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Malaria health crisis as a consequence of structural violence

A case study of the Yanomami community and the impact of deforestation

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Master in Sociology

Supervisor:
Dr. Violeta Alarcão, Integrated Researcher,
CIES, Iscte–University Institute of Lisbon

March, 2026

SOCIOLOGIA
E POLÍTICAS PÚBLICAS

Department of sociology

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Special thanks to my family and friends for their constant encouragement, patience, and belief in the value of this project. Your emotional and moral support has sustained me through every stage of this journey.

Lastly, I acknowledge the Yanomami people, whose experiences are at the heart of this thesis. This work is a humble contribution to the ongoing efforts to recognize, protect, and respect Indigenous sovereignty, health, and justice.

Resumo

Os Yanomami são um povo Indígena que vive na floresta amazónica, ao longo da fronteira entre o Brasil e a Venezuela. Apesar da demarcação oficial do seu território como terra protegida, o desmatamento continua a ameaçar a região. Uma das consequências desta degradação ambiental é a crescente crise de saúde entre os Yanomami, em particular o aumento da incidência de malária, uma doença parasitária transmitida por seis espécies conhecidas de mosquitos Anopheles na área. O desmatamento favorece a reprodução destes mosquitos e intensifica o contacto entre humanos e mosquitos, elevando o risco de transmissão. Esta tese propõe o conceito de violência estrutural como enquadramento teórico para ir além das explicações ambientais e analisar as desigualdades sistémicas que aumentam as disparidades de saúde entre os Yanomami. Enquanto grande parte da literatura existente se foca em fatores ecológicos e biológicos, esta investigação destaca as condições estruturais mais amplas, como a mineração ilegal, o enfraquecimento das proteções territoriais e decisões políticas que privilegiam interesses económicos em detrimento dos direitos dos povos Indígenas. Adicionalmente, o acesso limitado aos serviços de saúde e o apoio governamental inconsistente dificultam o diagnóstico e o tratamento da malária, contribuindo para o aumento da morbidade e mortalidade associadas à doença. Este estudo defende que a malária entre os Yanomami não constitui apenas uma emergência de saúde pública, mas também uma injustiça estrutural profundamente enraizada. Abordá-la requer tanto intervenção médica quanto reformas políticas que garantam a proteção das terras e dos direitos indígenas.

Palavras-chave: Yanomami, malária, violência estrutural, saúde Indígena, desflorestação, floresta amazónica

Abstract

The Yanomami are an Indigenous people living in the Amazon rainforest along the Brazil–Venezuela border. Despite the official demarcation of their territory as protected land, deforestation continues to threaten the Amazon region. One consequence of this environmental degradation is a growing health crisis among the Yanomami, particularly the increasing incidence of malaria, a parasitic disease transmitted by six known species of *Anopheles* mosquitoes in the area. Deforestation creates more favorable breeding conditions for these mosquitoes and increases human-mosquito contact, thereby elevating the risk of transmission. Drawing on theory-testing process-tracing and policy analysis, this thesis employs the concept of structural violence as a theoretical framework to move beyond environmental explanations and examine the systemic inequalities that increase health disparities among the Yanomami. While much of the existing literature focuses on ecological and biological factors, this research highlights the broader structural conditions, including illegal mining, weakened land protections, and policy decisions that prioritize economic interests over Indigenous rights. Furthermore, limited access to healthcare infrastructure and inconsistent governmental support hinder the diagnosis and treatment of malaria, contributing to increased morbidity and mortality. This study argues that malaria among the Yanomami is not only a public health emergency but also a deep-rooted structural injustice. Addressing it requires both medical intervention and policy reforms to protect Indigenous land and rights.

Keywords: Yanomami, malaria, structural violence, Indigenous health, deforestation, Amazon rainforest

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List of Acronyms

CAR	Cadastro Ambiental Rural (Rural Environmental Registry)
FAO	Food and Agriculture Organization (of the United Nations)
FUNAI	Fundação Nacional dos Povos Indígenas (Brazilian Amerindian organization)
ICESCR	International Covenant on Economic, Social, and Cultural Rights
SENAI	Secretaria Especial de Saúde Indígena
SICAR	Sistema de Cadastro Ambiental Rural (Environmental Rural Registry System)
UDHR	Universal Declaration of Human Rights
UN	United Nations
UNDP	United Nations Development Programme
UNDRIP	United Nations Declaration on the Rights of Indigenous Peoples
WHO	World Health Organization

Introduction

The Yanomami people are one of the largest Indigenous groups in the Amazon rainforest, with an estimated population of between 30,000 and 35,000 people. They live along the Brazilian-Venezuelan border in an area of approximately 9.6 million hectares. They depend on the plants and animals of their ancestral lands for their livelihoods and cultural practices. Despite the legal demarcation of their land, illegal deforestation encroaches on their territory, putting both the community and the environment at risk (InfoAmazonia, n.d.; García, 2025).

One of the consequences of this deforestation is the rise in malaria indices among the Yanomami people. The disease is transmitted by mosquitos, whose habitats are altered by deforestation, resulting in bigger malaria-carrying mosquito populations (World Health Organization, 2024). There are several ecological and biological studies carried out on the rise of mosquito populations and malaria transmissions, but there is a research gap in addressing the social and structural factors contributing to this health crisis.

My motivation for this research started during an internship in Brazil in 2019, when I was studying Environmental Science. Witnessing real-life examples of environmental degradation and its effects on local communities made a strong impression on me. While my study back then focused mostly on ecological processes, I became increasingly interested in the social dimensions of environmental issues and how inequalities and policy shape the lives of those most affected. In this thesis, I attempt to explore that intersection further.

This thesis aims to fill this research gap by analysing how structural violence contributes to the rise of malaria among the Yanomami. While much of the current literature focuses on the biological and environmental aspects of malaria, it often overlooks how broader political, economic, and social structures influence Indigenous health. This research seeks to understand how deforestation, illegal mining, weak land protection policies, and limited access to healthcare put the Yanomami people at risk of rising malaria indices.

This study examines the connection between environmental changes and structural inequalities to better understand how the rise in malaria among the Yanomami people is symptomatic of systemic issues. The research aims to demonstrate that effective solutions must not only address the immediate health crisis but also target the underlying structural violence that allows the marginalization of Indigenous peoples. This thesis highlights the need for an approach that combines medical intervention with policy reforms focused on protecting Indigenous rights and their lands and ensuring access to healthcare.

Chapter 1: Contextual framework

This chapter explores the context of the malaria health crisis and deforestation of the Brazilian Amazon. It is focused on the key drivers of forest loss, the social and political factors involved, and the social and health impacts on Indigenous communities.

1.1 Deforestation of the Brazilian Amazon

Drivers of deforestation

The Food and Agriculture Organization (FAO) of the United Nations defines deforestation as "the conversion of forest to other land use independently of whether human-induced or not" (FAO, 2018). The growing demand for products such as timber, soy, beef, and palm oil from global markets has led farmers to clear more land in the Amazon region (FAO & UNEP, 2020). Land grabbing is the illegal occupation of land in the Amazon region, which is also a cause of increased deforestation. Land grabbers claim and exploit land without the legal rights to do so (Brito et al., 2019). In 2015, the Annual deforestation was 1.7 million hectares per year, which is the highest rate of deforestation worldwide. In many developing countries, economic inequality is both a driver and a consequence of increased deforestation. Land grabbers and corporations acquire large areas of forest land for commercial benefits. This results in the displacement of smallholder farmers and Indigenous communities. Displaced communities may resort to clearing new forest areas for subsistence farming. This creates a cycle of poverty and environmental degradation (FAO & UNEP, 2020; Conceição et al., 2021).

Some of the major causes of deliberate deforestation in the Brazilian Amazon are pasture, small-scale farming, commercial crops, logging, and mining. The growth in global demand for beef, soy, timber, and minerals has increased these industries, which are driven by economic profit. Figure 1.1 shows the drivers of forest loss in the Brazilian Amazon between 2000 and 2013. The main contributors during this period were large-scale agriculture, small-scale agriculture, and infrastructure development. Wildfires also play a role in the loss of Amazon but are not the primary drivers. Although land that has been cleared by wildfires usually falls into the hands of illegal land grabbers, who exploit it for pasture or commercial crops (Conceição et al., 2021).

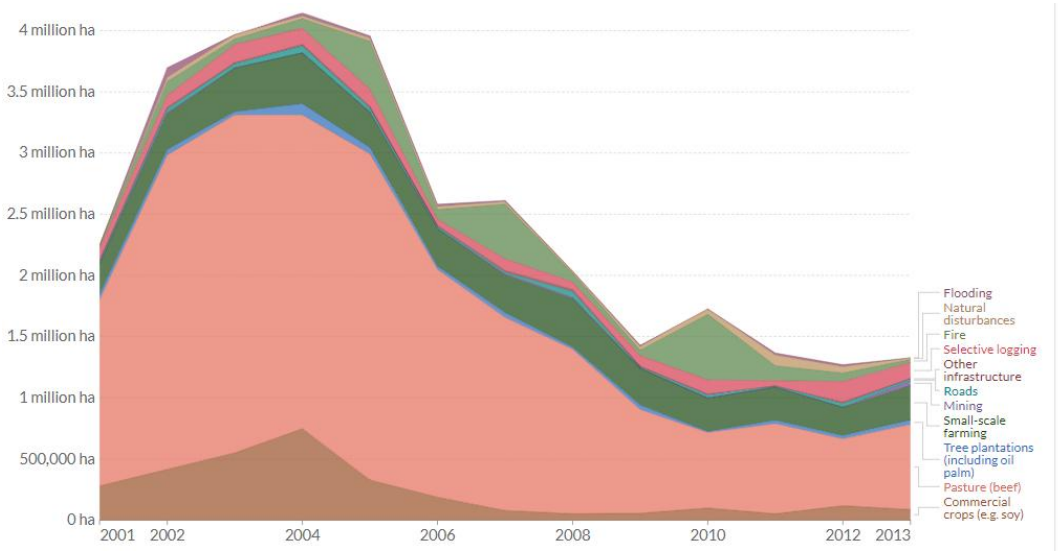


Figure 1.1 - Drivers of forest loss in the Brazilian Amazon (Source: Tyukavina et al.,2017)

Since 2013, deforestation in the Brazilian Amazon has experienced fluctuations, with a significant increase in forest loss after 2019. The main drivers for forest loss in the Amazon remained pasture and farming. According to Global Forest Watch and INPE data, forest clearing increased after 2019 due to weakened environmental enforcement and increased cattle ranching and land grabbing. After 2023, since Lula's presidency, there seems to be a decline in the deforestation rate due to stronger policy measures (Global Forest Watch, n.d.; Instituto Nacional de Pesquisas Espaciais, n.d.).

In the 1970s, the construction of a highway, the so-called BR-319, had started. This highway would lead right through the Amazon rainforest. The goal of the highway was to realize a strategic route for economic development in the region. This construction has led to increased deforestation, illegal logging, and mining, and has had negative consequences for the Indigenous communities that live in the area. Some Indigenous tribes have been displaced and lost their ancestral lands. The construction of the highway also negatively impacted the wildlife in the area, on which the Indigenous people relied for their livelihoods. Because of the controversy around the project, the project was temporarily stopped, but it was restarted in the year 2000, and construction is still ongoing today (Ferrante & Fearnside, 2020).

Deforestation in Indigenous lands and the Yanomami territory

In the Brazilian Amazon, there are over 400 Indigenous tribes, including the Yanomami, Kaiapo, Guajajara, and Karitiana. Although the UN does not have an official definition for the term 'Indigenous', they are mostly described as pre-colonial societies with strong links to territories and who have distinct social systems and cultures, and beliefs (UN Permanent Forum

on Indigenous Issues, 2006). The Amazon is the most ethnically diverse region in the world, hosting more Indigenous tribes than any other region. They have developed unique ways of living, cultures, and traditions. Because of the destruction of the Amazon rainforest, these Indigenous people are losing their traditional lands and sources of survival. Indigenous rights are often overlooked in favor of commercial interests (Survival International, n.d.).

