} and goes up to 5,000 mm.year^{-1} in some specific regions (INPE).

The vegetation is mainly represented by forest, with some borderlines of savannah. The figure 2 shows the predominance of forest land (green) and the presence of savannah surrounding it (beige).

Figure 2 - Vegetation in the Amazon basin. Source: RAISG, 2020.

This context of "dense forest" is one of the reasons for the phenomenon called "***flying rivers***"[1]. It is the water cycle flow from the Atlantic Ocean to the center and south-east of Brazil. It is estimated that the flying rivers flow at a volume of more than 200,000 cubic meter per second, almost the same volume as the Amazon river. The water vapour from the Atlantic ocean falls as rain over the forest, then the evapotranspiration from amazonian trees is transported by the wind and becomes rain over the center, south-east and south of Brazil So it is fair to say that they are crucial to the rainfall regime of the whole country. Figure 3 shows an example of one event of the flying rivers, passing over the Amazon region and going to the extreme south of Brazil.

[1] https://riosvoadores.com.br/english/

Figure 3 - Example of a flying river path going to the south region of Brazil. Source: The Flying Rivers Project.
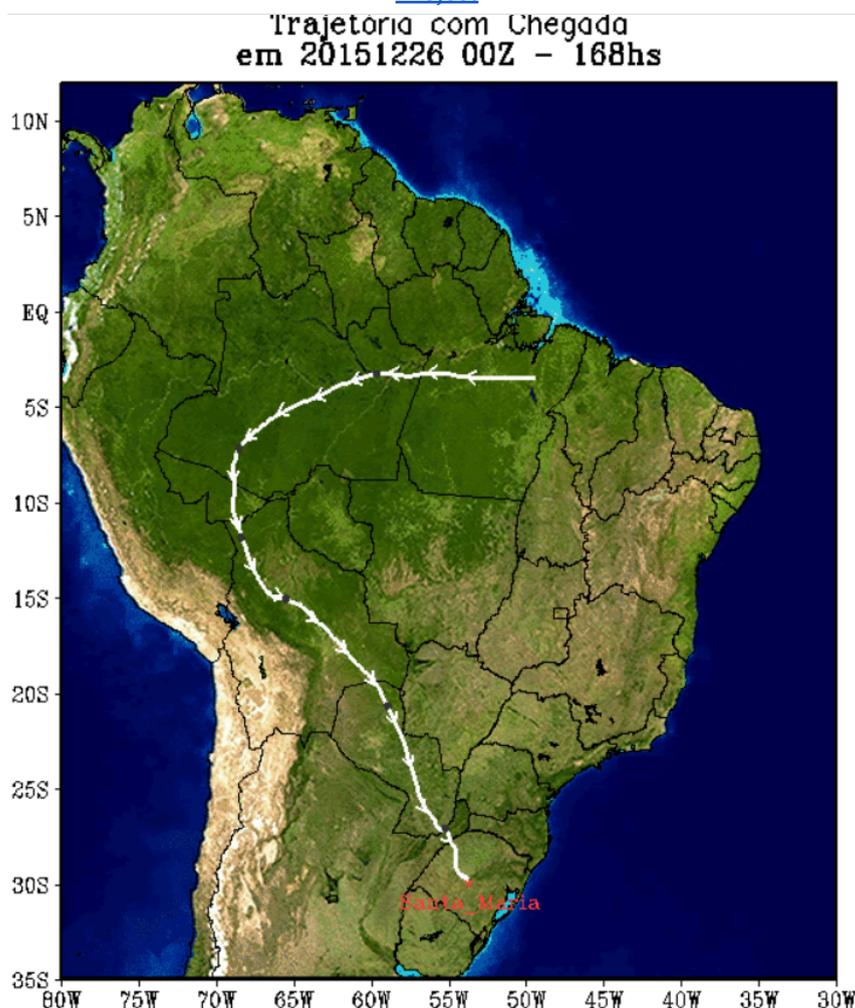

The Amazon basin socio-economic situation

The Brazilian Amazon region is known for its extractive activities such as forest logging, mining, plant extractivism (açaí, rubber, brazilian chestnut, etc.) and fishing. But other exotic activities with high socio-environmental impacts have been increasing in the last ten years.

The duet **cattle and soy** is a reality, especially in the southern Amazon. Cattle are rising significantly in the last decade. In the north region it has increased about 22%, the greatest rate in the whole country (INFOAMAZONIA). One city in the state of Pará, São

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Félix do Xingu, has the biggest herd of cattle in the country, more than 2,000,000 (figure 4).

Cattle breeding is known as one of the leading deforestation drivers. The *Meat Atlas* 2021, a German report on facts and numbers of the animals consumed by humans, indicates that 63% of deforested areas in the Amazon region become pasture to cattle feeding (CHEMNITZ AND BECHEVA, 2021).

Figure 4 - 10 municipalities in the Legal Amazon with more cattle. Source: Infoamazonia.
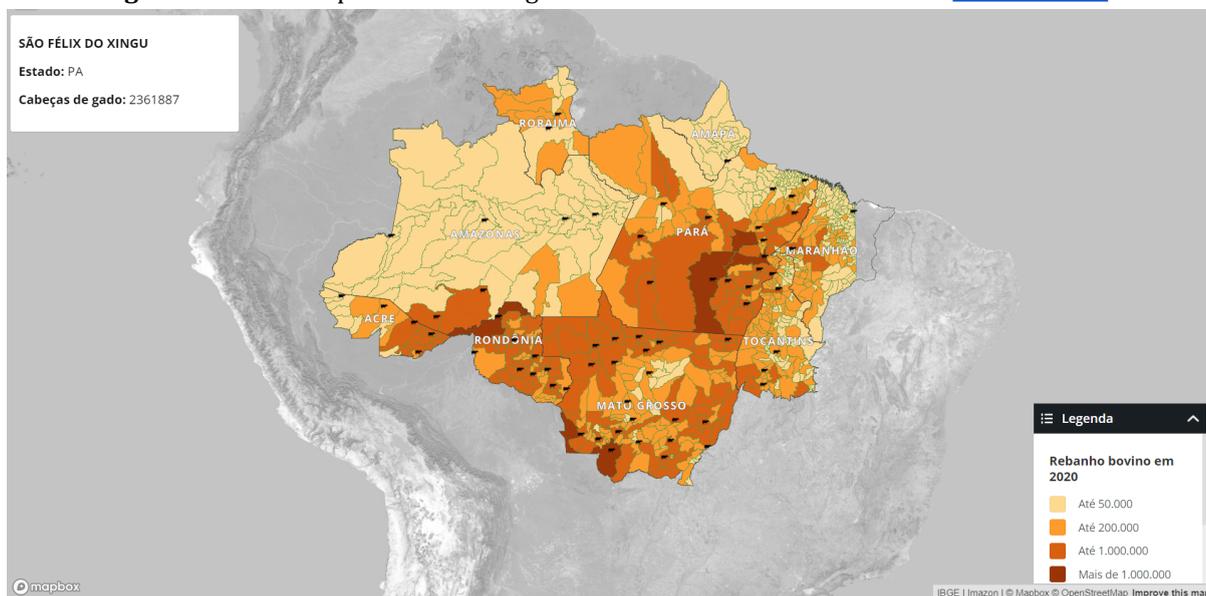

Soy has been under a more rigorous control since the launching of the moratorium in 2008. The ***moratorium of soy*** is an initiative that aims to ensure that no soy produced in the Amazon biome is related to deforestation (ABIOVE, 2021). It means that soy planted after July 22, 2008 can not be produced and commercialized in areas that were deforested after this date. According to ABIOVE (2021), in the last harvest (2019/2020) there were 5,410,000 ha of soy plantations in the biome with a fraction of 110,000 ha related to deforestation (Figure 5). It represents about 4% of the deforestation occurred in the 102 cities where soy is planted in the biome.

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Figure 5 - Land use in the Amazon biome and the representativity of soy. Source: ABIOVE, 2021.

Although official numbers point out that soy plantations in the Amazon have low direct responsibility in deforestation since the moratorium, the demanded infrastructure for their logistics are quite important. The federal and state roads are the main pathways to transport these products to their processing sites (slaughterhouses, meat packing, grain silos, harbors, etc.). Not coincidentally, ***95% of deforestation happens in a radius of 5,5 km from a road or 1 km from a navigable river*** (BARBER *et al.,* 2014). Figure 6 allows this perception.

Figure 6 - Deforestation hotspots in the Brazilian Amazon (until 18 September). Source: MAAP, 2021.
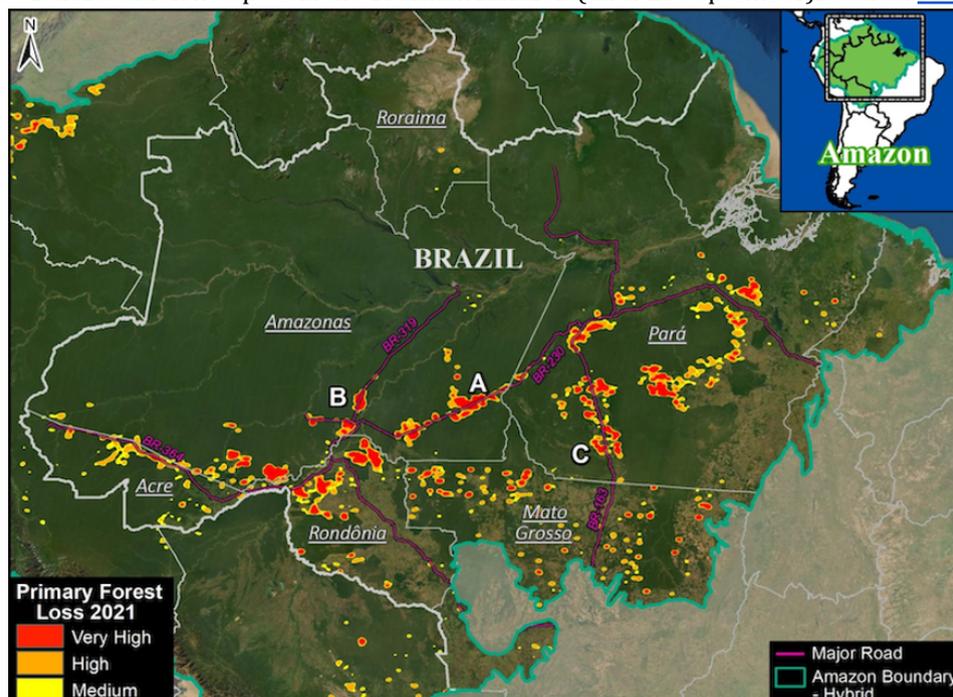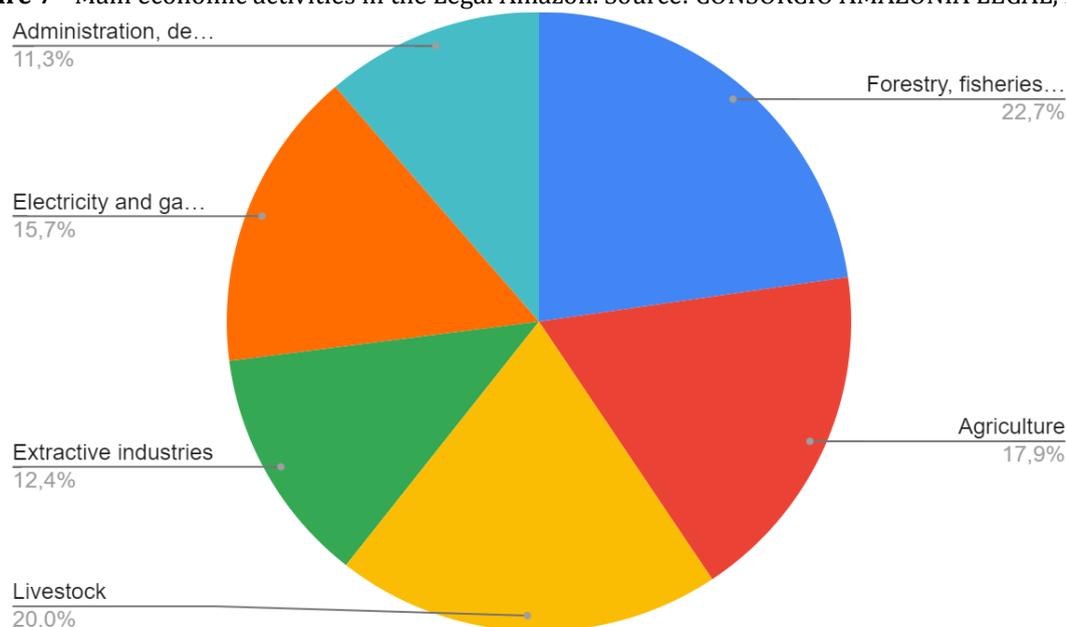
These agrarian activities are run by few people who own very extensive farms. On the other side, the great majority of the amazonian population lives in cities. Among more than 27,000,000 people (IBGE, 2014), the proportion is divided as almost 70% in urban areas and a little more than 30% in rural zones (IMAZON, 2009). The economic situation of the amazonian people is not so good. The region contributes less than 10% (R$ 623 millions) to the national GDP (CONSÓRCIO AMAZÔNIA LEGAL, 2021). The discrepancy between Legal Amazon and Brazil in working conditions are quite impressive. The analysis made by the consortium shows that:

> ...the proportion of workers with a signed labor contract in the Legal Amazon fluctuated between 23% and 25% of the employed population between 2012 and 2020 - a much lower rate than the 41%-45% observed in the rest of Brazil during the same period. Per capita household labor income (the average labor income earned by all household members) was only R$654 in the Amazon region in 2019, which is about 40% less than the average value observed in the rest of the country, of R$1074,00.

The main inputs in the **Amazonian GDP** are shown in figure 7. **Agriculture and livestock make almost 40%.** As presented before, these activities are related to exotic species for the biome, they don't improve its natural purpose of being a global driver to the implementation of a bioeconomy, they do worse by provoking the degradation of the Amazon biome.

Figure 7 - Main economic activities in the Legal Amazon. Source: CONSÓRCIO AMAZÔNIA LEGAL, 2021

Administration, de… 11,3%
Forestry, fisheries… 22,7%
Electricity and ga… 15,7%
Agriculture 17,9%
Extractive industries 12,4%
Livestock 20,0%

Contradictorily, Manaus, the capital of the state of Amazonas, has the 8th biggest GDP of Brazil. This position is due to the Free Economic Zone of Manaus, an industrial pole with approximately 600 companies producing bicycles, computers, cars, motorcycles, cellphones, televisions and other electronic goods (Fazcomex, 2021).

Regarding the rural zone of the Amazon region, there were more than 500,000 rural properties in the biome in 2019. They occupy an area of almost 1,500,000 km² or 35% of the biome. 93% of them are over an already deforested area. And about 440,000 are from small ranchers (~90%). Big farms (> 1,350 ha) represent about 3,5% (MIRANDA *et al.*, 2019).

