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Note

AMAZONIAN TIPPING POINT: SECURITY IMPLICATIONS OF CLIMATE CHANGE AND DEFORESTATION IN THE AMAZON RAINFOREST

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DGRIS

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It is coordinated by IRIS as part of the contract carried out on behalf of the French Ministry of Armed Forces' Directorate General for International Relations and Strategy (DGRIS). The Observatory's multi-disciplinary team includes researchers specializing in international relations, security, defence, migration, energy, economics, climatology and health. It is directed by Mathilde Jourde and François Gemenne.

The Observatory has initiated numerous collaborations with European partners (Netherlands, Luxembourg) and international partners (Australia, United States, India), international NGOs and national and international public bodies. These initiatives have strengthened cooperation on climate issues and their security implications.

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SUMMARY

COP30 opened on November 10 in Belém, right in the heart of the Amazon. This highly symbolic location framed discussions that focused heavily on the protection of the Amazon rainforest against multiple threats, notably climate change and deforestation. These international negotiations also highlighted the vulnerability of this ecosystem through the concept of a "tipping point," which was widely discussed throughout the sessions.

Although **no scientific consensus currently exists regarding the Amazonian tipping point**—its existence, timing, or geographic distribution—**this concept underscores both the present and future vulnerability of the region.** It therefore offers, on the one hand, an opportunity to examine the drivers of forest degradation, particularly deforestation and climate change. On the other hand, it also highlights the potential consequences of this degradation, especially the security impacts—whether concerning populations or geopolitical dynamics—linked to a possible shift in the ecosystem.

This note is part of a series produced by the Defence and Climate Observatory dedicated to the tipping points identified by the Intergovernmental Panel on Climate Change (IPCC) (IPCC, 2018; Collins et al., 2019). Following an initial note on the slowing—even the potential collapse—of the Atlantic Meridional Overturning Circulation (AMOC), **the present note now turns to the Amazon rainforest and its tipping point**. It will first provide an overview of the existing literature and the scientific (non-)consensus regarding the Amazon rainforest tipping point, as well as the cascading effects, particularly for human security (I). It will then examine the geopolitical issues linked to the degradation or protection of the Amazon rainforest (II). Finally, it will address the operational and capability implications of a potential tipping point for the armed forces, especially for the French Guiana Armed Forces (FAG) (III). The aim of this note is to inform political and economic decision-makers about the security and defence implications of the ongoing degradation of the Amazon rainforest.

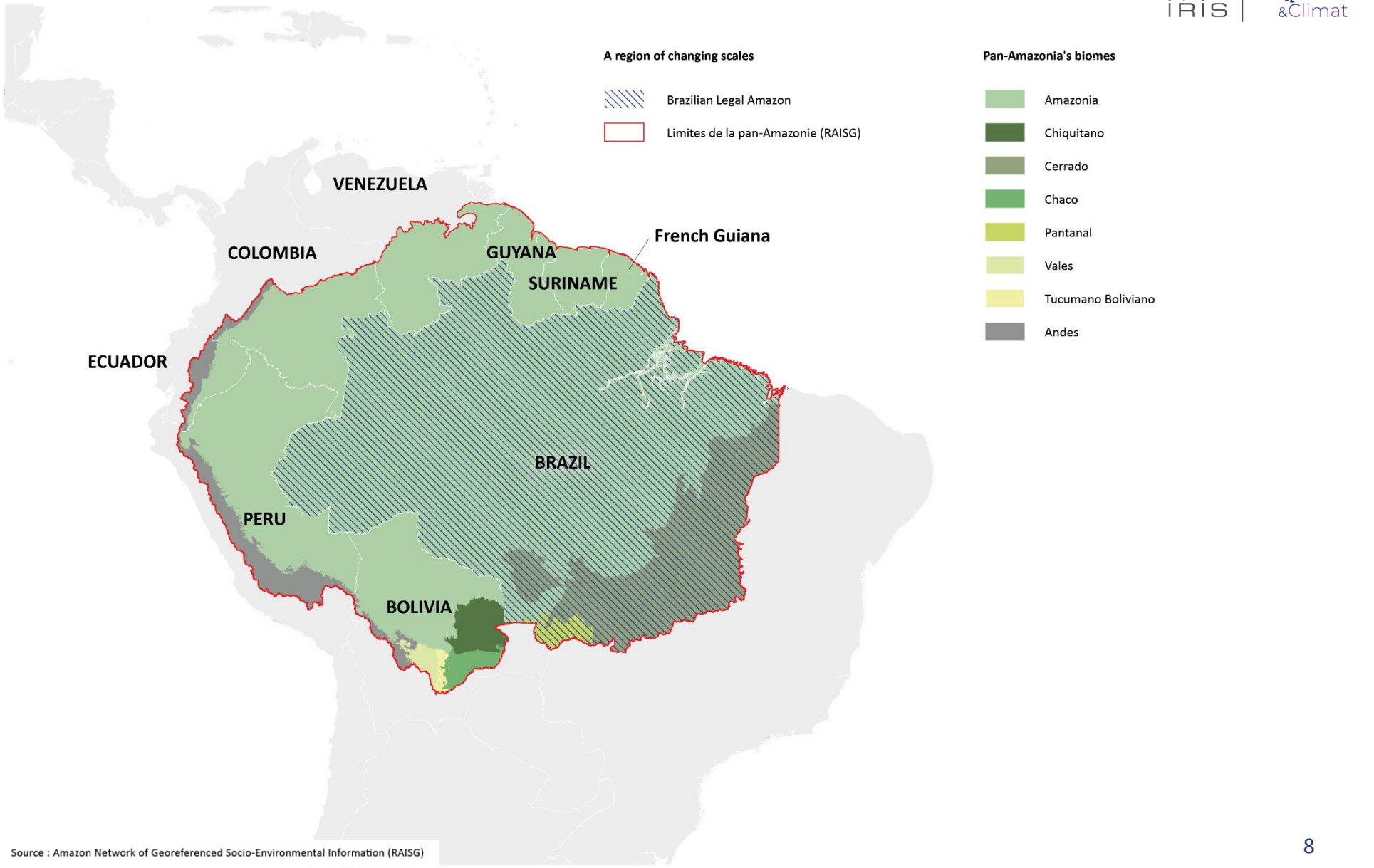
PART 1
THE AMAZON BIOME AT A TIPPING POINT?

A – Understanding the functioning and role of the Amazon region

The Amazonian biome[1], commonly referred to as the "Amazon rainforest," covers the basin[2] of the Amazon River (the "Amazon basin") as well as lands to its north and east, including the Guiana Shield. When limited to the humid tropical forest biome, the Amazonian biome extends over approximately 7.7 million km². However, **the Amazon rainforest is defined in multiple ways** (see Map 1), often based on natural boundaries, which leads to significant variations in estimates of its total surface area—from 5.5 million km², the size of Brazil's Legal Amazon, to 8.5 million km², the scale adopted by the Amazon Geo-Referenced Socio-Environmental Information Network (RAISG[3]) (Le Tourneau, 2023). This broader scale includes other biomes that surround the Amazonian biome and interact with it to sustain its ecosystem functions[4], such as the Cerrado to the south of Brazil's Legal Amazon (Aubertin, 2025). Other definitions rely on more artificial factors to designate, in an approximate way, a geographical area covering most of the Amazon basin. Contrary to widespread perception, **the Amazonian biome is not a homogeneous block of biodiversity[5]; rather, it encompasses a diversity of climatic and ecosystemic contexts**. This heterogeneity has led some researchers to prefer the expression "the Amazons" instead of referring to a single, uniform entity (Le Tourneau, 2019). Due to the diversity of its ecosystems, the Amazonian biome harbours nearly 10% of global terrestrial biodiversity and 13% of the world's total number of trees, making it an unparalleled reservoir of biological richness (WWF, 2025).

[1] A biome, or bioclimatic domain, is the largest ecological unit on Earth. It encompasses a set of ecosystems that share significant similarities in terms of climate and the species they host. It is named after the vegetation that predominates there (Bouron, 2024; Carion, 2018). Recent studies indicate that in the Amazon biome, 5.79 million km² can be classified as lowland tropical rainforest ecosystems, while the remainder consists of savanna and white-sand forest ecosystems, as well as freshwater and stagnant aquatic ecosystems (Moraes et al., 2021).
[2] The entire surface area that naturally drains toward the same river or underground water table.
[3] The Red Amazónica de Información Socioambiental Georreferenciada (RAISG), or Amazonian Network of Georeferenced Socio-Environmental Information in English, is a consortium of civil society organizations from Amazonian countries and the main body producing and disseminating statistical and geospatial socio-environmental information on the Amazon.
[4] The benefits provided free of charge to human societies by a given ecosystem. This definition can cover a very wide range of "services" of different types: resource production (energy, materials…), carbon storage, landscape or tourist amenities, positive health effects (thus reducing healthcare expenditures), water retention, and risk protection (Géoconfluences, 2025).
[5] The variety of living species (microorganisms, plants, animals) present in a given environment.

