



Climate change and environmental degradation in Yanomami People's Land: Intersectional threats and the need for improved policy-making

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ABSTRACT

The Yanomami are an Amazonian Indigenous people in northern Brazil and southern Venezuela. The Yanomami are considered a 'recent contact Indigenous People', with the first contacts with non-indigenous recorded between 1910 and 1940 and with some groups in voluntary isolation. They are one of the resilient peoples that practise their traditional way of life, which involves a strong connection to the land and the environment. Following an expert-driven literature review based on a set of available documentation on the Brazilian Indigenous Peoples, focusing on the overlapping threats that affect Indigenous Lands and triangulating the information collected with data produced on Brazilian Amazon Rainforest Monitoring Program by Satellite (PRODES) within the Space Research National Institute (INPE), this communication presents a case analysis of the main pressures and threats Yanomami People faces. The overlapped threats manifest in structural and cyclical issues, linked to the environmental crisis arising from extractives' illegal activities, such as logging, and mining invasions, the recurrent attacks, mercury contamination of the river water, malnutrition caused by contaminated fish, scarcity of hunting, and violence committed against the people, especially women and children. Added to these multiple social, political, and environmental threats are the impacts of climate change, which disproportionately affect forest peoples. Deforestation, fires, drought, and other extreme events that are linked to climate change effects are analysed, leading to reflections on Brazilian government policies' influence and on the urgency to implement policies in defence of Indigenous Lands, the Amazon Forest, and its guardians.

1. Introduction: indigenous peoples in Brazil

When Brazil was invaded by European expeditions, around the year of 1500, it is estimated that Indigenous peoples occupied the national territory comprising over 1.000 ethnic groups, with more than 1.200

languages spoken¹ and a population of approximately 3–4 million. Around 2 million occupied coastal regions, and the others the interiors of Brazil. The invasion by European settlers, and the historical processes and violence linked to this invasion, reduced the Indigenous populations drastically. The total Indigenous population was reduced to roughly

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¹ Aryon Rodrigues (2017) <https://periodicos.unb.br/index.php/ling/article/view/19521>

the Yanomami's unique culture, environment, and fundamental human and Indigenous rights. To address the Amazonian Indigenous people's perceived threats, both from human extractivist action itself and the impacts resulting from climate change, this communication uses a dual approach methodology.

Based on expert-driven literature, we describe historical and current conflicts faced by Yanomamis, including the significant influence of Brazilian government policies, which can either exacerbate or alleviate the challenges faced by the Yanomami people. By elucidating the role of government actions and decisions, it is possible to gain insights into the broader political and socio-economic context within which the Yanomami struggle for their rights and well-being. For that, we review papers and documents, including the reports prepared by relevant institutions linked to the Indigenous populations of Brazil, such as the Indigenous Missionary Council (CIMI), the Instituto Socioambiental (ISA), Oswaldo Cruz Foundation (Fiocruz), National Institute for Space Research (INPE), Mining Observatory and MapBiomass Network. In addition, reports produced by organisations of the Yanomami People were considered, especially the Hutukara Associação Yanomami (HAY), which monitors and studies the context of the Yanomami IL.

Additionally, this communication considers remote sensing data, specifically focusing on deforestation and annual fire spots within the Yanomami territory. By leveraging remote sensing technology, this study aims to discern spatial and temporal patterns of environmental degradation affecting the Yanomami regions. The data generated presents important information for analysis of how these communities have been impacted by deforestation, fire, and illegal mining.

Deforestation maps were obtained in vector files through the Brazilian Amazon Rainforest Monitoring Program by Satellite (PRODES), developed by the National Institute for Spatial Research (INPE).¹⁹ Fire spots were provided by the Queimadas Program (INPE).²⁰ The spots were detected through the reference satellite AQUA_M-T (MODIS sensor), and obtained between 2003 and 2022. The deforestation map was cut by the boundaries of the Yanomami Land and the area of annual forest loss was calculated using QGIS software. Fire spots were extracted for the land's interior, and the number of spots was counted each year using the same software. Images obtained by the Landsat satellite, OLI sensor (USGS/NASA)²¹ were used to highlight mining impacts in Yanomami Land.

The methodologic conceptual foundation acknowledges the necessity to guarantee Yanomami people's rights and mitigate the threats imposed on its Lands, originating from environmental crises, illegal invasions and climate change. The apprehension of the multidimensional and interdependent dynamics and demands, such as safeguarding land rights, enforcing laws, raising awareness, preserving the environment, and maintaining cultural heritage to safeguard the Yanomami's unique culture, is carried out through a multi-methodological and integrated approach, engaged in understanding this complex context. Beyond the case analysis methodology, anchored in remote sensing data focusing on deforestation and fire spots within the Yanomami Lands, the study considers the significant influence of Brazilian government policies on the challenges faced by the Yanomami people. This approach helps to contextualise these threats within the larger framework of governance and policy-making.

3. Case analysis on the Yanomami People's humanitarian crisis and the overlapped threats

In a land with 23 million hectares of continuous rainforest, the Yanomami reserve covers more than 9.6 million hectares, which is twice

the size of Switzerland.²² The region of the Yanomami Land is considered an irreplaceable area for the conservation of biodiversity in the world, (Le Saout et al., 2013). while simultaneously being one of the top ten areas most prone to illegal mining and deforestation in the Brazilian Amazon¹⁶.