In this year, 31% of hotspots were registered on farms and 22% took place on properties considered medium or large. ***By 2020, half of the hotspots in the Amazon happened in medium and large properties*** (KLEIN and MEDAGLIA, 2020).

It is not a surprise that in 2019, the cities with highest hotspots and the larger deforested area also have the biggest cattle herd. It is the case of São Félix do Xingu and Porto Velho, as can be seen in table 1 (SILVÉRIO *et al.*, 2019).

Table 1 - The 10 municipalities in the Amazon with the highest values for fires and deforested area in 2019 Source: IPAM, 2019.

Municipality	State	Hotspot	Deforestation (km²)
Apuí	AM	1754	151
Altamira	*PA*	*1630*	*297.3*
Porto Velho	***RO***	***1570***	***183.5***
Caracaraí	RR	1379	16
São Félix do Xingu	***PA***	***1202***	***218.9***
Novo Progresso	PA	1170	67.8
Lábrea	AM	1170	197.4
Colniza	MT	869	82.4
Novo Aripuanã	AM	665	122.3
Itaituba	PA	611	67.8

Forest fires occurrence in the Brazilian Amazon region

The rainforest is not "used to" fires since it is mostly humid. So forest fires occurring in the Amazon region are mainly due to human activities. For hundreds of years fire has been used to clean areas for crops by indigenous and small farmers. But in the last few years, the intensity and coverage of fires in the region has increased. The worst situations in this millenia were in the years 2004, 2007 and 2010. Along this period, there were three severe droughts that also influenced the number of active hotspots. This timeline is presented in figure 8.

Virtual CIMAN (Multi-agency Integrated Center for Operational Coordination) is the monitoring and support system for the Federal Coordination in Brasília. It integrates data derived from satellites with information, photos and details of the teams that are in the field fighting the fire, in real time[2].

Figure 8 - Total active hotspots detected in eight states of Legal Amazon from 1998 to 2018, and extreme drought peaks in 2005, 2010 and 2016. Source: BRASIL, 2020.
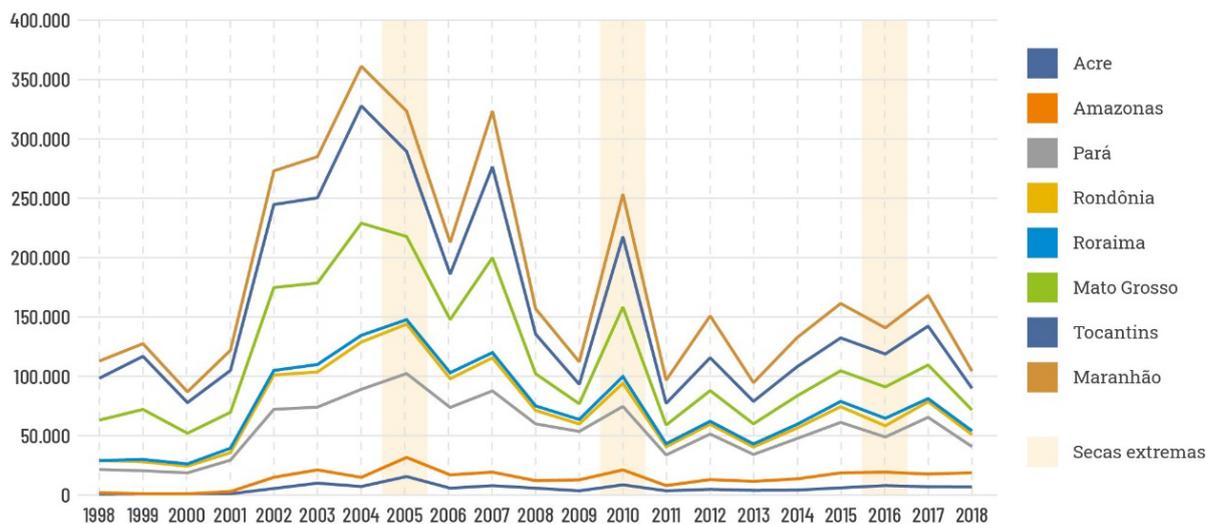

Figure 9 shows the numbers of hotspots in Brazil and in the Amazon region, from 1998 to 2021. It is noticeable that ***fire in the Amazon region is responsible for almost half of the national occurrences***. In fact, hotspots in the Amazon were 48.36% of the total in
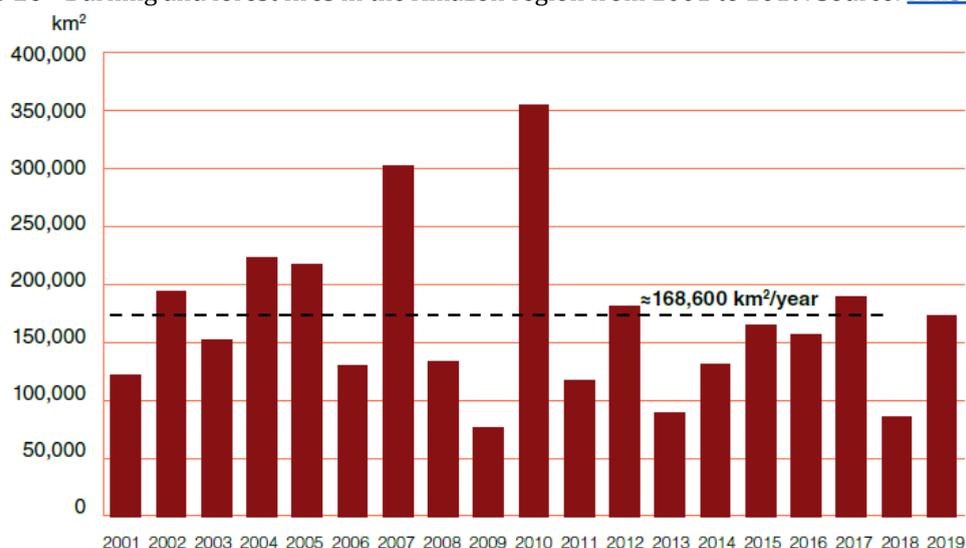
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[2] http://queimadas.dgi.inpe.br/queimadas/ciman/

Brazil. From 2002 to 2006, in 2009, 2017 and 2018, it was more than 50%, reaching 58.95% in 2005.

Figure 9 - Number of hotspots in Brazil and in Amazon from 1998 to 2021. Source: INPE, 2021.
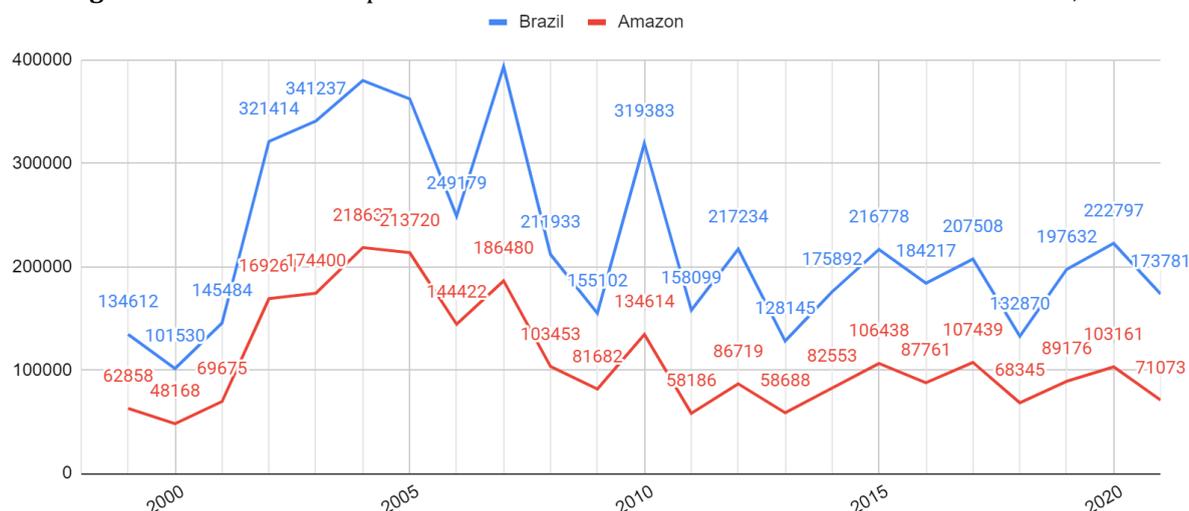
Despite the number of active hotspots being worst in the years 2004, 2005 and 2007, in area burnt, 2010 was more devastating. The annual average burnt area is about 169,000 km² and in 2010 the fire affected more than 350,000 km² (Figure 10). From 2001 to 2019, 13% of the Amazon region suffered from forest fires. It means 1,100,000 km². Brazil is responsible for 17% of this area (RAISG, 2020).

Figure 10 - Burning and forest fires in the Amazon region from 2001 to 2019. Source: RAISG, 2020.

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Experts in forest fire research highlights that, although there is a decrease of the annual area burnt in the last years it does not mean that the number of fires are reducing as well. **There are areas burning more than once.** 20% of the areas burnt were affected by fire more than three times (RAISG, 2020). Another critical situation is the growth of fire incidents in protected natural areas (PNA) and indigenous territories (IT). In 2019 about 29,000 km² and 40,000 km² were burnt in PNA and IT respectively. It was an increase of more than 10% above the annual average for both kinds of areas during the last 18 years. It shows that PNA and IT are becoming like green islands in the middle of a sea of pasture and crops.

According to Nepstad and colleagues (1999), in the Amazon region there are **three types of fire** that change according to their origin. The **agricultural management fire** is used by farmers and traditional people (indigenous, quilombolas, etc.) to clean the plantation site, already converted to this objective. The **recent deforestation fire** is applied by land-grabbers and even by official land owners that burns recently felled vegetation in order to prepare the area for an agribusiness activity, usually to pasture implementation. And there are the forest fires that occur accidentally when an agricultural management fire gets out of control. The most concerning type is the one associated with **deforestation**. It provokes the brutal change of the vegetation, since it gives the right conditions to pasture implementation where the cattle will stay, eat and trample any attempt of recovery from the natural vegetation. They can burn beyond the deforested area and start fires in preserved primary forests. Fires in preserved areas are difficult to control, they are known as ground fires, with small flames (< 30 cm) that burn slowly dry leaves and old logs, around 200 to 300 meters a day (KLEIN e MEDAGLIA, 2019).

The distinction among the fire types is important to understand what is going on in the Amazon region. Barlow and colleagues (2019) analyzed the situation in the biome, by comparing the number of active fires in August 2019 with fires in August 2018. In 2019 the number was three times higher than 2018 and the highest since 2010. Annual deforestation kept up with fire as shown in figure 11.

Not coincidentally, in 2019 happened the "***Day of Fire***", the August 10, when many intentional fires started together, as a coordinated action from farmers and land-grabbers (sometimes they are the same) to draw the attention of authorities. The intentionality of the action was confirmed by a message circulated by a farmer (MACHADO, 2019):

"(Producers) want August 10 to draw the attention of authorities. (...) In the region, production advances are happening without government support. 'We need to show the president that we want to work and the only way is to cut down. To form and clean our pastures is with fire.'"

Figure 11 - Annual deforestation (yellow line) and active fire counts (grey bars). Deforestation in 2019 (orange line) was an estimate. Asterisks indicate severe droughts. Source: Barlow, 2019.
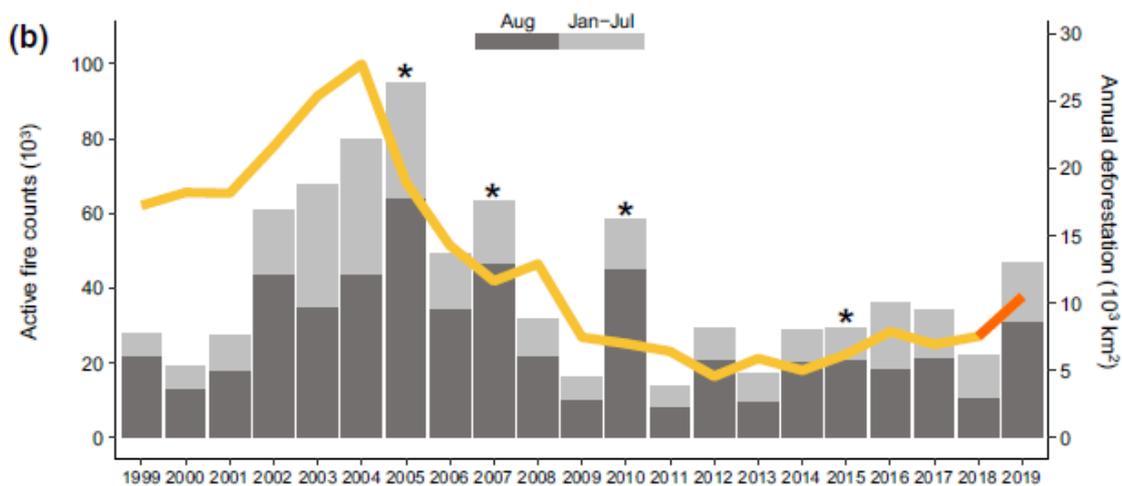
From that day until now, the numbers of fire and deforestation are getting worse. The understanding of some experts is that the Day of Fire never ended, just started a pattern. And that ***fires must be assessed together with deforestation***. The periods with highest area deforested are usually precedent of the periods of highest frequency of fires. Trees are felled and when the climate is dry enough, fires are started in the same areas. 2020 has the biggest number of hotspots in the Legal Amazon for the last 9 years, with more than 150,000, 20% higher than in 2019. In 2021, the expectation is not getting better (ARAGÃO, 2021).

Forest fires and the climate change in the Amazon basin

Forest fires are not yet recognized as one of the main drivers to global warming but their frequency and magnitude all over the world are beginning to defy this perception. ***Megafires*** are becoming more common. They are known for burning extensive surfaces and for long periods (even months). Before they happened in specific conditions such as severe droughts and big volumes of fuel from the biomass accumulated over the years. Now, they are happening regardless of these conditions, becoming more frequent due to climate change (NGS, 2020).

Some regions of the world were really devastated by these megafires over the last few years. Despite being regions used to fire seasons, where fire is an important element to the equilibrium of their biomes, the intensity of the last events has brought great damages to vegetation, to fauna and to humans. It is the case of Canada, USA (California), Turkey, Greece, Italy, Russia (Siberia), Australia and Brazil. The environmentalist Tim Flannery states that ***2021 may be remembered as the year of megafires*** (FLANNERY, 2021). According to recent analysis (FUTURE EARTH, 2021), from 2019 to 2021, about 0.38 million hectares burned in Brazil from megafires incidents (Figure 12), most of it at the wetlands of the Pantanal biome.