The Brazilian Amazon exemplifies how Indigenous rights are neglected to make way for expanding commercial interests. As shown in Figure 1.2, between 2017 and 2019, there were several Indigenous lands affected by illegal mining. According to data from DETER, 115 deforested mining areas were detected over 13 Indigenous lands between 2017 and 2019 (Rorato et al. 2020).

The struggle for land rights and environmental justice is, among other things, a sociological issue, involving complex interactions between power structures, historical colonialism, social hierarchies, and grassroots resistance movements. Marginalized communities struggle to defend their land and traditional lifestyles because they face long-standing unfair treatment and unequal power. This situation is influenced by the way institutions and systems control who can use land and resources. If Indigenous people cannot continue their ways of living and their traditions in the forest, they might lose their cultural identity (Survival International, 2008). Psychologists Tajfel & Billig (1973), known for developing Social Identity Theory, explain how cultural identity is crucial for group cohesion and social belonging. Deforestation and displacement disrupt the social fabric of communities, which can lead to the loss of traditional knowledge and cultural practices, and are therefore significant sociological impacts, as they affect identity formation, intergenerational continuity, and the collective resilience of marginalized groups. Even though the Indigenous lands are demarcated as protected land, deforestation continues to alter these areas. Conservation strategies have to be created to preserve these cultures and traditional knowledge (FUNAI, 2025).

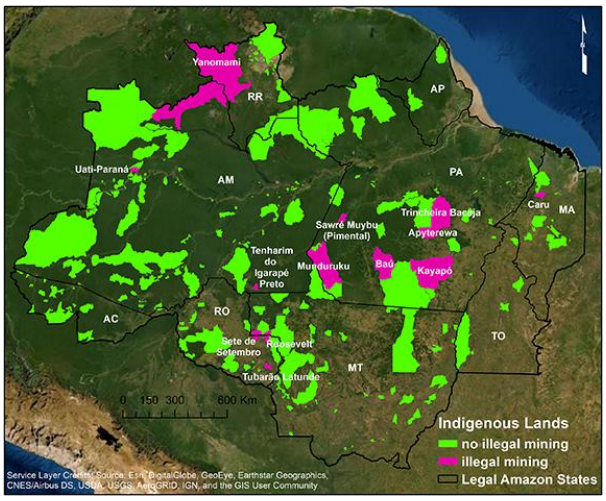


Figure 1.2 – Illegal mining in Indigenous lands in the Brazilian Amazon between 2017 and 2019 according to DETER (Source: FUNAI, 2025)

Most illegal mining within Brazilian Indigenous territories take place in the state of Pará. Figure 1.3 shows that the Indigenous lands with the biggest deforested areas between 2017 and 2019 are Apyterewa, Trincheira Bacaja, Kayapó, and Munduruku, all located in the state of Pará (Rorato et al., 2020).

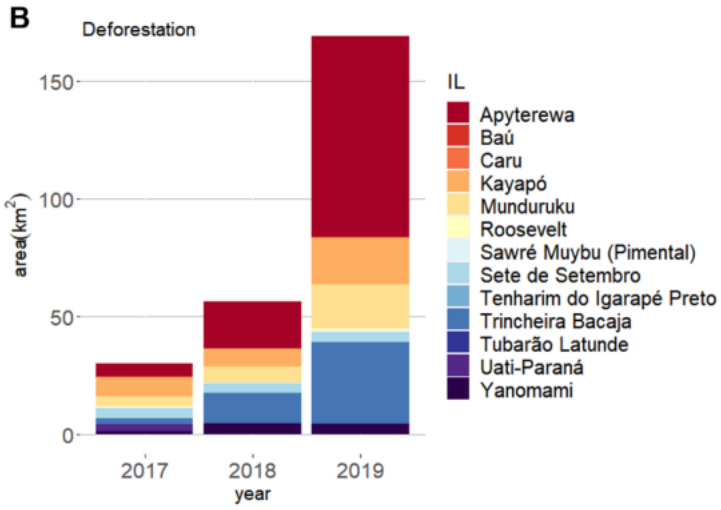


Figure 1.3 – deforested areas (km2) in Indigenous lands in the Brazilian Amazon between 2017 and 2019 (source: Rorato et al. 2020)

Besides deforestation within Indigenous lands, there is also an increase in deforested areas surrounding Indigenous reserves, further encroaching these territories. As Figure 1.4 shows, when the land preserve of the Karitiana (Brazil, state of Rondônia) Indigenous people was established in 1986, it was surrounded by rainforest. But in 2019, it was significantly more surrounded by farms. This kind of encroachment is happening across the Amazon forest. The

former president of Brazil, Jair Bolsonaro, wanted to stimulate the further expansion of farms in the Amazon, at the expense of protected lands. This put around 900,000 Indigenous people at risk of losing their homes (Munsterhjelm, 2015; IACHR & OAS, 2019)



Figure 1.4 - The difference in the land surrounding Karitiana land between 1986 and 2019 (NASA Earth Observatory, 2019)

There are six subgroups among the Yanomami people, who are mostly located in the Brazilian part of the Yanomami reserve. Besides the Yanomami, the Ye'kwana, an ethnic group of the Karib linguistic family, also coexist in the area, and six others Indigenous groups that remain completely uncontacted. In total, there are an estimated 26,854 people in 379 communities, occupying 9.6 million hectares (Serviço e Cooperação com o Povo Yanomami, n.d.; Instituto Socioambiental, n.d.).

Originally, the Yanomami were mostly intermittent nomads. Today, the Yanomami are mostly sedentary and practice subsistence agriculture to feed themselves. Their livelihoods consist mostly of agriculture and gathering, with hunting and fishing for their protein needs. The Yanomami people of a village live collectively in a circular-shaped house, called shabonos, which can shelter 20 to 120 people (Migliazza, 1967; Lizot, 1980; Marcano et al., 2004).

In the Yanomami territory, deforestation is increasing due to illegal mining and logging operations (Instituto Socioambiental, 2023). As Figure 1.5 shows, mining deforestation alerts in the Yanomami territory are generally concentrated in a few areas. Deforestation is most severe in several villages, including Demini, Palimiú, Tumatumari, Paraúri, and Homoxi (Instituto Socioambiental, 2023). These areas seem to be located near the border of the territory, close to the Venezuelan border, and/or along river routes. Even though the whole Yanomami territory is dealing with forest loss, remote areas in the center of the territory and which are less accessible, are likely to be less affected (Silva-Junior et al., 2023).

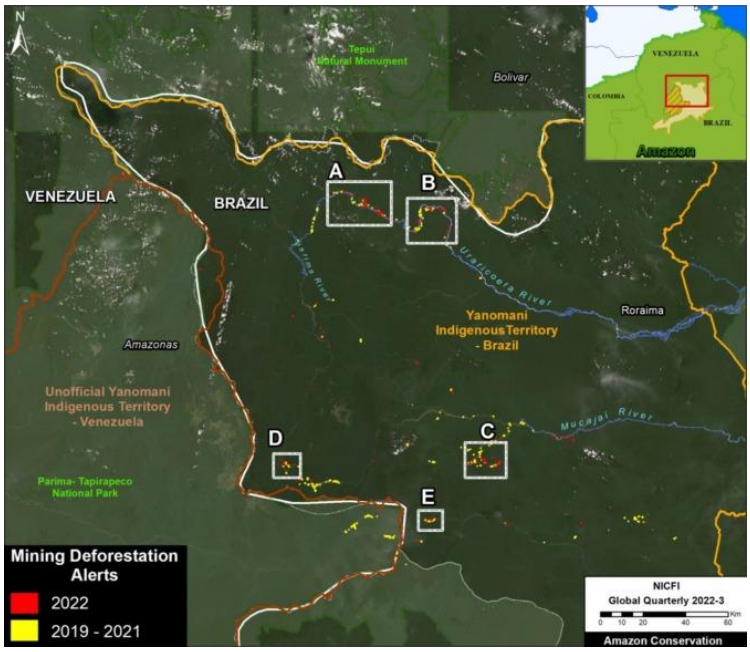


Figure 1.5 – Illegal mining deforestation alerts in Yanomami territory (MAAP, 2023)

Despite the negative impacts of deforestation, the Yanomami are fighting for their cultural heritage and ancestral lands through communal efforts and advocacy (Albert & de Almeida, 2021). The Yanomami villages have mostly lived in isolation from each other and the Brazilian society, but are now creating inter-village alliances to battle deforestation collectively. They are also working together with nonprofit organizations such as the Hutukara Yanomami Association. A Yanomami shaman and spokesman is representing their interests at the UN and in global environmental conferences (Dalmonego, 2024; Survival international, n.d.). Similarly, other Indigenous groups worldwide are also fighting for their Indigenous rights. Such as New Zealand's Maori, who are facing similar problems, and are actively reclaiming their lands by protests and legal action (Mutu, 2010). This shows the determination of Indigenous communities to preserve their heritage despite external pressures and environmental change.

1.2 Governmental policies in Brazil

Laws and Deforestation

In 1965, the Brazilian government established the Forest Code, which regulates the use and protection of forestland (Brazil, 1965). The law aimed to protect forests. However, in 1970, the Brazilian government implemented the Brazilian National Integration Plan (PIN), which was an infrastructure project to connect the Amazon region to the rest of the country. In contradiction to the Forest Code, the government began encouraging the settlement and development of the Amazon region, leading to a significant increase in deforestation (Brondizio & Moran, 2012).

To solve the growing concerns about deforestation, the Brazilian government implemented several laws to protect the Amazon rainforest. One of the most significant was the Federal Constitution of 1988, which states that the government must protect the Amazon for present and future generations (Soares, 1991). This has led the Brazilian government to take steps against deforestation by implementing the Federal Plan of Action for the Prevention and Control of Deforestation in the Legal Amazon in 2004. This plan intends to address the drivers of deforestation and consists of multiple phases. Firstly, between 2004 and 2008, geospatial monitoring was used to draw boundaries of Indigenous territories in the Amazon rainforest. Secondly, a new law was implemented to regulate forestry activities on public lands in 2006. In 2009, the Legal Land Program Law was introduced to address land tenure regulations, such as land grabbing and lack of documentation (Benatti & Fischer, 2018).

However, as Figure 1.6 shows, since 2012, deforestation rates have increased, partially because of changes in government policies and increased demand for land for agriculture and mining (Mendes, 2022). During the administration of President Dilma Rousseff, she invested 72 percent less money on anti-deforestation measures than Lula da Silva (2003-2011). In 2017, Michel Tenner reduced the budget by 51 percent. During the presidency of Jair Bolsonaro (2020-2022), he continued the anti-environment policies of his predecessors and cut funding for environmental agencies like IBAMA and ICMBio by over 24% in 2021 alone. In 2019, the Secretaria de Mudança do Clima, responsible for climate change and preservation, was dismantled by Bolsonaro's government. By weakening enforcement and promoting pro-development policies, Bolsonaro oversaw a surge in Amazon deforestation (Garrido, 2022; Agência Lusa, 2020; Mendes, 2022*).*