While most of the Yanomami groups were still living in isolation, the arrival of North American missionaries in the late 1950s culminated in the arrival of several epidemics, especially measles and the flu. In the 1970s, with the construction of the BR-210, the Yanomami Land faced the invasion of loggers and illegal miners in search of gold. These activities that were supported by the Brazilian military government at the time. As a result, 20 % of the Yanomami population was lost due to direct attacks to the Indigenous population and infectious diseases from 1986 to 1993. In 1992, through a long and arduous political struggle led by the Yanomami People, the reserve was created (Kopenawa and Albert, 2015)¹⁸.

Between 2019 and 2022, the Brazilian government implemented an economic exploration project in the Amazon, which manifested in the alteration of laws and public policies, the weakening and dismissal of environmental inspection (Gatti et al., 2023), and systematic disrespect for Indigenous and environmental rights^{16,23}. This project resulted in the invasion of several ILs for illegal mining, among them the Yanomami Land, which suffered not only from illegal mining but also from water mercury contamination, diseases brought by miners, violence, and even drug trafficking¹², in addition to the suffocation of agribusiness in their territory. These activities culminate in deforestation and environmental degradation, especially soil and rivers, increasing the risk of forest fires and contributing to climate change (Gatti et al., 2021).

Fig. 1 presents a spatiotemporal distribution of deforestation in the Yanomami Land. It illustrates the spatial location of all deforestation within the IL until 2022 and a historical series of annual deforestation in the IL between 2003 and 2022. The highest deforestation rates in the Yanomami Land occurred in 2019 and 2022. Within this period, 69.76 km² were deforested, almost three times more than under President Lula's second term in office (between 2006 and 2009), in which 24.28 km² were deforested (Fig. 1). As shown in Fig. 2, the year 2019 had the highest number of fires (318 fire spots), even though it was not an extreme *El niño*, as the year 2016, when a greater number of fires was expected due to the extremely drought event caused by this phenomenon, which was especially extreme between 2015 and 2016²⁹.

Fig. 2 presents a spatiotemporal distribution of fire spots in the Yanomami Land. It reveals the spatial location of fire spots detected within the ILs, between 2003 and 2022, and a historical series of annual number of fire spots detected in the IL, between 2003 and 2022. The fire level growth, especially in 2018, has caused serious environmental impacts to the Amazon region (Silva et al., 2018). A relevant part of the fires was produced by human action, illegally,²⁶ to promote land grabbing, invasions and seizure processes, since that, once burned, forest lands become more vulnerable to economic activities, such as mining. These environmental impacts directly affected the health and livelihoods of the Yanomami, including their traditional culture, socio-biodiversity and sustainability of the ecosystems in which they live, causing ecological breakdown and violent and irreversible impacts, which are now manifested in the humanitarian crisis experienced by the Yanomami in early 2023.

Apart from deforestation, illegal mining is one of the greatest risks faced by the Yanomami People, affecting the environment and the social organisation of the Yanomami communities. It is estimated that 20,000

²² Yanomami Indigenous Land (2023) <https://terrasindigenas.org.br/pt-br/terras-indigenas/4016>

²³ HAY/ISA (2022). Yanomami under attack report

²⁶ MPF (2020). Technical Note on Amazon fires

¹⁹ TerraBrasilis (INPE) <https://terrabrasilis.dpi.inpe.br/>

²⁰ Programa queimadas (INPE) <https://terrabrasilis.dpi.inpe.br/queimada/s/portal/>

