

Degraded area in the Tatução mining invasion, Uraricoera River, Waikás region - identified in an overflight conducted by Greenpeace on May 10, 2020.
Credit: Chico Batata/Greenpeace



THE IMPACTS OF THE
PANDEMIC ON THE YANOMAMI
INDIGENOUS TERRITORY
#MINERSOUTCOVIDOUT
#FORAGARIMPOFORACOVID

Mining invasion on the Mucajáí River, Kayanau, identified in an overflight conducted by Greenpeace on May 10, 2020.
Crédito: Chico Batata/Greenpeace



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Yanomami participate in a meeting of the Yanomami and Ye'kuana Leadership Forum, where they issued a manifesto against illegal mining on their lands, in November 2019. Credit: Victor Moriyama / ISA

EXECUTIVE SUMMARY

- The Yanomami and Ye'kwana are the indigenous peoples most vulnerable to Covid-19 and must be protected while there is still time.
- More than 20,000 illegal gold miners constitute the main vector for the spread of the new coronavirus in Yanomami Indigenous Territory today.
- A study by ISA and the Federal University of Minas Gerais demonstrates that in a worst-case scenario, 40% of the Yanomami who live in mining zones (13,889 out of a total population of 27,000) could become infected by Covid-19.
- Health posts in the Yanomami Indigenous Territory are the most vulnerable. Collective dwellings, a history of high morbidity due to respiratory infections, and poor local health infrastructure aggravate the situation.
- A significant increase in gold prices and the socio-economic crisis resulting from the pandemic will increase gold mining activity in the Yanomami Indigenous Territory.
- Gold miners could spread Covid-19 to the Moxihatetea, an isolated (uncontacted) indigenous people in the Yanomami Indigenous Territory.
- Preliminary analyses show approximately 2,000 hectares of forest in the Yanomami Indigenous Territory destroyed by illegal mining.

The Covid-19 pandemic makes the removal of the 20,000 gold miners working illegally in the Yanomami Indigenous Territory more urgent. Like a virus, the “gold mining epidemic” has been spreading through the territory over the years. Now, with the arrival of Covid-19 and its high transmission rate, it could trigger a humanitarian crisis.

The gold miners are the main vector of the new coronavirus within the territory. The Yanomami, like other indigenous peoples, are among the groups most vulnerable to the impacts of the new disease and could be severely affected by its advance. They must, therefore, be protected urgently, otherwise they are at risk of genocide with the complicity of the Brazilian state. Something needs to be done, now.

The escalation of the pandemic across Brazil requires a swift and extraordinary response from the federal agencies and authorities responsible for protecting the Yanomami, a people who came into contact with national society relatively recently, and who have several cultural and social characteristics that make them more vulnerable to the pandemic.

A study by the Socio-environmental Institute (ISA) carried out in partnership with the Federal University of Minas Gerais (UFMG), and reviewed by Fiocruz (Oswaldo Cruz Foundation for Public Health), reinforces this need. 13,889 people (50.7% of the population in the Yanomami Indigenous Territory) live less than five kilometers from the gold mining invasion areas. An estimated 20,000 gold miners are working in these regions. The results of the study show that if nothing is done to stop the transmission of the disease, about 5,600 Yanomami could be infected, which would represent 40% of the population living in these areas.

For cultural reasons, implementing social isolation measures is a challenge. The Yanomami, like other indigenous peoples, share their homes with several families, as well as drinking vessels and household items. If a highly contagious disease like Covid-19 enters the community, it is very difficult to prevent its transmission. Therefore, taking into account the gold mining invasion and cultural habits, there is a high chance of seeing scenarios of intense transmission unfold.

The Yanomami have several weaknesses in their overall health, including a history of respiratory diseases. Thus, if Covid-19 mortality rates are twice as high as in the non-indigenous population, 207 to 896 Yanomami could die as a result of the disease in areas impacted by mining, which would represent 6.5% of the population in those communities.

The study also concluded that the Yanomami are the people most vulnerable to the pandemic in the entire Brazilian Amazon. In addition to the mining invasion, they are highly vulnerable socially and suffer from precarious health care.

The analysis presented in this report used information from state health departments, population data, ICU hospital beds and ventilators available in the region, in addition to information from the health posts (*Polos Base*) and studies by the Oswaldo Cruz Foundation (Fiocruz) estimating the risk of the Covid-19 spreading and socioeconomic vulnerability in Brazilian states and municipalities.

Formally recognized and demarcated by the Brazilian government in 1991, the Yanomami Indigenous Territory is one of the largest in Brazil. It is home to both the Yanomami and Ye'kwana people, as well as groups of isolated (uncontacted) people.

With an area of 9.6 million hectares, equivalent to that of Portugal, and with a population of 27,398 people spread out in some 331 communities as well as groups of isolated people, the Yanomami Indigenous Territory lies between Amazonas and Roraima states. These states have some of the highest numbers of Covid-19 cases in Brazil relative to their respective total populations. Both states are already experiencing a collapse in their healthcare systems. Roraima has 0.72 Intensive Care Units (ICUs) for every 10,000 inhabitants, well below the number stipulated by the World Health Organization (WHO), which recommends a minimum of 3 for every 10,000 inhabitants. Amazonas, which has a rate of 1.24 beds per 10,000, is experiencing a collapse of its healthcare system in the capital, Manaus.

The Yanomami's collective dwellings, with many individuals and families in the same house, represent a risk factor in this context.

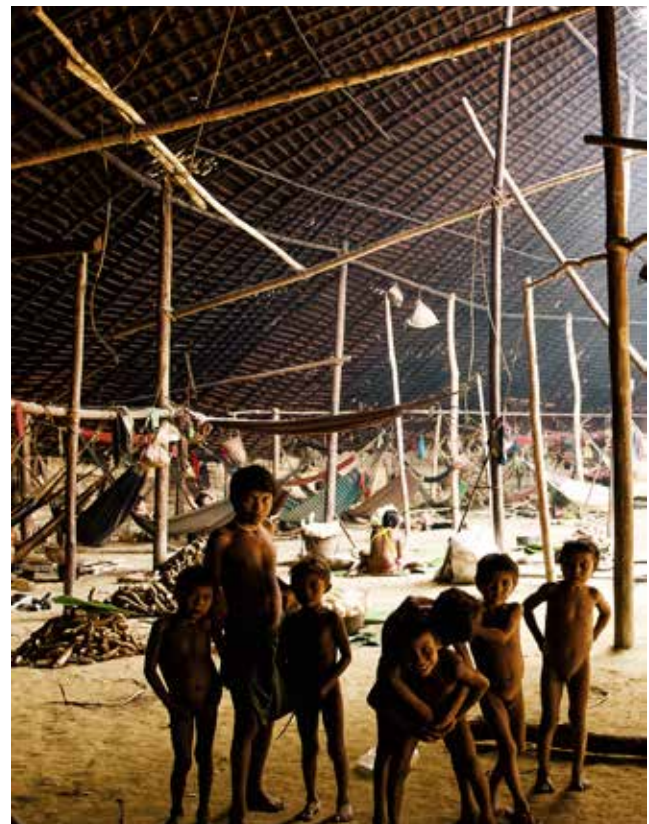
The average number of residents per household in the Yanomami Indigenous Territory recorded in the 2010 Demographic Census is 7.8, higher than the national average which is 3.3. The average number of households without their own bathroom or sanitation in the territory is 97%, while the national average is 6.2%¹.

Another risk factor is morbidity: the Yanomami have a high incidence of diseases that can worsen the coronavirus infection. According to the Indigenous Health Care Information System (Siasi), in the last ten years (2010 to 2019) the number of deaths related to acute respiratory infections (J00 to J22) increased by 6% in the population aged between 0 and 14 years, and by 300% in the population over 50 years.