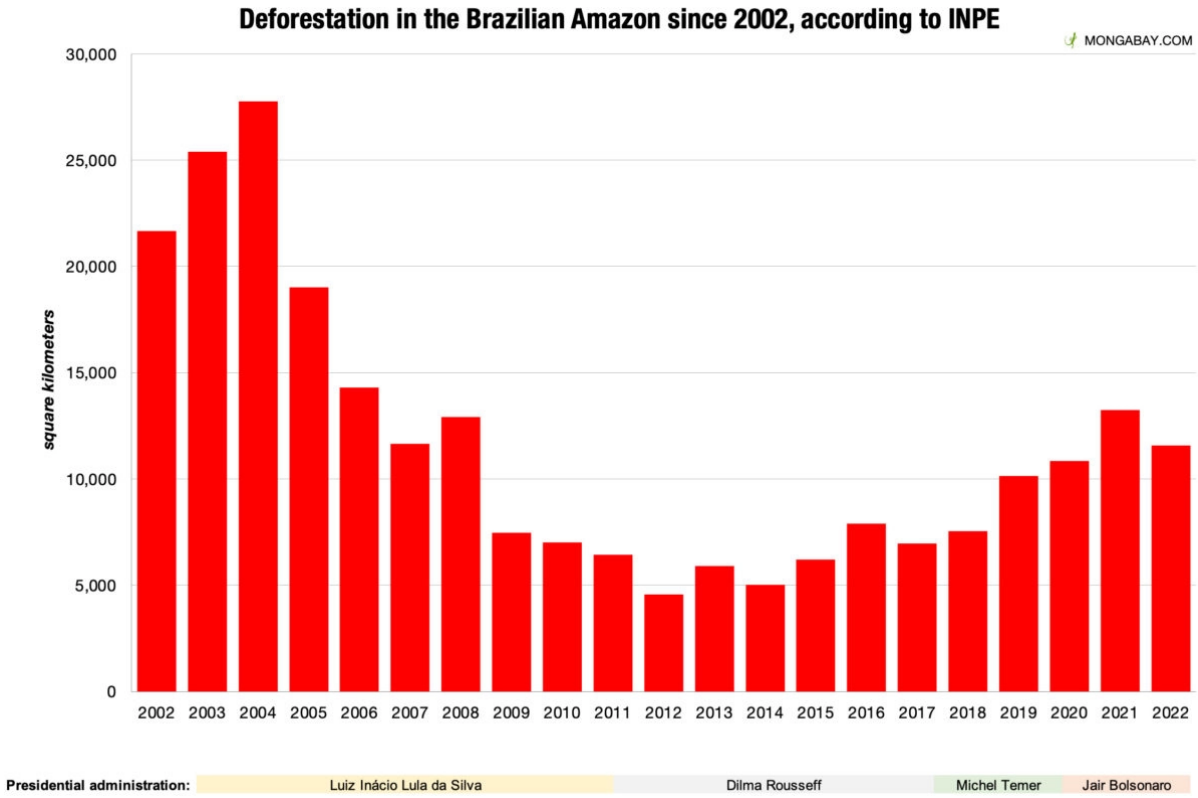


Figure 1.6 - Deforestation in the Brazilian Amazon since 2002 (source: Mendes, 2022)

The New Forest Code (Law No. 12,651) was approved in 2012. However, this sparked debates between environmental groups and the business sector. Environmental groups argued that this law weakened forest protection, but the business sector claims that the previous Forest Code was too restrictive. The private sector is pushing for more economic development opportunities and is resisting the full implementation of the New Forest Code (Benatti & Fischer, 2018).

Human Rights in Brazil

In 1948, Brazil signed the Universal Declaration of Human Rights (UDH) and committed to upholding the ideals and principles mentioned in the declaration. In 1966 Brazil signed the International Covenant on Economic, Social, and Cultural Rights (ICESCR) which is legally binding and protects economic, social, and cultural rights. In 2007, Brazil signed the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) and endorsed the UNDRIP in 2010. In addition, the Convention on Biological Diversity, signed at the Earth Summit in Rio de Janeiro in 1992, recognizes the importance of conserving biodiversity and the rights of Indigenous people (Wright & Tomaselli, 2014).

The deforestation of the Amazon violates several human rights mentioned in the Universal Declaration of human rights, such as the right to life (art.3), the right to property (art.

17), the right to a healthy environment (art. 22), the rights to participate in government (art. 21) and the rights to cultural identity (art. 27) (United Nations, 1948).

Indigenous rights in Brazil

From 1964 to 1985, under the military dictatorship, genocide among Indigenous people was carried out to develop highways, dams, and mines across the Amazon region. In 1985, the military regime collapsed, and Brazil became a democracy. The new constitution included historic reparations for the Indigenous people. Article 231 (chapter VIII) stated that Indigenous people "shall have their social organization, customs, languages, creeds, and traditions recognized, as well as their original rights to the lands they traditionally occupy". Indigenous groups could claim their traditional territory with the government agency FUNAI. FUNAI would demarcate the border of protected land, and with the approval of Brazil's president, FUNAI would then monitor and protect it (Calafate, 2018; Conceição et al., 2021).

With the fast-growing economy and the need for more land, the agri-business industry wanted to access protected lands. From 2011, the funding of FUNAI was cut by the Brazilian government. This has left many Indigenous lands unprotected. As a result, the illegal invasions of protected land increased (Mendes, 2022).

The deforestation of the Amazon violates several human rights mentioned in the United Nations Declaration on the Rights of Indigenous Peoples, such as the right to self-determination (art.3), the right to life, integrity, and security (art. 7), the right to a healthy environment (art. 22), the rights to participate in government (art. 21) and the rights to cultural identity (art. 27) (United Nations, 1948).

The Inter-American Commission on Human Rights (IACHR)

IACHR is a commission of the Organization of American States (OAS) and is responsible for promoting and protecting human rights in the Americas. It was created in 1959 and started conducting on-site observations for human rights in 1961 (IACHR, 2023).

The IACHR is addressing the human rights violations of Brazil's Indigenous communities. They conducted on-site visits to the Amazon's Indigenous lands to assess the situation of human rights abuses. In 2019, IACHR published a report on the Indigenous and Tribal Peoples of the Pan-Amazon Region (IACHR & OAS, 2019).

Since 2012, illegal logging and mining in the Amazon region have been on the rise again. The increase in invasions of protected land has been reported by the Yanomami and Ye'kwana Indigenous people, and the IARCH has given precautionary measures, a protection

mechanism in the form of a request to a State. These precautionary measures were urgent requests to the Brazilian government to take immediate action to prevent irreparable harm to Indigenous communities. The IARCH highlights a specific incident where a group of miners attacked the Yanomami community of Aracaçá in Roraima. During the attack, a 12-year-old girl was raped and murdered, while a 28-year-old woman and her 3-year-old son were kidnapped. The woman managed to escape, but the boy remained missing after being thrown into a river. The IATCH stresses the need to adopt reparation measures that promote the participation and well-being of Indigenous peoples (Survival International, 2019; IACHR, 2019; IACHR 2022).

The IACHR plays an important role in highlighting human rights violations of Brazil's Indigenous people. They urge the government to take appropriate measures to address these issues. The commission has contributed to the international recognition and visibility of the challenges faced by Indigenous communities in Brazil. The IACHR has promoted advocacy and support for justice, equality, and the protection of Indigenous rights (IACHR, 2023).

The National Indian Foundation (FUNAI)

FUNAI, the National Indian Foundation (Fundação Nacional do Índio), is a Brazilian governmental agency responsible for the protection and promotion of Indigenous people's rights. FUNAI was established in 1967 and aims to safeguard the rights, territories, and cultural heritage of Indigenous communities (Ministério dos Povos Indígenas, 2023).

FUNAI's main objective is to demarcate and protect Indigenous lands, to ensure their ancestral lands and prevent (further) encroachments. Additionally, FUNAI provides healthcare, education, and social services to Indigenous communities living in the Amazon (Schwartzman & Zimmerman, 2005; Ministério dos Povos Indígenas, 2023).

Indigenous lands demarcated by FUNAI have to be approved by the Brazilian president. Because of the lobbying of the agricultural industry, fewer Indigenous lands have been approved over the years. From 2003 to 2010, President Lula da Silva approved 87 Indigenous rights. But his successor, Dilma Rousseff, approved of just 21. Followed by Michel Termer, who approved only one. President Jair Bolsonaro approved no Indigenous preserves, and he even reduced the protected areas. He has proposed to take away FUNAI's power to demarcate new lands entirely. Furthermore, he has appointed a former police officer with strong ties to the agricultural industry, Marcelo Xavier da Silva, to lead FUNAI (FUNAI, 2025; Survival International, 2008). Due to the budget cuts in 2011 and again in 2016, FUNAI faces limitations in fulfilling its goal to protect Indigenous lands. Illegal mining in protected lands has

skyrocketed since 2017 and even further increased since Bolsonaro became president in 2019 (FUNAI, 2025; ANM, 2020).

According to a report by FUNAI (2025), women in Indigenous territories are increasingly exposed to sexual violence by illegal miners, especially in remote areas where state presence is minimal. The loss of their ancestral lands means women are also at risk of losing their role within the community. Women are mostly responsible for gathering and farming the community's gardens. Yanomami women can also become shamans, practicing traditional medicine and knowledge sharers. With displacement and the loss of ancestral lands, the role of women can change. This would weaken the Yanomami social structure (Chagnon, 1992; Schwartzman & Zimmerman, 2005).

Indigenous children have limited access to education, partially due to insufficient infrastructure. A report by UNICEF (2016) states that Indigenous children have a higher dropout rate compared to non-Indigenous children. Schools are often far away, and curricula do not take Indigenous cultural identity into account. To address this, FUNAI tried to adopt community-based education initiatives, but due to a lack of funding, these initiatives haven't been successful. Besides insufficient education, Indigenous children are also more vulnerable to health issues because their water sources are contaminated due to mining activities. These waters contain hazardous mercury and arsenic. According to FUNAI (2025), these environmental hazards can lead to long-term developmental issues.

The demarcation of Indigenous lands and FUNAI's protection of these lands is important to ensure women's and children's safety and health (FUNAI, 2025; Survival International, 2008).

1.3 Malaria in de Brazilian Amazon

Malaria is a vector-borne disease that occurs in the Amazon basin, and therefore also in the Yanomami lands. The symptoms of a malaria infection can be mild to life-threatening. Malaria can be prevented by vector control, chemoprophylaxis drugs, preventive chemotherapies, or a malaria vaccine. Treatment of the disease depends on the type of malaria but mostly consists of medicines in pill form or injectable medicines (World Health Organization, 2024).

Malaria is a parasitic disease caused by the Plasmodium parasite, carried and transmitted by Anopheles mosquitos. In Brazil, there are three Plasmodium parasites prevalent that can infect humans; Plasmodium vivax, plasmodium falciparum, and plasmodium malariae (Alexandre et al., 2010; Cavasini et al., 2000). In the Amazon basin, there are nine species of Anopheles mosquitos that can transmit Malaria; Anopheles Darlingi, Anopheles Intermedius,

Anopheles Aquasalis, Anopheles Marajoara, Anopheles Braziliensis, Anopheles Albitarsis, Anopheles Triannulatus, Anopheles Subpictus, Anopheles Nuneztovari, and Anopheles Oswaldoi (Tadei, W.P. & Thatcher, B.D., 2000; World Health Organization, 2024; Lima & Pimenta, 2016).

From 1997 through 2006, Brazil had around 500,000 confirmed malaria cases annually, most of which were in the Amazon Basin. (Ministry of Health, 2008). Overall, malaria indices in Brazil have been reduced between 2011 and 2022. However, in Indigenous villages and gold mining areas, the malaria indices have been increasing significantly over the last years. The government declared a public health emergency in 2023, particularly in areas like Roraima, where cases spiked sharply among Indigenous populations (WHO, 2023).

Chapter 2: Theoretical framework

Violence does not always have to be visible conflict; it is often embedded in policies and systems that harm vulnerable populations. This chapter introduces structural violence as the theoretical framework for analysing the causal mechanism between rising malaria indices among the Yanomami and deforestation of the Brazilian Amazon.

While different forms of violence are theorized, such as direct, structural, and cultural violence, they are interconnected and mutually manifest in the case of the Yanomami community (Hourani et al., 2021). Structural violence is often described as 'invisible violence' because it is built into society's systems, leading to inequalities. By applying structural violence to deforestation, power dynamics, and systematic neglect, leading to Yanomami's health inequalities can be examined (Galtung, 1998).

This theoretical framework allows us to explore the often overlooked ways in which policies and institutions can accumulate harm and become normalized. Given the interconnectedness of structural violence with direct and cultural violence, this thesis will examine the intersection of these forms of violence. Symbolic and environmental violence are also closely related to the topic and offer a comprehensive understanding of this case.

2.1 Understanding structural violence

The definition of violence according to the World Health Organization (WHO) is as follows: "the intentional use of physical force or power, threatened or actual, against oneself, another person, or a group or community, which either results in or has a high likelihood of resulting in injury, death, psychological harm, maldevelopment, or deprivation" (Dahlberg & Krug, 2002, p. 2).