Map 1 – Boundaries of the Pan-Amazon Region



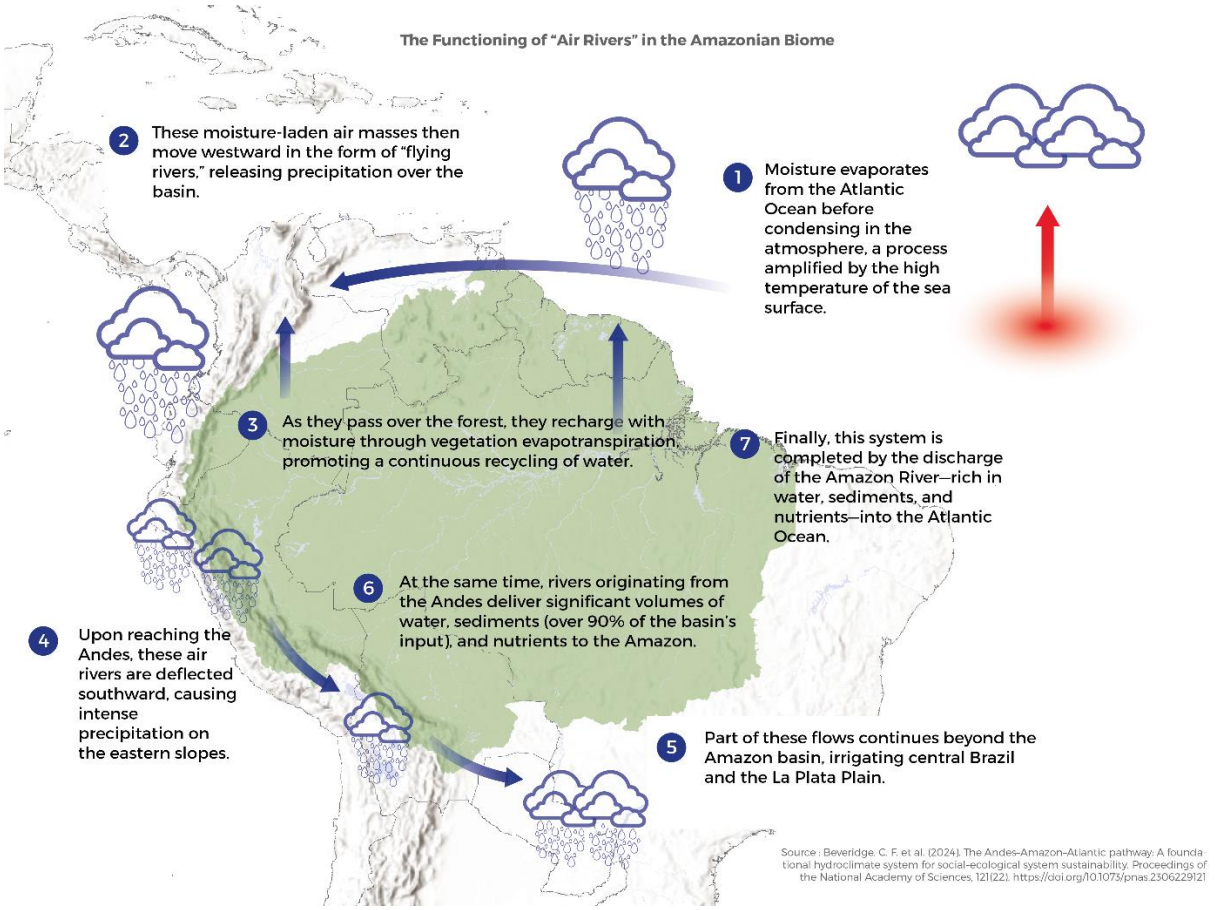
Source : Amazon Network of Georeferenced Socio-Environmental Information (RAISG)

The Amazon stands apart from other biomes due to two principal characteristics: its carbon storage capacity and its hydrological cycle[6], which make it a central component of the global climate system. Often described as a "carbon sink," **the Amazonian biome plays a key role in capturing and storing CO_2.** Estimates suggest that it stores between 367 and 733 gigatons of CO_2[7], concentrating nearly 20% of the world's carbon contained in terrestrial vegetation (Gagen et al., 2022; Nogueira et al., 2017). Through its ability to remove part of the anthropogenic greenhouse gas emissions from the atmosphere, this biome is therefore essential for mitigating climate change. At present, however, some scientists are questioning the biome's carbon absorption capacity (Aubertin, 2025). A study by Gatti et al. (2021) finds that the northwestern Amazon remains in balance, absorbing as much CO_2 as it emits into the atmosphere, while the southeastern portion, on the contrary, appears to constitute a net source of emissions, as it concentrates a large share of the Amazon's economic activities.

The Amazonian biome is also distinguished by a hydrological cycle that ensures both the renewal of the humid tropical forest ecosystem and the provision of water at a continental scale. The movement of atmospheric moisture transports water from the Atlantic to the Amazon and onward to the Andes, creating moisture recycling systems (see Figure 1). Approximately 50 to 75% of the average annual precipitation (around 2,200 mm) is returned to the atmosphere through this process of "air rivers," playing a decisive role in regional and continental rainfall patterns (IRD, 2025; Flores et al., 2024). This process largely regulates precipitation during the dry season, maintaining higher levels of rainfall and humidity in the Amazon compared to other territories at the same latitude (Staal et al., 2018; Nehemy et al., 2025). This natural phenomenon observed in the Amazon region is increasingly referred to by the emerging concept of the "Andes-Amazon-Atlantic pathway" (Beveridge et al., 2024; Monitoring of the Andes Amazon Program, 2025).

[6] The water cycle, or hydrological cycle, refers to the entirety of water transfers in its different states among Earth's water reservoirs (oceans, atmosphere, lakes, rivers, groundwater, and glaciers).
[7] Depending on whether one considers carbon storage by vegetation and/or deep soil.

Figure 1 – The Functioning of "Air Rivers" in the Amazonian Biome



Source : Beveridge, C. F. et al. (2024). The Andes–Amazon–Atlantic pathway: A foundational hydroclimate system for social–ecological system sustainability. Proceedings of the National Academy of Sciences, 121(22). https://doi.org/10.1073/pnas.2306229121

Beyond its role in the functioning of the regional hydroclimatic system, **the Amazonian biome is a structuring element of the continent's economic dynamics**. Nearly 70% of the combined gross national product of Brazil, Bolivia, Colombia, Peru, and Ecuador comes from activities directly dependent on its proper functioning, such as agriculture, hydroelectric production, and heavy industries (Lovejoy and Nobre, 2019; Purcell and Keary, 2023).

However, climate change and direct human pressures (agriculture, logging, mining activities, etc.) are degrading this biome, which is essential for climate balance. These pressures risk reducing the Amazon's carbon storage capacity, exacerbating global climate change and disrupting its role in regulating the regional hydrological cycle. Since the 1990s, research has focused on the mechanisms, causes, and consequences of human activities on climate stability (United Nations Framework Convention on Climate Change, 1992). As with other key climate systems, this raises the question of whether a large-scale collapse of the Amazonian biome could indeed occur, whether it would be associated with a specific tipping point, and what the implications would be (Flores et al., 2024).

B – Understanding the Amazonian biome Tipping Point

A tipping point is understood as a degree of change in a system's properties beyond which the system undergoes a potentially chaotic reorganization (IPCC, 2019). The potential tipping point of the Amazonian biome is often presented as a possible rapid and global transformation of its ecosystems into a state resembling a savanna. This phenomenon is explained by a cascading effect, whereby degradation or loss of forest cover in one area of the region could, through feedback mechanisms, lead to degradation and forest loss in other, distant parts of the biome (Boulton et al., 2022; Lenton et al., 2008; Boers et al., 2017; Lovejoy and Nobre, 2019). **Based on current scientific knowledge, however, there remains considerable uncertainty regarding the timing, spatial scale, and type of vegetation into which the biome might shift** (IPCC, 2021; Hirota et al., 2021; Flores et al., 2023; Flores et al., 2024). In addition, the great diversity of ecosystems within the Amazon complicates the development of uniform projections. Despite the disagreements surrounding this concept, it remains important to analyse its contours, including the associated drivers and its potential realization, in order to understand the risks involved.

1. Drivers of the tipping point and associated thresholds

Pressures on the Amazon can stem from local human activities related to land use or from climatic factors.

The Amazonian biome is primarily threatened by deforestation resulting from economic activities in the Amazonian countries (see Map 2). This deforestation is mainly driven by agriculture and livestock—historically the largest drivers—but also by timber trade, legal and illegal mining, particularly gold mining, and the development of transport infrastructure (Gagen et al., 2022; Meyerfeld, 2025; Runde et al., 2020). In recent years, deforestation has also been closely linked to the activities of drug traffickers, who acquire land—often from Brazilian public domains—to launder drug trafficking revenues through speculation on land titles. The resulting "narco-deforestation" arises from clearing these lands for agriculture, livestock, or infrastructure development (UNODC, 2023; Aubertin, 2025). Nonetheless, agricultural exploitation remains the primary driver of deforestation in the Cerrado[8], neighbouring the Amazonian biome (Aubertin, 2025).

Deforestation, in turn, increases the likelihood that the Amazon will reach a tipping point and lose part of its carbon storage capacity and its ability to regulate the regional hydroclimatic system, due to

[8] 98% of deforestation in the Cerrado in 2024 is estimated to have been caused by agricultural activities, through the conversion of new areas into cropland or pasture (RAD, 2025).

the loss of both quantity and quality of plant biodiversity (McKay et al., 2022; Costa et al., 2021). The Scientific Panel for the Amazon (SPA) considers that a cumulative deforestation rate of 20 to 25% across the Amazon basin—a subregion of the biome—would represent a significant tipping risk (Hirota et al., 2021). Current estimates place the level of deforestation at around 17% since 1985 (Gatti et al., 2021).

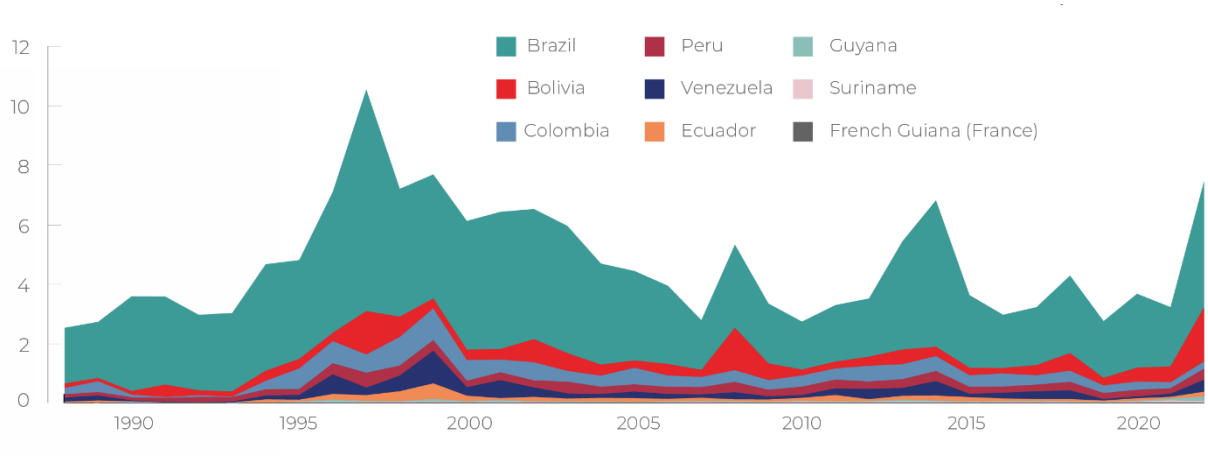
The effects of climate change also contribute to bringing the Amazon closer to a potential tipping point. In particular, global temperature increases and associated water stress raise plant and tree mortality (IPCC, 2021). According to certain IPCC CMIP6 models[9], a tipping point or irreversible degradation of the Amazonian biome could occur if a critical warming threshold between 2°C and 6°C is reached. Other critical thresholds related to water stress have also been suggested, such as annual precipitation below 1,000 mm[10] or a dry season lasting more than 6 to 8 months[11] (Flores et al., 2023). Heat and drought thus appear as the main destabilizing factors for the ecosystem (Hirota et al., 2021; Dakos et al., 2024). The increasing frequency of droughts in the 21st century (2005, 2010, 2015/2016…) has led some researchers to warn of the imminence of a tipping point (Lovejoy and Nobre, 2019).