¹ AZEVEDO, M.; DAMASCO, F.; ANTUNES, Antunes, M.; MARTINS, M.H.; REBOUÇAS, M.P. 2020. Análise de Vulnerabilidade Demográfica e Infraestrutural das Terras Indígenas à Covid-19. Núcleo de Estudos de População "Elza Berquó" - Universidade Estadual de Campinas. 117p.

ISA's study also shows that the health posts that serve the Yanomami Indigenous Territory have the highest degree of vulnerability among the 172 studied in Brazil. The 37 health posts in the territory score worst (0.7) - 1 being the worst possible score.

This is because the health posts that serve the territory have the lowest availability of beds and ventilators, the greatest limitations relating to transportation of the sick and the worst levels of social vulnerability. The high degree of social vulnerability indicates that the population served by these health posts has the worst life expectancy at birth, low levels of education according to the HDI (Human Development Index and HDIedu), a high percentage



IV General Assembly of the Hutukara Yanomami Association, Toototobi, Yanomami Indigenous Territory, Amazonas. © Edson Sato

of the population living in extreme poverty, as well as people in households with inadequate supplies of water and sewage and no running water. Such factors significantly increase the vulnerability of the Yanomami people to Covid-19.

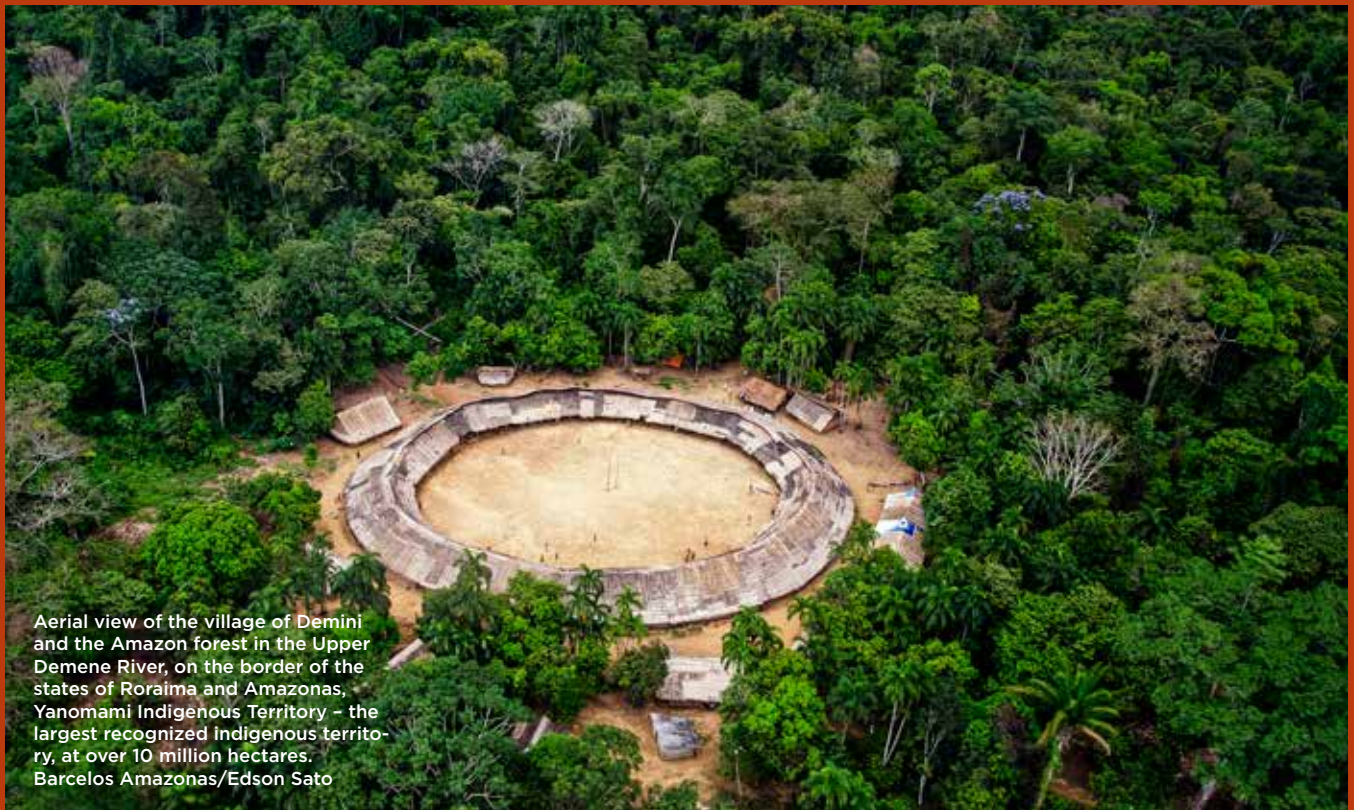
Covid-19 is already directly impacting the Yanomami. Until May 15, the Special Secretariat for Indigenous Health (Sesai) confirmed that 15 Yanomami had been diagnosed with the disease, in addition to 16 employees working in Yanomami health care in Boa Vista (capital of Roraima state). In early April, a 15-year-old Yanomami boy died of the disease at the Roraima General Hospital. The other fatal Yanomami victim was a baby. Considering high underreporting, these confirmed cases indicate that the virus is already circulating within the Yanomami Indigenous Territory and that, unfortunately, these may be just the first fatal cases.

Among the Yanomami, 4.5% of the population is over 60 years old, representing the age group most at risk for Covid-19. The sudden disappearance of the oldest people, known as “living libraries”, could have an impact on the Yanomami’s social reproduction and irreversible consequences for the survival of the Yanomami and Ye’kwana peoples’ cultural heritage.

The high degree of vulnerability of the Yanomami Indigenous Territory is also of concern regarding the isolated (uncontacted) indigenous peoples that inhabit the territory, the Moxihatetea. The National Indian Foundation (Funai) has registered the existence of these groups in the Yanomami Indigenous Territory through one confirmed report and six additional reports. Isolated (uncontacted) indigenous people are also impacted by the presence of the gold miners, who are increasingly operating closer to these communities, who have repeatedly shown that their choice is to remain in geographical isolation.



Yanomami village of Marari, with the Serra Aramamisi in back. Barcelos, Amazonas/Edson Sato



Aerial view of the village of Demini and the Amazon forest in the Upper Demene River, on the border of the states of Roraima and Amazonas, Yanomami Indigenous Territory - the largest recognized indigenous territory, at over 10 million hectares. Barcelos Amazonas/Edson Sato



Illegal mining area in the Couto Magalhães River, between the villages of Paapiu and Kayanau, identified by Greenpeace on May 10, 2030.
Credit: : Chico Batata/Greenpeace



ILLEGAL MINING: A PUBLIC HEALTH ISSUE

Deforestation and illegal mining are seen as serious public health issues by the Yanomami and Ye'kwana, mainly due to how they impact food security and access to preventive medicine.

Since the beginning of 2019, the Yanomami Indigenous Territory has suffered a dramatic increase in gold mining activity, with an estimated 20,000 invaders in the territory settling illegally in camps, some of them set up with permanent supply services and satellite communication systems. The increase in the price of gold internationally, the weakening of official policies to protect the rights of indigenous peoples and the environment, and pressure from the current government in favor of the legalization of mining on indigenous lands, all contribute to the renewed gold rush in the Yanomami Indigenous Territory (Figure 1).

ISA has been monitoring the progress of illegal mining through satellite images using the "Sirad" system. This has enabled the organization to identify mining along the rivers, in areas that were not detected by the satellites used by the Prodes-INPE and Deter-INPE systems. These systems are used by the National Institute for Space Research (INPE) to monitor deforestation in the Amazon. Prodes is annual, while Deter is a monthly alert system (the smallest area observed by the Prodes system for example, is 30m). The Sirad system, with its higher spatial resolution, has shown the enormous destruction that illegal mining has caused inside the Yanomami Indigenous Territory.