²¹ Earth Explorer (2023) <https://earthexplorer.usgs.gov/>

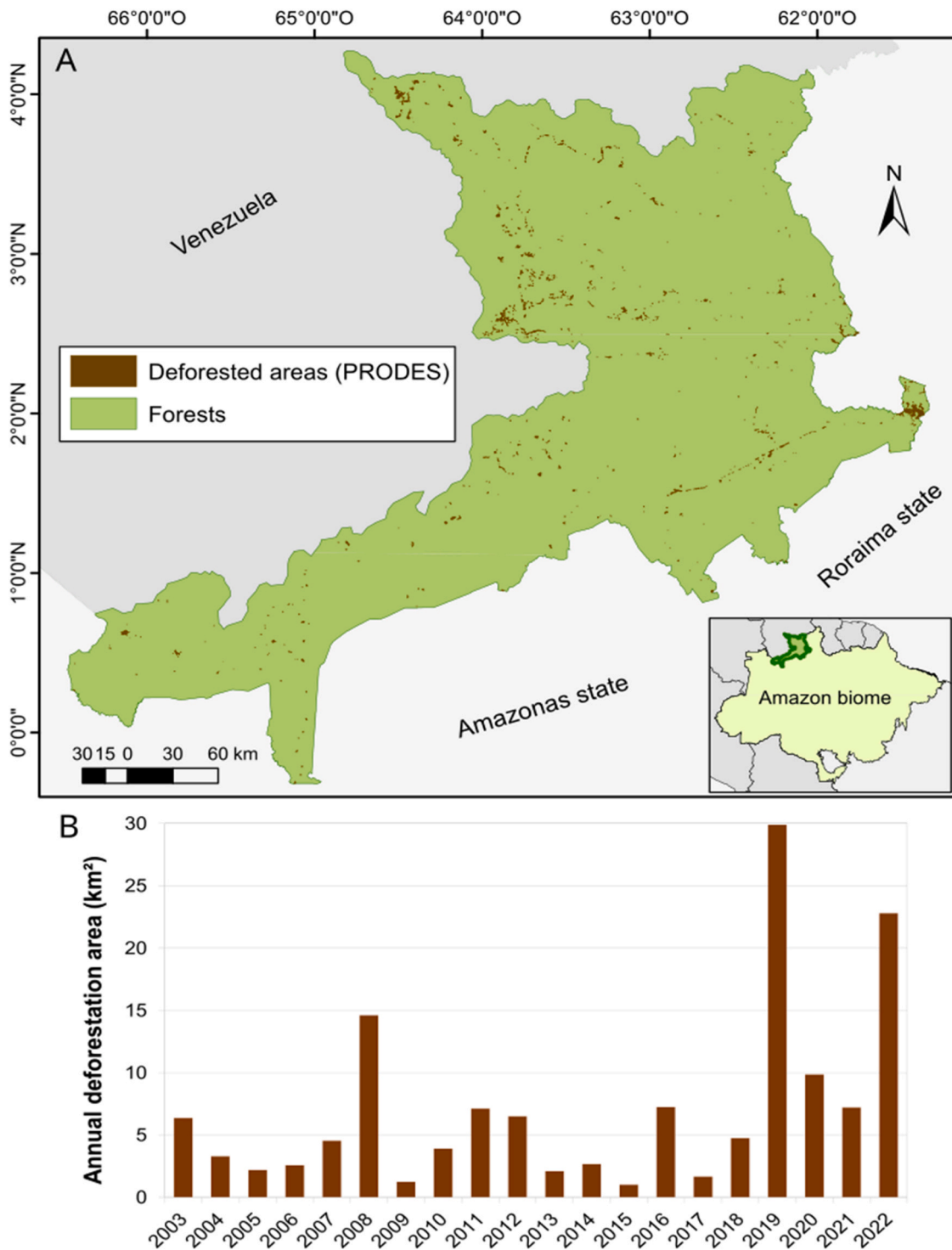


Fig. 1. Spatiotemporal distribution of deforestation in the Yanomami Land from 2003 to 2022 Data source: Brazilian Amazon Rainforest Monitoring Program by Satellite (PRODES) / National Institute for Space Research (INPE).²⁴¹.

miners illegally inhabited the Yanomami Reserve in 2022 when illegal mining grew by 54%.²⁷ Serious cases of malnutrition and lack of basic health care caused hundreds of deaths, mainly among children, the elderly and the most vulnerable individuals. UNICEF and Fiocruz pointed out that 80 % of children under 5 years of age had chronic

malnutrition in the regions of *Auaris* and *Maturacá*, within the Yanomami Reserve.²⁸ Through satellite images, Fig. 3 features an example of the area inside Yanomami Land constituted by natural forests in 2016 (in green). In 2022, the same area had several places where the forests were removed due to mining (in magenta), several near the river (in blue).

²⁷ HAY (2022). Scars in the Forest II: Evolution of illegal mining in the Yanomami Indigenous Land in 2021