Although distinct and governed by different mechanisms, climatic factors and human activities interact, often producing cumulatively devastating effects. Fires, for example, are triggered both by droughts and extreme temperatures affecting the region and by human activities, such as accidental, deliberate, or deforestation-related fires. In 2024, 140,346 fires were detected in the Amazonian biome by the Brazilian National Institute for Space Research (INPE), representing a 30% increase compared to 2023 (INPE – *Programa Queimadas*, 2025) and a record over the past ten years. Furthermore, forest areas already in a degraded state are approximately twice as likely to be deforested, contributing to a cascading effect toward increasing degradation across the Amazons (Hirota et al., 2021).

The data in the graphs below have been reallocated so that reported deforestation/degradation corresponds to the date of occurrence rather than the date of data collection.

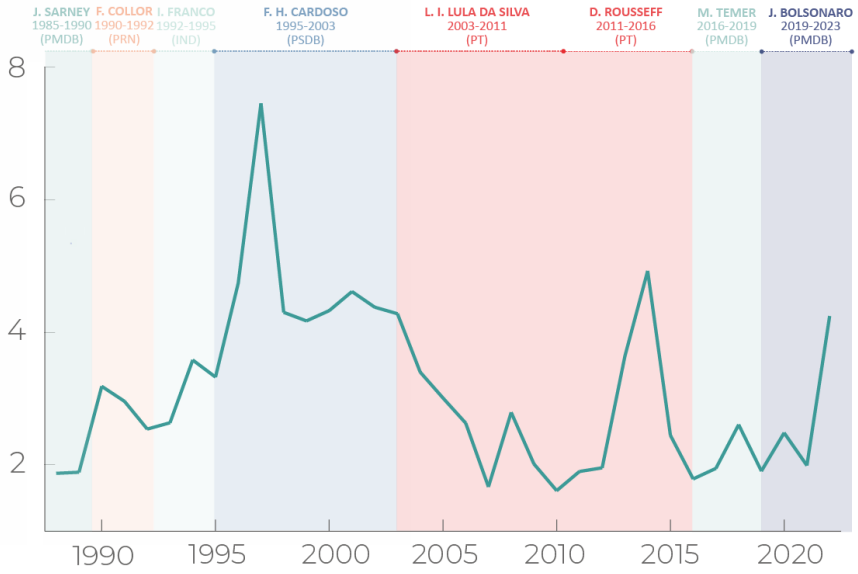
[9] The Coupled Model Intercomparison Project Phase 6 (CMIP6) models from the IPCC are next-generation Earth system models simulating global climate evolution under various socio-economic and emissions scenarios.
[10] On average, annual rainfall in the Amazon Basin is approximately 2,200 mm per year.
[11] The Amazon experiences a seasonal rhythm, with a dry season from May to October and a wet season from November to April, each lasting roughly six months. Over the past 40 years, the dry season has already lengthened by 4 to 5 weeks (Pena-Claros, 2023).

Figure 2 – Distribution of forest loss by state between 1988 and 2022, in millions of hectares



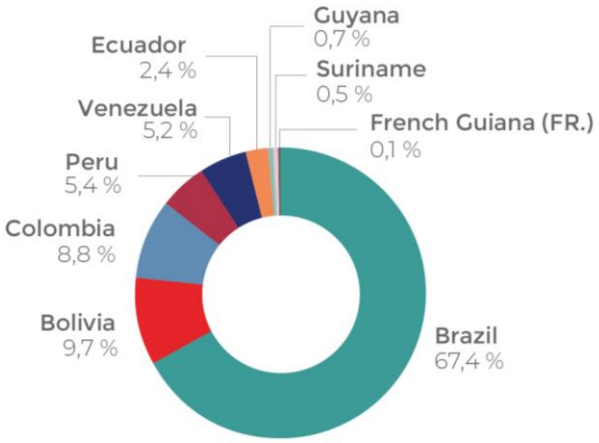
Source: European Commission Joint Research Centre (JRC) - TMF dataset

Figure 3 – Forest loss in Brazil per year, according to presidential terms, in millions of hectares



Source: European Commission Joint Research Centre – TMF Dataset

Figure 4 – Share of forest destruction by country, cumulative between 1988 and 2022, as a percentage of the total destroyed area (in millions of hectares)



Source: European Commission Joint Research Centre – TMF Dataset

Over the past fifty years, the Amazon rainforest has lost 20% of its area, primarily due to the exploitation of its resources. Deforestation, which began in the 1960s, intensified in subsequent decades as a result of development policies focused on agriculture and infrastructure. Despite a relative slowdown in the 2000s–2010s due to protective measures, deforestation surged again under the Bolsonaro presidency (2019–2023). Since Lula's return to office in 2023, the record remains mixed: environmental policies have been revived, but several agribusiness projects continue to drive deforestation.

2. Realization of the Tipping Point

According to the IPCC, the probability of a tipping point in the Amazon rainforest occurring by the end of the 21st century is low (Flores et al., 2023). However, the complexity of the Amazon makes projections of future dynamics uncertain, even though modelling has advanced in recent years. Recent studies suggest that by 2050, between 10% and 47% of the Amazonian biome could be exposed to disturbances likely to trigger unexpected ecosystem responses, bringing it closer to a tipping point (Flores et al., 2024). This tipping would occur over several decades, making its detection all the more difficult (IPCC, 2021).

Some studies highlight the geographical heterogeneity of the tipping point. Indeed, the idea of a generalized biome-wide tipping seems unlikely based on current models (IPCC, 2021). However, Parry et al. (2022), in a study focused on the northern and central Amazon, emphasize that this region is particularly vulnerable to degradation, estimating that 2 to 12% of this area would experience a sharp drop in carbon storage capacity if the 1.5°C threshold is exceeded**. While there is no scientific consensus on the possibility of a generalized tipping, there is concern that the risk may increase as climate change and/or direct degradation intensify (Hirota et al., 2021).**

The question of Amazonian savannization under major climatic shifts or intensified human activities has been raised since the 1990s (Nobre et al., 1991). Nonetheless, more recent studies indicate that such a process is unlikely, and that **the more probable outcome would be a shift toward an advanced degraded forest state with a significant reduction in biomass** (Hirota et al., 2021). Increased mortality among plant species most vulnerable to changing climatic conditions could also lead to a reduction in species diversity (Nogueira et al., 2017).

C – Tipping Point's Consequences

1. First-order effects of a tipping point in the Amazon rainforest

The tipping of all or part of the Amazonian biome would significantly affect the global climate system. The mechanism of carbon storage and processing by trees would be severely disrupted, as they would be fewer in number and in poorer health. Neglecting the CO_2 fertilization effect on plant growth[12], the IPCC estimates that forest dieback could release up to 200 gigatonnes of carbon into the atmosphere, thereby accelerating global temperature rise (IPCC, 2021).

Beyond the intensification of climate change that such a tipping point would entail, **its consequences would be primarily regional**. By altering the processes of evapotranspiration[13] and the Amazonian atmospheric rivers, the risks of **prolonged droughts** would be extremely high (Costa et al., 2021; IPCC, 2022). Rainfall in the Amazon basin would decrease unevenly. The same would be true for other areas that depend on the biome's hydrological cycle for their water resources, such as the La Plata basin, a key region for South American agriculture (Zemp et al., 2014; FAO, 2016). Furthermore, in a context where climatic events such as droughts and extreme precipitation are expected to intensify due to climate change, the reduction of Amazonian forest vegetation would further increase the risk of **flooding** (Bradshaw et al., 2007; Marengo and Espinoza, 2015). Vegetation loss would also amplify **local warming**, as in southern Amazonia, where temperatures could rise by up to an additional 0.5°C more than 100 km from cleared areas, in a context where regional temperature increases expected by the end of the century range between 2°C and 6°C (Butt et al., 2023; IPCC, 2022; Le Tourneau, 2025). Finally, the risk of **vector-borne disease** spread would also increase, driven both by deforestation and the rising frequency of extreme climatic events (IPCC, 2022; Runde et al., 2020).

[12] The CO_2 fertilization effect is one of the impacts of rising atmospheric carbon dioxide levels, leading to increased photosynthesis in plants and potentially enhancing the Amazon's capacity to sequester carbon. Although often overlooked by the IPCC, recent academic studies suggest it could play a significant role (see Esquivel-Muelbert, A. et al., 2025. *Increasing tree size across Amazonia*. Nature Plants, 1–10).