Illegal mining area in the Couto Magalhães River, between Paapiu and Kayanau, identified by a Greenpeace overflight on May 10, 2020. Credit: Chico Batata/Greenpeace

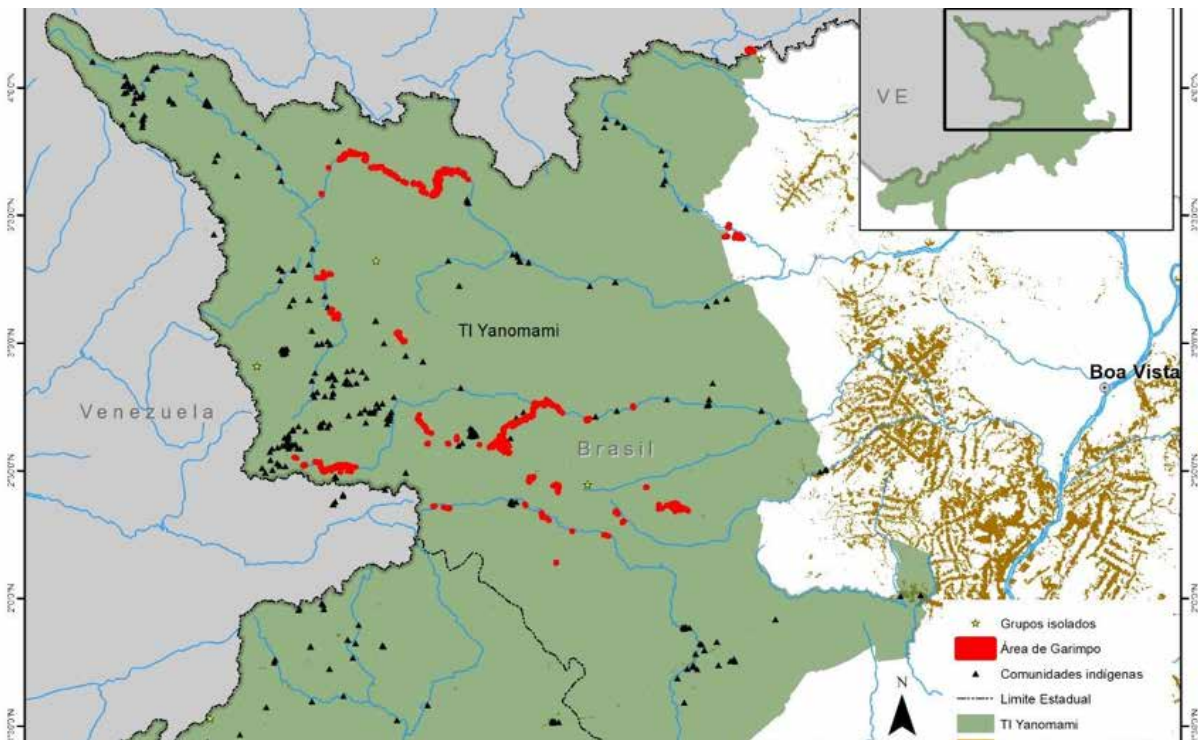


Figure 1.: Monitoring the expansion of illegal mining. Instituto Socioambiental (2020)

Sirad images demonstrate that since the first analysis in October 2018, a cumulative 1,925.80 hectares of forest have been degraded by illegal mining. In March 2020 alone, 114 hectares of forest were destroyed by mining (Figure 2).

ISA's monitoring system has detected the expansion of illegal gold mining in regions close to indigenous communities with less contact with outside society (Hakoma and Parima) and whose immune systems are more sensitive to disease. This is extremely worrying at this moment of unprecedented threat of contagion from Covid-19 among indigenous and non-indigenous people alike.

Threats are also present in the Serra da Estrutura, a region home to isolated Moxihatetea groups. In March 2020, ISA's monitoring system detected a new area being occupied (i.e. agricultural gardens) connected to this group, close to the headwaters of Igarapé Arame. The opened gardens may be associated with an attempt by some families to establish a new vil-

lage, in a region close to an area of intense mining (near the Rio Novo). It is possible that their approach is even intentional, with an aim to maintain an exchange relationship with the miners. In the history of the Yanomami and Ye'kwana, this kind of contact has always resulted in tragedy for both sides.

Annex 1 presents a comparison of the main areas of invasion by miners in the Yanomami Territory between January 2019 and March 2020.

Today, illegal mining consists of a complex network of actors organized nationally and internationally, supported by outside finance and the provision of supplies and equipment (mercury, food, fuel, boats, ferries, airplanes, helicopters, ATVs, etc.). In recent years, joint operations by the Federal Police, the Federal Public Ministry (MPF) and the army have advanced investigations into the gold supply chain in Roraima. Joint operations dubbed Xawara (2013), Warari Koxi (2015) and Tori (2018) brought to light part of the ways that gold mined illegally in the Yanomami Territory was exported through Securities Distributors (DTVM) located

in São Paulo and Rio de Janeiro after being “laundered” regionally through fraudulent invoices.² More recently, at the end of 2019, Operation Hespérides uncovered criminal organizations responsible for the illegal commercialization of gold mined in Brazil and Venezuela, for the first time identifying international links in the market for illegally mined gold.

Most of the legal proceedings that resulted from these operations remain unfinished, however, contributing to a wide sense of impunity that ends up encouraging continued illegal activity (note that all mining activity on indigenous lands is currently illegal, according to Brazilian law). In addition, the MPF published a series on its website demonstrating that regulation of the gold supply chain in Brazil is insufficient and inconsistent, making it very difficult to control and inspect by the competent authorities.

The Army discontinued inspection operations in the Yanomami Indigenous Territory 2018, and the four FUNAI Ethno-Environmental Protection Bases (BAPEs) in the territory were closed, leaving it unprotected. This resulted in an increase in gold mining unprecedented since the recognition of the Yanomami Indigenous Territory in the 1990s. This omission of the State spurred the MPF of Roraima to file Public Civil Action 1000551-12-2017.4.01.4200, which is currently in provisional compliance with the sentence. To date, only one BAPE has been reopened, on the banks of the Mucajáí River, which means that most of the Yanomami Indigenous Territory remains unprotected.

At the same time, the rise in the price of gold on the international market is intensifying pressures on the underground black market. Considered a valuable financial asset in times

of uncertainty in the economy, the price of gold has broken consistent records, maintaining an upward trend that should intensify with the deepening of the economic crisis resulting from the pandemic. In 2019, gold became the second largest export product in Roraima, without the state even having legal gold operations. Although gold ceased to appear in the official accounting of state exports at the end of 2019, it is known that illegal mining itself has not ceased and continues to put pressure on the Yanomami Indigenous Territory. At the same time, MPF investigations into the illegal gold supply chain pointed out that the inspection mechanisms meant to detect the origin of the gold circulating in the country are weak, and that there is a complete lack of control over the origins of gold in Brazil.

In September 2019, communities in the Waikás region of the Yanomami Indigenous Territory identified two aircraft and two helicopters that, since 2018, had been transporting miners into nearby mining areas. The aircraft owners have a proven relationship with gold mining and had previously been reported. In December of the same year, a fifth aircraft was identified and miners were caught with three vehicles in the Apiaú region, supplying two boats with fuel and gas for mining activities.