Galtung (1969) first coined the term structural violence in his article "Violence, Peace and Peace Research". He describes different definitions and dimensions of violence. He states that "violence is present when human beings are being influenced so that their actual somatic and mental realizations are below their potential realizations" (Galtung, 1969, p. 168). Galtung (1969) identified three types of violence that are related and reinforce each other: direct violence, structural violence, and cultural violence (Figure 2.1). Cultural violence is the aspect of a culture, such as ideology or religion that legitimizes violence. Structural violence is the systems and structures that result in harm that is not caused by an identifiable individual actor. Unlike direct violence, structural violence is embedded in institutions and policies that invisibly perpetuate harm by denying access to health, security, or autonomy. Direct violence is observable, physical harm inflicted on an individual (Galtung, 1969).

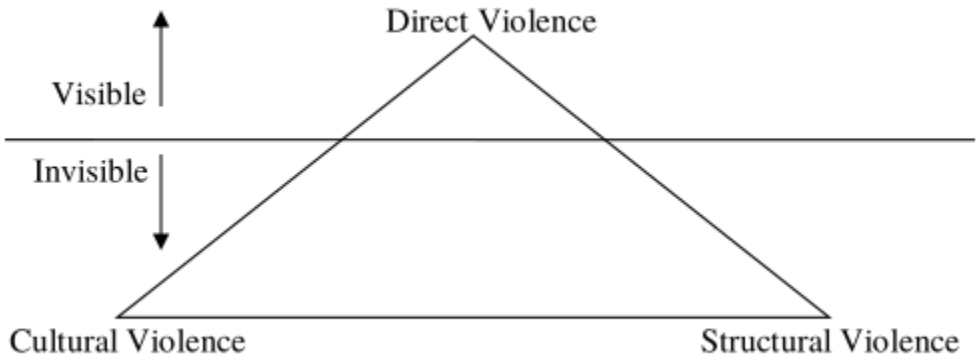


Figure 2.1 - Triangle of violence: direct, structural, cultural, based on Galtung's theory of violence.

Galtung (1969) suggests that the underlying cause of structural violence is the distribution of power. To support this theory, he identifies the components of social structures: actors, systems, structures, and ranks. Actors seek goals and interact with each other in the form of systems. They can interact with one another within more than one system. These systems together make up a structure in which actors can have different ranks within different systems. This approach leads to the concept of the level of actors, which refers to the idea that actors operate at different levels within social structures and systems (Galtung, 1969).

Structural violence is perpetuated by the uneven distribution of resources and opportunities. Power imbalances within social structures influence who has access to necessities such as education, economic stability, and healthcare. Structural violence does not directly consist of physical harm, and therefore it often remains invisible. It is embedded in society by policies that systematically disadvantage certain groups while benefiting others. Because structural violence is not directly visible and is normalized, it is harder to identify and challenge (Galtung, 1969).

Galtung explains that these harmful social structures persist because they are reinforced by institutions and cultural norms. Due to disadvantaging policies and social structures, the same patterns of inequality are reproduced over time. They sustain inequality by giving more power and resources to those on top, while marginalized communities remain disadvantaged (Galtung, 1969).

Farmer (2003) extends Galtung's theory by applying it to explain that structural violence directly contributes to the health inequalities of marginalized groups. He states that unequal

distribution of power can result in uneven access to healthcare and resources. Farmer (2003) says that disadvantaging social structures, resulting in structural neglect and state inaction, can cause and maintain the lack of access to healthcare. The affected groups suffer disproportionately from malnutrition and diseases (Farmer, 2003).

Scheper-Hughes (1992) emphasizes the biological consequences of structural violence in terms of health outcomes. Health disparities can be the result of social structures and institutions, such as healthcare systems and political policies. Those systems can facilitate violence against poor communities, women, and children. Scheper-Hughes conducted a case study on the high rates of infant mortality and child neglect in rural Brazilian communities. She argues that the absence of essential resources (food, healthcare, basic sanitation) is a direct consequence of institutionalized neglect and systematic oppression (Scheper-Hughes, 1992). She argued that social structures of poverty and inequality become embedded in everyday life that they shaping people's attitudes. She claims that inequalities in health, such as infant mortality, are not only the result of material deprivation, but also cultural norms, societal attitudes, and political exclusion (Scheper-Hughes, 2004).

In conclusion, there are five key aspects of structural violence to be distinguished:

1. **Systemic Inequality**

   Structural violence happens due to imbalances in power and the unequal distribution of resources. Galtung (1969) described this as the consequence of how social systems are structured. These disparities are mostly visible in unequal education and access to essential services, such as healthcare.

2. **Invisible Harm**

   Structural violence is not a visible conflict, but it is subtle and occurs over time. Galtung argues that it exists when people are prevented from reaching their full potential. Its effects are often normalized and go unnoticed (Galtung, 1969).

3. **Institutionalized Discrimination**

   Structural violence is sustained through social, political, and economic institutions. Scheper-Hughes (1992, 2004) and Farmer (2003) explain how policies and social norms reinforce existing inequalities through power imbalances.

4. **Impact on Health**

   Consequences of structural violence can manifest as poor health outcomes. Farmer (2003) states that poverty, political exclusion, and lack of access to healthcare are

embedded in broader structures of inequality. These conditions can increase vulnerability to health issues in marginalized communities.

5. **Global Perspective**

   Structural violence occurs worldwide and is reinforced by global, political, and economic structures. Both Galtung's theory and Farmer's work point out that low-income and formerly colonized countries are disproportionately affected.

2.2 Intersections of other theories of violence

The concept of symbolic violence was introduced by Bourdieu (1979) to describe a form of violence that isn't physical but still creates harm through power imbalances between different groups. Symbolic violence is behaviors, ideologies, and non-verbal communications that reproduce and legitimize power relations. It can manifest in language, media, and educational systems. It makes power dynamics seem natural or inevitable and therefore legitimizes inequality (Bourdieu, 1979). Symbolic violence reinforces and normalizes and legitimizes those conditions by making them seem natural or unavoidable. Montesanti and Thurston (2015) note that symbolic and structural violence often intersect to create environments where interpersonal violence can thrive.

Environmental violence is the harm caused to communities because of the destruction of their environment. This destruction is often human-inflicted and driven by economic or political decisions that prioritize profit. Bullard (2000) states that marginalized groups suffer disproportionately from environmental harm, such as deforestation and pollution. Daly & Farley (2011) state that these impacts are the result of unsustainable economic systems. This form of violence is also linked to structural violence, because both come from policies and practices that disproportionately affect vulnerable populations. These forms of violence create cycles of harm that are difficult to break.

Extractive violence is described as harm caused by the exploitation of natural resources. In Indigenous territories these activities often occur without the community's consent. Extractive violence results in environmental degradation and physical displacement of communities living in the area. It can also cause the erosion of cultural practices, livelihoods, and social cohesion of these communities. Gómez-Barris (2017) emphasizes that extractive violence functions as a form of structural violence, as it produces long-term due to governmental and corporate development interests.

In combination, these theories of violence provide a lens to understand how violence manifests in this case study. While cultural and structural violence addresses the systemic roots

of inequality, symbolic violence highlights the forces that maintain these inequalities, and environmental violence demonstrates the harmful environmental consequences. In this research, all forms of violence intersect and reinforce each other.

2.3 Deforestation as structural violence

The theoretical framework of structural violence could be applied to the case of deforestation in the Brazilian Amazon. Deforestation is mainly driven by an economic ideology that prioritizes economic growth. Social structures built on that economic ideology can favor certain groups, leading to disadvantages for other groups. The theory of structural violence suggests that certain industries, such as mining, logging, and agriculture, are prioritized due to their economic benefits, leading to policies and social structures that favor these sectors. This results in unevenly distributed power among government agencies, businesses, and Indigenous communities. This suggests a clear reflection of unequal power dynamics within the Brazilian social system, which is a key aspect of structural violence (Galtung, 1969; Silva et al., 2021).

The harm caused by deforestation is often invisible in the short term because the impacts manifest gradually and are embedded within the current systems. The rise in deforestation disrupts Yanomami lands, which are critical for their livelihoods. In line with Galtung's definition of structural violence, deforestation seems to be a systematic harm that results in the Yanomami's actual realization being below their potential. Bell (2006) expanded on that theory, illustrating that large-scale extraction is a form of structural violence because it marginalizes Indigenous communities by disrupting their traditional livelihoods.

Chapter 3: Methods and methodology

This chapter explains the methods that are used in this research, data collection, and the ontological and epistemological assumptions. In this research, the method of theory-testing process-tracing is applied. I chose this method because it allows for a systematic investigation of cause-and-effect relationships. This makes it well-suited for analysing the causal mechanism between deforestation and rising malaria indices. Since there are already established theories about causal links, this method will allow us to test whether these theories are true and present in this particular case.

Process Tracing is commonly referred to as a theory-based case study methodology (Stern et al. 2012; Beach, 2016). Derek Beach's and Rasmus Brun Pedersen's *Process-tracing Methods: Foundations and Guidelines* (2013) were used as a guideline throughout this research. Within this general method, policy analysis was also applied. Bardach (1977) developed a systematic method to evaluate policies, which is used to evaluate Brazil's policies towards deforestation within the causal mechanism.

3.1 Theory-testing process-tracing

Beach and Pedersen are professors and authors in political science and qualitative research methods. They co-authored a paper on process-tracing as a methodological tool for qualitative research, which has become a widely used approach, mostly in political science but also in sociology, public policy, and international relations. The method is adaptable and therefore applicable for a variety of research questions and fields (Beach & Pedersen, 2013).

Process-tracing can be a valuable method for sociological research to understand the causal mechanisms behind complex social phenomena. By applying this method to this specific case, we can gain insight into how several factors interact to result in a certain outcome. According to Beach and Pedersen, process-tracing is a suitable research method for tracing causal mechanisms. They highlight that it uses detailed and case-related empirical evidence of how a causal mechanism operates in real-world situations (Beach & Pedersen, 2013). A causal mechanism is the functional relationship between variables in a system.

Beach and Pedersen (2013) identify three types of process-tracing:

- Theory-testing process tracing uses existing literature to construct hypotheses about mechanisms, which are then evaluated against the empirical facts of a chosen case.

- Theory-building process-tracing seeks to build a theoretical explanation from empirical evidence in a specific case. Using the facts of the case to identify mechanisms and then construct a theory.
- Explaining-outcome process-tracing aims to find a convincing explanation for a puzzling outcome in a specific contextual case. This is a case-centric approach that is more in line with quantitative scholars in contrast to the theoretical centric orientation.

This research seeks to examine the relationship between deforestation and the rise in Yanomami malaria cases as a form of structural violence. Existing theoretical frameworks provide a foundation for hypothesizing the causal mechanism. Theory-testing process-tracing is a logical match, because this research aims to evaluate evidence and prove these existing theories. A lot of research has been done on deforestation, Indigenous rights and Indigenous health. This has resulted in an extensive body of literature, reports, and data. Therefore, there is no direct need for obtaining new data to answer the research question. Instead, a holistic approach is needed with the incorporation of scientific studies, reports by health organizations, and governmental data, to see how deforestation as a form of structural violence affects malaria-related health issues within the Yanomami community.

According to Beach & Pedersen (2013) theory-testing process-tracing assumes that we know both the intervention (X) and the outcome (Y). From there, a causal mechanism can be hypothesized based on existing theory. Beach and Pedersen (2013) formulated a three-step scheme for a theory-testing process-tracing case study. This three-step process-tracing model is applied in this research (see Appendix A for a detailed breakdown).

3.2 Policy Analysis

Policy analysis will be applied as a complementary method to support the testing of the causal mechanism. Policy analysis is the systematic evaluation of the impacts of governmental policies. In this research, policy analysis will be used to evaluate the Brazilian governmental policies on deforestation, land use, and public health.

Bardach (2012) developed an eight-step process for policy analysis. He notes that the steps don't necessarily have to be taken in this order, nor is every step significant in every problem. For the analysis of Brazil's deforestation policy, I will apply Bardach's policy analysis framework but limit the steps to those most relevant to this study, with a focus on problem definition, evidence collection, and policy outcomes. A detailed description of the policy analysis framework applied in this research can be found in Appendix B.

By applying Bardach's framework, this research will provide an assessment of Brazil's deforestation policies and their effects. The combination of process-tracing and policy analysis allows for an in-depth evaluation of policies as a causal mechanism. This offers important insight into the influence of governmental policies on deforestation and impacts on Indigenous communities.