Megafires in Brazil were usually related to the savannah regions. The Brazilian savannah, called Cerrado, has two very well defined seasons: rainy and dry. The months from June to October are when the fire season occurs every year. Cerrado needs fire, although not so intensively as the last few years. On the other hand, Amazonia does not need it for its biome dynamics. In fact, fires are interfering in the amazonian natural cycles and burning is actually helping to turn the Amazon into another biome: a savannah.
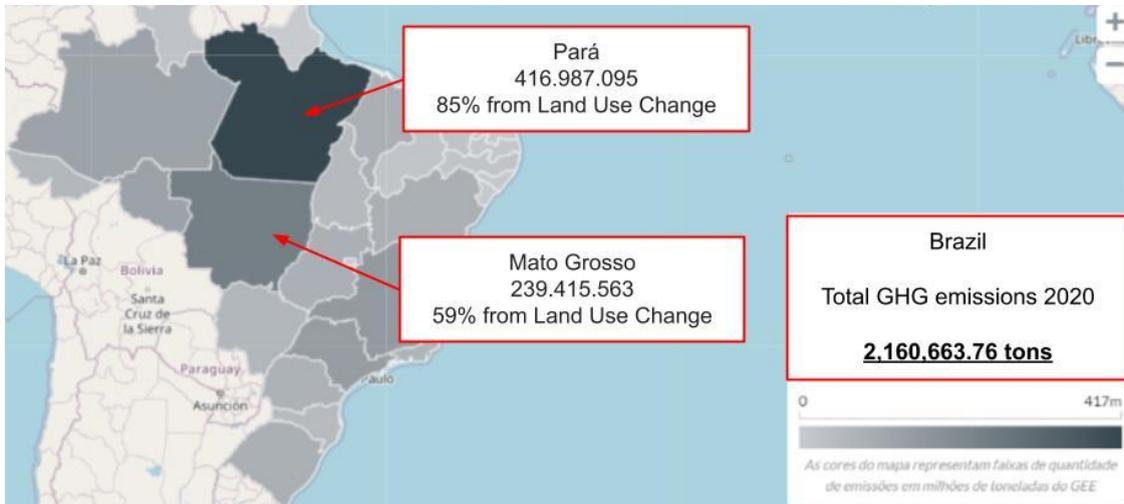
Figure 12 - Area burned by megafires (2019-2021). Source: Future Earth, 2021.
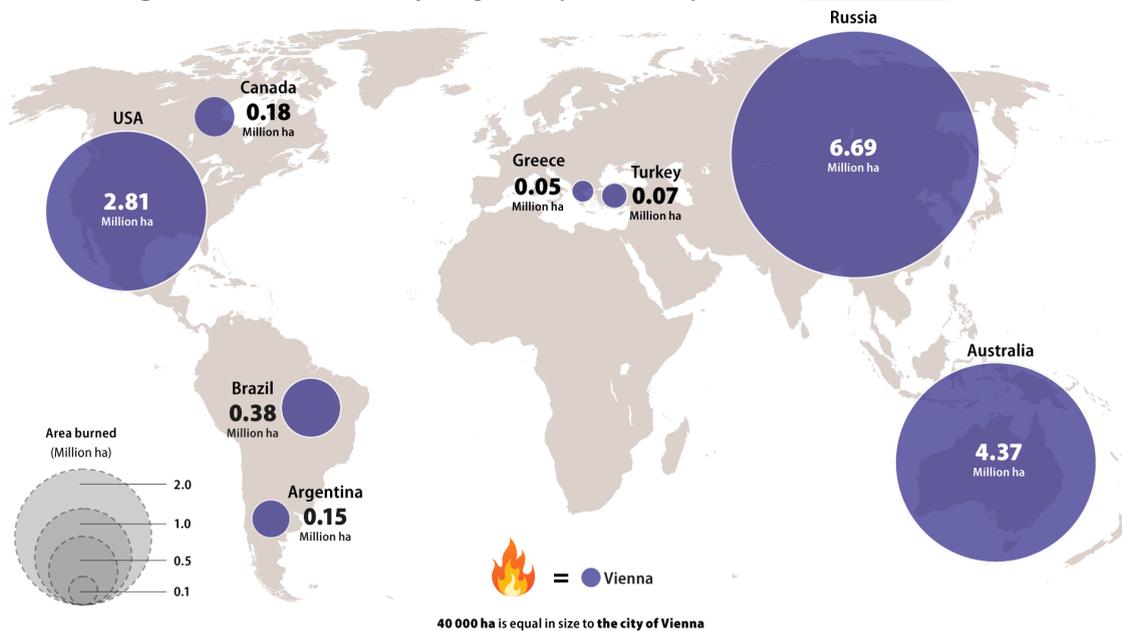
The ***savannisation*** phenomena is a reality agreed by experts. It is characterized by a transition from dense canopy to a significantly less one, typical of Savannahs. Deforestation and forest fires are increasing this transition, together with climate change. The effects are already evident at the borders that define the limits of the Amazon and the Cerrado biomes (ecotones). Cerrado is advancing into the rainforest, changing its landscape, fauna and activities. Areas that once were known by extractivism of products from the local regional socio-biodiversity are becoming monotonous crops and pasture.

Figure 13 shows CO_2eq emissions by state in Brazil 2020. It is evident that the Amazonian states are the ones which contribute the most, specially Pará (1st) and Mato Grosso (2nd). These two states together are responsible for more than 30% of Brazilian GHG emissions in 2020. Not coincidentally, they have the highest numbers for deforestation and forest fire hotspots in Brazil.

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Figure 13 - CO2-eq emissions (ton) per state in Brazil. Source: SEEG, 2021 (adapted).

This situation is driving the rainforest to a ***tipping point*** when there will be irreversible changes in its conditions, turning it into a savannah. It is advertised that if the deforestation surpasses 40% of forest area, the savannization process will prevail (NOBRE *et al*., 2016). The rainfall regime decrease has been observed at the most deforested areas of the Amazon basin, it is the southern and the southeastern regions. On the other hand, fire frequency is increasing, as can be seen in figure 14.

Figure 14 - Fire detections at the Southern Amazon from 2012 to 2020. Source: GFED, 2021.
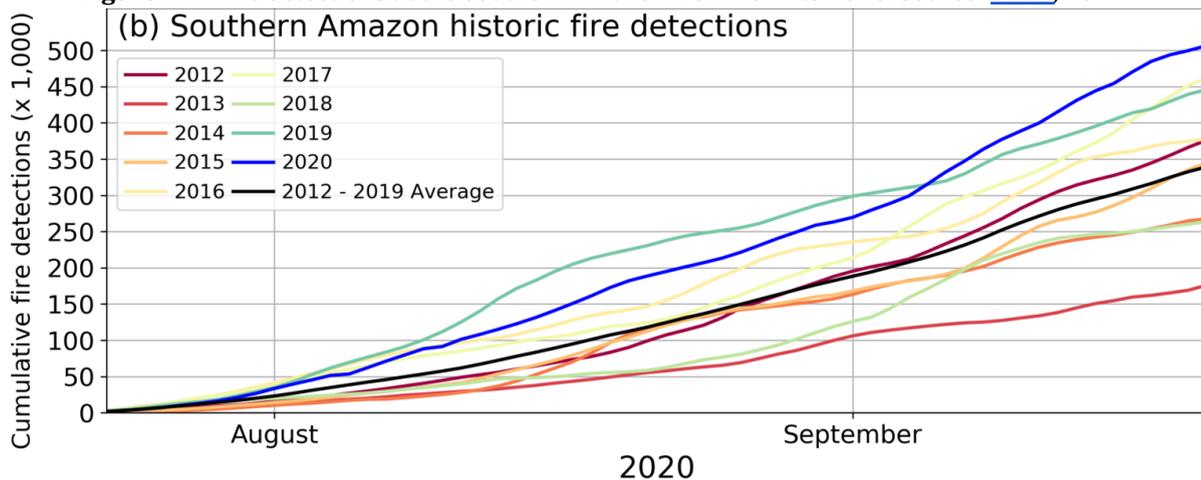
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Basic information on the governmental, social, economic status on forest fire

Relevant laws and regulations

Forest fires have been a target of regulations since the early 1900's. The first national **forest code**, a decree enacted in 1934, makes reference to the prohibition of fire use in forests and other kinds of vegetation and justifies its use in agriculture practices (BRASIL, 1934).

These conditions were repeated in the law of forest code (4771) implemented in 1965 (BRASIL, 1965). There was a specific article (27) that sets the prohibition of fire use and in one paragraph sets the general conditions when fire can be applied. In 1998, a new decree regulates this sole paragraph (BRASIL, 1998). It presents five chapters:

1. Prohibition of the use of fire;
2. Permission of use of fire;
3. Planning and temporary suspension of employment of fire;
4. Gradual reduction of employment of fire;
5. Final provisions.

It is important to notice that this decree creates the **National Forest Fire Prevention and Combat System - PREVFOGO**. It was implemented for *the development of programs, integrated by the different levels of government, aimed at ordering, monitoring, preventing and combating forest fires, in addition to developing and disseminating controlled fire management techniques, training human resources to disseminate the respective techniques and to raise awareness the population on the risks of inappropriate use of fire.*

The latest version of the Forest Code is from 2012. It has a whole chapter (IX) dedicated to regulating the use of fire and the control of forest fires (BRASIL, 2012). It announces that the federal government will establish the **National Policy for the Management and Control of Fires, Prevention and Fight against Forest Fires** (Article 40).

National Policy for Integrated Fire Management

The **National Policy for Integrated Fire Management** (NPIFM) is the law predicted in the Forest Code from 2012. The implementation of this law is perceived as a significant advance in the fight against forest fires in the whole country. It has just been approved in the chamber of deputies and now is in the senate for discussion before it goes to the president's sanction (BRASIL, 2021).

NPIFM aims to organize inter-institutional articulation in order to promote the **Integrated Fire Management (IFM)**, the reduction of forest fires damages and the restoration of fire ecological and cultural role. For this purpose, it predicts a committee and proposes some instruments.

The National Committee for Integrated Fire Management is composed of 14 federal institutions and the Ministry of Environment is the chair. The instruments are: IFM plans, Forest Brigades Programs, the **National Fire Information System (Sisfogo),** Financial Instruments, the **incident management tools (IMT)** and the Federal CIMAN. Sisfogo integrates the National Environmental Information System and intends to compile data on forest fires from all over the country, to promote networks and the interoperability of information systems. The system shall be used to emit authorizations for controlled and prescribed fires. It will gather information and data on (BRASIL, 2021):

- Records of forest fire occurrences;
- Records of authorizations and controlled and prescribed burnings;
- alerts for the occurrence of forest fires;
- Human and material resources of the bodies and entities involved in preventing and fighting forest fires;
- Spatialization of fires or fires with the insertion of coordinates in the form of points, lines or polygons; and
- Other data and information defined by the National Committee for Integrated Fire Management .

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IBAMA is the institution responsible for the implementation and operationalization of Sisfogo. IMT will be used for the implementation of the Integrated Fire Management Plans, the first instrument proposed in the policy.

So, the NPIFM will come to better organize the forest fires initiatives at a federal level, also aiming to improve the relationship with the state initiatives as well. Sisfogo is an instrument that is expected by almost every institution and professionals that deal with forest fire.

National Fire Moratorium

Since 2019, forest fire incidents have increased significantly. In an attempt to control the situation, the federal government established the *fire moratorium*. The initiative was a decree that prohibited the use of fire for 60 days after the release of the decree in the whole country. The first one was released on August 28, 2019 (BRASIL, 2019). It was extended for more 60 days. Since then, every year it has been declared a new moratorium. In 2020, the decree was released in July (BRASIL, 2020) and in 2021 it was in June (BRASIL, 2021). The period of prohibition for both years was 120 days.

Despite these decrees, the number of forest fire occurrences and the size of areas damaged has increased since 2019. The implementation of moratoria seemed to be a late response to the fire seasons.

Recommended Practice - ABNT

The **Brazilian Technical Standards Association** (ABNT in its portuguese acronym) has released in August 2021 the **Recommended Practice 1014** - Basic requirements and procedures guide for fighting forest fire (ABNT, 2021). It is a document with guidance to public institutions, private sector and civil society on better understanding about forest fires characteristics and about the most effective ways to prevent and combat them. It brings actions and measures to implement the Integrated Fire Management (IFM). It also describes Personal Protective Equipment (PPE), combating tools and vehicles and machines.

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National-level policy and system

Federal CIMAN

The federal CIMAN is also known as **Virtual CIMAN**. It is an initiative to centralize the strategy to prevent and control fires, gathering the main institutions that deal with forest fire. It has been following the fire seasons since 2014. It is composed by 12 federal institutions[3]. They get together with the brigades to analyze, plan and coordinate actions on forest fire combats in the most critical regions. CIMAN focuses on the big fires that need to join efforts from federal brigades and state and municipal institutions. Its main purpose is to increase the speed of response in firefighting actions.

In CIMAN website it is possible to better understand its mission. It is a platform where its available data and information on critical areas (national parks, ecological stations, indigenous territories, et.), brigades, firefighting operations, daily bulletins and map views. It is also possible to access statistics on hotspots on national, regional, state and biome level. And it is provided weather and fire risks forecast. Figure 15 presents these features.

Figure 15 - CIMAN website and its features. Source: CIMAN, 2021.


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[3] http://queimadas.dgi.inpe.br/queimadas/ciman/
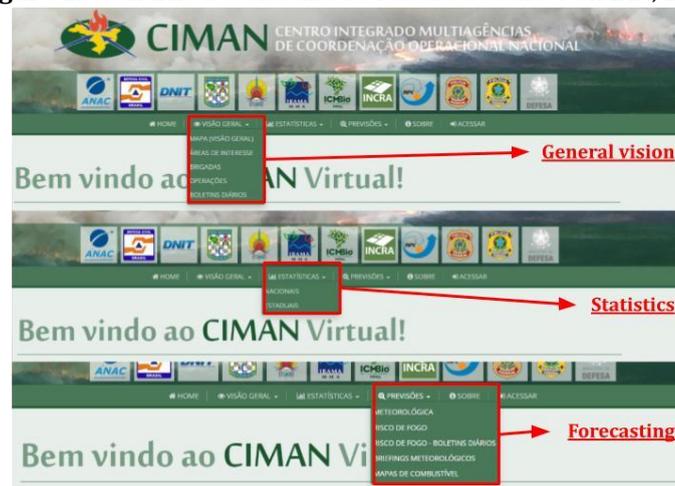
Every year there are operations that are reported on its website. There are about 10 operations per year, mostly in Indigenous Territory (IT), National Parks and Biological Reserves. It is possible to collect information about the estimated area burnt, number of hotspots, city and state and rainfall regime. Figure 16 shows the number of operations realized and monitored by CIMAN from 2014 to 2021. The rise of events in 2021 does not mean that there were more forest fires. Probably it is a consequence of the increase of governmental action due to the expressive frequency and magnitude of occurrences in previous fire seasons (2019 in Amazon and 2020 in Pantanal).