More recently, in March 2020, three incidents involving aircraft that clandestinely circulated in the Yanomami Indigenous Territory were reported to the MPF: a crash in Korekorema, whose passengers were rescued by a helicopter; the landing of a helicopter to supply miners in Palimiú; and a flagrant use of the airstrip and health post in the Kayanaú community to supply gold mining activities. On March 13, with Covid-19 contamination confirmed in Brazil, the authorities were informed about the arrival of miners very close to the Korekorema community, where a group of approximately 50 miners had set up camp and prepared rafts

2 BRASIL, Kátia. “Ouro da terra yanomami era vendido em empresa da Avenida Paulista”. *Amazônia Real*, 18 de maio de 2015. <<https://amazoniareal.com.br/ouro-da-terra-yanomami-era-vendido-em-empresa-da-avenida-paulista/>>. Accessed on March 31, 2020.



Illegal mining area in the Couto Magalhães River, between Paapiú and Kayanau, identified by a Greenpeace overflight on May 10, 2020. Credit: Chico Batata/Greenpeace

to open a mine -- proving that the pandemic has not prevented mining activity from continuing.

It is important to highlight that this information refers only to what has been possible to identify in terms of using Yanomami airspace to provide supplies to illegal gold mining operations. Other inspections in the Yanomami Indigenous Territory have also located the presence of aircraft and helicopters used to supply miners, and reports of air accidents involving gold miners are common.

Several studies have shown the relationship between a population's spatial mobility and the distribution of disease. Research on the behavior of illegal miners, who transit back and forth between cities and remote areas in the forest, characterize patterns for the transmission of diseases such as malaria³. Malaria-related infections and deaths were facilitated when illegal gold mining and logging activities began in southern Pará, attracting a flood of migrants and dramatically increasing the population in remote areas without health infrastructure⁴. Cases increase as a result of worsening economic conditions and decreased vector control interventions. The conditions and evidence reported above about the presence of illegal miners and the

transmission of disease can thus contribute to the transmission of Covid-19 in the Yanomami Indigenous Territory.

In 2014, the National School of Public Health of the Oswaldo Cruz Foundation (ENSP / FioCruz) coordinated a study on the presence of mercury (Hg) and the degree of contamination of the Yanomami and Ye'kwana population. The analysis covered the regions of Paapiú and Waikás - invaded by groups of miners. The World Health Organization (WHO) indicator was used as a reference parameter: levels above 6.0 $\mu\text{g.g}^{-1}$ can have serious health consequences, with primary toxicity in the nervous, central, urinary and cardiovascular systems; the respiratory and immune systems can also be negatively affected, generating weaknesses in the human organism's resistance and response capacity to the most serious effects of other diseases - for example, of Covid-19. Virtually all of the people evaluated had high levels of Hg in their hair. In view of the health situation and the level of toxicity verified, an immediate halt of gold mining activity was recommended.

3 SOUZA, P.F.; XAVIER, D.R.; MUTIS, M.C.S.; da MOTA, J.C.; PEITER, P.C.; de MATOS, V.P. et al. 2019. Spatial spread of malaria and economic frontier expansion in the Brazilian Amazon. PLoS ONE 14 (6): e0217615. <https://doi.org/10.1371/journal.pone.0217615>

4 FERREIRA, M.U.; CASTRO, M.C. 2016. Challenges for malaria elimination in Brazil. *Malaria Journal*, 15:284.

TRACKING THE ADVANCE OF ILLEGAL MINING

Images from Planet satellites show a comparison over time of the main illegal mining invasions.*

RIO COUTO MAGALHÃES



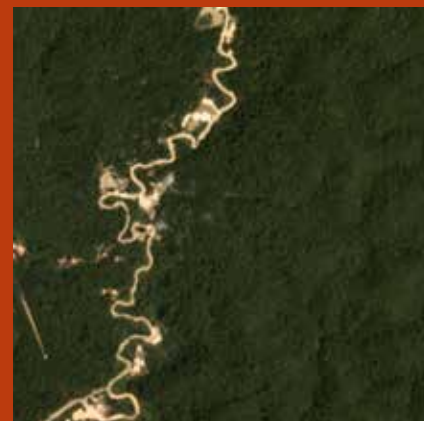
2016

The Couto Magalhães River is home to some of the communities that suffered the most from the last major influx of miners in the Yanomami Indigenous Territory at the end of the 1980's. The current situation threatens a return to that nightmare. In 2016, no traces of mining presence can be seen on this section of the river.



2019

By 2019, the image shows not only scars from mining activity along the riverbed, but also a clandestine airstrip, built to provide logistical support to mining in the region. Between the scars, one can see the formation of a multitude of artificial lakes, the perfect breeding grounds for mosquitoes carrying malaria.



2020

In 2020, the scars observed in 2019 continue to be open, and have widened. The proximity of illegal mining invasions to communities in this region is an additional risk factor. Indigenous organizations from the Yanomami Indigenous Territory have denounced the situation to the authorities tasked with controlling this kind of activity. Community members are increasingly approached by the miners, particularly young people who are offered menial jobs in exchange for goods, such as cellphones, clothes, and alcohol.

*Source: MapBiomias/imagens Planet

TRACKING THE ADVANCE OF ILLEGAL MINING

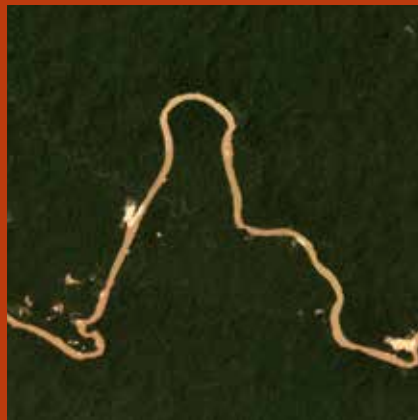
Images from Planet satellites show a comparison over time of the main illegal mining invasions.*

RIO MUCAJAÍ



2016

The Mucajaí River is one of the regions in the Yanomami Indigenous Territory where the upsurge in mining has been the most significant. As can be seen in the image, in 2016, although mining in the region had been denounced, marks on the landscape are practically invisible to satellite imagery.



2019

In the same spot in 2019 a profusion of scars along the course of the river can be seen. These marks show up both as sand banks (called “ferry burps” locally), as well as in forest clearings that show bare earth.



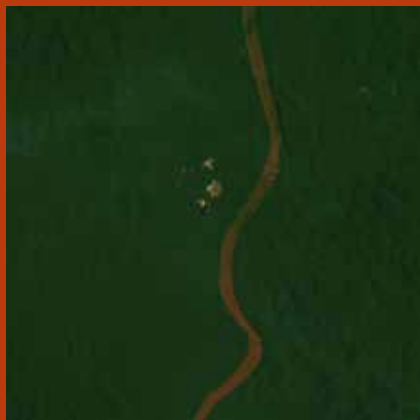
2020

The image from 2020 shows an increase in the scars detected in 2019, as well as newly degraded areas, indicating the persistence and intensification of mining activity. Remote monitoring of illegal mining in the region shows an increase of nearly 100% in the area degraded, in just one year.

TRACKING THE ADVANCE OF ILLEGAL MINING

Images from Planet satellites show a comparison over time of the main illegal mining invasions.*

RIO URARICOERA



2016

The Uraricoera River region is historically one of the most affected by illegal gold mining in the Yanomami Indigenous Territory. Through the mid 2010's, extraction from riverbeds using floating rafts was the most common. The Tatzão mining area, which shows up in the image, began around 2014 and besides supporting extraction via river rafts, also started digging for gold along river edges using heavy machinery.



2019

Despite multiple denunciations from indigenous organizations, little was done by the relevant Brazilian government authorities regarding illegal mining in the Uraricoera. In a few years, Tatzão transformed into the largest mining area in the Territory. This image shows expansion of the degraded areas that could already be seen in 2016, as well as new areas along the river.