3.3 Data collection

To evaluate the evidence systematically and transparently, Beach & Pedersen (2013) refer the use of Bayesian logic. Bayesian logic helps assess whether evidence supports our theory by weighing how expected each observation is (Appendix C).

Because this thesis relies on secondary data, it is essential to critically evaluate the sources and show how they connect to each other and to the research objectives. Before being submitted as evidence for causal interpretations, empirical material needs to be evaluated. To make sure this is as objective as possible, this process needs to be transparent. The idea is to find evidence to strengthen our conviction in the existence of the hypothesized causal mechanism, based on Bayesian logic. If strong evidence is found, and other explanations can be eliminated, the presence of the causal mechanism can be concluded.

Causal Process Observations (CPO) is the type of empirical material that is gathered in process-tracing methods. Collier et al. (2010) describe it as a piece of information or data that helps explain the context or mechanism. It contributes as leverage of a causal assumption, but it doesn't necessarily have to be part of a larger, organized set of observations. This means that the empirical material has to be evaluated in the case-specific context before it can be considered evidence (Collier et al., 2010).

Evaluating evidence in process-tracing involves four key steps: collecting data, assessing its content, checking its accuracy, and evaluating its probability (Beach & Pedersen, 2013, p. 122). For a detailed explanation of the process-tracing evidence evaluation steps, see Appendix D.

A wide range of sources can provide reliable evidence, such as interviews, archived documents, public speeches, and news articles. In process-tracing, evidence is classified into four categories: pattern evidence, which looks for statistical patterns in data; sequence evidence, which examines the order of events; trace evidence, which involves physical proof of an event; and account evidence, which comes from reports, interviews, and other records (Beach & Pedersen, 2010). For this thesis, I focus mainly on biological research, sociological theories, and reports from the Brazilian government, the UN, and NGOs.

3.4 Ontological and epistemological assumptions

Beach and Pedersen (2013) discuss two main ontological debates regarding the process-tracing methodology. The first debate discusses whether causality is about mechanisms or just regular patterns. The second ontological debate is about what kind of causal link is present: probabilistic causality or deterministic causality. These ontological debates are relevant to this research because clarifying how causality is understood provides the foundation for applying the process-tracing methodology.

The first debate is about the nature of causation between X and Y. There are two different views on this. The neo-Humanistic perspective states that causality is a 'link' or 'force' between two variables (X and Y). It argues that causality is just a regular link between X and Y, that we can't measure or fully understand (Beach & Pedersen, 2013). The other ontological perspective of causality is the mechanistic view, which focuses on understanding how X causes Y through a specific process or mechanism. This mechanistic ontology is focused on studying how the causal process works. For this thesis, I'm more aligned with the mechanistic view, because I trace how certain factors (X) lead to outcomes (Y) through specific processes.

The second debate is about whether it is a probabilistic causality or deterministic causality. Beach and Pedersen (2013) use the inheritance of IQ as an example to distinguish between probabilistic and deterministic causality. A probabilistic causality means that it has both predictable and random elements. For example, while children inherit cognitive abilities from their parents (which is systematic), their IQ's will vary from their parents' (which is random). In this view, even if we know a lot about the parents' IQ, we can't predict the child's IQ exactly, but we can estimate it fairly well (Beach & Pedersen, 2013).

On the other hand, deterministic theories focus on necessary and sufficient causes. A deterministic relationship means that if something happens, it's because certain conditions were met, and these conditions are necessary for the outcome to occur. As Beach and Pedersen (2013) explain, instead of looking for patterns in large groups, we look at whether certain factors (X) are necessary for causing the outcome (Y) in specific cases. This approach is typically used in small studies to understand how specific causes work in individual cases. This deterministic approach is therefore most compatible with my research setup. Probabilistic theories are more useful for studies that look at larger groups. While firsthand data collection was not feasible, triangulation of secondary sources ensures credibility.

Chapter 4: Identifying the causal mechanism

In this chapter, the causal mechanism will be conceptualized and operationalized. The causal mechanism is the pathways or processes that result in the rise of malaria indices among the Yanomami. The causal mechanism will be hypothesized based on the previously discussed theories. After establishing the causal mechanism that will be tested, it can be operationalized in practical terms by determining what observable manifestations can demonstrate whether the causal mechanism is present in this case.

4.1 Conceptualization of the causal mechanism

Based on existing theories, we can hypothesize the causal mechanism between X and Y. Figure 4.1 shows the conceptualization of the causal mechanism linking the input X (deforestation) to output Y (rising malaria).

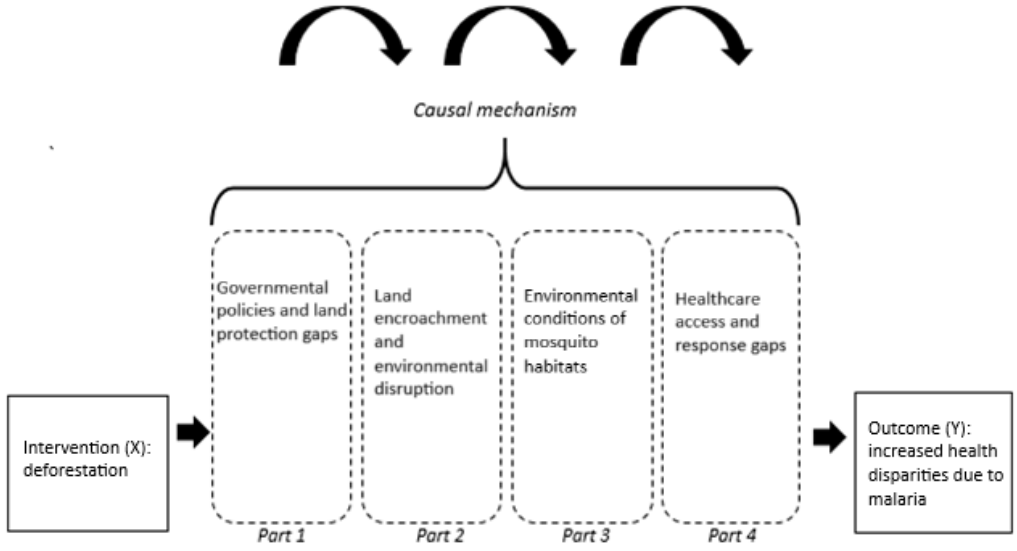


Figure 4.1: Conceptualization of the theorized causal mechanism

- **Independent variable X: deforestation**
- **Part 1 (n_1→): Governmental policies and land protection gaps**

  Governmental policies influence land use, which can either accelerate or hinder deforestation. Weak governance or inadequate enforcement can lead to more land clearance. Enforcement is also dependent on the budget allocated to the institutions responsible for this enforcement.
- **Part 2 (n_2→): Land encroachment and environmental disruption**

  Encroachment of Yanomami territory is a direct consequence of deforestation. This can lead to displacement and potentially bring human populations closer to environments

favorable for malaria transmission, which can lead to increasing contact between humans and mosquitoes.

- **Part 3 (n_3→): Environmental conditions of mosquito habitats**
  Deforestation alters ecosystems and may lead to favorable breeding grounds for malaria-carrying mosquitos. This leads directly to an increase in mosquito populations, increasing the risk of malaria transmission.
- **Part 4 (n_4→): Healthcare access and response gaps**
  Without effective medical response or prevention measures, malaria transmission could accelerate, leading to rising malaria cases.
- **Outcome (Y): Rising Malaria Cases**

4.2 Operationalization of the causal mechanism

Following the theorizing of the causal mechanism is the operationalization of the causal mechanism. To prove or disprove the theorized parts, we need to predict what the observable manifestations are in this specific case. It is key to analyse which observable indicators can be used to test the causal mechanism. Case-specific observable variables, events, or conditions need to be identified. Table 4.1 illustrates what observable indicators belong to the variables, and in what sources this evidence can be found.

Part 1: Governmental policies and land protection gaps

The increase in deforestation in the Yanomami territory is directly linked to government policies and gaps in land protection. The policies in place determine the degree of extractive activities, land grabbing, deforestation, and environmental destruction in the region. If there are policies preventing these activities, their effect also depends on whether they are properly enforced.

It's important to examine if there are weak land protection policies and how they may have contributed to increased deforestation, leading to malaria outbreaks among the Yanomami. Firstly, it is important to determine what environmental protection laws and policies are implemented in Brazil. Then, based on satellite imaging of Instituto Nacional de Pesquisas Espaciais (INPE), policy reports, and FUNAI reports, we can gather insight into the effectiveness and enforcement of these policies.

The UN plays a supporting role because it determines international standards for Indigenous land rights and environmental protection. Looking at UN resolutions, global environmental agreements, and public health guidelines can help determine whether the Brazilian legal system aligns with these international norms.

Part 2: Encroachment of land

Encroachment driven by illegal mining, deforestation, and land grabbing results in environmental conditions that can facilitate malaria transmission. Due to the encroachment of the Yanomami, they might be forced to relocate to areas with a higher risk of Malaria transmission.

For this causal mechanism to be fully understood, we need to understand how the Yanomami are encroached due to deforested areas. Important aspects of this understanding are the number of illegal activities within the Yanomami reserve, infrastructure facilitating deforestation, and the proximity of deforested areas to Yanomami villages.

To trace this causal link, various sources can be analysed, including Satellite imagery of the INPE, field studies, and observations, or FUNAI reports.

Part 3: Environmental Conditions of Mosquito Habitats

To understand how environmental conditions contribute to the rise of malaria among the Yanomami people, we need to link habitat changes to mosquito populations. We need to determine how cleared forest influences breeding conditions for (Anopheles) mosquitoes. Observable indicators of this entail changes in water bodies, vegetation, and mosquito populations.

To determine this connection, multiple data sources can be analysed, such as satellite imagery of deforested areas, entomological and biological studies, and health reports on malaria outbreaks (of FUNAI health posts). This data can be compared to satellite data of deforested areas within the territory.

Part 4: Healthcare access and response gaps

The last part of the theorized causal link is that limited healthcare infrastructure in remote regions creates a barrier to malaria prevention, diagnosis, and treatment. Observable manifestations of this are the number of healthcare facilities in the Yanomami territory and how much of the population has access to these services. Secondly, an important observable indicator is the reported malaria cases and malaria-related deaths among the Yanomami.

To trace this causal link, multiple sources of evidence can be examined, including health reports and epidemiological data from the Health Ministry. Additionally, local surveys, testimonies and FUNAI reports can be consulted. WHO health frameworks can provide insight into whether the healthcare policies in the Yanomami territory align with global recommendations.

Table 4.1: Overview of the operationalization of the causal mechanism

Causal mechanism entity	Governmental policies and land protection gaps	Land encroachment and environmental disruption	Environmental conditions of mosquito habitats	Healthcare access and response gaps
Variable	• Deforestation rate • Policy enforcement • Governmental investment in land protection	• Land encroachment • Infrastructure development • Proximity to deforested areas	• Presence of stagnant water bodies • Habitat expansion (measured in increading numbers mosquitos)	• Availability of healthcare services (i.e. amount health posts and supplies) • Healthcare access (time to reach/distance to healthcare facility) • Malaria case management
Indicator	• Annual deforestation rate in ha/year or m² • Number of violations of environmental laws related to deforestation in indigenous lands (i.e. SICAR/CAR) • Budget allocated to environmental protection policies and Indigenous land protection	• Number of or area (ha or ha/year or m²) illegal miners, loggers, or settlements in the Yanomami land • Road construction, illegal mining, and settlements near Yanomami territory • Distance of Yanomami settlements to deforested areas	• Number of stagnant water bodies in deforested areas or Yanomami territories • ncrease in areas where mosquito habitats can grow due to deforestation in Yanomami territory • Change in vegetation	• Number of healthcare facilities in Yanomami territory • Percentage of Yanomami population with access to healthcare services • Percentage of malaria cases effectively treated in healthcare facilities in Yanomami communities
Data source	• Satellite imagery (INPE) • Data CAR / SICAR • Policy reports • FUNAI reports • UN reports	• Satellite imagery (INPE) • Data CAR / SICAR • Field studies - FUNAI reports	• Field studies of entomological research • Satellite imagery • Health data FUNAI health posts	• Health Ministry data • Local surveys • FUNAI Yanomami health reports • UN health reports

4.3 Testing the causal mechanism

In this chapter the existence of the separate parts of the causal mechanism will be proven or disproven by compiling evidence and relevant sources. In the next chapter, these observations will then be evaluated based on their case-specific context to determine their inferential weight.