**Figure 16 -** Number of firefighting operations coordinated by CIMAN. Source: INPE, 2021.
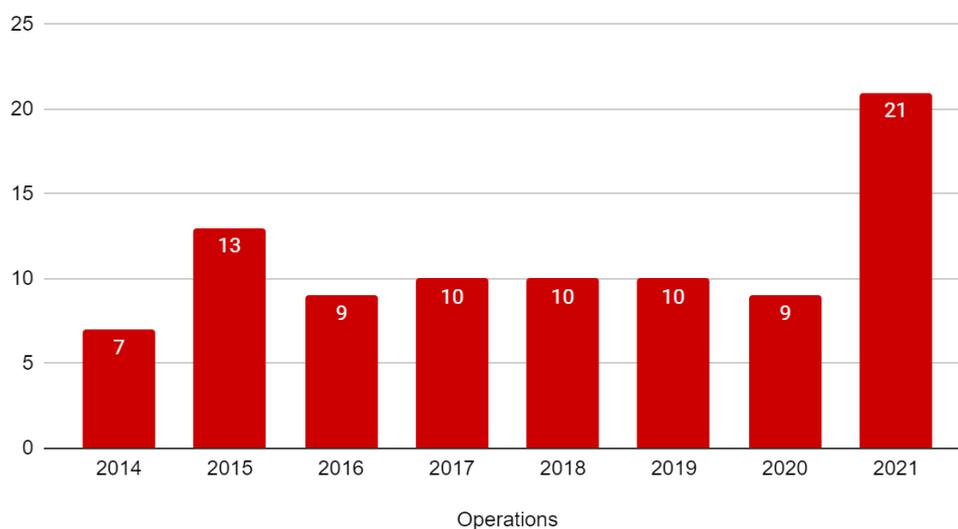
PREVFOGO

As stated before, the ***National Forest Fire Prevention and Combat System*** - PREVFOGO - was created by a decree in 1998. Actually, it was created earlier, in 1989 by the decree 97635, that established in its article 2 the purpose of PREVFOGO and its coordination by the Brazilian Institute of Environment and Natural Resources - IBAMA (BRASIL, 1989).

Nowadays, PREVFOGO is a specialized center inside IBAMA, the most important institution dedicated to the prevention and control of forest fires in Brazil. It has representatives in 22 IBAMA's superintendences and State coordinations all over the country. It is linked to the Environmental Protection Board of IBAMA and its

"headquarters' is in Brasília, DF. It is organized in 7 different centers. Figure 17 shows its organizational chart.

Figure 17 - Organizational chart of Prevfogo. Source: IBAMA, 2021.
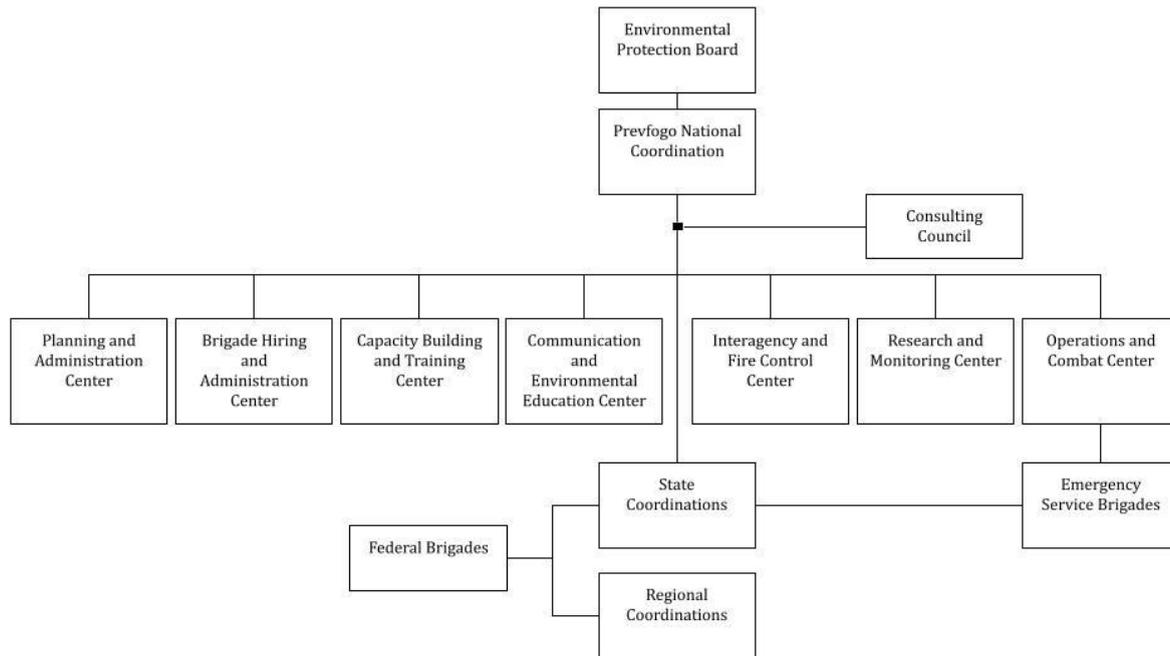
Each center in Prevfogo is responsible for a different task. There are planning and operational centers. The operational ones are related to hiring and capacity building of the temporary brigades. The ***Brigades Federal Program*** aims to implement the Integrated Fire Management (IFM) prioritizing the Indigenous Territories, Quilombos'[4] territories, agrarian reform settlements and supporting federal conservation units. So, each year new brigades are formed to implement the strategies and combat the forest fires. In 2020, 1,481 brigade members were hired to compose 77 brigades (PREVFOGO, 2021).

Prevfogo is also responsible for managing programs and projects. Its main project was supported by the ***Amazon Fund***, as it can be seen in table 2. The project began in 2014 and it allowed Prevfogo/IBAMA to acquire equipment like stoves and gas cylinders,

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[4]https://www.culturalsurvival.org/publications/cultural-survival-quarterly/quilombo-brazilian-maroons-during-slavery

accessories for motor pumps, for power generators, water tanks and hoses. Also it was acquired *three "firewall" trucks for transporting people and equipment, 14 adapted pickup trucks, two F4000 type adapted trucks, kits of personal protection equipment, combat equipment (kits for repairing costal bombs and fire dampers) and radio communication system, including training for use and maintenance* (Fundo Amazônia, 2021). A new two floors building was built to store and repair equipment and to host federal CIMAN situation room and meetings.

Another relevant program coordinated by Prevfogo is the **Interagency Action Program**. Its major objective is to increase IBAMA's response capacity to fire control, prevention and combating forest fires throughout the country. To achieve this purpose, the program promotes planning workshops to create permanent inter-institutional forums as State/Municipal Committees for the Control of Fires, Prevention and Fight against Forest Fires. There are 12 state committees operating (Green states in figure 18). In the Legal Amazon, three states did not have a committee until April 2017, the last update of the project (IBAMA, 2017).

Amazonia sem Fogo (Amazon without fire) is another program that Prevfogo is directly related to. It began in 1998 and it finished in Brazil in 2008. But in 2011 it continued in Bolivia and went until 2017. In 2012, the project began in Ecuador and it is still in progress. So it is a trilateral cooperation among these countries and supported financially by Italy. Prevfogo goes on as a reference center and supports institutions from Bolívia and Ecuador to settle national programs (IBAMA, 2017a).

Figure 18 - State/Municipal Committees for the Control of Fires, Prevention and Fight against Forest Fires. Source; <u>IBAMA</u>, 2017.
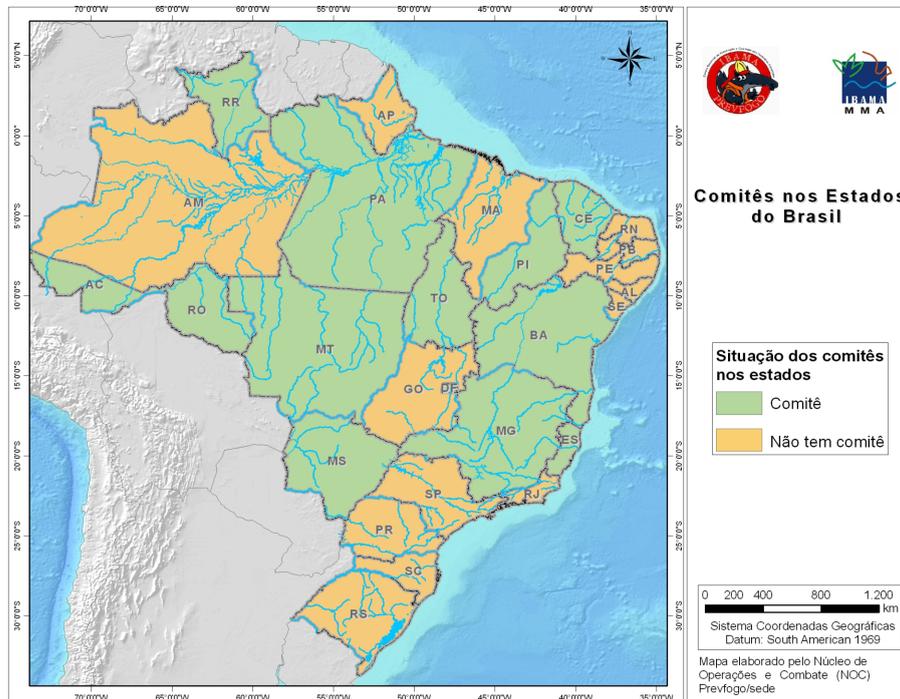
CEMADEN

The ***National Center for Monitoring and Alerting of Natural Disasters*** - CEMADEN - is a linked unit to Ministry of Science, Technology and Innovation (MCTI) that has as mission *to monitor natural threats in risk areas in Brazilian municipalities susceptible to the occurrence of natural disasters, in addition to carrying out research and technological innovations that can contribute to the improvement of its early warning system, with the ultimate goal of reducing the number of fatal victims and material damage throughout the country* (CEMADEN, 2016).

Regarding forest fires, CEMADEN has an initiative to support local planning and decision-making actions, to prevent and control forest fires in the Amazon. It was implemented the ***Forest Fires and Fire Monitoring Platform***. It is a platform that focuses on the triple border region covering Brazil, Peru and Bolivia. It is an

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improvement of the Situation Unit Monitoring System, which has been maintained by the State Secretariat for the Environment (SEMA) of the State of Acre since 2013.

The platform is a product from the ***project MAP-Fire***, a multi-stakeholder project that aims to increase the understanding of fire probability and its impacts in the Amazon basin (TREESLAB, 2021). Figure 19 shows an example of possible analysis on the state of Acre, crossing two variables (roads and area burnt).

ICMBIO

The ***Chico Mendes Institute for Biodiversity Conservation*** (ICMBIO) is a federal autarchy linked to the ministry of environment, created in 2007 with the purpose of being the executor of the ***National System of Conservation Units*** (SNUC in its portuguese acronym), a law that regulates the procedures to the implementation of conservation units (BRASIL, 2000). It promotes *biodiversity research, protection, preservation and conservation programs and exercises the environmental police power to protect federal Conservation Units* (ICMBIO).

Figure 19 - Burnt areas (red dots) and roads in the state of Acre. Source: CEMADEN, 2021.
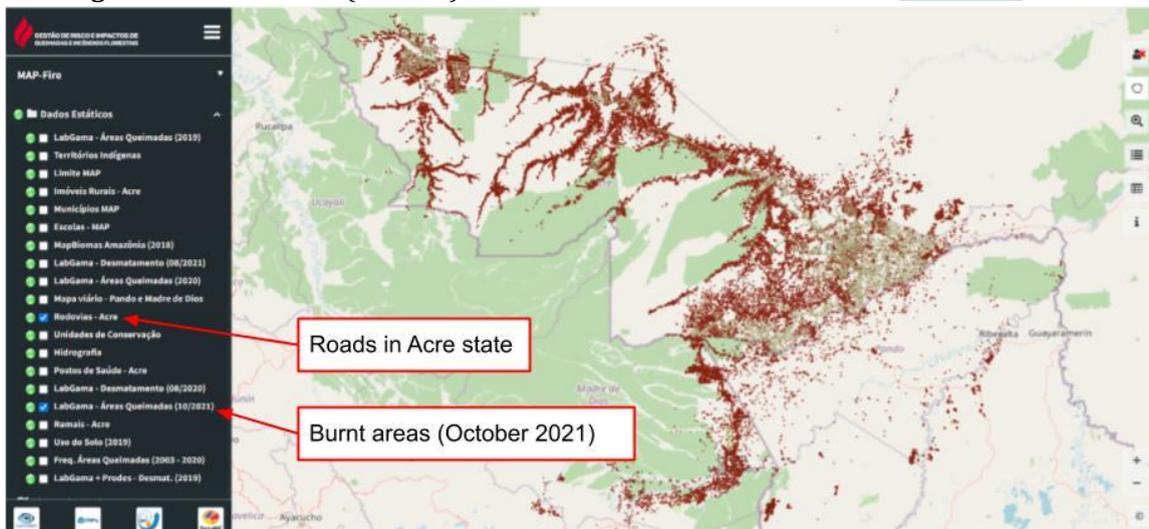
ICMBIO has important actions to prevent and control forest fires in the conservation units. In its Protection Activities, ***Environmental Emergencies*** and ***Environmental Monitoring*** are directly related to forest fires. Environmental Emergencies are about

the brigades. Each fire season, about 1,600 temporary brigades are hired to work in 96 conservation units. There are 334 different conservation units under the management of ICMBIO, but not all of them need fire brigades. Brigades are equipped with water tank planes, monitoring planes and helicopters, for transporting troops and for launching water. Every fire season there are actions to prevent fires such as firebreaks, monitoring and environmental education programs. There are also capacity building for Instructors of Brigades, Brigadiers, Investigators of Cause and Origin of Forest Fires and Incident Command System (ICMBIOa).

Environmental monitoring of deforestation and hotspots is done in a ***Monitoring and Environmental Information Room***. Based on satellite images from PRODES[5] and DETER[6] programs, this activity used to provide periodic fire risk bulletins, but the last one is from 2013 (ICMBIOb).

Regional-level policy and system

Usually, all forest fire alert systems are based on data from the ***Fires Program (BD Queimadas) of the National Institute of Spatial Research*** (INPE, 2021). The regional initiatives customize this system to have a more specific approach. Two projects and two NGOs are presented below, due to its relevance on fighting forest fires in the Amazon region.

Acre Queimadas

Acre Queimadas (Acre Fires) is one system dedicated to provide information on the fire situation of the state. It is a project supported by the National call in 2018 to fund research in ecology, monitoring and integrated fire management (CNPq/IBAMA, 2018). Acre Queimadas analyzes the extent, level of degradation and future scenarios of fires (SONAIRASILVA, 2021).

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[5] http://www.obt.inpe.br/OBT/assuntos/programas/amazonia/prodes

[6] http://www.obt.inpe.br/OBT/assuntos/programas/amazonia/deter/deter

The project is under the coordination of Dr Sonaira Silva from the Federal University of Acre (UFAC). It provides periodic reports since April 2020 with information about the area burnt and maps, pointing where the fires happened (SILVA, 2021). Figure 20 shows an example of the results in the last periodic report available. The data for 2021 is from October, so it lacks data from November and December. But, in the state of Acre, the year of 2021 is already representative for forest fires.