2020

From 2019 until the present, the degraded area along the Uraricoera has grown at a steady monthly rate that can be measured by remote sensing. Indigenous people from the region report that in just a few years Tatzão has turned into an actual gold mining town right in the middle of the Yanomami Territory, complete with small shops, brothels, and all sorts of equipment needed to support mining activities.

*Source: MapBiomias/imagens Planet

YANOMAMI HEALTH POSTS HAVE THE WORST VULNERABILITY SCORES

The study also shows that the health posts (*Polo Base*) serving the Yanomami Indigenous Territory have the highest degree of vulnerability among the 172 other health posts that were analyzed in Brazil. The 37 posts in the Yanomami Territory have the worst score at 0.7 - with 1 being the worst possible score -- the closer to 1, the greater the vulnerability of the health post. The average vulnerability index for the 172 health posts on indigenous territories in Brazil 0.53.

This most critical index was only found in the health posts that serve the Yanomami. This is because they have the lowest availability of beds and ventilators, have the greatest limitations related to the transportation of patients and the most severe levels of social vulnerability. The high degree of social vulnerability indicates that the population served by these health posts has the worst life expectancy at birth, low levels of education as per the Human Development Index (HDI), a high percentage of the population living in extreme poverty, people in households with inadequate water and sanitation supplies, and no running water. Such factors significantly increase the vulnerability of the Yanomami people to Covid-19.

The elderly represent, on average, 4% of the population in the 37 health posts that serve the Yanomami population. Some health centers serve communities with a large number of elderly people, such as the Auaris post (139 elderly people), Balawau (63 elderly people), Maraiá (110 elderly people), Maturacá (92 elderly people) and Surucucu (87 elderly people). Annex 2 shows the age structure of the population served at the 37 health posts that serve the Yanomami Indigenous Territory.

In order to determine the most vulnerable health posts due to their proximity to areas invaded by gold-mining, a spatial analysis was carried out evaluating the location of villages, mining areas, illegal landing strips and the coverage areas of the posts. Based on information reported by communities, a five-kilometer buffer area was drawn around villages, mining areas and illegal airstrips. Then, through geoprocessing operations, the intersections between the areas of occupation of villages, health posts, gold mining invasions and illegal landing strips were identified.

The results indicate that 23 health posts that serve villages located in areas further from gold mining invasions (more than five kilometers away) face *high risk*, that is, they are highly vulnerable to Covid-19 (Table 1). This vulnerability is due to the low number of beds and ventilators available, the limitations related to the transportation of the sick, and the worst social vulnerability indexes. The 23 high-risk base health posts serve a population of 14,127 indigenous peo-

ple, some of which serve a large number of elderly people (over the age of 60), such as Marauiá (110), Maturacá (92), Balawu (63), Novo Demini (58) and Missão Catrimani (53).

The situation gets worse, however, in areas close to mining invasions. The 14 health posts in these areas are at *critical risk*, that is, they present a very high vulnerability to Covid-19 (Table 1). In addition to the highest degree of vulnerability resulting from the unavailability of available beds and ventilators, limitations in the transportation of the sick and the worst levels of social vulnerability, the proximity to mining areas greatly increases the risk of contamination in these villages. These posts serve a population of 13,889 indigenous people - just over half the Yanomami population - who live in villages less than five kilometers from gold-mining invasions. Some of them serve a large number of elderly people, such as Auaris (139), Surucucu (87), Xitei (57) and Aratha-U (43).

Table 1. Degree of risk among health posts due to proximity to mining invasions.

	High Risk	Critical Risk
Health Posts	23	14
Population	14.127	13.889

THE RISK OF COVID-19 CASES

The Susceptible Infectious Recovered (SIR) model⁵ is one of the most used mathematical models to estimate the spread of epidemics. It describes the dynamics of contamination in a population based on the number of infected individuals, population size, contagion rate and a recovery parameter. Using this model it is therefore possible to estimate the number of people who may be contaminated in a given scenario of disease spread. Based on this model, ISA estimated the impact of the spread of Covid-19 in the Yanomami Territory in different scenarios.

The dissemination model considered the population served at each of the 14 health posts considered at *critical risk*, as well as the hypothesis of the initial occurrence of a single case in their region of service. The model adopted the assumptions of homogeneity of contacts and that the areas closest to mining invasions are more likely to be contagious, since miners transit through towns and, when entering the Territory, can act as vectors of the disease.

As there are no studies on the contagion rate (R0) for an indigenous village (available studies show values for urban areas) and the cultural characteristics of the homes of indigenous populations (with collective housing and sharing of utensils) make it difficult to isolate people, the model constructed infection scenarios based on R0 values within the confidence interval reported for Covid-15, that is, values between 2 to 4 (2, 2.25, 3 and 4) in order to compare transmission scenarios both more and less intense than in urban areas.

5 DIEKMANN, O.; HEESTERBEEK, H.; BRITTON, T. 2013. *Mathematical Tools for Understanding Infectious Disease Dynamics*. Princeton University Press.
FRASER, C.; RILEY, S.; ANDERSON, R.M.; FERGUSON, N.M. 2004. Factors That Make an Infectious Disease Outbreak Controllable. *Proceedings of the National Academy of Sciences of the United States of America* 101 (16): 6146-51.
KERMACK, W.O.; MCKENDRICK, A.G. 1927. A Contribution to the Mathematical Theory of Epidemics. *Proceedings of the Royal Society, Series A* 115: 700-721.
SOATERT, K.; PETZOLDT, K.; SETZER, R.W. 2010. "Solving Differential Equations in R: Package deSolve." *Journal of Statistical Software* 33 (9): 1-25.

The population studied was 13,889 people (50.7% of the population of the Yanomami Indigenous Territory), who live less than five kilometers from gold-mining areas. An estimated population of 20,000 gold miners have invaded these areas.

Table 2 shows the results of the Covid-19 contagion scenarios in the regions located less than five kilometers from gold mining invasions.

In the worst case scenario, with a perspective of more intense transmission, adopting the contagion rate (RO) of 4, the occurrence of a single case in these regions can result in 5,603 new cases after 120 days (Table 2). That is, if we do nothing, 40.3% of the Yanomami population served in the 14 *critical risk* health posts near mining areas would be infected. If the lethality of Covid-19 for indigenous people is twice as high as for the non-indigenous population, we estimate that there would be 207 - 896 deaths, adopting the rates of the States of Roraima and Amazonas, respectively.

Considering a transmission scenario similar to the urban context, adopting contagion rates (RO) between 2 and 2.25, the occurrence of a single case in the region can result in 2,131 to 2,710 new cases after 120 days, in villages near mining areas (Table 2). In other words, between 15.3% and 19.5% of the Yanomami population served by the 14 critical risk health posts would be infected. If the lethality is twice as high as in the non-indigenous population and the contagion rate (RO) is 2.25, there would be 100 - 433 deaths, adopting the rates of the States of Roraima and Amazonas, respectively.

Table 2: Number of Covid-19 cases in scenarios with different contagion rates (RO values).

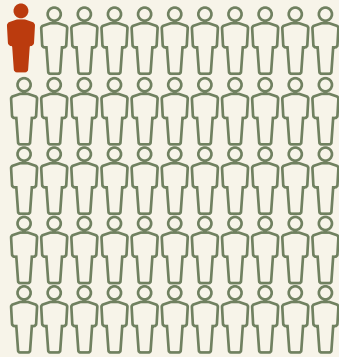
Yanomami population near mining invasions (13,889 people)		
RO	30 days	120 days
2	361 people	2,131 people
2,25	1,255 people	2,710 people
3	4,169 people	4,169 people
4	5,603 people	5,603 people

NUMBER OF COVID-19 CASES IN SCENARIOS WITH DIFFERENT CONTAGION RATES (R0 VALUES)

30 DAYS

120 DAYS

R0=2



R0=2,25



R0=3



R0=4



Figure 3 shows Covid-19 contagion curves in the Yanomami population considering different contagion rate (RO) scenarios.