²⁸ UNICEF (2019). UNICEF warns about chronic malnutrition of Yanomami children

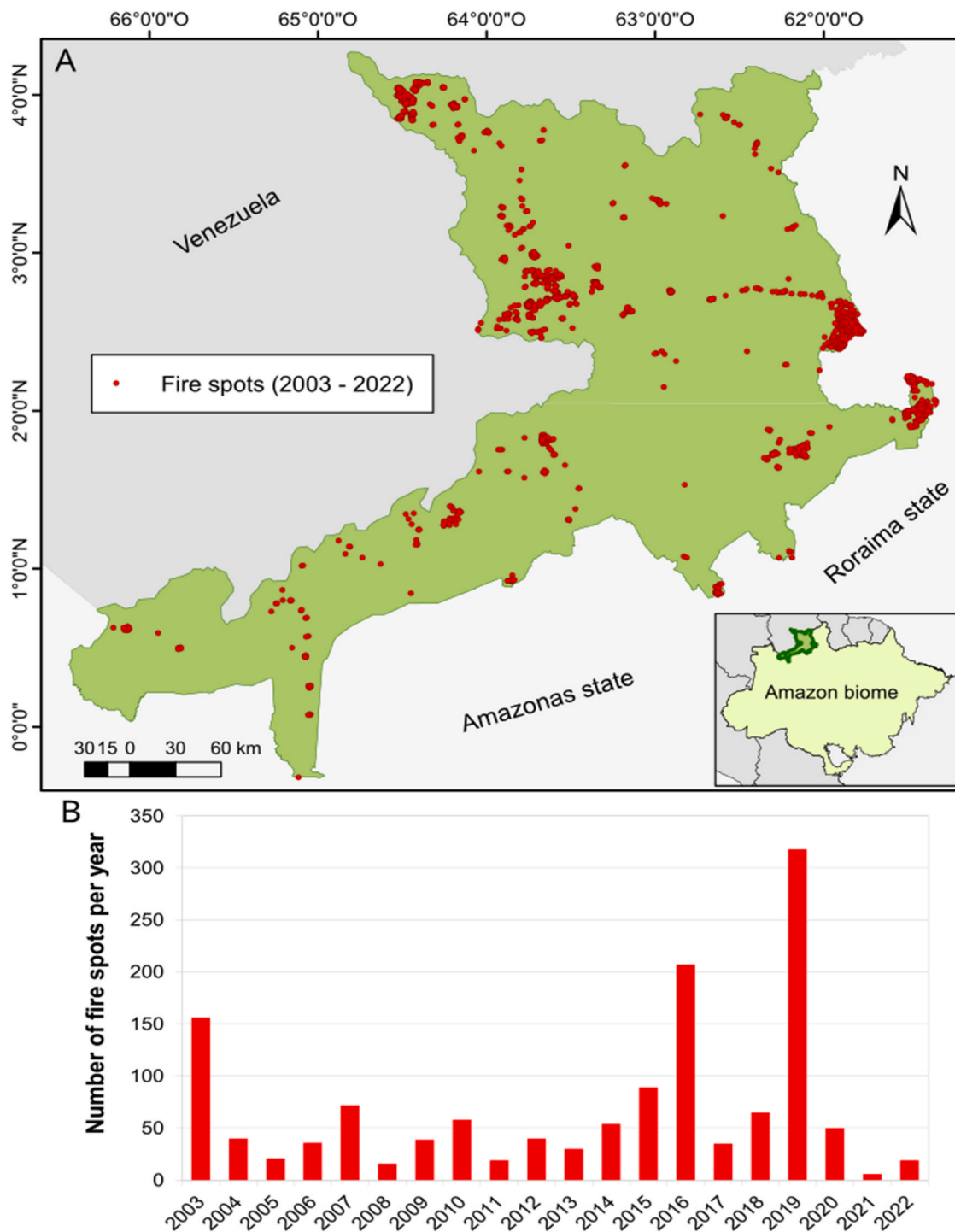


Fig. 2. Spatiotemporal distribution of fire spots in the Yanomami Land between 2003 and 2022 Data source: "Queimadas" Program / National Institute for Space Research (INPE).²⁵¹.

Recurring territorial conflicts marked the 2019–2022 government. Among them, the overlapping of certifications and property registrations in ILs, including over 500 requirements for exploitation of the Yanomami Land, caused more than 3 million hectares to be devastated by mining activities^{21,22,28,29}. The federal government acted favourably towards the invaders with two specific actions between 2019 and 2021: i) The renewal of the ordinance restricting the use of land inhabited by

isolated Indigenous people for only 6 months; and ii) the launch of a series of “Anomalies Cards”, by RIGeo (Brazilian Geological Survey), pointing out places with greater chances of mining precious metals precisely in the region where isolated Indigenous populations live.³⁰

In 2021, in addition to the Yanomami Land devastation, the invader illegal miners intensified the armed attacks, including the use of tear gas