Figure 20 - Area burnt in the state of Acre. Source: Silva, 2021.
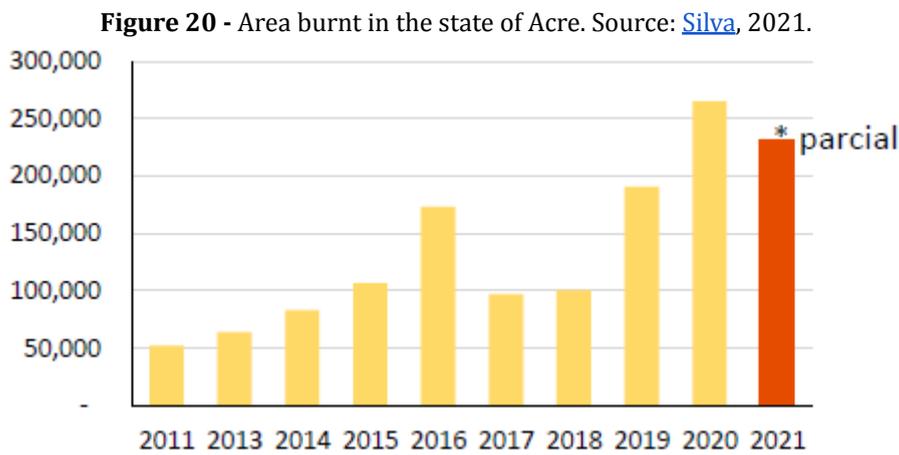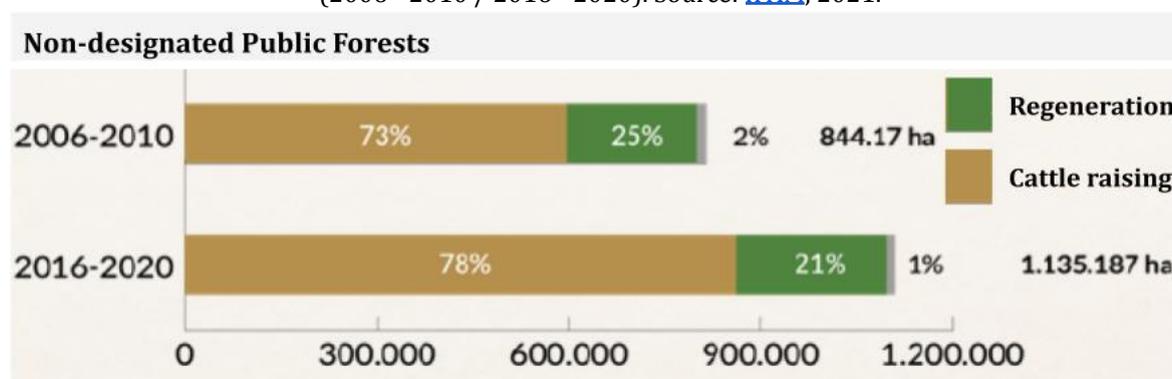

SEM-FLAMA

The project "***Solutions to reduce the social and environmental impacts of fire in Sustainable Use Amazon forests***" - SEM-FLAMA has a more regionalized approach. It aims to improve the understanding of the relationships between fire management practices, forest fires and their sociocultural and ecological consequences. It is applied in two conservation units in the state of Pará: the National Forest (FLONA) of Tapajós and the Extractivism Reserve (RESEX) of Tapajós-Arapiuns. These units have more than 30 thousand people (EMBRAPA, 2019) . The project intends to present alternatives to the use of fire by the small farmers through workshops. The project runs from 2019 to 2022 and will release a ***fire warning and forecast system***, based on the data collected in the workshops. This is another project funded by the call CNPq-IBAMA n.° 33/2018. The call approved 25 projects, among them 6 are in the Amazon region.

IPAM

The **Amazon Environment Research Institute** (IPAM) is a brazilian NGO dedicated to fostering sustainable development in the Amazon region since 1995. Forest fires are an issue developed by IPAM in scientific research, education and monitoring activities. In 2019, the institute started publishing **technical notes** about the fire situation in the biome (IPAM, 2021). The technical notes had the same title: **Amazon in Flames**. Each one of the 8 had a specific subject. The first one related deforestation with fire occurrence, the second answered where the fire was occurring, the third made an analysis of what was to be expected in 2020, the fourth linked deforestation, fire and COVID-19, the fifth discussed about the kinds of fires in the Amazon, the sixth gave attention to fire in Indigenous territories, the seventh was focused on fire in non-intended public forests and the eighth was about fire and cattle raising in public land.

Among the many results that all the technical notes had brought since 2019, it is important to note the last one that reinforces the chain deforestation - fire - cattle (SALOMÃO *et al.*, 2021). Figure 21 shows the increase of deforested area in **non-designated public forests** in the Amazon. Beyond the growth of deforestation, it is evident that very few of those areas returns to forest (21%), the greatest area (78%) consolidates as pasture, closing the cycle of land grabbing.

Figure 21 - Consolidation of pasture in non-designated public forests in the Amazon basin in two periods (2006 - 2010 / 2016 - 2020). Source: IPAM, 2021.

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ISA

The Socio-Environmental Institute (ISA) is a NGO founded in 1994, dedicated to *propose integrated solutions to social and environmental issues with a central focus on defending social, collective and diffuse goods and rights related to the environment, cultural heritage, human and peoples' rights* (ISA). It works through programs, integrated projects and campaigns. Forest fires are an issue treated specially by the **Amazon Network of Geo-referenced Socio-environmental Information** (RAISG in its portuguese acronym). ISA and other 7 NGOs got together to *generate and disseminate the information to fully visualize the Amazon and the threats and pressures that hover over it, and serve as intelligence reports so that the Amazon is better known, appreciated and cared for* (RAISG). Since 2012, RAISG has published the **Atlas Amazon under Pressure**, a document with maps that improve and update the socio-environmental challenges that the biome faces, including forest fires.

Another important initiative coordinated by ISA is the **Alertas+ Panel** (Alerts+ Panel). It is a platform to track alerts about deforestation, illegal mining and forest fires in Indigenous Territories and conservation units in the Amazon basin. It is possible to make customized searches, selecting the kind of alerts, vegetation types being burned, type of territory, aggregated by municipality or state or hydrographic basin and the period of interest. Results are shown by number of warnings, time evolution and accumulated values. Figure 22 shows an example of results on the number of alerts.

Figure 22 - Results on the number of hotspots alerts in Indigenous Territories in municipalities from the Amazon basin. Source: Alertas+, 2021.

Number of alerts from January 2020 to December 2021 in Indigenous Territories by municipality

Municipalities in the Amazon basin
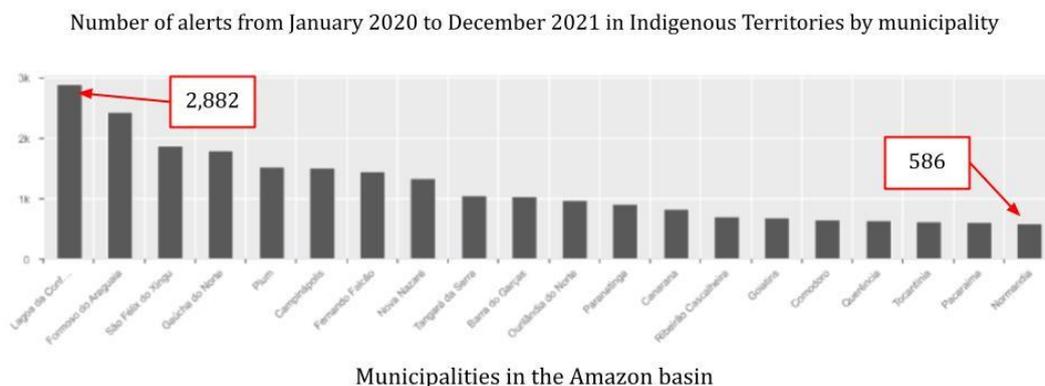
Relevant national/regional structures for combatting forest fire

The information about structures is presented and discussed in different topics. The main structure to be pointed out is the ***Environmental Emergency Battalion*** (BEA in its acronym in portuguese), which is a subject of the survey trip to Cuiabá, Mato Grosso.

Other structures that can be mentioned are the ones supported by the ***Amazon Fund***, which are quickly presented in table 2. All projects were financed to improve infrastructure of state Firefighters Companies from Tocantins, Pará, Mato Grosso, Acre and Rondônia. Also it is important to highlight the project presented by Prevfogo, which allowed the improvement of its headquarters in Brasília.

Relevant socio-economic matters

Budget and staff

In 2021, until September, only 21,7% (R$ 83,5 millions) of the amount of financial resources dedicated to actions against deforestation and fires was used by IBAMA and ICMBIO, (CARDOSO, 2021). This low expense of the resource also shows difficulties that these institutions are having due to the lack of specialized personnel and the dismantling of the inspection regulations. A contest for IBAMA and ICMBio will happen in the beginning of 2022. However, the 739 vacancies (568 for IBAMA and 171 for ICMBio) are not enough to solve the deficit of these institutions: 2,311 professionals at IBAMA and 1,317 at ICMBIO (CARDOSO, 2021).

There is always a difference between budget allocation (amounts authorized by law), commitment (reservation of financial resources) and payment. In 2020, the allocation for the Prevention and Control of Forest Fires in Federal Priority Areas (IBAMA) and Environmental Inspection and Prevention and Fight against Forest Fires (ICMBIO) was R$38.6 million and R$32.7 million respectively (CARDOSO, 2021). In the end, the amounts paid were R$ 27.9 million (72%) to IBAMA and R$ 12.6 million (58%) to ICMBIO. In fact, the budget of the ministry of environment has been decreasing since 2017, as shown in figure 23.

Figure 23 - History of the budget of the ministry of environment and related entities. Source: Climate Observatory, 2021.

Other relevant issues

Despite the weakening of the regular institutions dedicated to environmental issues, as stated before, pretentious big operations have been realized by the Armed Forces during the fire seasons since 2019. The operations were called ***Brasil Verde*** (Green Brasil) and they were focused on combating fires and environmental crimes in the Amazon region. Operação Brasil Verde 1 and 2 were implemented by presidential decree that authorized the Army to settle the Guarantee of Law and Order [Environmental] (GLO). They were realized mainly in federal territories like Indigenous lands and conservation units. About 2,500 soldiers and professionals from other institutions were involved in these operations.

The Brasil Verde 1 occurred from August 24 to October 24, 2019. Brasil Verde 2 began on May 11, 2020 and finished on April 30, 2021. During the two operations, almost 20,000 fires were fought by land and air, resulting in about 6,000 fines (among other environmental crimes) and more than BRL 3.4 billions (BRASIL, 2019a; Brasil, 2021a).

Although the expressive numbers of the operations, as discussed before in this report, since 2019, deforestation and forest fires are growing. So, this partial transfer of the

responsibility for the Amazon conservation to the militaries was not efficient. Brasil Verde costed five times the budget of IBAMA (PAES, 2021).

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Survey results in areas with frequent forest fires

Survey trip to Cuiabá

On November 4th and 5th 2021, a presential survey was conducted in the city of Cuiabá, the capital of the State of Mato Grosso. The selection of the city is justified by the important numbers related to forest fires in the region. Mato Grosso is the state with the highest frequency of annual hotspots in almost all the last years. Also, the state is potentially the most organized and prepared to face the fire problem.

During the two days of the survey, three different institutions were visited and six experts were interviewed. The institutions and the experts were:

- Institute Center of Life (ICV) - Deroní Mendes (program coordinator);
- Federal University of Mato Grosso (UFMT) - Professor Jaçanan Milani (Forest Engineer Dept), Prof Evandro Silva (University Rector), Professor Leandro Batirolla (Dean of Research);
- Environmental Emergency Battalion of the Fire Fighters Military Department of the State of Mato Grosso (BEA/CBMMT) - Lieutenant Colonel Jusciery Marques (Commander); and
- Lieutenant Colonel Paulo Barroso (former BEA commander, freelance consultant).

In addition to them, two federal institutions in Brasília were also visited and more experts were interviewed:

- National Center for the Prevention and Combat of Forest Fires (PrevFogo/IBAMA) - Lara Steil (Coordinator of the Interagency and Fire Control Center); and Flavia Leite (Chief of Prevfogo/IBAMA);
- Chico Mendes Institute for the Conservation of Biodiversity (ICMBIO) - João Morita (Fire Prevention and Control Coordinator).

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A previous questionnaire was sent to all institutions, with more objective questions. The face-to-face interviews were oriented to gather more qualitative perceptions and possible common understanding of the forest fires challenges.

The next topics resume the information given by each participant/institution. The more quantitative data are given in the questionnaire responses.

Organizational structure for forest fire countermeasures

This topic refers to the institutional arrangement dedicated to settle the countermeasures to forest fires. Since there are organizations with different missions and not exclusively related to forest fires, in order to have more effective countermeasures, it is necessary a well established governance, with clear roles and responsibilities.

CIMAN/MT

CIMAN/MT is the acronym for ***Operational Coordination Multi-Agency Integrated Center from the state of Mato Grosso***. It is the only state CIMAN, besides the federal one. It is a central situation room with a consultative and deliberative character. It was created in 2021 by a state decree (MATO GROSSO, 2021). According to the decree, it is intended to:

I - monitor the situation of fires and forest fires in the State;

II - promote, in a central situation room and from a unified command, the sharing of information about its ongoing operations;

III - seek joint solutions to fight forest fires; and

IV - make information available to society, providing publicity and transparency to its ongoing actions.

It is constituted by seven members, representing different state institutions like secretaries of civil defense and environment, military and civil judiciary police and

Official Expertise and Technical Identification. Also, at least 11 more institutions are invited to participate such as the Army, the Navy and the Air Force, Prevfogo, ICMBIO, National Indian Foundation - FUNAI, National Institute of Colonization and Agrarian Reform - INCRA, SESC Pantanal and some private companies and NGO's. The general coordinator is the operational director of the Military Fire Department and the deputy general coordinator is the commander of the Environmental Emergencies Battalion (BEA) or the executive secretary of the State Fire Management Committee (FMC).

CIMAN/MT has ordinary and extraordinary meetings to discuss and coordinate fire operations, using the standardized incident management tool called Incident Command System (SCI). Figure 24 shows a presential meeting in BEA's facility.

As per the article 8 of the decree, CIMAN/MT will be set every fire season and will remain until a period of 30 (thirty) days after the authorization of fires in the state.

Figure 24 - CIMAN/MT ordinary meeting in the BEA situation room. Source: Mato Grosso, 2021.

Fire Management Committee

Mato Grosso state has a ***Fire Management Committee*** (FMC). It was created to prevent, monitor, control and fight forest fires within the State of Mato Grosso in an integrated manner (MATO GROSSO, 2011). To perform these tasks, the FMC is composed of 15

official state representatives (government secretaries, research institutes, etc.) and 18 other invited institutions. The president of FMC is the Secretary of Environment and the executive secretary is conducted by the Firefighters Company of Mato Grosso. Since it intends to put together many different institutions, almost all perceptions on the problem shall be heard and discussed.

The FMC has periodic meetings (monthly) focused on fulfilling your purposes, which are mainly intended to support the state govern of Mato Grosso to formulate its public policies on prevention, preparation, reduction, control, accountability and fighting forest fires.