The study also constructed individual scenarios for each critical risk health post. The dissemination model considered the population served at each post, as well as the hypothesis of the initial occurrence of a single case in the region the post serves. The model adopted the assumptions of homogeneity of contacts and that the areas closest to mining invasions are more likely to be contagious. Table 3 shows the occurrence of cases of Covid-19 in each critical risk health post.

Taking the Surucucu health post as an example, where there are reports that a representative of the District Council for Indigenous Health (Condisi), who tested positive for Covid-19, visited the service region. In the worst case scenario, with a perspective of more intense transmission, adopting the contagion rate (RO) value of 4, the occurrence of this single case in the region may result in 962 new cases after 120 days (Table 3). In other words, if we do nothing, 39% of the population served by the post would be infected. If the lethality is twice as high as in the non-indigenous population, there would be 35 - 153 deaths, adopting the rates of the States of Roraima and Amazonas, respectively.

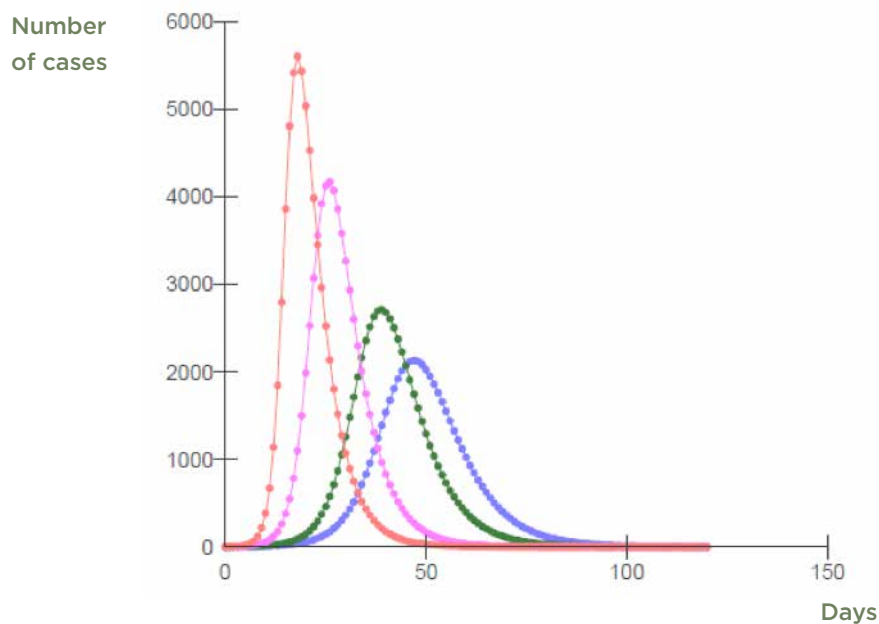


Figure 3. Covid-19 contagion scenarios, over a period of 120 days, for different contagion rate (RO) values: 2 (blue), 2.25 (green), 3 (pink), 4 (red); and a Yanomami population of 13,889 inhabitants served by the 14 health posts located less than five kilometers from mining areas.

In a less intense transmission scenario, adopting contagion rates (RO) between 2 and 2.25, the occurrence of a single case in the region of the Surucucu health post can result in 375 - 477 new cases after 120 days (Table 3). That is, between 15.3% and 19.5% of the population served at the post would be infected. If the lethality is twice as high as in the non-indigenous population and at the contagion rate (RO) of 2.25, there would be 17 - 76 deaths, adopting the rates of the States of Roraima and Amazonas, respectively.

Other examples involve three health posts that have significant areas degraded by mining: Paapiu, Homoxi and Waikás.

At the Paapiu health post, considering only the indigenous population served there (307 people), and a transmission scenario similar to the urban context, adopting contagion rates (RO) between 2 and 2.25, the occurrence of a single case in the region of the health post could result in 47 - 60 new cases after 120 days (Table 3), representing between 15% and 19% of the population served. If the lethality is twice as high as in the non-indigenous population and at the contagion rate (RO) of 2.25, there would be between two and nine deaths, adopting the rates of the States of Roraima and Amazonas, respectively.

In a scenario of more intense transmission, adopting the contagion rate (RO) value of 4, the occurrence of a single case in the Paapiu health post area may result in 123 new cases after 120 days, meaning that 40% of the population served would be infected. If the lethality is twice as high as in the non-indigenous population, there would be between four and 19 deaths, adopting the rates of the states of Roraima and Amazonas, respectively.

At the Homoxi health post (serving 276 people), in a transmission scenario similar to the urban context (RO rates between 2 and 2.25), the occurrence of a single case in the region of the health post could result in 42 - 53 new cases after 120 days (Table 3). If the lethality is twice as high as in the non-indigenous population and at the contagion rate (RO) of 2.25, there would be between one and eight deaths, adopting the rates of the States of Roraima and Amazonas, respectively. In a scenario of more intense transmission, adopting the contagion rate (RO) value of 4, the occurrence of a single case may result in 110 new cases after 120 days, meaning 39% of the population served would be infected. If the lethality is twice as high as in the non-indigenous population, there would be between four and 17 deaths, adopting the rates of the states of Roraima and Amazonas, respectively.

At the Waikás health post (serving 179 people), in a transmission scenario similar to the urban context (RO rates between 2 and 2.25), the occurrence of a single case in the region of the health post could result in 27 - 35 new cases after 120 days (Table 3). If the lethality is twice as high as in the non-indigenous population and at the contagion rate (RO) of 2.25, there would be between 1 and 5 deaths, adopting the rates of the States of Roraima and Amazonas, respectively. In a more intense transmission scenario, adopting the contagion rate (RO) of 4, the occurrence of a single case could result in 72 new cases after 120 days. If the lethality is twice as high as in the non-indigenous population, there would be between two to 11 deaths, adopting the rates of the states of Roraima and Amazonas, respectively.

Overall, and considering that contagion rates in rural areas may be higher compared to urban areas, the lack of control over the introduction of Covid-19 in the Yanomami Indigenous Territory could infect, on average, 40% of its population. Territorial protection measures and control of health agents can have clear effects on the transmission of the disease.

Table 3. Critical risk health posts, population served, and number of cases considering different contagion rates (R0).

Health Post	Younger than 1 year	2-14 years	15-29 years	30-45 years	50+59 years	Older than 60 years	Total population	Number of cases R0=2	Number of cases R0=2,5	Number of cases R0=3	Number of cases R0=4
Alto Catrimani	10	134	59	40	12	9	264	41	51	79	106
Alto Mucajai	20	297	157	99	19	26	618	95	120	186	249
Aratha-U	22	322	171	96	29	42	682	105	133	205	275
Auaris	151	1.928	951	639	168	139	3.976	619	776	1.192	1.603
Hakoma	25	310	182	93	27	28	665	102	130	200	268
Haxiu	37	437	227	127	33	32	893	137	174	268	358
Homoxi	9	150	58	32	15	12	276	42	53	83	110
Maloca Paapu	18	226	113	73	13	22	465	71	91	139	187
Paapu	4	131	100	46	14	12	307	47	60	92	123
Parafuri	16	238	120	68	15	16	473	73	92	142	190
Surucucu	83	1.173	641	386	76	87	2.446	375	477	732	962
Waikás	3	82	42	34	4	14	179	27	35	54	72
Waputha	27	376	194	103	29	19	748	115	146	223	301
Xitei	62	933	482	255	108	57	1.897	291	370	569	762

HISTORIC LINK BETWEEN MINING AND EPIDEMICS IN THE YANOMAMI INDIGENOUS TERRITORY

The Yanomami and Ye'kwana, whose language is in the Karib family, and are linguistically and culturally different from their Yanomami neighbors, lived in relative tranquility until the mid-1970s, when pressures on their territory intensified. Fifty years ago, negotiations began for the construction of the Perimetral Norte road. The road was seen as strategic to the Calha Norte Project, an occupation plan for the region north of the Amazon River elaborated in the final years of Brazil's military dictatorship. At the time, the government considered indigenous societies to be decadent and backward, openly promoting forced integration and the colonization of their lands as official policy. The impact of starting work on the section of the road in Roraima was tragic, causing illness, conflicts, and death of thousands of indigenous people.