²⁹ CIMI (2022). Violence Against Indigenous Peoples in Brazil Report

³⁰ RIGeo - Anomaly charts: Roraima <https://rigeo.sgb.gov.br/handle/doc/23282>

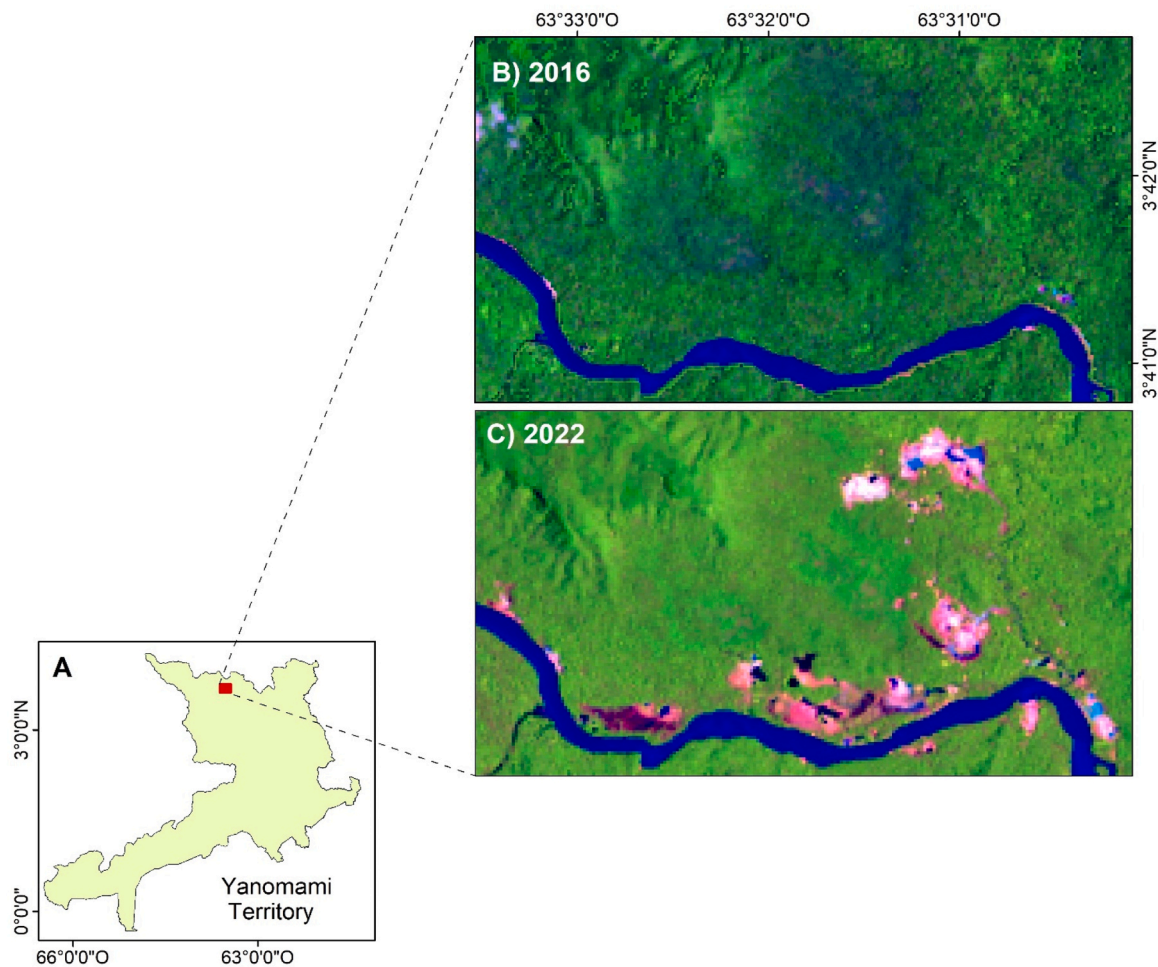


Fig. 3. Example of a site where mining has advanced in the Yanomami Land, in Landsat satellite images (OLI sensor) **Data source:** Created by the authors. The images were provided by USGS/NASA and processed by PRODES/INPE.

bombs, whose use is controlled and could be authorised only by the Brazilian Army, in several villages of the Yanomami people, killing men and sexually assaulting women and children, destroying families and assassinating wise elders who held important practices of traditional Yanomami culture²⁸. In addition, the massive presence of illegal miners in Yanomami Land is still identified as one of the main vectors of malaria, COVID-19, and other infectious diseases. It is important to understand that Indigenous peoples are particularly affected by infectious diseases, as they live in a community system where all main activities are carried out together, and there is often no space for easy isolation of infected people, making the spread of diseases even faster. Also, the lack of assistance forced Yanomami people to search for illegal mining camps to communicate with the Special Indigenous Health District-Yanomami (DSEI-Y) to request urgent basic health assistance (Cupertino et al., 2020)^{30,31}.

On January 20, 2023, under the newly elected government, the Brazilian Health Ministry declared a public health emergency to combat the lack of assistance for the Yanomami. The Yanomami Emergency Operations Center (COE Yanomami) was created on January 26 with the responsibility of creating and implementing strategies to respond to the Public Health Emergency of National Importance in the Yanomami

Land, including mobilising resources for the restoration of health services and coordination with state and municipal SUS managers.³²

The Brazilian Federal Police investigated illegal activities in Yanomami Land, pointing to a money-laundering scheme arising from the illegal extraction of gold. MapBiomas³³ indicated that 91.6 % of mining in Brazil is concentrated in the Amazon. The recent mining expansion in the country coincides with its advance on ILs and Protected Areas. From 2010–2020, the area occupied by mining inside ILs grew by 632 %.³⁴ In 2020, half of the national mining area was in Protected Areas (40.7 %) and ILs (9.3 %), mainly in the Kayapó, Munduruku and Yanomami Lands^{34,35}. Reports by the Brazilian Federal Police on the contamination of rivers in the Yanomami Land revealed that four rivers in the region were highly contaminated by mercury. The levels registered are 8600 % higher than the stipulated maximum for human consumption.³⁵ Indigenous people from 14 regions in the Yanomami Land had high levels of

³² COE Yanomami. Governo Brasileiro - Centro de Operação de Emergência Yanomami; <https://www.gov.br/saude/pt-br/composicao/svsa/resposta-a-emergencias/coes/coe-yanomami>

³³ MapBiomas (2022). 91.6 % of the mined area in Brazil is in the Amazon

³⁴ MapBiomas (2021). The Expansion of Mining and Garimpo in Brazil in the last 36 years: Highlights from the Annual Mapping of Mining and Garimpo in Brazil between 1985 and 2020

³⁵ IPEN (2022) Rivers in Yanomami Land have 8600 % mercury contamination, Federal Police report

³¹ Cupertino et al., (2020). COVID-19 and Brazilian indigenous populations.

mercury contamination, according to the analysis made.³⁶ This contamination had already been identified in 2016 when it indicated 100 % of the contamination among adults in the *Araçáçá* Yanomami region.³⁷

The crisis that has gripped the Yanomami Land is a consequence of years of uninterrupted actions and the absence of protection for the lives of the native people, particularly: i) the lack of basic health care during the COVID-19 pandemic, especially for Indigenous and native peoples³²; ii) the non-protection or demarcation of ILs^{22,30}; iii) the lack of support from environmental protection agencies, that has drastically reduced resources and competencies²²; iv) the active action in favour of extractive/mining activities in indigenous Lands^{21,28}; v) the constant and active promotion of violent and prejudice speeches^{21,22}; and vi) the failure to meet basic food demands for vulnerable populations, especially during the pandemic crisis, which led to an incalculable number of deaths and losses that could have been avoided^{21,28,30}.

Of note regarding mining activity in the Yanomami Land is that in the state of *Roraima* there is no licence for mining exploration.³⁸ This means that all mineral extraction that originates in this state must undergo criminal laundering to be traded, nationally or internationally.

4. Towards mitigating the intersecting threats towards Yanomami People

The findings highlight the intersecting threats faced by the Yanomami people, including encroachment on their ancestral lands, environmental adversities, and a lack of effective legal protection. Yanomami people grapple with overlapping pressures and issues arising from invasions, mining operations and farming activities expansion encroaching upon their lands. This intrusion threatens their territorial integrity and disrupts their traditional way of life. Moreover, it underscores the pressing need to address these external threats to ensure the Yanomami People's existence and well-being. The Yanomami are also confronted by various environmental adversities, including deforestation and rampant forest fires, prolonged droughts, and other extreme climatic events. These extreme events exacerbate their difficulties, further imperilling their lands, food security, and overall resilience. The devastating impacts of these environmental challenges underline the urgency of implementing strategies to address and mitigate them.