In accordance with the bylaw of the committee, there are two main "products" under its competence: the ***Integrated Plan for the Prevention of Fires and the Fight against Forest Fires in the State of Mato Grosso (POTIF)*** and ***Action Plan for the Prevention and Control of Deforestation, Fires and Forest Fires in the State of Mato Grosso.*** Discussions about those plans will come later in this document (Status of disaster prevention and forest fire countermeasures [soft side]).

The FMC also has the attribution to implement ***technical chambers*** dedicated to more technical matters. At least, these chambers have to deal with Prevention, Preparation, Response and Accountability.

*Status of disaster prevention and forest fire countermeasures (soft side)*

In this topic, the discussions are focused on the structuring actions, which means the laws, plans, programs and projects on forest fires prevention and control in the state of Mato Grosso.

These actions come from the interaction of different institutions such as the FMC, the Environment Secretary, the Firefighters State Department, the state parliament, state university and NGO's. In the survey, three institutions were visited: Institution Center of Life (ICV), Forestry Department/Federal University of Mato Grosso (FENF/UFMT) and the Environmental Emergency Battalion (BEA).

ICV programs

ICV is a 30 years old NGO located in Mato Grosso (Cuiabá and Alta Floresta) that aims to *build shared solutions for the sustainability of land use and natural resources* (ICV, 2021). ICV works through programs and cores (social business, economic incentives for conservation, socio-environmental rights, environmental transparency and territorial intelligence). The territorial intelligence (TI) is occupied by the *dissemination and application of geotechnologies in the planning, execution and monitoring of the different projects*. On the fire subject, TI main activities are the **Fire Monitor** and the **mapping of forest fire prevention and combat brigades present in Mato Grosso** beside other projects that uses the **Global Forest Watch** to curb illegal deforestation and forest fires in Mato Grosso. The Fire Monitor is a dashboard to visualize hotspots in the state of Mato Grosso (Figure 25). It uses data from the **Queimada Program** of the National Institute for Space Research (INPE)[7]. It is possible to see the hotspots by biome, city, month, year (2018-2021) and land category.

Figure 25 - Dashboard of Fire Monitor of hotspots from January to October 2021, specially in the Amazon region (light grey), representative biome on the north of Mato Grosso. Source: ICV, 2021.

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[7] https://queimadas.dgi.inpe.br/queimadas/portal
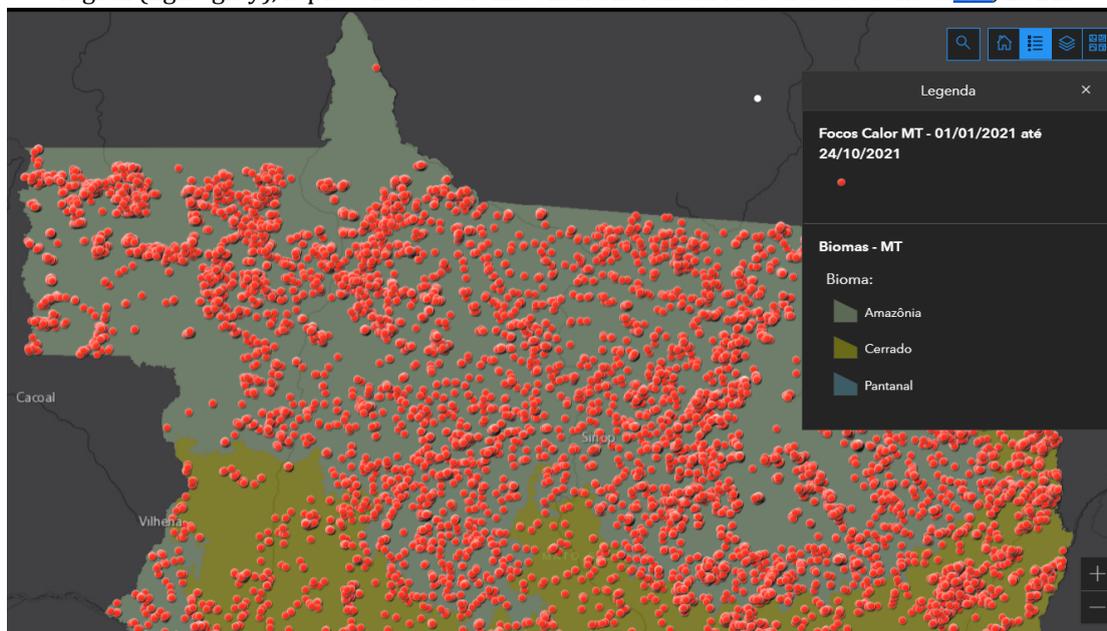
The mapping of brigades is a platform developed in the Story Maps of ArcGIS[8]. It shows the active brigades in the state, their status, the brigade type, the biome and the city. In its last update (July 2021), there were 43 brigades in the Amazon part of the state, 9 of them were permanent, 30 temporary and 4 were in implementation (Figure 26). 19 of them were from the Firefighters Department of Mato Grosso, 9 were federal brigades, 12 mixed (firefighters and temporary brigades) and 3 communities (self-organized). Those brigades cover an area of more than 480 thousand km^2 of Amazon biome in the state. There is no data about the number of members or the situation of equipment and training.

Figure 26 - Fire brigades dashboard of Mato Grosso state. Source: ICV, 2021.
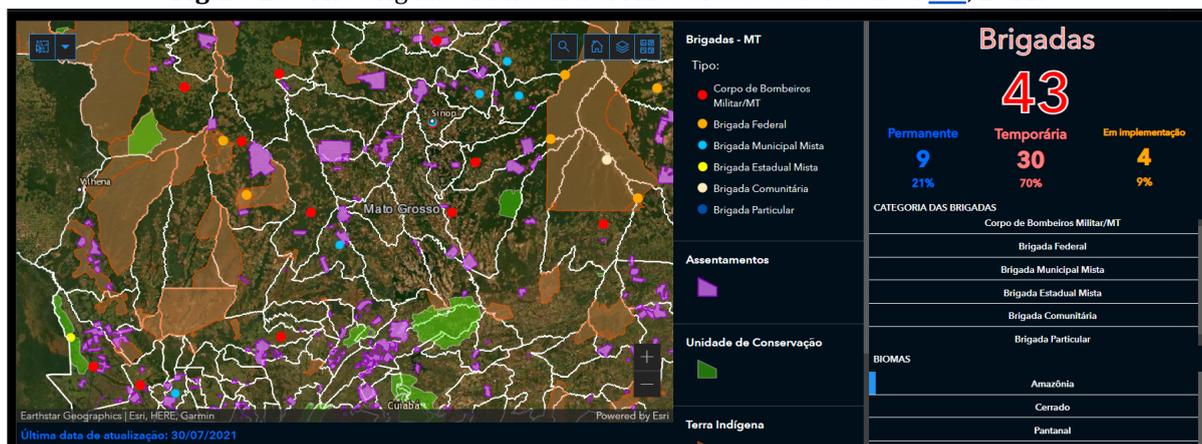
UFMT research and extension activities

The University of Mato Grosso (UFMT) is a federal center of learning and research founded in 1970 with campi in Cuiabá, Sinop and Barra do Garças. Sinop is in the transition from Cerrado to Amazon biome, Cuiabá in the Cerrado next to Pantanal and Barra do Garças is entirely in the Cerrado.

The research and extension activities related to the fire problem is very recurrent in the university. Nowadays there are 6 projects focused exclusively on this issue, specially in the Pantanal region due to the devastating fire season in 2020. There are projects on

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[8] https://www.esri.com/en-us/arcgis/products/arcgis-storymaps/overview

forest regeneration after fire, prescribed burning for management of fire, fire susceptibility in conservation areas, plant curtains for fire protection.

BEA planning activities

The Environmental Emergency Battalion (BEA) is a branch from the Mato Grosso State Military Fire Department. It was created in 2010 with the purpose of operationalizing the Military FireFighter Aviation Group - GAVBM, a system for the prevention, control and combat of forest fires, motivated by raising structuring resources from the Fundo Amazônia, through the "Forest Firefighters" project[9].

One of main responsibilities of BEA, together with other institutions of the FMC and CIMAN/MT, is the ***Plan for Operations in the Forest Fire Season*** or ***POTIF*** in its portuguese acronym. Since 2018, there is an annual planning for the fire season, regarding *prevention, preparation, response and accountability actions related to forest fires, defines the use of human and material resources, as well as presents the necessary resources for the operationalization of the actions foreseen in this document* (MATO GROSSO, 2021a).

Every year POTIF presents a schedule of actions and the description of its strategic instruments for response to forest fires. Each step has its activities, regarding the necessities of each moment throughout the year. In the months before the dry season (November to April), there are activities on prevention and preparation. During the dry season (May to October) there are some preparation, accountability and response activities. Table 2 shows the steps and activities distributed throughout the year.

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[9] http://www.cbm.mt.gov.br/bea.php?id=215

Table 2 - Forest fire actions annual schedule in Mato Grosso. Source: POTIF, 2021.

STEPS		MONTHS
Pre-event (before)	Planning	January to March
	Passive prevention	January to December
	Preparation	April to August
Event (during)	Active prevention and supervision	February to November
	Accountability	February to November
	Response	July to October
Post-event	Assessment and correction	December to January

Based on historical data series and last year's fire season numbers, POTIF brings an estimation of critical cities and regions as well as equipment and capacity building needs for forest fire activities. From 2018 to 2020, the annual costs were very similar. In 2021, costs rose up to more than eight times the highest value in the last four years (Figure 27). This situation is explained by the expressive higher number of operations in this current year, a consequence of a greater concern due to fire seasons of 2019 (Amazon) and 2020 (Pantanal).

Figure 27 - Annual estimated cost for forest fire prevention and control in Mato Grosso. Source: POTIF, 2018 to 2021.

R$.year-1
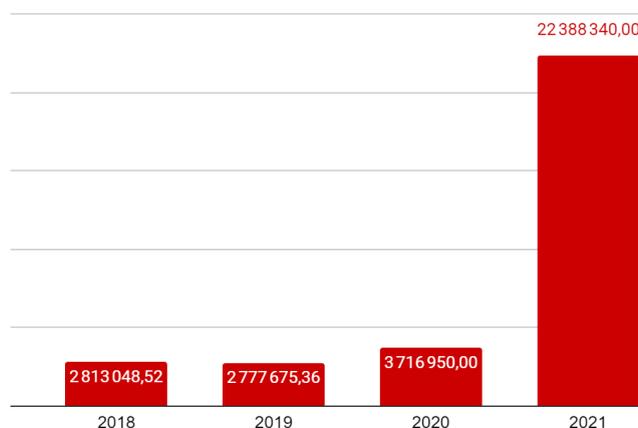
The description of cost items is different in each POTIF, making it difficult to compare, but in all cases, the Response activities are the most expensive, especially because of air operations and daily rates for brigades. In 2021, the biggest cost item is related to the implementation of Decentralized Military Firefighter Bases (BDBM in its acronym in Portuguese), which makes up more than 50% of 2021 total daily rates (MATO GROSSO, 2021a).

State Fire Control Policy

In August 2020 the **State Fire Control Policy (SFCP)** was enacted in Mato Grosso. It is a legislative instrument that regulates the use of fire. It means that the law recognizes fire as an *integrating part of ecological, economic and sociocultural systems* (MATO GROSSO, 2020). SFCP promotes the integration of institutions for fire management and intends to reduce forest fires impacts, to promote the controlled use of fire or its substitution by other practices whenever it is possible, to increase the ability to fight forest fires and to restore burnt areas, among other objectives.

The law institutes the **State Committee for Fire Control** as its main instrument of governance. This committee is composed by nine state institutions and it is chaired by the Secretary of Environment. ICMBIO and IBAMA also are part of the committee. It is supposed to meet ordinarily three times per year. It is not clear how the implementation of this committee interferes with the FMC.

The main instruments to be promoted by SFCP are the **Integrated Fire Management Plans, the Forest Brigades Programs, the financial instruments** (ex.: REDD+) and the **CIMAN/MT**. It regulates the allowed uses of fire, the integrated management in protected areas, the gradual substitution of fire in rural zones and the accountability of the unauthorized use of fire.

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Status of facilities and facilities for disaster prevention and forest fire countermeasures (hard side)

In this topic, the information is about the structural actions, which means the infrastructure, the equipment and brigades for forest fires prevention and control in the state of Mato Grosso.

BEA's facilities

Although BEA was created in 2010, it was only in 2014 that it really started its operation due to the acquisition process which was completed only in 2016 (BARROSO, 2017). BEA had a project approved on the Amazon Fund which aported R$ 16 millions to the institution. This resource allowed the acquisition of:

- Two forest fire fighting aircraft - Air Tractor;
- 12 Vehicles (Five Forestry Auto Pump, Six Forest Rapid Auto Pump, 1 Fuel Tank).

It was also possible to do the implementation of the Environmental Emergency Battalion Ground Air Base in the municipality of Sorriso (Figure 28), to conduct three forest fire season operations, from 2014 to 2016 and to do some capacity building such as a private air pilot course.

Figure 28 - Air base to fight forest fires in the Amazon. Source: ALMT, 2019.

Nowadays, BEA has its headquarters in the city of Cuiabá. It is installed in an old state government school, which is being rebuilt to fit the needs of a Firefighting Department.

To this reconstruction, the REDD+ Early Movers program (REM-MT)[10] invested about R$ 250,000.00 (REM-MT, 2021). The State Public Ministry (MPE), Court of Justice (TJMT), Secretariat of Public Security (SESP) and resources of Terms of Adjustment and Conduct (TACs) of the Secretariat of Environment (Sema-MT) apported more R$ 1,050,000.00 to the renovation of BEA facility. Figure 29 shows how BEA was on 5th November 2021.