Speculation of mineral resources in Yanomami and Ye'kwana lands also began to intensify at the same time. The Radambrasil Project (1975) revealed the existence of mineral deposits in what is today the Yanomami Indigenous Territory. Although not economically attractive to mining companies, the news brought an invasion of wildcat miners to the region. In 1976, hundreds of wildcat miners settled in Surucucus for the extraction of cassiterite (tin ore). At the end of the 1980s, the number of miners working in the forest was estimated to be as much as 50,000⁶.

The impact on Yanomami life was brutal. With an immune system unprepared for the diseases brought on by the wave of miners who invaded their lands, epidemics quickly spread, decimating entire communities. The increased circulation of miners and the consequent out-of-control contact with indigenous people resulted in the rapid dispersion of diseases that affected the entire population of the area⁷. Alcida Ramos is precise in detailing the relationship between mining activity in the Yanomami Territory and the spread of epidemics through Yanomami communities at the time:

6 ALBERT, Bruce. "A fumaça do metal: história e representações do contato entre os Yanomami". Anuário Antropológico 89. Rio de Janeiro: Tempo Brasileiro, 1992, p. 151-189.

7 RAMOS, Alcida Rita e TAYLOR, Kenneth I. "The Yanoama in Brazil 1979 and Yanomami Indian Park, Proposal and Justification". IWGIA Document 37. Copenhagen, 1979. P. 123.

“From mid-1987 to January 1990, the height of the gold rush, it is estimated that about a thousand Yanomami, that is, 14% of their population in Roraima, died mainly from diseases such as malaria (National Foundation 1991: 73). If we consider that this figure refers only to the approximately 6,700 Yanomami who live in the state of Roraima, we have a percentage of more than 22% of deaths in less than three years.

In the first year of construction of the Perimetral Norte, 1974-75, infectious diseases killed 22% of the population of four villages, the first affected by the road's construction (Ramos 1979). Two years later, another 50% of the inhabitants of four other communities succumbed to a measles epidemic. On the Apiaú River, at the eastern end of the Yanomami Territory, it is estimated that about 100 people would have already died in the mid-1970s, leaving only 30 survivors (Taylor 1979). In distress, they left the area and joined other communities. By February 1992, what had once been their land was a gigantic burning area of over 30,000 hectares, transformed into a regional colonization project. In turn, the 60 people who remained of the 102 people who had lived in the Ajarani River region, in the southernmost part of the Yanomami Territory in Roraima, also dispersed, paving the way for an intense occupation by Brazilian settlers on what had been their lands. Some of these Yanomami live today as outsiders on the sites of these settlers.

While the Perimetral Norte road depleted indigenous lives and exposed survivors to the expropriation of their lands in the southern lowlands of Yanomami territory, further north

in the Parima mountains, interest in the minerals spread across the Serra de Surucucus began. From an initial nucleus of eight prospectors in search of cassiterite and the sporadic interest of the Icomi mining company (Taylor 1979), a mining rush bloomed, with up to 500 men paid by small local companies to extract cassiterite. The few months of activity by miners in the region generated armed conflicts with the Indians and serious health problems, as attested by photographs from the time. The miners were expelled in 1976 by the federal government (Taylor 1979).

Gold would come later. In 1980, when the international market reached unusually high peaks, about 2 thousand gold miners occupied one of the edges of the Yanomami area, at 10 Furo de Santa Rosa, on the upper Uraricoera River. The Yanomami of that region, known as Yanam or Xirixana, were quick to feel the effects of the malaria epidemics that followed the invasion.”⁸

⁸ RAMOS, Alcida Rita. “O papel político das epidemias: O caso Yanomami”. *Série Antropologia*, n. 153. 1993. 21p. Ps 9-10.

Mining has caused the most intense migration wave ever recorded in the Amazon region. In 1987, 200 migrants arrived in the state of Roraima every day⁹. Eight years later, there were at least 300,000 gold miners in Brazil and 30% of the Amazonian population at the time was directly or indirectly linked to gold mining activities¹⁰. While temporary workers mined for gold only part of the year in order to purchase consumer and entertainment goods, professional gold miners were fully engaged in the activity, making prospecting trips, opening new tracks and gaining control over the gold mining areas (providing police, food and other supplies, transportation, machinery and fuel).

Along with the professional miners, other agents also began to finance mining operations, which have become a highly profitable undertaking - especially in mechanized mining, where about 70% of the profits go to the owner of the equipment - thereby forming an exceptionally wealthy elite¹¹. Public officials and other professionals also began to invest in mining, providing equipment, fuel, food and transportation. Local political leaders openly supported mining activity in the region, following the example of then Governor Ottomar de Souza Pinto (PTB-RR), who was directly opposed to the demarcation of Indigenous Territories in the state, sometimes contrary to the guidelines of the National Institute of Colonization and Agrarian Reform (Incra) and Funai¹².

Since the first attacks in the 1970s, decades of invasion by gold miners in the Yanomami Territory have followed, generating frontal attacks by invaders, gaining the proportions of a true genocide. One of the most brutal attacks on the Yanomami took place in 1993, in which a massacre conducted by Brazilian miners decimated the community of Haximu, a group of isolated people just across the Venezuelan border¹³.

The Haximu episode sparked a legal case that resulted in one of only two convictions of genocide in the history of Brazilian justice. The decision, however, was not enough to effectively hold those involved accountable, or to definitively control mining activity on the Yanomami Indigenous Territory. On the contrary: mining continued even after the demarcation of the Yanomami Indigenous Territory in 1991. Pedro Emiliano Garcia, one of the five people convicted of crimes against humanity for the Haximu genocide, became one of the many “mining area owners” in the Yanomami Territory. In 2018, an aircraft owned by him was spotted supplying clandestine mines in the region¹⁴.

13 COMISSÃO PELA CRIAÇÃO DO PARQUE YANOMAMI. “O contexto socioeconômico do massacre de Haximu”. February 3, 1994.

14 ERVA, Leão. “Polícia Federal prende em Roraima garimpeiro condenado por genocídio”. Folha de S. Paulo, November 14, 2018. Available at: <<https://www1.folha.uol.com.br/poder/2018/11/policia-federal-prende-em-roraima-garimpeiro-condenado-por-genocidio.shtml>>. Accessed on March 31, 2020.

9 MACMILLAN, Gordon. “At the end of the rainbow? Gold, land and people in the Brazilian Amazon”. Columbia University Press, New York, 1995. P. 31.

10 MACMILLAN, Gordon. Op cit., P. 1.

11 MACMILLAN, Gordon. Op cit., P. 44.

12 O ESTADO DE S. PAULO. “Roraima libera área de índios para o garimpo”. São Paulo, September 25, 1979.

MERCURY CONTAMINATION OF THE YANOMAMI AND YE'KWANA

One of the most serious effects of clandestine gold mining activity on indigenous lands is mercury poisoning among populations living close to contaminated rivers. Mercury causes permanent damage to human and animal health, and is widely used in illegal gold mining. Used to facilitate the identification of the ore during its extraction, mercury is dumped directly into the environment, along with other tailings, without any precautions as to social or environmental damages. Once the local ecosystem is contaminated, mercury penetrates the food chain, poisoning entire communities.