Specific actions are necessary to safeguard the Yanomami people and their rights. Therefore, the following **policy recommendations** are made.

The first one is the need to adjust current laws to effectively guarantee the right to Free, Prior, and Informed Consent to any activity that directly or indirectly impacts the Yanomami people and their Lands. This right is internationally guaranteed by the ILO Convention 169,³⁹ of which Brazil is a signatory but has not duly implemented.

The second policy recommendation is to protect Yanomami Land rights better by ensuring that the Yanomami have legal recognition and ownership of their traditional lands. This includes demarcating and securing their territories and preventing encroachment by outsiders.

The third policy recommendation regards the need to strengthen law enforcement to combat illegal activities within Yanomami Land, such as mining, logging, and land grabbing. The current legislation is largely ignored as far as the implementation is concerned due to the influence and lobbying of these commercial sectors. To be able to move forward, there is a need to undertake integrated and multidimensional actions

that fight environmental crimes and address the poverty to which illegal invaders are subjected. Also, procedures for the inspection of illegal mineral extraction and sales, nationally and internationally, may help to curb the problem. This also requires bolstering law enforcement agencies, providing adequate resources, and imposing strict penalties for those who violate the law.

In addition, it is important to raise awareness about the challenges the Yanomami face and advocate for their rights and well-being. This involves engaging the public, media, and policymakers to promote sustainable and ethical practices in the Amazon region and the recognition of the legitimacy and relevance of the wisdom and sciences of the Yanomami people, their culture and traditional practices. A further measure needed is related to the need to preserve the Yanomami Lands, and all of the Amazon rainforest. This entails promoting sustainable practices, discouraging deforestation, and supporting reforestation efforts. Education and cultural preservation are also important, and there is a perceived need to support educational initiatives that prioritise the preservation of the Yanomami language, culture, and traditional knowledge. This helps empower the Yanomami People and ensures the heritage of future generations.

It is also crucial to, in a truly participatory way, define and implement, in dialogue with the Yanomami Indigenous Associations, such as HAY, appropriate measures to restore food security to these demographics, increasing the efforts of public authorities to include Indigenous peoples in the decision-making processes at all levels of governance, including to ensure the representation of Indigenous peoples in governance bodies for climate and environmental policymaking. Finally, through collaboration and engagement, including partnerships between Yanomami communities, governmental bodies, Non-Governmental Organisations, and international organisations, the protection of the Yanomami Lands can be enhanced by combining local knowledge with external resources and advocacy.

These recommendations, if effectively implemented, can contribute to safeguarding the Yanomami people's culture, ancestral lands, languages, and sustainable future, ensuring their well-being, dignity, nutritional security, and health while preserving their sciences that are unique and relevant to the planet's socio-biodiversity. This communication is a holistic account of the multifaceted issues confronting the Yanomami, encompassing external pressures, environmental threats, and the policy landscape. It underscores the need for a concerted effort, both nationally and internationally, to support the Yanomami in their quest for a sustainable and secure future.

CRedit authorship contribution statement

Walter Leal Filho: Project administration, Supervision, Validation, Writing – original draft, Writing – review & editing. **Maria Alzira Dinis:** Methodology, Writing – original draft, Writing – review & editing. **Yara Martinelli:** Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Cassiano Gustavo:** Data curation, Formal analysis, Investigation, Methodology, Software. **Clarissa Rosa:** Data curation, Formal analysis, Methodology, Writing – original draft.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

Data will be made available on request.

³⁶ [Rede Amazônica \(2023\)](#). Indigenous people from 14 regions in Yanomami Land have high levels of mercury contamination, Federal Police report

³⁷ [FIOCRUZ \(2016\)](#). High levels of mercury contamination worry the Yanomami indigenous community

³⁸ [DPU \(2021\)](#). Nota Técnica Nº 2 - DPGU/SGAI DPGU/GTI DPGU.

³⁹ [ILO Convention 169](#) - Indigenous and Tribal Peoples Convention.