Part 1: Governmental policies and land protection gaps

Governmental policies play a role in regulating land use and protecting natural areas. Legal frameworks control how land is used and conserved and protected. Direct forest conservation and restoration policies are most important, but also indirect policies, such as agricultural land use regulations, play a role in regulating deforestation. In Brazil, these kinds of policies shape how the Amazon rainforest is used and protected (McAfee, 2017; Wuepper & Finger, 2023).

In 1965, Brazil implemented the first Forest Code. This law stated that it is mandatory for landowners in the Amazon to maintain 80% of their property under native vegetation. It was created to ensure that the rainforest is protected. However, only 10% of private land in the Amazon has a legal ownership record. Therefore, it is since 2010 mandatory for all rural properties to be registered through Cadastro Ambiental Rural (CAR) (Brock et al., 2021). The Forest Code also prohibits clearing vegetation in sensitive areas such as steep slopes and riverbanks. In 2012, the New Forest Code was established (Federal Law No. 12.651/2012). This revised Forest Code contains general rules on the control of forest products, forest protection, and forest removal (Júnior et al. 2014). Under this revised Forest Code was also a new national

land registry (SICAR) implemented (Andrea et al., 2017). To support these regulations, Brazil also adopted an environmental crime framework to penalize environmentally harmful activities.

According to Ungar (2017), Brazil has one of the most modern environmental crime frameworks. A key element in the environmental crimes framework of Brazil is the Environmental Crimes Federal Act No. 9.605/1998, which states sanctions for activities harmful to the environment, such as illegal environmental, forestry, and wildlife activities. It covers activities like illegal land clearing, hunting of endangered species and pollution. Penalties consist of heavy fines, confiscation of equipment, and in severe cases imprisonment (Brazil, 1998). When illegal deforestation is detected, the land can be embargoed. This means the land is officially prohibited from being used for grazing, farming, or other production, and products from this land can't be sold legally (Gibbs et al., 2012). This environmental crime framework is important for the protection of the Brazilian Amazon.

However, these legal frameworks have been insufficient in combating illegal deforestation of the Amazon. The 1965 Forest Code required landowners in the Amazon to maintain 80% of their property under native vegetation, but weak enforcement and legal loopholes allowed landowners to bypass these regulations. In 2005, in the Amazon of Mato Grosso, 82 of the farms that were surveyed complied with the Forest Code (Stickler et al., 2013). Soares-Filho et al. (2014) stated that even with the Forest Code in place, more than 29 million hectares were illegally deforested in the Amazon region before 2006. The 2012 revision of the Forest Code eased regulations, such as reducing the area that must be preserved or allowing 'compensation' for environmental damage. This means landowners can clear forest in one place and offset it by protecting or restoring the forest somewhere else. This environmental compensation is not always verified or monitored, which legitimizes illegal land clearing (Bourscheit, 2012).

Similarly, the mandatory registration by CAR is poorly enforced. A study by Furumo et al. (2924) analysed 846,420 CAR registrations in the Brazilian Legal Amazon and found that property overlaps were more prevalent on larger properties, in more densely settled areas, and areas with less secure land occupancy. These overlaps result in overestimations of forest reserves up to 9.7 million hectares. This is a form of noncompliance with the Forest Code that is often overlooked (Furumo et al., 2024). A study conducted among soy farms in Mato Grosso found that 16% of soy farms are still not registered in the CAR system. Most registered farms were still in the initial stage of registration, only 11% of all registered soy farms made it to the final stage of the registration process, and only 4,03% were free from environmental liability

(Carvalho et al., 2024). Furthermore, the CAR system has been used to register illegally occupied areas, facilitating private land claims in protected areas. In the state of Pará, for example, over 70% of protected areas had CAR-registered properties within their boundaries, with a 25% increase in the number of properties within protected areas since 2017. This has led to significant deforestation within these areas, with deforestation in protected areas more than doubling from 217,196 hectares in 2019 to 463,858 hectares in 2022. The lack of validation of CAR registrations has allowed their misuse, enabling illegal land grabbing, deforestation, and cattle ranching within protected areas (Candino et al., 2024). Azevedo et al. (2017) found that small properties in Mato Grosso and Pará had lower deforestation directly after registering at CAR, but this effect decreased over time, and in Pará disappeared completely by 2012. There was no consistent pattern observed for medium and large properties.

The Brazilian Institute for the Environment and Renewable Resources (IBAMA) is the most important environmental law enforcement agency. They carry out environmental monitoring, control and supervision and act as environmental police. Since 2007, the enforcement of forest laws within protected areas became the responsibility of a new agency, Chico Mendes Institute for Biodiversity Conservation (ICMBIO). ICMBIO and IBAMA are linked to the Ministry of Environment, which is responsible for the coordination and planning of deforestation prevention and control policies. The environmental law enforcement also relies on other authorities such as the Federal Police, the Military Police and the Civilian Police. Law enforcement within Indigenous lands includes FUNAI and for investigative operations also the Brazilians Agency of Investigation (ABIN). For operations in violent deforestation frontiers an elite law enforcement unit called National Public Security Force provides support. For operations against the transportations of illegal timber on federal roads, the Federal Highway Police plays a role and additionally the Brazilian army may provide support in cases of illegal activities on the borders of the Brazilian Amazon and neighboring countries (Ministério do Meio Ambiente e Mudança do Clima, 2004). Since 2004 IBAMA has been monitoring with the use of the Real-Time System for Detection of Deforestation (DETER), carried out by the National Institute of Space Research (INPE).

Weak enforcement and limited resources significantly hinder the effectiveness of environmental laws in Brazil, allowing deforestation to persist. Under President Jair Bolsonaro, IBAMA's budget was reduced by 25% in 2019, and staff numbers decreased by 55% in the same year (Martinez, 2025). In 2024, IBAMA's firefighting budget was cut by 24% compared to 2023 (Igini, 2024). This has led to insufficient enforcement of compliance of the Forest Law. A study done in Mato Grosso among soy farms found that only 30% of properties that were illegally deforested had embargoes, meaning the deforestation was recognized, fined and

isolated to allow regrowth (Carvalho et al., 2024). Over 1.3 million hectares with embargoes were still used for production, due to non-compliance with the embargoes (Gibbs et al., 2022).

Part 2: Land encroachment and environmental disruption

Brazil has 732 Indigenous territories (ITs) officially demarcated. Even though these ITs are officially recognized, deforestation is still rising in these areas, mostly due to illegal production and mining activities. Silva-Junior et al. (2023) observed a 195% increase of deforestation in Indigenous territories during 2019–2021, compared to the previous three years. They also found that the deforestation inside the ITs was more inward with 30% farther from the borders toward the interior or the Indigenous reserves.

The Yanomami territory was officially demarcated in 1992, but the enforcement of the protections has been weak. There are reports of over 20,000 illegal miners operating within the territory in the years leading up to 2015 (Garnelo & Wright, 2015). Since the Yanomami people depend on the rivers for their livelihoods, illegal mining activity impacts the lives of the communities that depend on these rivers. Over 62% of the Yanomami population lives in areas under the influence of invaders. About 59% of the rivers inhabited by the Yanomami people are under effect by mining and invasions, with a high probability of mercury contamination. The hubs of Waikàs, Sauba, Ericó, PAAPIU Macujaí, Apiaú, Haxiu, and Marari stand out with over 80% of the population and villages in a situation of immediate risk.

In Yanomami territory, illegal gold mining is the primary driver of land encroachment. Because of these mining activities, illegal airstrips and roads are constructed and open-pit excavation sites. Satellite studies identified 188 illegal airstrips and approximately 5,053 hectares over 61 mining sites in the demarcated Yanomami land (Silva Junior et al., 2023; Figueiredo, 2023; Instituto Socioambiental, 2023). Digging large sediment pools for gold extraction, leads to the formation of stagnant water bodies (Pinto et al., 2021). Abandoned pits, trenches, and fuel containers collect rainwater, increasing the area of shallow water even more, especially because these mining camps often lack drainage infrastructure. Furthermore, runoff patterns from deforested airstrips and compacted soil prevent natural water absorption. Communities close to mining activities show higher malaria indices (Silva et al., 2022).

Near the city of Boa Vista, on the east side of Yanomami territory, there has been an increase in agricultural activities. Between 2017 and 2022, over 729 km² of the territory experienced changes in vegetation cover. About 700 km² is linked to fire activities, associated with the expansion of pasture areas and agribusiness interests. To clear land for cattle ranching and soybean cultivation, the forest is intentionally burned. The municipalities of Alto Alegre

and Iracema, which are partially within the Yanomami territory, have seen an increase in soybean planting areas (Figueiredo, 2023).

Because of this increasing land encroachment, some Yanomami communities have been forced to relocate deeper into the forest. This displacement driven by violence, disease transmission, and environmental degradation caused by invading *garimpeiros* (illegal miners) (Silva Junior et al., 2023). This disrupts Yanomami's traditional livelihood, such as fishing and agriculture, because they are tied to specific ecological zones. Deeper forest areas may also not support long-term settlement due to limited resources (Garnelo & Wright, 2015).

In a study conducted in Amazon, Mato Grosso, a correlation between illegal mining activities and increasing malaria incidence was observed. With an average increase of malaria incidence of 0,31 (95%CI=0.22-0.40) for each 100 kg increase in gold production per year (Duarte & Fontes, 2002). Vittor et al. (2006) found that deforested sites had an Aopheles Darlingi biting rate is 278 times higher than the rate in forested areas.

Part 3: Environmental conditions of mosquito habitats

Malaria is transmitted by Plasmodium-infected Anopheles mosquitos. Within the Anopheles genus, there are numerous species complexes, which are similar morphologically but different in behavior, ecology, and ability to transmit disease. Sinka et al. (2012) identified approximately 70 Anopheles mosquito species that are potential vectors of malaria that affect humans. Of the 33 Anopheles species occurring in the Brazilian Amazon, 9 of the species are found to be infected with the Plasmodium parasite. The most prominent species in the Brazilian Amazon Basin is the Anopheles Darlingi.

Anopheles mosquitos have four life cycles: egg, larva, pupae, and adult. The adult stage is when female Anopheles can act as a malaria vector, and they can live up to a month. Adult females can lay 50 to 200 eggs per time. Eggs are laid directly on water. They hatch within 2-3 days into larvae, which live in water (CDC, 2020). Anopheles require water bodies for their aquatic eggs, larvae, and pupae (Moutinho et al. 2011). Waterbodies are essential for the Anopheles life cycle, and environmental changes can significantly impact mosquito population density.

Anopheles Darlingi occur in forested areas and reach their highest population density during the rainy season. The Yanomami of the Mucajaí Basin (Brazil, state of Roraima) are spread along a mountainous region, 900 m above sea level, and the temperatures range from

25°C to 30°C during the day and 13 to 16°C at night. The relative humidity reaches 80% and an average rainfall of 2000 mm per year, and an average of more than 100 mm per month.

Deforestation and especially gold mining activities produce stagnant water bodies. This provides favorable conditions for Anopheles mosquitoes to breed. Tadei & Thatcher (2000) found that Anopheles mosquito populations are bigger in areas that are altered or disturbed by human activities. Wang et al (2016) conducted a study in Yunnan Province, China, and found that the population rate of Anopheles Minimus was 3.8% in forested areas and increased to 52.5% in deforested areas. In deforested areas, the larval to pupal development was reduced by 1,9 to 3,3 days. Additionally, the loss of biodiversity may reduce natural mosquito predators such as birds, frogs, and bats, allowing mosquito populations to grow unrestrained (Kamaraju & Velamuri, 2008).