Two recent studies conducted by Fiocruz reveal evidence of mercury contamination. After a request made by Davi Kopenawa, leader and Yanomami shaman, Fiocruz carried out an investigation in the regions of Paapiu (where there was intense gold mining activity in the 1980s-1990s) and Waikás (where a gold mining invasion is currently taking place). The study published in 2018 revealed that even almost 30 years after mining activities had stopped in Paapiú, 6% of the population still had high levels of mercury in the body. On the other hand, in the Waikás region, where mining activity is booming, almost 30% of the population in four Ye'kwana villages and more than 90% of the population in the Yanomami village of Aracaça were contaminated by mercury¹⁵. In a study yet to be published, Fiocruz conducted a new investigation in the Maturacá region and revealed that 56% of women of reproductive age and Yanomami children under the age of five were contaminated by mercury.

¹⁵ VEGA, Claudia M. et al. "Human Mercury Exposure In Yanomami Indigenous Villages from the Brazilian Amazon". *Int. J. Environ. Res. Public Health* 2018, 15, 1051.

Mercury interferes with cellular metabolism, and one of the most harmful characteristics of this contaminant is the ability to cross the blood-brain barrier and the placental barrier, reaching the brain of young children and fetuses still forming in the mother's womb. This characteristic greatly increases the risk of serious consequences of mercury contamination, making women of reproductive age and children under five years of age into the most vulnerable groups. For every 1.0 µg of mercury found in the hair of pregnant women, there is evidence that demonstrates a loss of 0.18 points in the children's intelligence quotient (IQ), still in the intrauterine phase¹⁶.

It can therefore be said that there is a directly proportional relationship between the levels of mercury in the body of mothers and the cognitive development of children and there are no safe rates for exposure to mercury during pregnancy. The systematic presence of illegal miners, dumping mercury into traditional territory, can threaten the survival

16 VASCONCELLOS, Ana Claudia Santiago de et al. "Burden of Mild Mental Retardation attributed to prenatal methylmercury exposure in Amazon: local and regional estimates". *Ciênc. saúde coletiva*, Rio de Janeiro, v. 23, n. 11, p. 3535-3545, Nov. 2018. Available at: <http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1413-81232018001103535&lng=en&nrm=iso>. Accessed April 1, 2020.



Yanomami women and children in the Papiú region, as the hair samples collected in 2014 for mercury tests are returned. Mercury contamination is associated with illegal mining, which uses mercury to extract gold. Excess mercury is thrown directly into rivers and enters the food chain, through the consumption of river water and fish. Papiú Region, Alto Alegre, Roraima. Marcos Wesley/ISA

and well-being of an entire generation, compromising the physical and mental integrity, health and livelihood of the population.

Brazil is a signatory to the Minamata Convention on Mercury, which came into force in the country in August 2018. In Article 7, the Convention states that State Parties must adopt measures to reduce or eliminate the use of mercury in artisanal and small-scale gold mining, and establishes the requirement for a national action plan for this type of mining if it takes place.

The Convention also establishes guidelines in relation to the production and sale of mercury, its emission and release, as well as treatment of contaminated areas, health issues and others. The Convention is still being implemented in the country, however, and the current control mechanisms related to the use of mercury are fragile or non-existent.



Brazilian Air Force Helicopter transfers a Yanomami from the village of Homoxi to the Surucucu health post. 10% - 15% of the Yanomami died as a result of the invasion of illegal miners between 1985 and 1993. Credit: Charles Vincent -ISA

CONSTITUTIONAL AND INTERNATIONAL OBLIGATIONS OF THE BRAZILIAN STATE IN RELATION TO INVASIONS OF INDIGENOUS TERRITORIES

Brazilian law obligates the Brazilian State to guarantee the territorial integrity of indigenous lands against invasions and to take measures to ensure their permanent possession by indigenous peoples. **These provisions are contained in Article 231 of the Federal Constitution of 1988, recognizing indigenous peoples' customary rights over the lands they traditionally occupy, and to maintain and revitalize their social organization, customs, languages, beliefs and traditions. The Union is responsible for demarcating, protecting, and enforcing respect for all of the assets on indigenous lands in the country.**

The continuation of mining activities in the Yanomami Indigenous Territory and the resulting epidemics represent the violation of a series of rights of the Yanomami and Ye'kwana peoples as recognized in the Federal Constitution, as well as in international instruments such as the United Nations Declaration on the Rights of Indigenous Peoples, and the 1966 International Covenants - on Civil and Political Rights, and Economic, Social and Cultural Rights. We highlight among them the rights to life, physical and mental integrity; to health; to the practice and revitalization of cultural traditions and customs; to subsistence; to traditionally occupied territories and resources within them; and to the conservation and protection of the environment and productive capacity of their lands.

Ariabu village with the Serra das Cachoeiras in the background, Yanomami Indigenous Territory
© Marcos Amend/2017



The Brazilian State's inaction in controlling pressures on the Yanomami Indigenous Territory and in maintaining its territorial integrity, as well as in protecting the life and health of the Yanomami and Ye'kwana people also violates obligations under Convention 169 of the International Labor Organization (ILO) , namely: to develop coordinated actions for the protection of the rights of indigenous peoples (Arts. 2 and 3); to adopt special measures to safeguard the people, institutions, goods, cultures and environment of the peoples concerned (Art 4); and recognition and guarantee of definitive possession over traditional territory, including through sanctions and measures to prevent invasion and unauthorized use (Arts. 13, 15, and 18).

The Yanomami, like other indigenous peoples, are among the groups most vulnerable to the impacts of Covid-19 and would be severely affected by its advance. They must be protected urgently, as they face the risk of genocide, with the complicity of the Brazilian State.

Something needs to be done. Now!

ANNEX 1

Health Post	< 1 year	1-14 years	15-29 years	30-45 years	46-60 years	> 60 years
Ajarani	3	22	13	7	3	1
Ajuricaba	14	199	103	49	24	21
Alto Catrimani	10	134	59	29	23	9
Alto Mucajai	20	297	157	77	41	26
Alto Padauri	11	90	48	34	23	7
Apiáú	5	59	36	11	7	12
Aracá	6	110	50	26	18	14
Aratha-U	22	322	171	75	50	42
Auaris	151	1.928	951	541	266	139
Baixo Catrimani	11	84	41	20	6	9
Baixo Mucajai	10	176	86	37	18	7
Balawau	25	337	188	106	94	63
Cachoeira do Araçá	3	45	28	12	7	9
Demini	12	98	53	34	10	12
Ericó	10	151	90	48	25	11
Hakoma	25	310	182	82	38	28
Haxiu	37	437	227	100	60	32
Homoxi	9	150	58	26	21	12
Inambú	11	242	137	71	32	26
Maia	21	271	156	106	29	40
Maloca Paapiu	18	226	113	62	24	22
Marari	23	396	230	121	64	43
Marauiá	80	1.143	689	353	180	110
Maturacá	51	985	530	276	155	92
Médio Padauri	23	305	144	101	50	24
Missão Catrimani	31	410	253	121	45	53
Novo-Demini	29	323	180	102	49	58
Paapiu	4	131	100	32	29	12
Palimiú	32	454	201	110	52	44
Parafuri	16	238	120	55	28	16
Sauba	10	161	72	47	30	21
Surucucu	83	1.173	641	320	142	87
Toototobi	21	288	163	75	65	33
Uraricoera	8	141	76	25	20	12
Waikás	3	82	42	30	8	14
Waputha	27	376	194	79	53	19
Xitei	62	933	482	221	142	57



Clandestine airstrip near the Couto Magalhães River illegal mining area, Yanomami Indigenous Territory.
Credit: Chico Batata/Greenpeace



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