References

- Veras, A., Vidal, D.G., Barros, N.A., Dinis, M.A.P., 2022. Building bridges between indigenous peoples and geotourism activity: the case of the raposa ethno region in Roraima, Brazil. In: Mbah, M.F., Leal Filho, W., Ajaps, S. (Eds.), *Indigenous Methodologies, Research and Practices for Sustainable Development*. Springer, Cham, pp. 355–370. https://doi.org/10.1007/978-3-031-12326-9_21.
- Atlas of Humanity (2022). Indigenous People of Brazil. Available at: (<https://www.atlsofhumanity.org/indios>).
- Aventura do Brasil (2022). Guaraní and Tikuna – The Largest Indigenous Tribes in Brazil. Available at: (<https://www.aventuradobrasil.com/blog/guarani-and-tikuna-the-largest-indigenous-tribes-in-brazil/>).
- CIMI - Conselho Indigenista Missionário (2022). Relatório Violência Contra os Povos Indígenas no Brasil - Dados de 2021 [Violence Against Indigenous Peoples in Brazil Report - 2021 Data]. Conselho Missionário Indigenista. Brasília. Available at: (<https://cimi.org.br/wp-content/uploads/2022/08/relatorio-violencia-povos-indigenas-2021-cimi.pdf>).
- COE Yanomami (2023). Governo Brasileiro - Centro de Operação de Emergência Yanomami [Brazilian Government - Yanomami Emergency Operation Center]. Available at: (<https://www.gov.br/saude/pt-br/composicao/svsa/resposta-a-emergencias/coes/coe-yanomami>).
- DPU (2021). Nota Técnica Nº 2 - DPGU/SGAI DPGU/GTI DPGU. Defensoria Pública da União. Licenciamento para a Atividade de Lavra Garimpeira no Estado de Roraima [Licensing for Garimpeira Mining Activity in the State of Roraima]. Available at: (<https://direitoshumanos.dpu.def.br/wp-content/uploads/2022/02/Nota-Te%CC%81cnica-referente-ao-licenciamento-para-a-Atividade-de-Lavra-Garimpeira-no-Estado-de-Roraima-%E2%80%93-Lei-Estadual-1.453-2021-.pdf>).
- Earth Explorer (2023). Earth Explorer. Available at: (<https://earthexplorer.usgs.gov/>).
- FIOCRUZ (2016). Elevados níveis de contaminação por mercúrio preocupam a comunidade indígena Yanomami [High levels of mercury contamination worry the Yanomami indigenous community]. Escola Nacional de Saúde Pública Sergio Arouca. Informe ENSP. Available at: (<https://informe.ensp.fiocruz.br/noticias/39388>).
- FUNAI (2020). Indians in Brazil: Who They Are. Available at: (<https://www.gov.br/funai/pt-br/atualizacao/povos-indigenas/quem-sao>).
- Cupertino, G., do Carmo Cupertino, M., Gomes, A., Braga, L., Siqueira-Batista, R., 2020. COVID-19 and Brazilian indigenous populations. *Am. J. Trop. Med. Hyg.* v. 103 (n. 2).
- Gatti, L., et al., 2023. Increased Amazon carbon emissions mainly from decline in law enforcement. *Nature* v. 621, 318–323. <https://doi.org/10.1038/s41586-023-06390-0>.
- Gatti, L.V., Basso, L.S., Miller, J.B., et al., 2021. Amazonia as a carbon source linked to deforestation and climate change. *Nature* v. 595, 388–393.
- HAY - Hutukara Associação Yanomami (2022). Cicatrizes na Floresta II: Evolução do garimpo ilegal na Terra Indígena Yanomami em 2021 [Scars in the Forest II: Evolution of illegal mining in the Yanomami Indigenous Land in 2021]. Hutukara Associação Yanomami/Associação Wanassedume Ye'Kwana, Boa Vista. Available at: (<https://acervo.socioambiental.org/acervo/documentos/cicatrizes-na-floresta-a-evolucao-do-garimpo-ilegal-na-ti-yanomami-em-2020>).
- HAY - Hutukara Yanomami Association (2024). Proteção Territorial [Territorial Protection]. Available at: (<https://hutukarayanomami.org/protacao-territorial/>).
- HAY/ISA (2022). Hutukara Associação Yanomami (HAY), Associação Wanassedume Ye'kwana, Instituto Socioambiental (ISA). Yanomami sob ataque: garimpo ilegal na Terra Indígena Yanomami e propostas para combatê-lo [Yanomami under attack: illegal mining in the Yanomami Indigenous Land and proposals to combat it]. Editora HAY, Boa Vista. Available at: (<https://acervo.socioambiental.org/acervo/documentos/yanomami-sob-ataque-garimpo-ilegal-na-terra-indigena-yanomami-e-propostas-para>).
- ILO (1989). Convention 169 - Indigenous and Tribal Peoples Convention. International Labour Organisation. Available at: (https://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:55:0:NO::P55_TYPE,P55_LANG,P55_DOCUMENT,P55_NODE:REV,en,C169,/Document).
- INPE (2023). TerraBrasilis (INPE). Available at: (<https://terrabrasilis.dpi.inpe.br/>).
- INPE (2023b). Programa queimadas (INPE). Available at: (<https://terrabrasilis.dpi.inpe.br/queimadas/portal/>).
- Instituto Socioambiental (2023). Yamaki Ni Ohotai Xoa: nós ainda estamos sofrendo [We are still suffering]. Available at: (<https://acervo.socioambiental.org/acervo/documentos/yamaki-ni-ohotai-xoa-nos-ainda-estamos-sofrendo-um-balanco-dos-primeiros-meses-da>).
- Instituto Socioambiental (2024). Megaincêndios em florestas de Roraima podem causar desastre ambiental [Megafires in Roraima forests could cause environmental disaster]. Available at: (https://www.socioambiental.org/noticias-socioambientais/megaincendios-em-florestas-de-roraima-podem-causar-desastre-ambiental?utm_source=isa&utm_medium=Redes&utm_campaign=).