Conditions that increase mosquito-human contact can significantly elevate malaria risk. Female mosquitoes infected with Plasmodium are more attracted to human breath and body odors than uninfected mosquitoes, making them more efficient disease vectors (Smallegange, 2013). Due to illegal mining activities, workers migrate to these areas, resulting in an increase of population in these remote places. This can also contribute to the increased spread of malaria (Murta et al., 2021)

Part 4: Healthcare access and response gaps

In Brazil, approximately 241,000 clinical malaria cases were registered in 2012, of which 99.9% were in the Amazon region (MS/SVS, 2013). According to the Ministry of Health, there were 30,972 cases of malaria in Yanomami territory in 2023 (Ministério da Saúde, 2024).

Due to the large impact of mining on malaria incidence, Dutra et al. (2024) found that the malaria crisis impacted the Yanomami disproportionally. They compared malaria incidence before and after mining between Yanomami and non-Indigenous municipalities. The malaria incidence was disproportionately higher among the Yanomami from 2017, with the largest differences in malaria incidence occurring during Bolsonaro's presidency from 2019-2021. The results show that the yearly malaria incidence among the Yanomami was up to 15% higher when compared to non-Indigenous municipalities. If only considered the P. falciparum cases, the malaria indices were even up to 5% higher among the Yanomami. Given that the surge in mining in the Yanomami territory occurs along with the largest differences, it suggests that the high malaria indices among Yanomami occurred due to the surge in illegal mining in their territory (Dutra et al., 2024).

In January 2023, a Public Health Emergency of National Importance (ESPIN

Yanomami) was declared. 34 years earlier, in December 1989, the Yanomami Emergency Health Care Plan (PEASY) was approved. This interval in time shows the existence of a structural issue, driven by economic interests and inconsistent Indigenous health policy since the 1970s. PEASY was coordinated by the Brazilian Ministry of Health and was supported by FUNAI, Commission for the Creation of Yanomami Park (CCPY), various research institutes, and the Brazilian Air Force (Lobo & Cardoso, 2023). The plan seemed a significant step towards improving Yanomami healthcare. However, the long-term success was limited due to the inconsistent implementation of the plan and insufficient governmental actions. Despite the plan, the Yanomami continued to experience health crises, and the plan was discontinued.

Currently, the Yanomami Special Indigenous Health District (DSEI) has 37 health centers in the Yanomami territory. But due to a lack of personnel, only 5% of vacancies are occupied. Furthermore, due to the invasion of illegal miners, seven centers had to close down, one was set on fire, and the others are in a precarious state (Gonzales, 2023). 98% of access to Yanomami land is by air, but there are only two helicopters provided to FUNAI and the SESAI (Special Secretariat for Indigenous Health) (Scherf & Silva, 2023).

In the Venezuelan area of the Yanomami territory, healthcare is delivered through basic primary health centers. Communities living in the area of this health post have access to medical care. Remote populations depend on visits from a mobile medical team. Some communities can’t be reached by these medical teams and have no access to healthcare (Grenfell et al., 2008).

In March 2024, Brazil introduced tafenoquine, a single-dose treatment for *Plasmodium vivax* malaria, to the Yanomami population. Tafenoquine, developed by Medicines for Malaria Venture (MMV) and GlaxoSmithKline (GSK), is administered alongside chloroquine and requires prior (G6PD) testing to ensure patient safety. The Brazilian government's adoption of this regimen marks the first implementation of tafenoquine outside clinical trials, aiming to improve treatment and reduce malaria in remote and vulnerable communities (MMV, 2024).

The intensity and regularity of malaria transmission has a strong influence on the degree of immunity (Donald, 1957). Donald (1957) conducted research in two different areas of the Yanomami reserve. In areas where malaria is stable, transmission is intense and constant throughout the year, exposed people develop a higher level of immunity. In areas of unstable malaria, with lower levels of transmission intensity and frequency, and with irregular bursts of malaria, people don’t develop immunity. Based on this classification, malaria is unstable at Mucajaí (Brazil) communities and stable in Orinoco (Venezuela). Malaria is constantly present (hyperendemic) and the transmission is stable among Orinoco communities, but its morbidity and prevalence are lower than in Mucajaí communities, with unstable transmission rates.

Donald (1957) explained that Orinoco villagers have experienced malaria for a long time, and due to an outburst of mining activity, malaria was only recently introduced to Mucajaí communities. The long and continuous contact with the malaria infected mosquitos in Orinoco villages has built anti-malarial immunity (Nielsen et al. 2002). A study found that immunity to malaria can suppress gametocytemia (a eukaryotic germ cell that plays a role in malaria transmission) (Baird et al. 1991). This can reduce malaria morbidity by reducing transmission and suppress the presence of parasites in the bloodstream (parasitemia) (Bull & Marsh 2002).

In the previous chapter, the causal process observations illustrate how the causal mechanism manifests in practice. We can adjust our confidence in the presence of our theorized causal mechanism based on the probability of an observation (Bayesian reasoning).

While structural violence addresses the systemic roots of inequality, cultural violence reveals the cultural narratives that legitimize it and can result in an observable manifestation: direct violence. This research shows that all three forms of violence intersect and reinforce one another in the Yanomami case, creating layered and persistent injustice. Interpreting the findings through this lens reveals that malaria among the Yanomami people is not an isolated health outcome but the result of overlapping forms of violence.

Even though Galtung's theory of violence is often conceptualized as a pyramid, an inverted pyramid might be a better depiction of how structural violence intersects with other types of violence, resulting in Yanomami's malaria health crisis. Figure 5.1 illustrates how cultural violence, structural violence, and direct violence interact in the context of the increasing malaria indices of the Yanomami people.

The governmental encouragement of developing the Amazon for economic benefits legitimizes deforestation. This ideology of economic growth is the underlying cultural violence resulting in deforestation and its consequences. Because of this underlying ideology, the Brazilian government is maintaining structures that systematically harm the Yanomami. Galtung states direct violence, is physical harm inflicted on individuals, in this case manifested in malaria infections and related deaths.

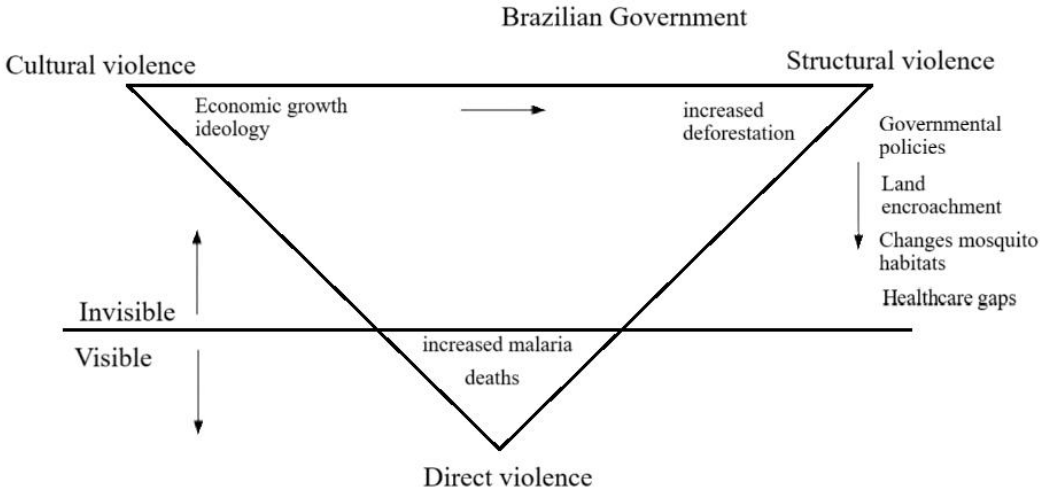


Figure 5.1 – Interplay of forms of violence and the causal mechanisms according to Galtung's theory on violence.

The Brazilian legal system has laws in place that aim to protect the Amazon and Indigenous rights, but the system operates in ways that disproportionally disadvantage Indigenous communities. The Forest Code (1965, revised in 2012) and environmental crime laws (Federal Act 9.605/1998) seem progressive in theory. However, consistent with Galtung's framework, the structural violence embedded in the system manifests in the failure to enforce these laws (Galtung, 1969). Persistent non-enforcement, weak verification mechanisms, and poor monitoring (e.g., CAR and SICAR enabling false land claims) normalize illegal environmental harm. When 70% of protected areas in Pará have illegal land registrations, and over 1.3 million embargoed hectares remain in production (Gibbs et al., 2022), the government is going against its own legal system.

According to Galtung (1969) structural violence is characterized by social structures that systematically prevent certain groups from accessing resources, resulting in marginalization and inequality. Due to forest clearings, the Yanomami are dislocated preventing them from accessing their own ancestral lands, crucial for the survival. The Brazilian government allows this to happen by failing to control manipulated land registries supporting illegal activities. The selective inaction of the state is as a form of structural exclusion, marginalizing Indigenous communities while privileging production, economic, and agribusiness interests.

Deforestation is pushing deeper into Yanomami territory (Silva Junior et al., 2023) as a consequence of weak enforcement. The spread of diseases and pollution are results of this invasion. Mining camps pollute water sources, mostly with mercury, and create favorable mosquito habitats. The construction of roads and airstrips in Yanomami territory creates stagnant water and a fragmented landscape. This has led to the displacement of communities, retreating deeper into forests, away from contaminated zones (Garnelo & Wright, 2015). Such displacements are structural in cause and impact the affected communities. Sites further into the forest are far away from health posts and traditional lands. They expose Yanomami to unfamiliar ecological zones that may not sustain long-term settlement. This shift is a forced action driven by structural violence.

Mining-related deforestation and poorly drained excavation pits create stagnant, shallow waters. These are favorable conditions for mosquitoes to breed and speed up the larvae development. These changes in mosquito ecologies result in bigger mosquito populations, increasing the risk of malaria transmission. Because these stagnant mining pools accelerate mosquito development, the biting rates of the most dominant mosquito (Anopheles Darlingi)

increase 278 times in deforested areas (Vittor et al., 2006), (Wang et al., 2016). This environmental degradation is a direct result of the Brazilian system that prioritizes profit over Indigenous health. This supports Galtung's argument that structural violence operates through unequal power relations at the expense of marginalized populations (Galtung, 1969).

Despite repeated public health emergencies (1989 and 2023), Indigenous healthcare I still under-resourced. The failure to maintain health infrastructure, fill staff vacancies, and prevent the closure of health posts due to illegal mining shows systemic disregard. Only 5% of health posts are fully staffed, and many have been shut down, burned, or abandoned (Gonzales, 2023). With 98% of access to Yanomami territory being aerial, and only two helicopters available, basic healthcare logistics are structurally undermined. Government failure to fund and staff Indigenous health infrastructure reflects long-term institutional neglect. These gaps are not accidental but systemic outcomes of political decisions that deprioritize Indigenous wellbeing.

Dutra et al. (2024) illustrate that malaria incidence surged among Yanomami communities, while non-Indigenous areas were less impacted. This injustice is a result of structural conditions that sustain Indigenous marginalization, such as underfunded health systems, weakened environmental protection agencies, and policies that legitimize extractive activities. Donald's (1957) compared stable (Orinoco) versus unstable (Mucajaí) malaria zones among the Yanomami, which reveals that long-term structural instability suppresses community immunity. In Mucajaí, where malaria surged together with recent gold mining, communities are immunologically vulnerable, leading to higher malaria morbidity. This is, besides a biomedical disparity, also an outcome of unstable living conditions created by systemic disruption. This is consistent with Galtung's notion that structural violence causes indirect harm by creating vulnerabilities to marginalized groups (Galtung, 1969).

Where structural violence is sustained, it also manifests in biological vulnerability (Scheper-Hughes, 1992). Immunity-building requires consistent exposure and healthcare support. Due to displacement, infection bursts, and treatment gaps, Yanomami communities suffer a higher disease burden. This highlights how the biosocial suffering of the Yanomami is connected to policy failures and current economic priorities.

Chapter 5: Limitations

This thesis aims to investigate an invisible form of violence that is embedded in social structures. Proving a social phenomenon that is not directly observable is complex and inherently comes with limitations. Because structural violence is invisible and a long-term process, it is difficult to measure it within the scope of a single study. The conceptualization of the causal mechanism aims to convert the theory into observable manifestations, but even so, social structures and institutions remain conceptual rather than tangible.