Figure 29 - BEA's facilities: a) situation room with real-time updated satellite images b) garage c) hangar with equipment for fire prevention and control. Source: Consultancy.
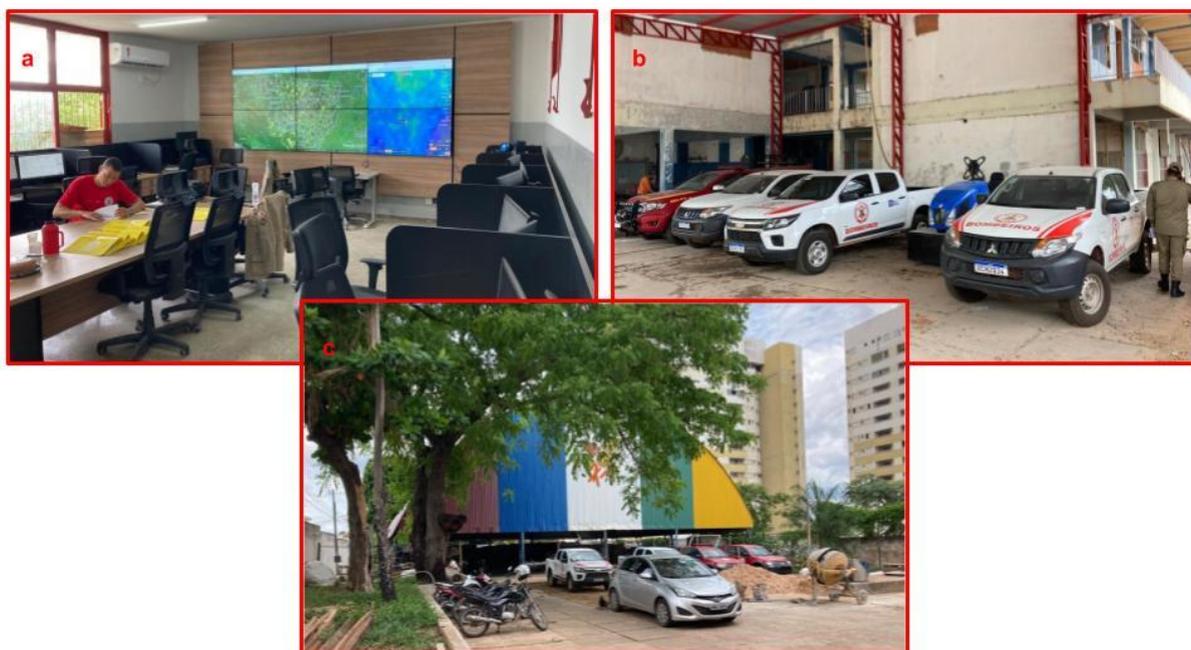
Temporary Response Instruments

Every fire season POTIF presents the distribution of ***instruments for prevention and control of fire***, related to the results of the previous fire season and the conditions of the current year. In the plan there are three types of strategic instruments:

- ***Management Instruments (MI)*** - Operational Board, BEA, Regional Commands and CIMAN/MT;
- ***Temporary Response Instruments (TRI)*** - Mixed Municipal Brigade (MMB), Mixed State Brigade (MSB), Military Firefighter Decentralized Base (MFDB), State

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[10] https://remmt.com.br/index.php/pt/

Indigenous Brigade (SIB), Operational Support Intervention Teams (OSIT), Mechanized Operational Support Team (MOST);

- ***Accountability Instruments***.

The MI's are perennial initiatives that are based on the consolidated infrastructure of the Firefighters from the state of Mato Grosso. The main activity in this kind of instrument is the connexion among the institutions on strategic and operational levels. It means the communication between decision makers at the headquarters and firefighters at the field. It is made with the support of situation rooms: one centralized in BEA and others in the regional commands. The situation rooms will be better discussed in the next topic.

The TRI's are defined in each fire season. They are characterized by the implementation of physical structures with the objective of *expanding the service of Mato Grosso State Military Fire Brigade (MT-MFB) on forest fire prevention and combat, especially in locations that do not have Operational Units of the MT-MFB and need an established response in the TIF response phase* (MATO GROSSO, 2021a).

The decision of where the TRIs will be placed is made based on the study of the frequency of hotspots in the last decade (2011 to 2020) in municipalities in the state of Mato Grosso and in its conservation units. In the fire season 2021 there were 53 TRI's planned to be implemented: 15 MMB, 11 MSB, 22 MFDB and five OSIT. They were placed in 20 cities with more hotspots in the last decade. The figure 30 shows the distribution of regional commands (colors) and the MSB's (light green), the MFDB's (dashed in red lines) and the MMB's (dashed in yellow lines).

MMB is an integration of efforts from the state government, the municipality government, private companies and class entities that get together to prepare the first response to forest fires. MMB is installed usually in the municipalities that don't have permanent firefighter operation units. It is composed of two military firefighters and at least six civilian brigades, which are hired for the fire season or they are provided by the city halls. This team is responsible for checking the situation of hotspots identified in the

situation rooms; if it is a forest fire, MMB start the combat at the rural areas and especially at the state conservation units.

Figure 30 - Location of regional commands and TRI's in Mato Grosso State during the 2021 fire season. Source: Mato Grosso, 2021.
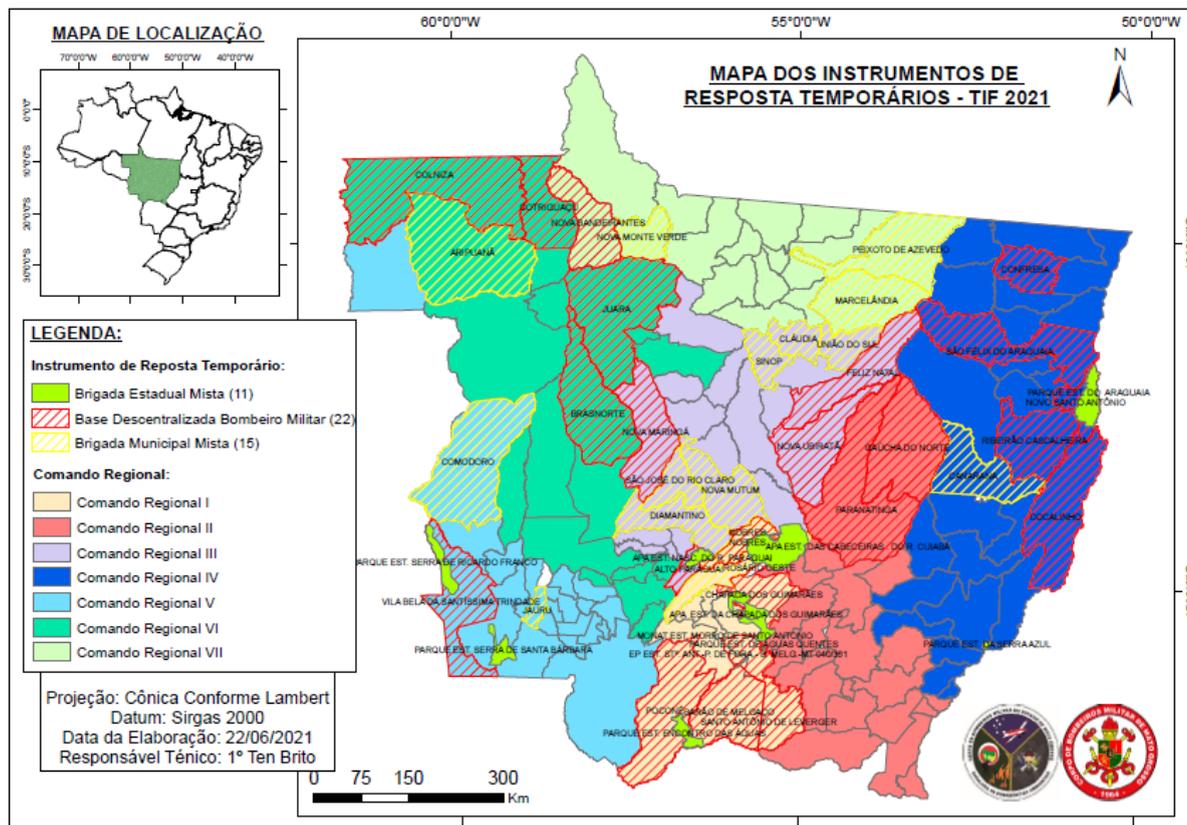
MSB is an initiative from the state government that hires civilian brigades to act in the fire season, concentrated in the state conservation units. MSB is composed of two military firefighters and at least eight civilian brigades. They are equipped with a 4x4 pick-up trucks and other essential equipments such as flame mufflers, radio communication structure, back bombs, uniforms, helmets, water bottles, boots, etc.

MFDB is also a state initiative, composed only of military firefighters. There are four of them, installed in critical zones defined by the numbers of hotspots and the lack of operational conditions. MFBD is also equipped with 4x4 pick-up trucks and other essential equipment. They track hotspots monitored by the situation rooms, checking *in loco* if the hotspot is a forest fire. If it is confirmed, MFDB starts the combat immediately,

providing the first response (level 1), prioritizing the preservation of the state conservation units.

OSIT is an expert team of at least two military firefighters who have concluded the forest fire prevention and fighting course (CPCIF in its portuguese acronym). They have access to logistics resources that are more adequate to combat level 2 forest fires. This level incidents are the ones that surpass the response capacity of operational units, MMB's and MFDB's.

Early warning, monitoring, and communication of forest fires

Situation rooms

Situation rooms are the main instruments for early warning, monitoring and communication of forest fires. They are real-time surveillance initiatives that monitor satellite images which show hotspots on the ground. This identification is reported to the nearest operational unit in order to check its condition and in the case that a forest fire is confirmed, firefighters begin the response level one quickly.

There are two types of situation rooms: one centralized and others decentralized. The **Centralized Situation Room (CSR)** is installed in BEA's facilities in Cuiabá (figure 31). CSR promotes the systematization of the **Decentralized Situation Rooms (DSR)**, manages the OSIT's and the MFDB's and coordinates the supervision activities.

Figure 31 - Centralized Situation Room with hotspots (yellow marks on the map) identified by satellite images. Source: Consultancy.

DSR are installed at the regional commands. So there are seven DSR operating. They are responsible for the assessment of ongoing occurrences, the level 2 occurrence declaration and the request for support to the CSR. In terms of technological infrastructure, the situation rooms (centralized and decentralized) are the same.

Status of cooperation

Forest fires are a concern that goes beyond the national frontiers, so in search for solutions, there are some joint efforts from other countries through governments, foundations and cooperation agencies. In Mato Grosso, there are some initiatives that support the Firefighters and other state institutions to improve their capacity to prevent and fight forest fires.

Nowadays, probably one the most representative initiative is the program ***REDD+ Early Movers (REM-MT)***. The program *remunerates and rewards the climate change mitigation effort of REDD+ pioneers (Early Movers) at the state, subnational or national level, aiming to foster sustainable development, and generate lessons learned until a global REDD+ mechanism becomes operational* (REM-MT, 2021).

Although it is mainly focused on reducing GHG emissions, there are some activities related to forest fires, also because preventing the burning of trees is one of the ways to stop the return of carbon dioxide to the atmosphere. A clear example is the financial support to the renovation of BEA's facilities, cited before in this document. The resources to REM Mato Grosso comes from the **German Development Bank (KfW)** and the United Kingdom government through the **British Department for Energy and Industrial Strategy (BEIS)**. The estimate is 44 million euros.

Other cooperation agreements among Mato Grosso government institutions, federal institutions (Prevfogo and ICMBIO) and international agencies shall be presented in the responses of the questionnaires sent to them.

On-site needs for support

All participants described some critical points related to the situation of their respective institutions. Certainly, the most relevant issues are from BEA, the institution directly and specifically related to the forest fire problem. But the other institutions are important stakeholders that support BEA on the strategies in the planning of fire seasons.

As the hotspots monitoring systems are advanced in the state of Mato Grosso, the on-site needs for support are more related to the Response step, during the occurrence of fire incidents. There is a real need to **accelerate the first response level one in order to avoid bigger fires**. Due to the wide range of the state of Mato Grosso and the Legal Amazon, there is a big challenge to reduce the time between identification of hotspots and the arrival of firefighters and brigades at the site. This challenge could be overcome with better communication between the CSR and DSR, and between DSR and MMB, MSB, OSIT and MFDB.

In fact, it was a clear message from colleagues of Prevfogo/IBAMA and ICMBIO. Firefighters and brigades need better **radio-communication** for on-ground operations. Also it was cited the need for improvement of the **temporary base camps** that are implemented at critical fire zones.

Uniforms, personal protective equipment (PPE) and forest fire fighting tools are costly and need to be bought every fire season. Fighting fires is a very degrading activity, even if tools and equipment are specifically designed to this end, most of them become useless after a fire season.

In a more structural perspective, **land vehicles and aviation** are also a bottleneck in fighting forest fires. Pick-ups, tractors, quad bikes and motorcycles are very demanded in the fire seasons and they need frequent maintenance. Airplanes are very costly. The experts from Prevfogo and ICMBIO agree that a **helicopter** is very important to increase the efficiency of first responses because it can come in any type of relief, leave the firefighters very close to the incident, it can bring a great amount of water and it can quickly evacuate firefighters from dangerous areas.

Actually, there is no need for buying airplanes since agricultural airplanes can be used during the fire season, a period of the year when they usually are little used. A national policy (PL 4629/20) is being discussed in the parliament in order to define the use conditions of agricultural planes at forest fires (CÂMARA DOS DEPUTADOS, 2021). Helicopters are more specific and they are not used in agriculture activities.

In a structuring perspective, **capacity building** is always a critical issue. Brigades need to be trained every fire season since they are hired only for 6 months and usually they are not the same teams hired in the previous year. Experts from ICMBIO and Prevfogo understand that it would be more effective if there are **continuous education programs**. And it needs to reach the rural population that uses fire for agricultural or cultural purposes. So, the development of these programs is a must do.

Also, there is a common agreement among all participants about the necessity of an **integrated information system** that gathers all institutions which deal with the forest fire problem in order to improve the communication among them and their decision making processes. Implementing Sisfogo is probably the consolidation of this need, but to make it operational and efficient there are some important steps to do like: the development of the appropriate technological infrastructure, the capacity building of the

professionals who will work on the system, planning of its maintenance and updating, definition of the hardware involved, among others.

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SEIVA -Informação Sustentável - *CNPJ: 39.28.53.87/0001-05 - Thiago Oliveira Rodrigues, diretor executivo.*
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Cooperation by donors against forest fires

Major donors and their projects

The table 3 compiles the main donors and their respective donations (USD) during the last 20 years. The dollar value used to calculate the donations was R$ 5,57.

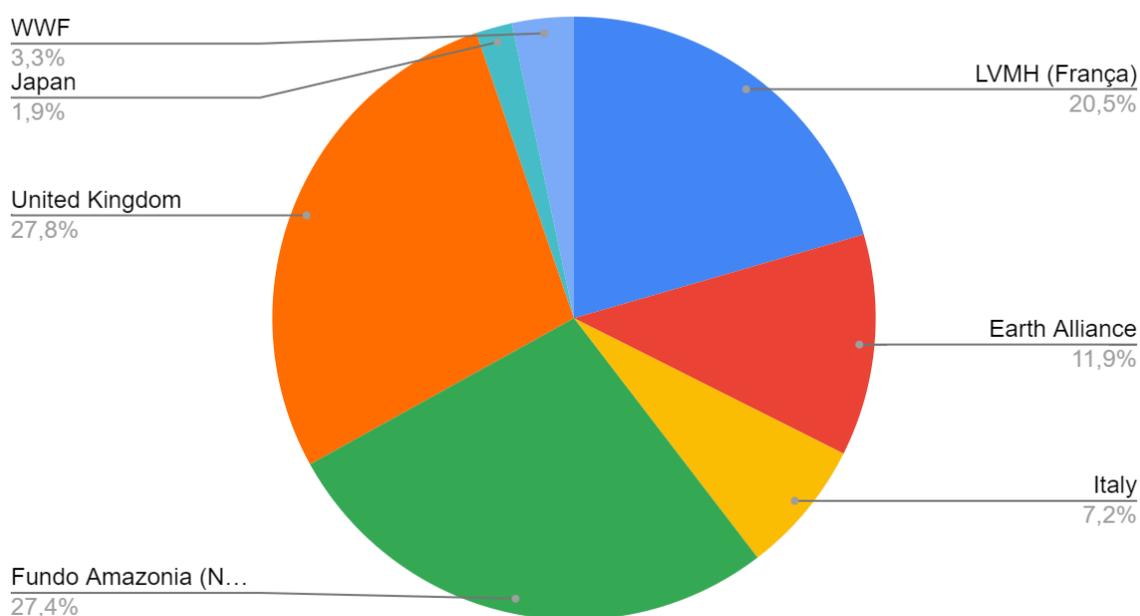**Table 3 -** Overview of Donor Interventions Concerning Forest Fire in Brazil.