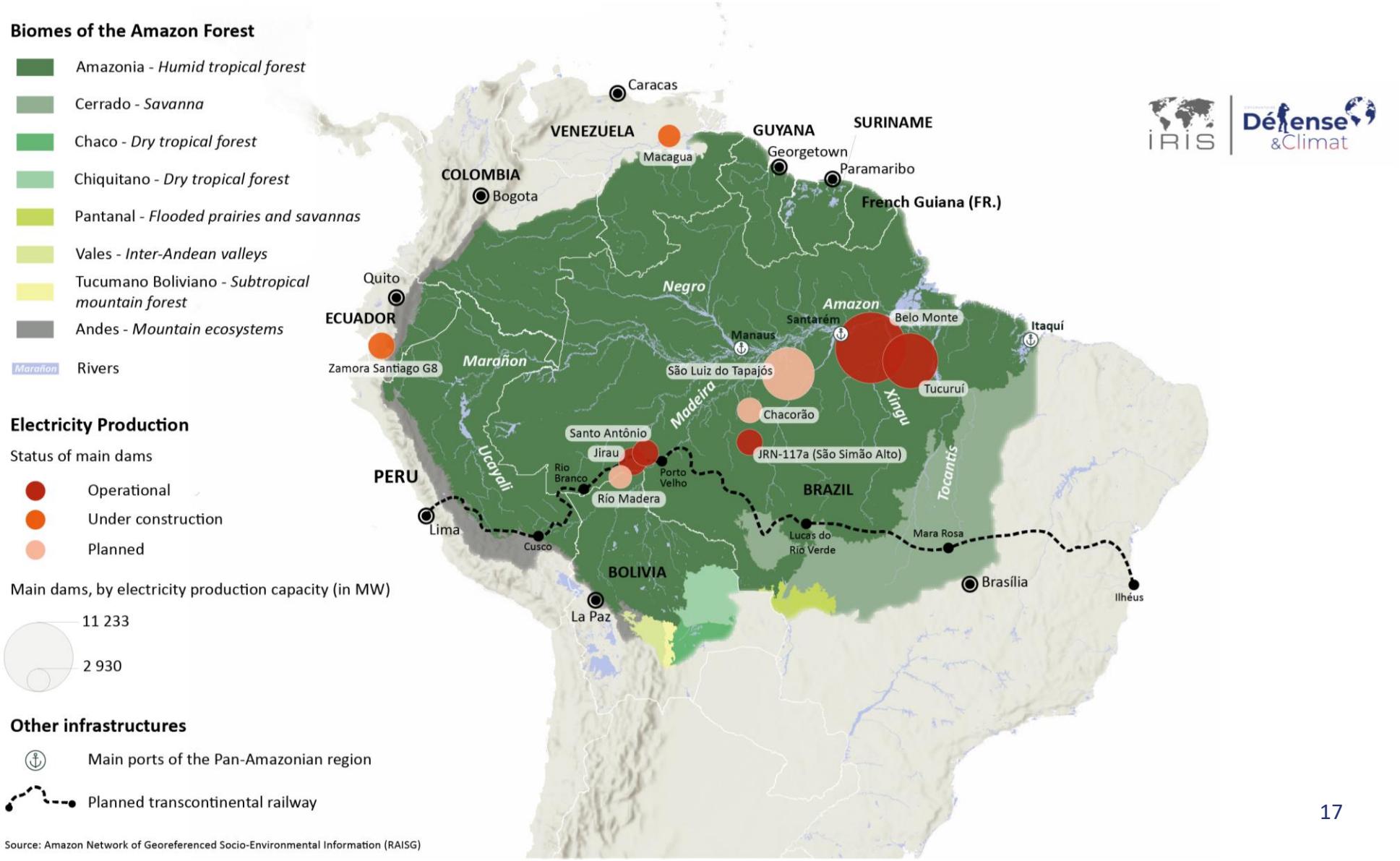
[13] Hydrological process of water transfer that evaporates from the soil, liquid reservoirs, and plant transpiration into the atmosphere.

2. The cascading effects of the Amazon rainforest tipping point

The literature on the secondary effects of Amazonian biome degradation remains limited (Banerjee et al., 2022). Paradoxically, the heavy industries established in the region depend on the biome's ecosystem functions—particularly rainfall sustained by the evapotranspiration cycle—and therefore risk compromising their own productivity if ecological degradation continues, even though they are among its primary drivers (Purcell and Keary, 2023) (see Map 2). Furthermore, the **fisheries** sector on the Amazon River and its tributaries, which generates nearly 465 million USD per year and 160,000 jobs, could be affected by more frequent droughts linked to dysfunctions in the regional hydrological cycle and climate change (Furtado et al., 2024). Another type of shock could result from a sharp reduction in **hydroelectric capacity** due to declining water resources. A study by Arrias et al. (2020) on dams in the Brazilian Amazon shows that in the event of a combination of intensified climatic extremes and continued deforestation, the maximum daily electricity production potential could drop by nearly 70%. The authors also indicate that this situation would exacerbate production difficulties already pronounced during the dry season. In **agriculture**, a transformation of the Amazonian biome—and consequently a disruption of the precipitation cycle—could lead to significant reductions in crop productivity, such as for soy. This crop, widely cultivated in the region, could be among the most severely affected by rising temperatures (Assad et al., 2008).

Furthermore, the acceleration of Amazonian biome degradation and the increasing frequency and intensity of associated extreme climatic events (droughts, floods, mega-fires) pose a **significant risk to the human security of the approximately 43 to 47 million inhabitants of the biome**, whether Indigenous populations or urban residents (Kileen, 2024; Sweigart, 2025). **Mega-fires** are likely to generate both direct risks, such as death or injury, and indirect risks, due to pollution and the destruction of agricultural land and infrastructure (Wang et al., 2023). Between 1996 and 1999, fires cost Brazil approximately 0.2% of its GDP, and their frequency is expected to rise sharply as the Amazon basin experiences further climatic disruption and deforestation (De Mendoçar et al., 2004).

Map 2 – The Pan-Amazonian Region: Economic Pillar, Ecological Reservoir, Threatened Area



Source: Amazon Network of Georeferenced Socio-Environmental Information (RAISG)

Furthermore, carbon monoxide smoke produced by fires rises into the atmosphere and accelerates the melting of Andean glaciers, posing a **risk to local water security**, as these glaciers are the primary source of freshwater in the region (Allen, 2020). Populations are also threatened by **food insecurity** linked to declining agricultural productivity, which could affect numerous exported and locally consumed crops (Arabica coffee, sugarcane, soy, etc.), also compromising income stability (Ortiz et al., 2013). Additionally, less frequently discussed cascading effects include the **loss of historical and cultural heritage** in the Amazon rainforest due to the destruction of land and Indigenous ways of life (Bowman et al., 2021). Biodiversity loss could further **impact the supply of medicinal plants** and naturally occurring chemical compounds in the Amazon, which form the basis of many pharmaceuticals worldwide (World Bank, 2015).

The Amazonian biome, composed of a mosaic of ecosystems, forms a heterogeneous system that plays a central role in regional and global climate balance. Anthropogenic pressures, combined with the effects of climate change, could lead to irreversible biome degradation and a tipping point, threatening its carbon storage capacity and hydrological cycle. Although no consensus exists regarding this tipping point, the study of anthropogenic aggravating factors shows that biome degradation exposes the region to first-order risks (storage capacity, intensification of climatic hazards, etc.) and, through cascading effects, to second-order consequences that affect regional economic activities and human security. Because these anthropogenic pressures and their effects manifest as externalities and concern a territory spanning nine countries, it is essential to analyse the implications of this degradation, both from geopolitical and operational and capacity perspectives.

PART 2

GEOPOLITICS OF THE AMAZON TIPPING POINT: CLIMATE CHANGE AND DEFORESTATION OF THE AMAZONIAN BIOME, BETWEEN SOURCE OF TENSION AND OPPORTUNITY FOR COOPERATION

The complexity of the Amazonian biome and the challenges it faces require a collective response from the Amazonian states. Cooperation, essential for reducing deforestation—driven by both legal activities (agriculture, industry, etc.) and illegal ones (coca cultivation, gold mining, timber trafficking)—and for mitigating the impacts of climate change, remains fragmented. Each country defines protected areas on its territory according to different criteria and maintains its own legal framework for environmental protection of the Amazon. While these frameworks are protective[14], they struggle to coordinate at the regional level and often clash with extractive logics, which are perceived as drivers of economic development for the Amazonian states. Attachment to sovereignty can thus sometimes be seen as a structural obstacle to regional cooperation.

The protection of the Amazonian biome also attracts extraregional actors—foreign powers, international organizations, and non-governmental organizations (NGOs)—**due to the biome's crucial role in maintaining global climate balance**. However, these actors sometimes encounter opposition from Amazonian states, which view certain interventions as infringing on their sovereignty. The Amazonian biome is therefore both a source of cooperation and tension, owing to the diversity of services it provides (Rowe, 2021). Some of these services benefit the planet as a whole, such as climate regulation, while others are more advantageous at local or national scales, such as the commercial exploitation of resources (Lant et al., 2008). **This section thus aims to analyse how climate change and deforestation of the Amazonian biome can simultaneously foster cooperation among stakeholders and generate tensions.**

A – Relative regional and international cooperation on the protection of the biome

1. Regional cooperation limited by the primacy of national sovereignty

Since 1998, the Amazon Cooperation Treaty Organization (ACTO) has been the main regional framework dedicated to the collective management of the Amazonian biome, primarily focused on reducing deforestation. It stems from the 1978 Cooperation Treaty and brings together eight Amazonian states—Brazil, Bolivia, Colombia, Ecuador, Guyana, Peru, Suriname, and Venezuela—while France has held only observer status since 2004 for French Guiana (Martin et al., 2022). ACTO is designed as a multilateral forum aimed at strengthening regional cooperation while limiting external

[14] The constitutions of Suriname (1987) and Brazil (1988) were the first in the region to incorporate an environmental dimension, thus inaugurating true "ecological constitutions." Subsequent legal texts progressively strengthened environmental protection. More recently, some constitutions have gone beyond the modern, human-centered approach to adopt a "biocentric" perspective — as is the case in Ecuador (2008) and Bolivia (2009) (Melo & Burckhart, 2024).

interference (Filippi and Macedo, 2021; Merino, 2025). It has developed various projects in areas such as sustainable water resource management, deforestation mapping, ecosystem protection, and the recognition of Indigenous peoples' rights. More recently, another initiative, **the Leticia Pact** (2019), signed by the same states except Venezuela, sought to improve coordination in response to environmental disasters and to develop satellite-based monitoring mechanisms for the Amazon rainforest (Ramirez, 2019).