Another limitation of this study is the lack of available and reliable data. The governmental data on land rights and public health are either non-existent, incomplete, or outdated. Collecting data in remote regions like the Yanomami territory is challenging due to geographical isolation. It is also a challenge to collect reliable data on this topic because it is a complex and ongoing political and social debate in Brazil. This lack of comprehensive data limits the accurate representation of the scope and severity of the issues discussed. For example, land registry systems such as CAR and SICAR are manipulated, which makes the precise extent of illegal land claims unclear. This affects data reliability and might lead to an underrepresentation of the issue.

The absence of direct fieldwork makes it impossible to capture the lived experience of Yanomami. Secondary data sources can also provide useful context, but depending on the source can contain biases. Without direct engagement with the Yanomami, the research lacks the important perspective of the affected communities. This is a limitation, because without the incorporation of direct testimonies, the research can risk misrepresenting their experiences and perspectives.

The methodological approach itself also introduces some limitations, because the conceptualization of the causal mechanism is subject to assumptions. The reliance on secondary data is susceptible to interpretation bias. Especially because this research discusses a complex social phenomenon, structural violence, the interpretation is influenced by the researcher's perspectives and the available literature. While the study aimed to minimize this bias, the nature of the available data can influence the way information is presented and understood.

This study focused on deforestation as an aspect of structural violence. However, other forms of violence were outside the scope of this work. These factors are connected and intertwined with the broader phenomenon of structural violence. It would not be possible to capture the full scope of violence that the Yanomami face.

The research was conducted within a dynamic geopolitical context. Political situations and policies are subject to constant change. Particularly in Brazil, where Indigenous rights and environmental laws and enforcement fluctuated over the recent years. Therefore, the findings of this research reflect a specific moment in time. If new policies are introduced, the study's conclusions need to be revisited.

Despite these limitations, the research offers important insights into the intersection of ecological destruction, public health crises, and systemic neglect faced by the Yanomami people. The study shows structural violence in the Brazilian Amazon and contributes to the broader debate on Indigenous rights and environmental justice.

Chapter 6: Conclusion and recommendations

6.1 Conclusion

This thesis finds that the rising incidence of malaria among the Yanomami is not merely a biomedical consequence of environmental disruption, but a direct outcome of structural violence—where systemic neglect and unequal power dynamics embedded in law, policy, and governance perpetuate Indigenous vulnerability. Each stage of the causal mechanism—from deforestation to health system collapse—reflects the failure of institutions to protect Indigenous lives from avoidable harm. Although Brazil's legal system appears to recognize Indigenous rights and environmental protections in theory, the evidence shows that these protections are selectively enforced. This selective inaction is not random; it is shaped by a system that privileges economic interests and systematically excluding Indigenous peoples.

Environmental protection measures such as CAR and SICAR are manipulated, normalizing illegal land grabbing. The legal framework is ineffective because of weak oversight and systematic neglect. Legal recognition of Indigenous territory exists in principle, but enforcement failures reveal a deeper structural bias. Regulatory systems actively allow dispossession through bureaucratic loopholes and land registry manipulation. When more than two-thirds of protected lands in Pará have illegal registrations and remain productive, these are not isolated violations.

This systematic tolerance of deforestation to favor extractive activities results in long-lasting harm in the Yanomami territory and public health crises. Despite legal recognition of the Indigenous territory, enforcement gaps are enabling the continued expansion of extractive industries. The inward movement of deforestation and mining is a geographical manifestation of this structural violence.

These observations support the theory that legal systems and state inaction can operate as instruments of structural violence. By tolerating illegal practices, the state facilitates ecological and biological harm (Scheper-Hughes, 1992). The empirical evidence supports the presence of the theorized causal mechanism linking deforestation to rising malaria rates among the Yanomami. Each stage of the mechanism is empirically observable. The data on illegal land registrations, the increase of stagnant water bodies, and collapsing healthcare infrastructure confirm that this is not a coincidental correlation. It is a structured and repeatable causal mechanism. Therefore, the malaria crisis in Yanomami territory is not only a biological side effect, but it is socially and institutionally created.

6.2 Recommendations

This thesis shows that the rise in malaria among Yanomami is but a result of intersecting forms of violence. The Brazilian legal system has laws to prevent environmental degradation and protect Indigenous peoples (e.g., The Forest Code and the Environmental Crimes Law) but are undermined by weak enforcement. To address this, the Brazilian legal framework and implementation require improvement. An example of stricter enforcement is more monitoring by satellite surveillance and on-the-ground inspections, to detect illegal activities. The CAR and SICAR systems currently allow for false land claims and land registry manipulation. These systems should be reformed with stricter verification procedures to prevent that.

The Brazilian state should take action to address the under-resourcing of healthcare services in the Yanomami region. Even though there are healthcare frameworks for Indigenous peoples, healthcare posts in the Yanomami territory are often understaffed, underfunded or even closed. This situation could be resolved by increasing investments in healthcare infrastructure in remote areas. It is important to ensure that health posts are staffed and sufficiently equipped for the health needs of the Yanomami.

For future research, the impacts of deforestation on the specific health outcomes of Yanomami could be further explored. Besides malaria, there are other health issues related to deforestation and mining activities. For some of these health issues, deforestation itself is not necessarily the direct cause, but related activities, such as mining are spreading hazardous substances in the environment. It could be valuable to conduct further research on the relation between these activities and diseases in Indigenous communities.

Longitudinal studies to measure long-term health effects of environmental degradation would be very valuable. Additionally, future research could focus more in-dept on the effectiveness of different legal and policy interventions, comparing regions with stronger enforcement to those where protection is weaker, to determine best practices for protecting Indigenous territories and improving the health.

Within the Brazilian Amazon there are also other Indigenous groups. It is valuable to conduct further research on the health situation of these groups. This way, it could be examined if the causal mechanism is also present in other cases, and if the theory is broader applicable.

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Appendix A - Theory-testing process-tracing (Beach & Pedersen, 2013)

This appendix outlines the three-step framework for theory-testing process-tracing, as developed by Beach & Pedersen (2013):

1. **Conceptualizing the causal mechanism:** the first step into testing if a hypothesized causal mechanism was at function in a case, is to conceptualize the causal mechanism between X and Y. All aspects between X and Y, such as different actors and actions, need to be conceptualized based on existing theory.
2. **Operationalizing the causal mechanism:** the second step is to translate the hypothesized causal mechanism to case-specific predictions. It has to be determined what observable manifestations should occur if the causal mechanism is present in the case.
3. **Collecting evidence:** the last step is to collect empirical evidence that i) the causal mechanism was present and ii) the causal mechanism functioned as hypothesized. In this step it is tested whether the evidence is liable enough and indicates that each part of the mechanism was present. Based on the evidence, the hypothesized causal mechanism can be accepted or rejected (*Beach & Pedersen, 2013)*

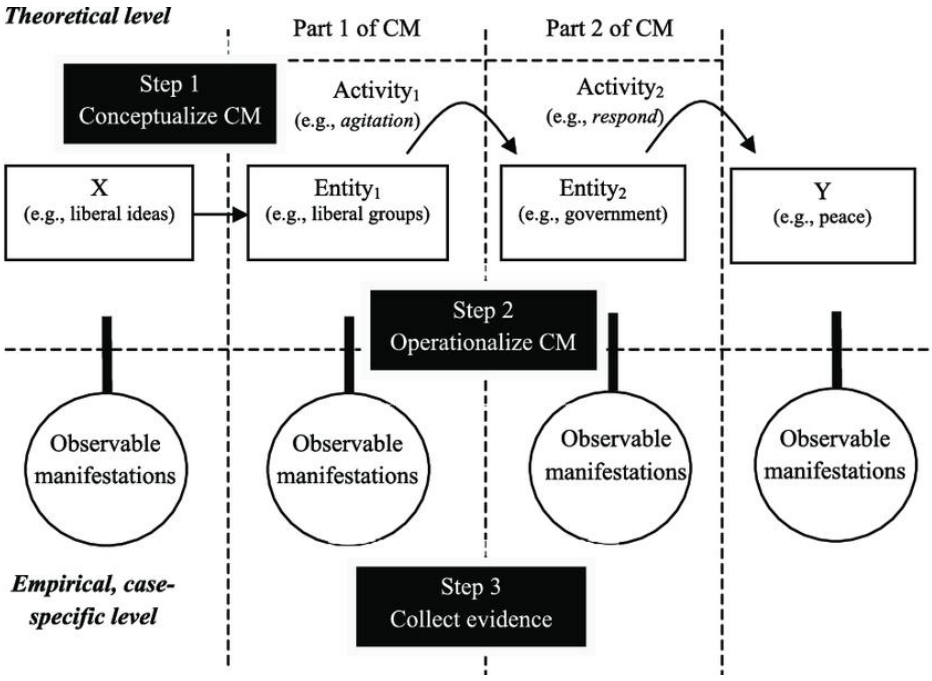


Figure A1: Theory-testing process-tracing steps (Beach & Pederson, 2013, p. 15)

Appendix B – Bardach's policy analysis framework

This appendix outlines the full policy analysis framework developed by Eugene Bardach (2012), which is widely used for evaluating public policies. While the entire model provides a comprehensive step-by-step guide, only the steps most relevant to this research were selected and applied.

Full Bardach Model:

1. Define the problem – Clearly articulate the issue that requires policy attention.
2. Assemble the evidence – Collect data and information to understand the problem and inform potential solutions.
3. Construct the alternatives – Identify possible policy options to address the problem.
4. Select the criteria – Determine the values or standards that will be used to evaluate the alternatives (e.g., cost, equity, feasibility).
5. Project the outcomes – Predict the likely results of each policy option.
6. Confront the trade-offs – Analyse the compromises involved in choosing one option over another.
7. Decide – Make a decision based on the analysis.
8. Tell your story – Communicate the recommendation effectively to stakeholders or decision-makers.

Application in this study:
In the context of this research, steps 1 (Define the problem), 2 (Assemble the evidence), and 3 (Project the outcomes) were applied. These steps were sufficient to assess Brazilian deforestation and health-related policies and to evaluate their impact on the Yanomami. The remaining steps were not included, because this study does not propose new policy solutions but only focuses on understanding the causal effects of existing ones.

Appendix C – Bayesian Logic in Process-tracing

Bayesian logic is used to assess the strength of evidence in support of a causal mechanism. As Bennett (2006) explains, in Bayesian logic it is not the number of pieces of evidence that is important, but rather "the likelihood of finding certain evidence if a theory is true versus the likelihood of finding this evidence if the alternative explanation is true" (Bennett, 2006, p. 341). Here, we use the term hypothesis to refer to hypotheses about the existence of each part of a theorized causal mechanism. In a formula, it looks like this: posterior = likelihood × prior ÷ evidence. This is the basis of Bayesian logic (Beach & Pedersen, 2013, p. 84; Fairfield & Charman, 2017).

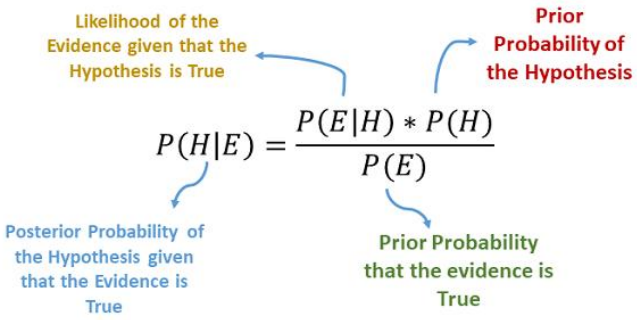


Figure C1: Bayesian logic formula (Kharkar, 2023)

Appendix D – Evaluating evidence in process-tracing

Based on Beach and Pedersen (2013), the evaluation of evidence in process-tracing follows four key steps:

1. Collecting data: Gathering evidence based on what is expected to find if the hypothesized causal mechanism is present.
2. Assessing content: Analysing the collected data using contextual knowledge to see if it aligns with our predictions.
3. Checking accuracy: Critically reviewing the data, questioning whether it truly reflects what we intended to measure and identifying potential errors (Beach & Pedersen, 2013, Chapter 6).
4. Evaluating probability: Stronger conclusions can be drawn when evidence is unlikely to appear by chance. The probability of specific evidence should be assessed in the case's context.