- IPEN (2022). Rios na Terra Yanomami têm 8600% de contaminação por mercúrio, revela laudo da PF [Rivers in Yanomami Land have 8600% mercury contamination, reveals PF report]. Instituto de Pesquisas Energéticas e Nucleares. Available at: (http://www.ipen.br/portal_por/portal/interna.php?secao_id=39&campo=17680).
- ISA - Instituto Socioambiental (2023). Yanomami Indigenous Land. Available at: (<https://terrasindigenas.org.br/pt-br/terras-indigenas/4016>).
- IWGIA (2020). Indigenous Peoples' rights in Brazil. Available at: (<https://www.iwgia.org/en/brazil.html#:~:text=Indigenic%20peoples%20in%20Brazil&text=The%20principal%20indigenic%20ethnic%20group,%20while%2076.9%25%20speak%20Portuguese>).
- Kopenawa, D. & Albert, B. (2015). A queda do céu: Palavras de um xamã Yanomami [The fall of the sky: Words from a Yanomami shaman]. Companhia das Letras, São Paulo.
- Le Saout, S., Hoffmann, M., Shi, Y., Hughes, A., Bernard, C., Brooks, T.M., Bertzky, B., Butchart, S.H.M., Stuart, S.N., Badman, T., Rodrigues, A.S.L., 2013. Protected areas and effective biodiversity conservation. *Science* v. 342, 803.
- Map Biomas (2022). 91,6% da área garimpada no Brasil ficam na Amazônia [91.6% of the mined area in Brazil is in the Amazon]. Available at: (<https://brasil.mapbiomas.org/2022/09/23/916-da-area-garimpada-no-brasil- ficam-no-bioma-amazonia/#:~:text=%E2%80%9CA%20s%C3%A9rie%20hist%C3%B3rica%20mostra%20um,Diniz%2C%20coordenador%20t%C3%A9cnico%20do%20mapeamento>).
- MapBiomas (2021). A Expansão da Mineração e do Garimpo no Brasil nos últimos 36 anos: Destaques do Mapeamento Anual de Mineração e Garimpo no Brasil entre 1985 a 2020 [The Expansion of Mining and Garimpo in Brazil in the last 36 years: Highlights from the Annual Mapping of Mining and Garimpo in Brazil between 1985 and 2020]. Available at: (https://mapbiomas-br-site.s3.amazonaws.com/Fact_Sheet_1.pdf).
- MPF (2020). Ministério Público Federal – Nota Técnica sobre as queimadas na Amazônia [Technical Note on Amazon fires]. Available at: (<https://www.mpf.mp.br/pgp/documentos/NotaTecnica.queimada.areas.amazonia.protege.pdf>).
- Observatório da Mineração (2023). Dinamite Pura: Como a política mineral do governo 2019-2022 armou uma bomba climática e anti-indígena [Pure Dynamite: How the government's 2019-2022 mineral policy armed a climate and anti-indigenous bomb]. Observatório da Mineração/ Sinal de Fumaça, Brasília/São Paulo. Available at: (<https://acervo.socioambiental.org/acervo/documentos/dinamite-pura-como-politica-mineral-do-governo-bolsonaro-2019-2022-armou-uma>).
- PIB (2014). Aikanã People. Available at: (<https://pib.socioambiental.org/en/Povo:Aikan%C3%a3>).
- PIB (2018a). Akuntsu People. Available at: (<https://pib.socioambiental.org/en/Povo:Akuntsu>).
- PIB (2018b). Desana People. Available at: (<https://pib.socioambiental.org/en/Povo:Desana>).
- PIB (2018c). Yanomami People. Available at: (<https://pib.socioambiental.org/pt/Povo:Yanomami>).
- PIB (2018c). Tuyuka People. Available at: (<https://pib.socioambiental.org/en/Povo:Tuyuka>).
- Queimadas (2023). "Queimadas" Program/INPE. Available at: (<https://queimadas.dgi.inpe.br/queimadas/portal>).
- Rede Amazônia (2023). Indígenas de 14 regiões na Terra Yanomami têm altos níveis de contaminação por mercúrio, revela laudo da Polícia Federal [Indigenous people from 14 regions in Yanomami Land have high levels of mercury contamination, reveals Federal Police report]. Portal Rede Amazônica. Available at: (<https://g1.globo.com/r/roraima/noticia/2023/03/21/indigenas-de-14-regioes-na-terra-yanomami-tem-altos-niveis-de-contaminacao-por-mercuro-revela-laudo-da-policia-federal.ghtml>).
- RIGeo (2020). Cartas de anomalias: área Roraima – Amazonas [Anomaly charts: Roraima – Amazonas area]. Available at: (<https://rigeo.sgb.gov.br/handle/doc/23282>).
- Rodrigues, Aryon, 2017. A originalidade das línguas indígenas brasileiras. [The originality of Brazilian indigenous languages]. *Rev. Bras. De. Linguística Antropol.* 9 (1), 187–195. <https://doi.org/10.26512/rbla.v9i1.19521>.
- Silva, C.V.J., Aragão, L.E.O.C., Barlow, J., et al., 2018. Drought-induced Amazonian wildfires instigate a decadal-scale disruption of forest carbon dynamics. *Philos. Trans. R. Soc. B-Biol. Sci.* v. 373.
- Sumauma (2023). Não estamos conseguindo contar os corpos [We can't count the bodies]. Revista Sumauma. Available at: (<https://sumauma.com/nao-estamos-conseguindo-contar-os-corpos/>).
- Survival International (2023). Brazilian Indigenous Peoples. Available at: (<https://www.survivalinternational.org/tribes/brazilian>).
- Survival International (2023). Yanomami People. Available at: (<https://www.survivalinternational.org/tribes/yanomami>).
- TerraBrasilis (2023). Brazilian Amazon Rainforest Monitoring Program by Satellite (PRODES)/INPE. Available at: (<http://terrabrasilis.dpi.inpe.br>).
- UNICEF (2019). UNICEF alerta sobre desnutrição crônica de crianças Yanomamis [UNICEF warns about chronic malnutrition of Yanomami children]. Portal UNICEF. Available at: (<https://www.unicef.org/brazil/comunicados-de-imprensa/unicef-alerta-sobre-desnutricao- cronica-de-criancas-yanomamis>).