However, both ACTO and the Leticia Pact suffer from political and institutional deadlocks. Several analyses describe ACTO as "a zombie institution" (Gray, 2018) due to internal divisions that have significantly reduced the organization's operational capacity (Martin et al., 2021). Moreover, the absence of supranational authority, dispute resolution mechanisms, and enforcement bodies greatly limits its influence over national policies regarding the management of biome resources (Merino, 2025). Similarly, researchers note that the Leticia Pact remains primarily a statement of intent. Lacking effective institutional tools, it has not enabled operational cooperation, including among police forces, despite the urgent need to combat gold mining and illegal mining activities, which are partly responsible for deforestation (Mattos et al., 2024).

The main obstacle to these regional dynamics lies in the primacy of national sovereignty within pan-Amazonian governance, which hinders the development of a collective response to potential tipping point drivers. Some researchers highlight the paradox of Amazonian states: they support regional industrial co-development[15] but oppose cooperation on biome protection and deforestation control (De Oliveira Paes, 2022). **In this context, environmental cooperation tends to develop primarily at the bilateral level** (Ventura, 2025). Several joint operations between Colombia and Brazil, for example, have been conducted to combat illegal mining or cross-border trafficking, but these efforts remain sporadic and limited in scope.

3. Cooperation based on monitoring, military training, and development aid

Despite the reluctance and political opposition of some Amazonian states, international cooperation for the protection of the Amazon biome has nevertheless developed due to its role in maintaining global climate balance (Dehm, 2021). **This cooperation is structured around three main dimensions: environmental monitoring via satellite and radar, training of military personnel reflecting the militarization of the "fight against deforestation," and international development aid.**

[15] Through the development of two regional international development organizations, for example: the Andean Community of Nations (CAN) and the Initiative for the Integration of the Regional Infrastructure of South America (IIRSA) (De Oliveira Paes, 2022).

The development of monitoring in the Amazon basin relies both on long-standing cooperation with the United States and a strategic partnership with China, placing Brazil at the centre of a technological and geopolitical triangulation. Since the 1970s, the United States has contributed to the creation of the first mapping systems for the Amazon basin, notably through the RADAR program (Dagicour, 2020). This partnership continued with the development of the *Sistema de Proteção da Amazônia* (SIPAM), which relies largely on technologies provided by American companies and enabled the deployment of an extensive network of meteorological equipment designed to detect potential tipping point indicators by monitoring regional climatic and atmospheric changes (Pinzelli, 2014). At the same time, Sino-Brazilian cooperation plays an equally central role, through the CBERS (China–Brazil Earth Resources Satellite) program since 1988, with upcoming launches (CBERS-5 and 6) confirmed during President Lula's visit to China in 2023 (Brazilian Ministry of Foreign Affairs, 2023). **This dual relationship makes the Amazon a site of technological and geopolitical competition that goes beyond purely environmental concerns** (Soliz de Stange, 2023; Ventura, 2025).

Military cooperation around the protection of the Amazonian biome illustrates a form of "green militarization"[16] **that combines environmental objectives with geopolitical influence strategies** (Penido et al., 2022). Since the 1970s, the United States has regularly conducted training programs for the armed forces of Amazonian states, such as Operation Amazon17, held in November 2017, which brought together the American, Brazilian, Colombian, and Peruvian armed forces for joint exercises focused on humanitarian aid and crisis management scenarios in the Amazon (Betim, 2017; Garcia, 2017). These exercises are particularly designed to address fires, a key driver of deforestation. The sale of equipment used in biome protection also contributes to this militarization logic, as illustrated by the use of American-designed Hercules C-130[17] aircraft during the mega-fires in the Brazilian Amazon in 2019 (France 24, 2019; Ventura, 2025). This militarization has been criticized by numerous political and academic actors, who argue that it reinforces Amazonian states' military dependence on the United States (Forner, 2023) and sustains a logic of violence in biome protection, with limited environmental impact but negative security consequences for local populations (Corredor-Garcia & Vega, 2023). Green militarization is thus denounced as an ambiguous form of security-focused cooperation (Cecena, 2014).

Finally, international cooperation for the Amazon also involves international development aid funds, which are currently limited. International development cooperation for the protection of the Amazon has always been significant, particularly in Brazil, despite the inherent tensions associated with this

[16] Concept defined as the use of military and paramilitary personnel, training, technologies, and partnerships in the context of environmental conservation efforts (Lunstrum, 2014).
[17] The Lockheed C-130 Hercules is a military transport aircraft designed by the United States in the early 1950s. It has achieved remarkable success, with over 2,700 units built for nearly seventy user countries (Lockheed Martin, 2024).

type of aid—regarding the sovereignty of recipient states and the involvement of foreign funding actors (Junior, 2023; Merino, 2025). There are multiple multilateral funds[18] administered by Amazonian states to protect the biome and combat deforestation, such as the Amazon Fund, which is supported notably by Norway and Germany[19] (see Figure 5). Until recently, bilateral aid primarily came from the United States through the U.S. Agency for International Development (USAID), which financed projects to combat deforestation in the Brazilian, Colombian, and Peruvian Amazon[20].

However, the announcement of the dismantling of USAID following Donald Trump's return to the presidency in 2025 called into question the sustainability of these mechanisms, weakening regional protection policies (Maisonnave, 2025; Ventura, 2025). New international financing mechanisms for the Amazon were nevertheless presented at COP30 in Brazil in November 2025 (COP30, 2025). Among them is the Tropical Forest Forever Facility (TFFF), an innovative financial instrument designed to mobilize public and private investors to fund an investment pool. A portion of the profits from this fund, which encourages cooperation beyond Western public funding, would then be redistributed to states that can demonstrate they have effectively protected their tropical forests (Aubertin, 2025). Other non-Western partners, such as China, have also been engaged for several years in providing financial support to Amazonian states (Yang and Paim, 2024). It remains, however, difficult to assess whether these new funding mechanisms will match the previous level of U.S. aid.

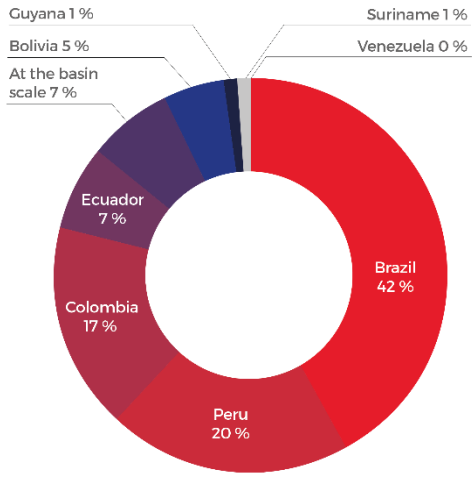
[18] Among the multilateral funds, one can cite the Pilot Program for the Conservation of the Brazilian Rainforest (RF-PPG7), the Program for Protected Areas in the Amazon Region (Arpa), the Brazilian Climate Fund, the Amazon Fund, and the Amazon Bioeconomy Fund. See Júnior, L. A. et al. (2023). *International development cooperation in the Amazon*. Novos Estudos - CEBRAP, 42(3), 449–473.

[19] Detailed information on all donations can be found at https://www.amazonfund.gov.br/en/transparency/donations/ (Norway is by far the largest contributor, with 75% of contributions already used by the fund, followed by Germany at 8.5%).

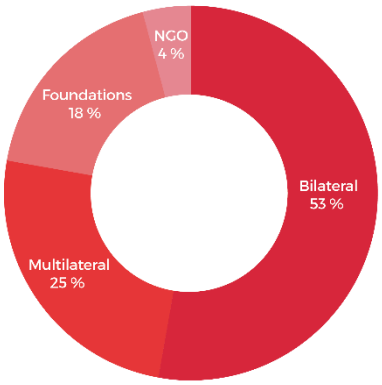
[20] In Brazil, USAID launched an Amazon Biodiversity Conservation Partnership, endowed with $14 million in 2024, aimed at strengthening the livelihoods of local and indigenous communities (Maisonnave, 2025). In Colombia, support amounted to approximately $70 million (Griffin, 2025), while in Peru, a significant portion of the $135 million in annual aid was directed toward alternatives to coca cultivation, which is closely linked to deforestation (Kruesi, 2025).

Figure 5 – Overview of international Aid in the Amazon

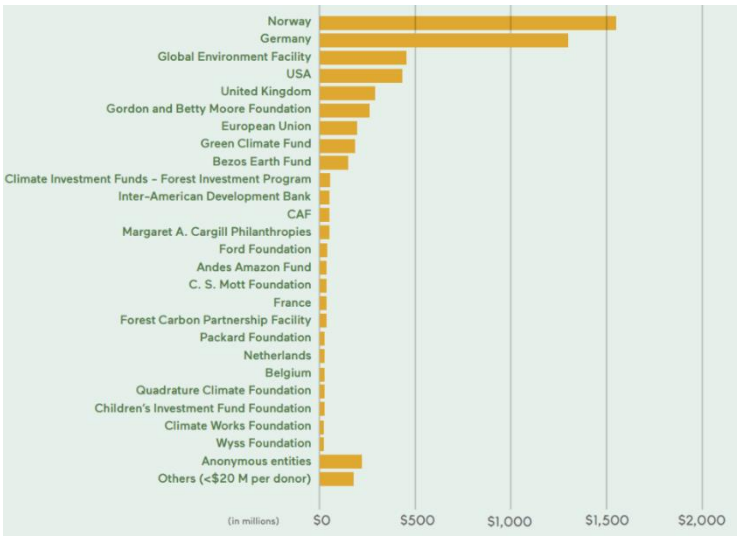
Total funding allocated to conservation and management in the Amazon by country (2020-2022)



Total funding allocated to conservation and management in the Amazon by donor type (2020-2022)



Donor funding in the Amazon (2020–2022)



Source : Juelsgaard, A. (2024). International Funding for Amazon Conservation and Sustainable Management: An analysis of grant funding from 2013 to 2022. Washington D.C.: Amazon Sustainable Landscapes Program. https://documents1.worldbank.org/curated/en/099013124134523569/pdf/P173602148229b06d1888c18c700f8cf469.pdf

This study, conducted over the period 2020–2022, provides an overview of the current state of international development aid for the Amazon (although the return of Donald Trump and the dismantling of USAID in 2025 are major factors not taken into account here). Foreign states are in fact the primary contributors to this aid. Among them, the United States ranked as the third-largest state donor between 2020 and 2022, after Norway and Germany. The main beneficiaries of these funds are national governments—despite their difficulty in coordinating protection programs at the regional level—international NGOs, much to the displeasure of Amazonian states that view their actions as an internationalization of Amazon forest protection to which they are opposed, and the private sector, which in particular benefits from the USD 600 million Amazon Bioeconomy Fund (2020).