Project	Donor	Total Cost (USD)	Project Period	Source (websites)
	LVMH (France)	8,621,000.00	2019	https://epocanegocios.globo.com/Empresa/noticia/2019/08/lvmh-doa-10-milhoes-de-euros-para-combater-fogo-na-amazonia.html
	Earth Alliance	5,000,000.00	2019	https://ealliance.org/amazonforestfund/
Fogo! Emergência crônica	Italy	3,015,868.69	1999-2002	https://antigo.mma.gov.br/estruturas/225/_arquivos/4__amaznia__encontrando_solues_225.pdf
Prevfogo / Ibama	Fundo Amazonia (Norway and Germany)	2,642,049.04	2014-2020	http://www.fundoamazonia.gov.br/pt/carteira-de-projetos/busca/index.html?facet_category_exact=tema/combate-a-incendios-queimadas/&reloaded&page=2
Proteção Florestal Tocantins		1,202,168.18	2012-2019	
Bombeiros Florestais de Mato Grosso		2,246,833.01	2011-2017	
Acre: Incêndios Florestais Zero		2,383,686.54	2012-2016	
Pará Combatendo os Incêndios Florestais e Queimadas Não Autorizadas		3,020,780.76	2012-2020	
Rondônia mais Verde		2,700,269,30	2012-2021	
	United Kingdom	11,680,264.44	2019	https://www.independent.co.uk/news/uk/politics/amazon-rainforest-wildfires-uk-donation-10-million-boris-johnson-climate-a9078526.html
	Japan	818,000.00	2020	https://www.gov.br/abc/pt-br/assuntos/noticias/brasil-japao-e-unops-cooperam-para-combater-incendios-florestais-na-regiao-amazonica
Emergency Amazon Fire Fund (Brazil and Bolivia)	WWF	1,390,408	2019-2021	https://files.worldwildlife.org/wwfcmsprod/files/Publication/file/3ao3p1z7t6_Amazon_May_Update.pdf?_ga=2.66923886.1982601132.1635451359-1690308615.1635451359

Although it is not an exhaustive list, it presents the major donors that often contribute to the Amazon biome and more specifically to the prevention of forest fires. The main

initiative is the Amazon Fund, which *attracts donations for non-reimbursable investments in actions to prevent, monitor and combat deforestation, and to promote the conservation and sustainable use of the Legal Amazon. It also supports the development of deforestation monitoring and control systems in the rest of Brazil and other tropical countries[11]*. All the six projects supported by the fund were related to firefighters capacity building, acquisition of fire fighting equipment (vehicles, tools, etc.) and infrastructure improvements. The total amount was USD 14,195,786.83, spent between 2011 and 2021.

Figure 32 shows how the donations were distributed by the donors. There are different kinds of donation and some of them can be traced back to its country of origin. UK, Germany and Norway are the major donors, being these last two donors through the Amazon Fund. WWF and Earth Alliance created funds specifically to combat forest fires at the biome. The money goes to partners such as NGO's that are directly involved in protecting vulnerable communities as indigenous territories. Also goes to Firefighters Companies to buy equipment and to improve infrastructure.

Figure 32 - Distribution of donations (USD) for forest fire prevention and control in the Amazon biome.

WWF
3,3%
Japan
1,9%

United Kingdom
27,8%

Fundo Amazonia (N…
27,4%

LVMH (França)
20,5%

Earth Alliance
11,9%

Italy
7,2%

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[11] http://www.fundoamazonia.gov.br/en/home/

In addition to these initiatives, there are some actions to capture spontaneous donations. They are leaded by the most recognized NGO's acting with environmental issues such as Greenpeace[12], WWF[13] and TNC[14].

[12] https://doe.greenpeace.org.br/proteja-amazonia-das-queimadas/p

[13] https://doe.wwf.org.br/queimadas

[14] https://www.tnc.org.br/ajude/florestasemfogo/

Issues, lessons learned, and needs obtained from the ongoing cooperation projects

The Amazon fund monitors the results of the projects it supports. From the 6 projects on forest fires, 5 are concluded and 1 will finish in 2022. All projects had a common purpose of reducing fire incidents in each state of the Amazon region. Despite the positive numbers related to some of their specific objectives such as professionals trained or equipment acquired, it did not reflect directly on the mitigation of forest fires. As stated before, since 2019 the numbers of forest fires have increased significantly.

One important outcome of almost every project is that the ***major improvements in infrastructure and the acquisition of essential equipment are strongly dependent on these external funds***. Without this kind of money, it is very difficult to know if firefighters headquarters would be properly equipped, if they would have planes and helicopters or even combatting equipment. Many important firefighting infrastructure came out due to specific funds, entirely or partially, like the new headquarters of Prevfogo in Brasília or BEA in Cuiabá, Mato Grosso. The financial resources from official government budgets (federal or state or municipal) seem to be not enough. As forest fires are primarily an environmental issue, it stays in the second plan, as the environment as whole.

But it is also necessary to develop some ***methods and metrics*** to have a better understanding on how much money is necessary to have efficient infrastructure to prevent and control forest fires, if the usual amounts are enough or not, if they are being applied correctly, if the rising numbers on deforestation and forest fires are a direct effect of the decaying numbers ($) related to planning, monitoring and fighting initiatives.

Proposed measures for major forest fire drivers

Deforestation

One crucial fact on forest fires is their strong relation with **deforestation**. Deforestation can be understood as the **main driver to forest fires** in the Amazon region nowadays. And in turn, the main driver to deforestation is **cattle raising** that actually is a procedure to **occupy the land**. So, the land issue is the problem to face.

While there is no effective control and punishment of **land-grabbers**, deforestation and forest fires will continue to happen and to rise. In fact, it is the present case in the Amazon region: until the end of 2020, more than 18 million hectares of non-designated public forests (32% of total forests on this condition) were illegally declared as private property on the National System of Rural Environmental Registry (CAR in its portuguese acronym)[15]. The same situation happens with indigenous territories.

According to experts, to reduce land grabbing in the Amazon basin, it is necessary to **strengthen** the work on monitoring, surveillance and protection, done by the directly related institutions like **IBAMA, ICMBIO** and **INPE**. The land regularization must be on a transparent and rigorous debate. **Irregular CAR's** must be immediately **canceled** and non-designated public land has to be regulated as conservation units or indigenous territories. Finally, land-grabbers and everyone else responsible for deforestation and forest fires must be quickly identified and properly penalized, in order to discourage these illegal activities.

Legal use of fire

Regarding the **legal use of fire** that sometimes goes wrong and starts forest fires, it is important to increase the **awareness about technological alternatives** to replace the use of fire and, more important, to make them feasible. The majority of the alternatives

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[15] Alencar *et al.* Amazon in Flames - Technical Note n.° 7 - Deforestation and fire in non-intended public forests. 2021. 12 p. Available at: https://ipam.org.br/bibliotecas/amazonia-em-chamas-7-desmatamento-e-fogo-nas-florestas-publicas-nao-destinadas/

are more expensive and more time costing than the use of fire. ***Capacity building*** of small farmers is crucial. The SEM-FLAMAS project seems to be a good example because of its regionalized approach (National Forest and Extractivism Reserve). But it still lacks results to confirm, since the project ends in 2022.

Responses on fire events

About the initiatives for ***forest fire combat and control***, as presented in this report, there are a lot of ***systems that monitor*** and identify hotspots. The challenge is to ***accelerate the responses*** in the field by drastically reducing the time between the identification of uncontrolled burnings and communication of brigade troops. And ***troops*** must be able to ***move fast*** to reach the fire origin. It is a big challenge in Brazil and in the Amazon basin due its continental coverage. It depends on efficient vehicles like helicopters and adapted trucks and pickups. Linked to response actions, it is very important to ***improve the capacity of accountability*** in order to identify the responsibles for forest fires and illegal burnings and give them the appropriate punishment.

NGOs

NGOs are still the main actors on prevention, monitoring and sensibilization initiatives. They have been targets of companies, individuals and even government agents interested in maintaining "business as usual" with the indiscriminate use of fire. In order to keep generating alerts, conservation projects, transparency in funds management and primary support to the most vulnerable communities (indigenous people, remnant peoples of quilombos) it is crucial to ***foster NGO's work***, especially the ones with many years of experience in the Amazon biome like the ones reported before. But NGOs have to work together with the other stakeholders, they can not act isolated.

Japan's future support potential

After assessing the results of this consultancy, it becomes clear that some sectors and initiatives would be ideal targets for future support from Japan. Although there are a lot of monitoring systems, one concern of the professionals interviewed in the survey trip is the need for a better centralization of the information. *Sisfogo*, the information system predicted in the National Policy for Integrated Fire Management should be a good opportunity for Japan's support.

The infrastructure for monitoring and fast response systems is always in need for upgrading. The *situation rooms* can be improved with new softwares and equipment and also with training activities to the ones that operate in these structures. And there are some strategic regions in the Amazon basin that lack minimum infrastructure and it would be very good to develop decentralized basic bases.

Capacity building will always be a relevant sector to be supported. Brigade troops are renewed every fire season and there are frequent advances in techniques, methods and equipment, justifying the need for a *periodic and continuous education process*. Besides the brigade troops, it is also important to aware and sensitize the small farmers, indigenous people and other habitants from the "deep" Amazon about the Integrated Fire Management (IFM) procedures and requirements. They need to be capable of using fire correctly and also capable of conducting the first combat to avoid bigger fires and slow up the advance of fire before firefighters arrive with better equipment.

Equipment, Personal Protective Equipment and *tools* are a constant necessity in every fire season. Combating fires degrades them very quickly. An external support to acquire them is a more efficient procedure. Public procurement in Brazil uses to be very bureaucratic and fire season can not wait.

Appropriate vehicles to speed up the arrival of brigade troops at the fire's site is very relevant to the success of fire extinguishing. Because they are specific to be operated in tough conditions, they demand regular maintenance and they operate in some months of the year. So it is important to elaborate strategies in order to make it feasible to

maintain them and maybe use them in other activities or use vehicles from other activities in the fire season. One example is the use of agricultural airplanes that are used to pulverize pesticides in crops being adapted to also be capable of releasing water over a forest fire. Helicopters are very useful to put the brigade troops quicker and closer to the fire site, but they are not commonly used in agricultural activities.

NGOs are institutions used to receive foreign support and to develop projects with foreign partners. In order to facilitate the execution of more pragmatic initiatives, NGOs tend to be the most effective coordinators. Some of them have a great expertise in the Amazonian challenges such as forest fires and they can be the best interlocutors with government institutions. Since there are a great number of projects going on under the supervision of NGOs, supporting them can be a good opportunity.

And by the same reason of the ongoing projects and multiple actors involved in reducing forest fires in the Amazon basin, it would be very strategic to promote an *event* to gather experts from NGOs, academia, governments, civil society, indigenous people, quilombolas, private companies, small and big farmers, firefighters, brigades and other relevant actors affected by forest fires. Forest fires are a complex problem and need to be assessed by different perspectives with the greater and common purpose of extinguishing them.

In 2019 a big event called *Wildfire Conference*[16] was held in Brazil and it gathered the main experts in the subject. It would be very helpful to unite some of them again to debate and create a *more purposeful agenda*. An event to align similar and complementary initiatives, to identify the bottlenecks and synergies, to start the development of specific metrics that could answer about the effectiveness of the ongoing actions and make more assertive prognosis and establish shared responsibilities and verifiable goals. An international event is being planned to happen in Brazil in 2022. Maybe it is a good alternative for support.

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[16] Wildfire Conference - 7th International Conference on Forest Fires. http://www.ibama.gov.br/wildfire2019

Conclusions

Fire has been a tool for many years in the Amazon region. Fire is the cheapest way to clean and prepare an area for agriculture and pasture. It eliminates the natural vegetation and its ashes are a source of some elements needed for crops. In this regard, forest fires are ***strongly related to deforestation***. Fire is frequently used to clean areas after cutting down trees. Rural areas in the Amazon, far away from the surveillance of state and federal institutions, increase their productive surface by advancing on the primary forests. Fire is needed to complete deforestation and to give the minimum conditions for the settlement of the agribusiness activities.

2019 seems to be a ***turning point*** for the Amazon biome, especially regarding the duel between conservation and development. The traditional Brazilian path to development, with low efficiency, based on commodities and land conversion, has been increasing in the region with weak control from the surveillance institutions.

But NGOs, academia and some companies are alert and are producing ***data and information*** with more accuracy and reliability. This information is reaching the whole world and making the business difficult for the ilegal farmers and companies.

Although the capacity of different institutions and systems to follow and disseminate alerts for hotspots, numbers of fire occurrences and areas burnt are increasing. The perception of ***no punishment*** is a reality among land grabbers that are advancing rapidly on the conversion of primary forests to pastures. And it is not a problem of few laws and regulations. The Brazilian legislation on environmental issues is very advanced and forest fire is the object of an ongoing law project that will probably be enacted soon in 2022.

Apparently, there are many ***funding opportunities*** for improving infrastructure, capacity building and equipment acquisition but it lacks specific metrics to assess the impacts caused by them. It is not clear if there is enough funding or if the money is being well spent.

Firefighting state companies seem to have improved in the last 10 years. At least 5 situated in the Amazon region (Acre, Mato Grosso, Pará, Rondônia and Tocantins) had financial support (Amazon Fund) to rebuild and buy vehicles and tools. But still it is difficult to see a direct relation between better conditions to prevent and control forest fires and the number of fire events. If they were worse equipped and structured, the forest fires could have caused more damage?

Funding from foreign countries is still very important to raise up projects and campaigns related to environmental issues like forest fires. The government budget for this subject is decreasing year after year. There is still a prevalent line of thinking that conservation stops the socio-economic development of the country and it is possible to advance the exploitation of the natural resources without damages. It is very difficult for some decision makers to understand that there is no development without an appropriate management of natural resources and, in the case of Brazil, its main wealth is exactly its renewable resources. Surprisingly, besides infrastructure, awareness, capacity building and education for sustainability is a strong necessity.

informação para sustentabilidade

"Artigo III

Fica decretado que, a partir deste instante,
haverá girassóis em todas as janelas,
que os girassóis terão direito
a abrir-se dentro da sombra;
e que as janelas devem permanecer, o dia inteiro,
abertas para o verde onde cresce a esperança".

Thiago de Mello, *Os Estatutos do Homem, 1964*