4. A specific French position

France occupies a unique position in international cooperation on the Amazon due to its direct presence within the biome through the department of French Guiana. While this territory does not represent a large portion of the Amazonian biome[21], the majority of Guiana's territory lies within it (97%) (Suarez et al., 2015), giving France a significant strategic interest in the preservation of this space. Regional degradation of the biome thus has direct repercussions on its national territory. Furthermore, French Guiana is the only European territory located in South America, further enhancing its geopolitical significance[22]. However, the colonial legacy of French Guiana[23] fosters a certain mistrust among Amazonian states toward France, linked to their strong attachment to the principle of national sovereignty.

Nevertheless, the intensification of climate change impacts and efforts to combat deforestation—partly driven by illegal activities such as unlawful gold mining and drug trafficking—tend to foster the emergence of strategic cooperation between the security forces of French Guiana and its neighbours (Sintive, 2025). For example, the Strategic Dialogue of the Guiana Plateau, which brings together French Guiana, Guyana, and Suriname, with Brazil participating as an observer since 2022 (Buisson, 2025), incorporates environmental and climate issues and dedicated a seminar to this topic for the first time in its 2025 edition[24]. However, durable cooperation on the drivers of a potential Amazon tipping point is more difficult to envisage with Brazil, which refuses such collaboration due to the Brazilian army's perception of the French military[25] (Le Tourneau, 2025; Blancodini, 2025), differences in strategic priorities (Buisson, 2025), and diplomatic tensions between the two states—particularly between leaders Jair Bolsonaro and Emmanuel Macron[26]—although a diplomatic rapprochement has begun since President Lula's election in 2023 [27].

French cooperation with Amazonian states for the protection of the biome is therefore primarily manifested through military collaboration addressing the cross-border issue of illegal gold mining under the auspices of Operation *Harpie* (see Part 3). Combating this activity, which continues to

[21] This represents 0.09 million km², or 1.34% of the Amazon biome.
[22] French Guiana thus benefits from €19 million in European ERDF funds for the 2021–2027 period, a portion of which is dedicated to actions supporting the protection of the Amazon.
[23] French Guiana became a French department in 1946.
[24] For the first time, the 2025 edition dedicated a seminar to climate security issues on the Guiana Shield and the tipping point factors of the Amazon rainforest, organized by the Defense & Climate Observatory.
[25] Due to its size, presumed resources, and the foreign interests it attracts, the Amazon region has fueled fears of foreign invasion within the Brazilian army since the 1960s. Under Jair Bolsonaro's presidency, these concerns resurfaced, this time linked to a supposed French threat associated with the military presence in French Guiana (Le Tourneau, 2007; Gielow, 2019).
[26] During the 2019 Brazilian megafire crisis, Emmanuel Macron and Jair Bolsonaro exchanged multiple criticisms about the Amazon through the media. Moreover, these statements fit within a broader history of French declarations in favor of the internationalization of Amazon biome management (Casarões & Farias, 2022).
[27] An example of this is the announcement of a Franco-Brazilian co-investment program for the Amazon amounting to €1 billion over the 2024–2028 period.

expand, constitutes the central focus of France's strategy for preserving the Amazon basin. The main partner on this issue remains Brazil, around which cooperation is structured through a bilateral Police Cooperation Centre (CCP) established in Saint-Georges since 2009. This collaboration is expected to expand with the planned establishment of an international CCP in Manaus and the ratification in France of a new bilateral mutual legal assistance agreement (Maysounave, 2024; *Gendarmerie nationale*, 2025). The military forces of both nations also regularly conduct joint mirror surveillance operations along the Oyapock River (Operations Rochelle and Jararaca) (Maysounave, 2024). **Cooperation on combating deforestation due to gold mining is also in place, though less advanced, with other cross-border partners such as Suriname.** This is explained by the legality of gold mining and mercury trade in Suriname, a metal used by miners and highly toxic to the environment (Moullet et al., 2006). Activity continues to rise significantly along the Maroni-Lawa river basin, which defines the Franco-Surinamese border (Thébia, 2023). A first bilateral cooperation declaration on river management was signed in 2021, but it remains insufficient according to a recent World Wildlife Fund report (WWF, 2024), as it does not establish cooperation between military forces. This gap leads to local, national, and even international cross-border tensions, exacerbated by the involvement of Chinese merchants supplying equipment to Surinamese miners (Depp, 2025; Buisson, 2025; Menet & Bondaz, 2023)**. Cooperation between France and Guyana remains limited** due to the absence of a shared border, although a diplomatic rapprochement has recently occurred with the opening of a French embassy in Georgetown in October 2025 and Guyana's participation in the Strategic Dialogue of the Guiana Plateau since its launch in 2021.

Thus, although regional and international cooperation between Amazonian states and foreign partners—most notably France—on combating deforestation and addressing the effects of climate change on the Amazonian biome is active, it remains structurally constrained by developmental priorities[28] and the states' attachment to national sovereignty. In the case of France, however, shared challenges related to illegal gold mining and drug trafficking foster the emergence of durable cross-border collaborations, despite certain international tensions, particularly with Suriname. In this way, in the Amazon, climate diplomacy functions both as a lever for multilateral dialogue and as a lens revealing regional sovereignty-related tensions.

[28] Refers to an ideology advocating industrialization in middle-income countries as a driver of economic growth, often at the expense of the social and environmental dimensions of sustainable development.

B – Tensions Surrounding the Destruction of the Amazon Biome and Increasing Deforestation

1. Tensions Related to the Involvement of International Actors in Biome Management

Tensions surrounding the involvement of international actors in the management of the Amazon biome stem from both academic and political critiques of foreign actions on one hand, and the actions of the Amazonian states themselves on the other.

International tensions over Amazonian biome management can be partly explained by the **persistence of a discourse on the international governance of the Amazon**, promoted over the decades by various political and academic actors, primarily from the Western world. Among the most emblematic proposals are those of Pascal Lamy, calling for the recognition of the Amazon as a "global public good" (2005), and Al Gore, who stated that "contrary to what Brazilians think, the Amazon does not belong to them; it belongs to all of us" (Barrionuevo, 2008). More recently, statements by G7 heads of state and government regarding the 2019 mega-fires in the Amazon have reignited these debates. Beyond public statements, some researchers have also explored the possibility of foreign or UN intervention in the Amazon, in the name of protecting the human rights of indigenous peoples or recognizing ecocide and its international security consequences. However, these proposals are generally considered legally unfounded and regarded as violations of the territorial sovereignty of Amazonian states (Walt, 2019; Toledo & Bizawu, 2019). Since 1945, Amazonian states have condemned such international governance initiatives as reflecting neocolonial behaviour. Recent remarks by former Brazilian President Jair Bolsonaro, accusing foreign powers of seeking to impose international management of the biome, fall within this long-standing tradition of mistrust (Casarões & Farias, 2022).

These discourses have fuelled Amazonian states' opposition to numerous international projects aimed at managing the biome since 1945. Indeed, as early as 1946, the proposal to create an international scientific institute for the Amazon[29], under the auspices of the United Nations Educational, Scientific and Cultural Organization (UNESCO), was abandoned due to opposition from the Brazilian government, which favoured the establishment of the current National Institute of Amazonian Research (INPA). This institute was intended to promote economic and scientific development in the region while asserting national sovereignty (Mougey, 2018). In the 1990s, the proposal for a "debt-for-nature" [30] swap was likewise rejected by Brazilian elites, who characterized

[29] International Institute of the Amazonian Hylea
[30] This mechanism was introduced by T. Lovejoy, Vice President of the World Wildlife Fund, in 1984 and involves reducing the public debt of a developing country in exchange for a commitment to environmental protection in various forms. In the 1990s, this mostly took the form of buyback operations of portions of the debt of South American or Caribbean countries by Western NGOs (Yue & Nedopil Wang, 2021).

the initiative as "foreign intervention" seeking to curb the country's development under the guise of environmental protection (Trapasso, 1992). Although rhetoric around the internationalization of the Amazon has periodically resurfaced over the decades[31], the debate had appeared to shift toward recognition of national responsibility for protecting the biome, in line with environmental standards and global expectations—at least until the election of Jair Bolsonaro. Even though President Lula is currently seeking to restore ambitious policies for the protection of the Amazonian biome, the structural tension between defending national sovereignty and meeting international expectations makes the issue inherently complex (Le Tourneau, 2025).

Moreover, several academic studies highlight the **lack of political will among Amazonian states to implement truly binding environmental policies**. This inertia contrasts with their claim to be the sole legitimate actors in protecting the Amazonian biome—a position that has drawn strong criticism within the international community (Merino, 2025; Martin et al., 2022; De Oliveira Paes, 2022). According to some researchers, this stance of asserted legitimacy has allowed these states to benefit from international funding linked to voluntary coordination of conservation efforts without having to comply with certain international environmental commitments deemed too restrictive for their sovereignty (De Oliveira Paes, 2022). Indeed, Martin et al. (2022) explain that, taken as a whole, international treaties on environmental protection and commitments to greenhouse gas reductions provide a sufficient supranational framework to govern the Amazonian biome, without the need to renegotiate new regional mechanisms—unlike the efforts currently pursued by several Pan-American treaties and organizations mentioned earlier to circumvent binding instruments. The ineffectiveness of the policies implemented is thus analysed as a consequence of a **deficit of political will rather than a lack of operational normative frameworks** (Aubertin, 2025; Merino, 2025). In this same logic of bypassing existing mechanisms, Amazonian states have promoted carbon offset projects, reflecting a strategy to legitimize their actions without fundamentally challenging their developmentalist models.

2. Indigenous Peoples Facing Local-Level Tensions

At a more local scale, the management of the Amazonian biome generates tensions within Amazonian societies, particularly affecting Indigenous populations, who face both political and legal pressures as well as conflicts—sometimes violent—within their communities and against miners and agricultural operators.

Indeed, **Indigenous populations play a central role in preserving the Amazonian biome, but their efforts to protect it often clash with extractive policies pursued by certain states**. Across Amazonian

[31] For a more comprehensive summary, see Júnior, L. A., et al. (2023). *International development cooperation in the Amazon.* Novos Estudos - CEBRAP, 42(3), 449–473. https://doi.org/10.25091/s01013300202300030005

countries, Indigenous peoples and their territories constitute a significant share of both the population and the land area of the Amazon (see Figure 6). In Brazil, for example, 23% of the Legal Amazon is recognized as Indigenous land under the 1988 Constitution, which progressively established their exclusive usage rights over certain territories (Walker et al., 2020). These populations typically maintain their lands in a natural state, without agricultural cultivation, thereby contributing to the conservation of the biome and limiting deforestation (Villen-Perez et al., 2020). However, these territories are increasingly targeted by legal and illegal mining operators due to the significant mineral reserves they contain (copper, tin, nickel, iron ore, bauxite, manganese, gold) (Mataveli, 2022a; Ferreira et al., 2014). While national legislations recognize the land rights of Indigenous peoples[32], they rarely guarantee effective control over the mineral resources beneath their lands, which can lead to their seizure and exploitation, thus threatening their protective role for the biome.

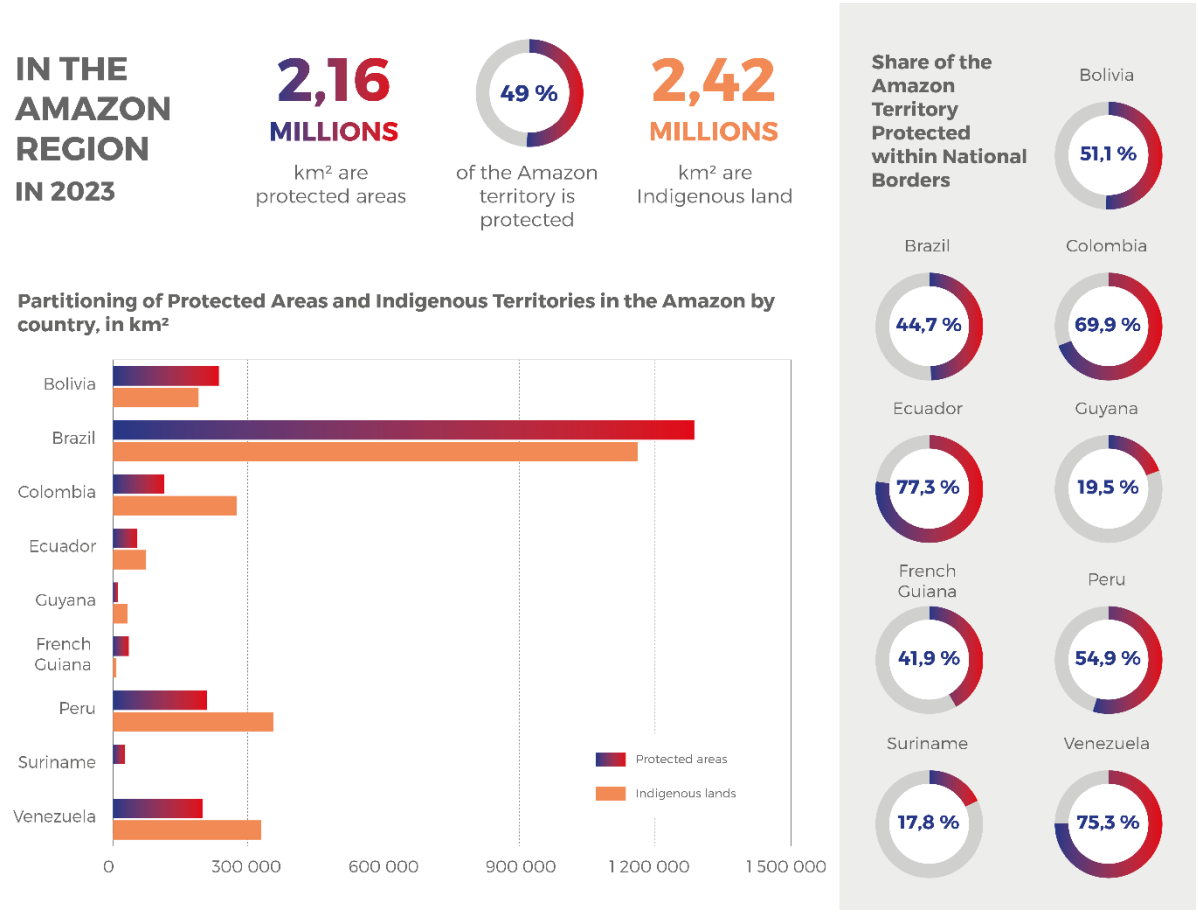
The mining of Indigenous lands and the resulting local conflicts constitute a major political and legal issue in Brazil, which contains the majority of Indigenous territories within the Amazonian biome (Quijano Vallejos et al., 2020) (see Figure 6). This issue, deeply rooted in Brazil's political history, has pitted environmentalist and indigenous rights movements against a political class largely oriented toward economic development since the 1988 Constitution (Keppi, 2013; Giacobbi, 2025). The rise of illegal mining activities during Bolsonaro's presidency in the Legal Amazon, including on Indigenous lands, is closely linked to the progressive weakening of environmental policies in Brazil (Villen-Perez et al., 2020; Mataveli, 2022b). Although some of these policies have been reinstated since Lula returned to the presidency in 2023, Indigenous organizations remain critical: one year after his inauguration, Lula had ratified only ten Indigenous territories, far from his campaign commitments[33] (Meyerfeld, 2024). Some researchers and activists criticize his Amazon policy as superficial and media-focused, arguing that it fails to address the underlying drivers of legal deforestation in the Amazon, namely intensive agricultural exploitation (Le Tourneau, 2025; Ventura, 2025).

Mining, combined with other anthropogenic pressures such as agriculture and logging, fuels local violence and accelerates deforestation in the Amazon, threatening its capacity to deliver ecosystem functions (Plummer, 2014; Matavelli, 2022; Villen-Perez, 2020). Over the past three years, the average annual deforestation rate on Indigenous lands in the Legal Amazon has been 81% higher than the annual average observed between 2012 and 2021 (Matavelli & De Oliveira, 2022). The establishment of such mining sites within or near indigenous territories not only generates clashes between miners and communities but also creates internal divisions within tribes between members involved in these

[32] There is a requirement for the consent of the Indigenous landowner in Guyana, but this right remains limited, and a right of first refusal exists for commercial mining concessions in Colombia (Quijano Vallejos et al., 2020).
[33] Lula had promised to ratify "as many Indigenous territories as possible" during his term. As of October 2025, 104 demarcation processes that met all the necessary legal and administrative criteria were awaiting government approval (APIB, 2025).

activities and those who oppose them (Haslam & Tanimoune, 2016; Ricardo & Ricardo, 2011; Rorato et al., 2021). These conflicts sometimes result in deadly violence: the Indigenous Missionary Council (CIMI) documents dozens of murders each year, mainly targeting environmental defenders within Indigenous communities. In 2024, it recorded 53 such killings, mostly related to territorial conflicts (CIMI, 2025).

Figure 6 – Protected Areas and Indigenous Territories in the Amazon by Country in 2024



Source : RAISG. (2023). *Amazonia 2023 – Protected Areas and Indigenous Territories – Stable forest.* https://www.raisg.org/en/publication/amazonia-2023-protected-areas-and-indigenous-territories/

D'après ces données de RAISG, l'un des plus gros consortiums de collecte de données sur le biome amazonien, les aires protégées couvrent 25.5 % du territoire du biome ce qui montre à première vue un engagement en matière de protection du biome. Cependant, la moitié de celles-ci relèvent de catégories de protection peu strictes, où l'exploitation des ressources naturelles est autorisée, ce qui ne correspond pas toujours aux objectifs de conservation. En termes de superficie, les territoires autochtones représentent 28,5 % de la région amazonienne, et le chevauchement entre les aires protégées et les territoires autochtones correspond à 5,1 %, ce qui porte la superficie nette totale couverte par les deux à 49 % des Amazones. Dans certains pays, l'extraction de combustibles fossiles a été autorisée à l'intérieur des aires protégées, entraînant la contamination des sols, de l'eau et de la faune.

PART 3

OPERATIONAL AND CAPACITY IMPLICATIONS OF TIPPING POINT FACTORS FOR THE FRENCH ARMED FORCES

The legal and illegal extractive economic dynamics in the Amazon, combined with climate change, are gradually driving this territory toward a state of advanced forest degradation—sometimes referred to as a "tipping point" (Hirota et al., 2021). This phenomenon calls for an adapted pan-Amazonian governance, whose principles and challenges were discussed in the previous sections of this note.

Among the actors in this governance, the armed forces of Amazonian states and territories play a central role in securing this space, reflecting its strategic importance. For France, the French Armed Forces in Guiana (*Forces armées en Guyane*, FAG) are particularly involved, notably through Operation Harpie. The major consequences of forest degradation—the disruption of the regional hydrological cycle and accelerated deforestation—impact these armed forces both operationally and in terms of capacity.

French Armed Forces in Guiana and Operation Harpie

The French Armed Forces in Guiana (*Forces armées en Guyane*, FAG) encompass all French military units stationed in French Guiana, the only French and European overseas territory located in South America. Under the authority of a Senior Commander (COMSUP FAG), the FAG comprise units from the Army, the Air and Space Force, and the Navy. The COMSUP FAG is supported by a joint staff headquartered in Cayenne and commands 2,100 military personnel from the three services, as well as 200 civilian defense staff.

Their missions focus on defending the territory and the national population, with particular attention to the Kourou Space Center (Operation Titan) and combating illegal activities, notably illegal fishing (Operation Polpêche) and illegal gold mining (Operation Harpie). These missions are carried out in coordination with other state services present in the territory, such as the border police, gendarmerie, and customs authorities.

Officially launched in 2008 by the President of the Republic, Operation Harpie aims to combat illegal gold mining by shutting down clandestine mining sites in French Guiana to halt the activities of illegal miners (*garimpeiros*). This objective is achieved through joint patrols composed of FAG personnel, gendarmes, and officers from the National Forestry Office, the Guiana Amazonian Park, customs, and the border police, supported by aerial reconnaissance. The value of military seizures and asset destruction was estimated at €94.5 million for 2024. Operation Harpie continues the legacy of Operation Anaconda, conducted by the *Gendarmerie Nationale* between 1997 and 2008, targeting illegal mining sites.

A – Operational Consequences of Climate Change and Amazon Deforestation for the Armed Forces in French Guiana

The FAG's operations are affected both in scope and in nature by climate change and deforestation: missions are expanding due to the growing number of people turning to illegal gold mining as a source of income, and are diversifying, particularly due to the increase in Humanitarian Aid and Disaster Relief operations (HADR).

Beyond their role as transportation routes, rivers also constitute a vital resource for riverside populations, whose economy relies heavily on fishing and subsistence agriculture (Xu et al., 2011).

However**, the disruption of the Amazonian hydrological cycle directly undermines these activities, as the drying of waterways leads to the loss of fish stocks, and reduced rainfall poses serious challenges for small-scale farmers, most of whom still depend on it for irrigation** (Join for Water, 2025). In 2024, the region experienced more than one hundred consecutive days of drought—an unprecedented episode that decimated crops, weakened livestock, and pushed several rural areas to the brink of water rationing (Join for Water, 2025). **This degradation of subsistence conditions drives part of the local population to seek alternative sources of income, notably through illegal gold mining** (Depp, 2025). Although it is not the sole factor, this phenomenon mechanically contributes to increasing the number of clandestine miners that the FAG must confront.

The combination of extended drought periods and the increase in wildfires—often linked to deforestation (see Part 1)—heightens the health, social, and economic vulnerabilities of Amazonian communities. **These recurrent crises lead the FAG to be increasingly deployed in HADR operations** (Chave, 2025; Sintive, 2025). This expanded role falls within the framework of the Civil Security Response Organization (ORSEC) plans, which allow the prefecture to requisition the armed forces to support the population in the event of climatic hazards or prolonged crises (Laratte, 2025) [34]. For example, in 2024, faced with an exceptional drought that disrupted both land and river logistical flows, the FAG were mobilized to establish an emergency air bridge (Ministry of the Armed Forces, 2025). For over two months, they transported several tons of equipment, water, and essential supplies to isolated communities, temporarily compensating for paralyzed civilian supply chains (Sintive, 2025). These exceptional missions also affected the FAG themselves, which were forced to be resupplied with drinking water by air during patrol operations against illegal gold mining, creating both strategic constraints (increased visibility of patrols to *garimpeiros*) and logistical difficulties (reduced operational range and shorter mission durations).

The evolution of FAG operations thus entails enhanced civil-military cooperation in HADR missions, as well as in the fight against illegal gold mining, with the involvement of development organizations such as the French Development Agency (AFD) upstream of Operation Harpie to address the economic and social drivers of the phenomenon (Raffatin, 2025).

[34] As defined by the interministerial instruction on the deployment of the armed forces on national territory when acting at the request of the civilian authority, dated 14 November 2017, the criterion used to decide on the use of the military is known as the "4I" rule: when civilian resources are considered unavailable, inadequate, nonexistent, or insufficient (*Secrétariat général de la Défense et de la Sécurité nationale*, 2017).

B – Capacity Implications: Impacts on Human, Material, and Organizational Resources

The new missions, or the transformation of existing ones, driven by climatic factors and deforestation in the Amazon, place **increased or altered demands on the FAG and require the mobilization of additional human and material resources**. However, this adaptation remains slow, as the resources available in the territory are already heavily utilized and under significant strain (Sintive, 2025).

Historically, the river network has been the main axis of mobility in the Amazon, both for the armed forces and for traffickers, particularly illegal gold miners. However, the progressive drying of waterways—resulting from the disruption of the hydrological cycle and the lengthening of drought periods—affects criminal mobility (Giacobbi, 2025; Buisson, 2025). Faced with the increasing impossibility of using major rivers and regional ports such as Cartagena or Santos for their logistical and transactional flows, criminal networks have adapted by shifting part of their activities to air transport, increasingly preferred for the movement of gold and illicit goods (Giacobbi, 2025). This evolution requires a reorientation of FAG capabilities: **combating illegal gold mining and other trafficking increasingly relies on aerial surveillance missions, which are resource-intensive in terms of personnel and equipment** (Sintive, 2025; Laratte, 2025). The FAG currently operate five SA 330 *Puma* helicopters, while the gendarmerie operates two AS350s. Accordingly, to meet the critical need to renew the fleet, the delivery of four new H225M *Caracal* helicopters began in August 2025 and will be completed by the end of 2026 (French Air and Space Force, 2025). The replacement of the *Écureuils* with H145s is also planned to increase autonomy, safety, and versatility of aerial assets (Sintive, 2025).

Moreover, **if the frequency of river drying continues to increase, access to certain forward military bases could become more difficult from the headquarters of the Joint Staff in Cayenne** (Sintive, 2025). This particularly concerns the bases in Camopi[35] and Maripasoula. Additionally, other strategic riverine and land control points could also see their accessibility reduced. This constraint would require a revision of the entire logistical chain in the territory to ensure the continuity of surveillance missions, notably within the framework of Operation Harpie (Sintive, 2025). Among possible adaptation measures, some institutional actors have suggested the potential construction of a new road along the river, but field personnel question the feasibility of such infrastructure, its cost, and the deforestation it would cause (Korysko, 2025).

A number of military equipment currently in service is not fully adapted to the new environmental and climatic conditions. In the event of river drying, the engines of riverine vehicles could be damaged

[35] Hosting part of the 3rd Foreign Infantry Regiment (3e REI) ground forces (*Académie de Guyane*, 2024).

by changes in sediment density in the water and by lower water levels (Laratte, 2025), accelerating their obsolescence. In addition, the shortage of riverine craft, such as pirogues, could also limit the mobility and responsiveness of the FAG (Buisson, 2025).

Moreover, military personnel deployed in the Amazon could be physically affected by the lengthening of drought periods and rising average temperatures in the region. Humid heat leads to fatigue, exhaustion, and increased risk of heat-related injuries, reducing physical performance and potentially impacting the conduct of operations in the field (Ely et al., 2010; Laratte, 2025). A study by Hocking et al. (2001) on Australian soldiers under experimental conditions also shows that tropical climates impair cognitive abilities: prolonged exposure to heat resulted in a 17–23% increase in error rates on fast tasks and an approximate 40% decrease in productivity on slower tasks compared to controls. To mitigate these risks, the pace and intensity of missions, as well as training schedules, are adjusted for military personnel and *gendarmes* as practiced in other tropical environments (Laratte, 2025; Department of the Army, 2022). Some studies also highlight the need to adapt military uniforms, for example by integrating liquid or air circulation systems under protective clothing or cooling vests (McLellan et al., 2013). However, the chosen method must account for soldiers' mobility needs, the constraints imposed by added weight, energy requirements, and integration with protective gear (Sullivan-Kwantes et al., 2021). In the case of French Guiana, the lengthening of drought periods in 2024 and their consequences for the drying up of watercourses also made it more difficult to supply patrol units on mission with water, as they usually rely on drinking water from creeks in the jungle for resupply (Sintive, 2025). Finally, climate change may also alter local biodiversity and promote the proliferation of mosquitoes, vectors of diseases, increasing the emergence and risk of outbreaks within military bases (Laratte, 2025).

Type of Impact	First order climate change effects	Second-order effects on the French armed forces	Examples
Operational	• Drying up of rivers and waterways • Loss of fishery resources/ loss of agricultural yields • Disruption of precipitation patterns	• Increase in the frequency of missions due to the rise in illegal gold mining • Increase in HADR operations	• Civil-military cooperation with the French Development Agency (AFD) as part of *Operation Harpie* to address the socio-economic drivers of illegal gold mining • Deployment of an emergency airlift to supply isolated populations during the 2024 drought
Capacity-related	• Drying up of rivers and waterways • Lengthening of drought periods • Rise in average temperatures	• Adaptation of equipment and personnel • Increased demand for and reorientation of human and material resources	• Modernization of the helicopter fleet (H225M *Caracall,* H145) to meet the growing need for aerial missions • Adaptation of uniforms and training schedules to limit fatigue and heat-related health risks • Airborne supply of drinking water during patrols due to drought conditions

CONCLUSION

By highlighting the security consequences linked to the degradation of the Amazon rainforest and the risk of crossing its tipping point, this note underscores their impact on human security. The analysis of geopolitical stakes (tensions between ecosystem protection and state sovereignty, as well as internationalization) and the already significant operational (increase in HADR operations and rise in environmental crime) and capability-related (unsuitability of certain equipment and assets) impacts has also demonstrated that the security situation is likely to worsen if these degradations continue.

Due to the difficulty of making reliable predictions in a region marked by high meteorological and climatic variability (El Niño phenomena, tropical conditions, etc.), many uncertainties remain regarding the existence, mechanisms, and manifestation of the tipping point. Nevertheless, the scientific community agrees that, at the current rate of degradation, the Amazon rainforest will experience unprecedented mortality of its ecosystems, leading to a significant reduction in vegetation cover and considerable cascading effects. It is therefore essential that this information be taken into account at both the political and military levels so that appropriate responses can be implemented, both in terms of mitigating the degradation of the Amazon forest and in terms of adapting populations, institutions, and states.

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