

**What is the real
socioeconomic impact
of gold and diamond
exploration in the Amazon?**



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Study carried out by Instituto Escolhas

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The real impact of gold and diamond extraction

3 years

is the maximum period during which the impacts of gold and diamond extraction on the **health** indicator of the municipalities of the Legal Amazon last

5 years

is the maximum period during which the impacts of gold mining and diamond extraction on the **education** indicator of the municipalities of the Legal Amazon last

5 years

is the maximum period during which the impacts of gold and diamond extraction on the **per capita GDP** of the municipalities of the Legal Amazon last

5 years

Is the average period during gold and diamond extraction causes an **increase in deforestation** in the municipalities of the Legal Amazon

Introduction

Gold and diamond exploration does not bring significant advances to the population in municipalities of the Legal Amazon¹. The results of this unprecedented study show that the effects on indicators such as health, education and GDP per capita are brief--they cease to exist between three and five years,² and thus they do not bring development to the region.

With only momentary effects on the indicators, the extraction of these minerals is incapable of transforming the local reality in the long term, and it will keep the region poor, sick, and uneducated.

This activity, based strictly on natural resource withdrawal, is unable to change the economic dynamics so as to generate lasting benefits, which depend on knowledge and innovation, and by no means will it compensate for the negative impacts that remain in place, such as deforestation, mercury contamination of rivers and populations, social disorganization, violence, slave labor, and prostitution.

This study, carried out by an interdisciplinary team of specialists in regional development, was based on a robust methodology for the evaluation of public policies. It managed to assess the isolated effects of gold and diamond extraction on the socioeconomic situation of all municipalities in the Legal Amazon.

This was possible due to the use of the Generalized Propensity Score to compare municipalities and a dose-response function to assess the effects of activity--both calculated using Stata software.

Initially, all municipalities in the Legal Amazon in which gold and diamonds were extracted between 2005 and 2016 (treatment group) were selected. These municipalities were grouped according to the number of years during which they were exposed to the activity (from one to 12 years) and then compared to others, also within the Legal Amazon, in which the activity did not take place (control group).

The computer simulation was careful to compare municipalities with and without mining, provided their socioeconomic situation was similar, so as to ensure that the effect of gold and diamond extraction was captured in an isolated manner.

For each of the municipalities in which gold and diamond extraction took place (73 municipalities), algorithms identified its ideal pair, but without mining, in order to carry out the comparison. Control variables (covariates), such as the municipalities' collection capacity, physical capital and violence, among others, were also included in the calculations, eliminating the risk that the indicators of the control group municipalities would be influenced by the effect of other economic activities.

Thus, the study assessed municipalities with and without extractive activity and with a similar socioeconomic situation in 2005, as well as their trajectories until 2016, therefore capturing the isolated effect of gold and diamond extraction on selected indicators of health, education, GDP per capita, employment and income, and deforestation.

It is in light of these results, which reveal the temporary impact of extractive activity and debunk the illusion of wealth generation and development, that initiatives such as those that intend to permit mining within Indigenous Peoples' Lands (Bill 191/2020³) or to legalize mining in irregular situation must be evaluated, since the findings indicate that these activities do not bring real benefits to the population.



Aerial view of an area destroyed by illegal mining in the Amazon. Photo: Parallaxis

By shedding light on the fact that gold and diamonds will not eliminate the region's poverty, disease and lack of education, the study also sparks discussion about economic alternatives that could, in fact, generate wealth and lasting well-being.






¹ Defined according to the Brazilian Institute of Geography and Statistics (IBGE).

² They are no longer statistically significant.

³ Bill 191, presented on February 6, 2020 by the Executive Branch, intends to regulate paragraph 1 of article 176 and paragraph 3 of article 231 of the Constitution, so as to establish the conditions for the exploration and mining of mineral and hydrocarbon resources and for the use of water resources to generate electricity in Indigenous Lands.

Temporary effect

RESULTS OF THE SOCIOECONOMIC IMPACT OF GOLD AND DIAMOND EXTRACTION IN MUNICIPALITIES OF THE LEGAL AMAZON

	Indicator	Minimum time the activity must exist in the municipality in order for an impact to be observed:	For how long is the impact observed after the activity starts?	What is the maximum period during which the impact lasts?
	Health	At least 6 years	Up to 9 years	Up to 3 years
	Education	At least 4 years	Up to 9 years	Up to 5 years
	GDP per capita	At least 2 years	Up to 7 years	Up to 5 years
	Deforestation	At least 2 years	Up to 7 years	Up to 5 years
	Employment and income	At least 3 years	The entire period	The entire period

Source: prepared by the authors. Note: the results reflect all groups of municipalities with gold and diamond extraction. In the employment and income indicator, the impact was verified for the analyzed period of 12 years.



HEALTH

The results showed that, for the health indicator, some of the effect was only observed due to mineral extraction for, at most, three years. This was a momentary effect, detected statistically starting from six years during which activity occurred in the municipalities, and only up to nine years. That is, the maximum period for which some effect was observed was just three years.



EDUCATION

In the case of education, the situation was not very different. The effect on municipalities that were exposed to mining activity was detected for a maximum of five years. The simulations confirmed the effect from four years after the municipalities were exposed to the activity, and it ceased to be present after nine years. It was also a temporary impact.



PER CAPITA GDP

For per capita GDP, the impact was also brief. Gold and diamond extraction only caused some effect on this indicator for a maximum of five years. The effect was confirmed by the simulations starting from two years since the activity started in the municipalities and, even so, after seven years the effect was no longer detected.



EMPLOYMENT AND INCOME

In the case of the employment and income indicator, the impact was observed in municipalities that were exposed to mineral extraction for at least three years and remained for the entire period analyzed: 12 years. However, it is necessary to question the quality of employment generated, since, in the last decade, wages in the mineral sector decreased. In 2010, the sector's average wage in Brazil and the Legal Amazon was five minimum wages. By 2019, it was 4.4 minimum salaries⁴.

In addition, the mineral extraction industry is among those that employ the least along the productive chain. For every 100 direct jobs in the sector, 86 jobs are created along the chain. In the manufacturing sector, for example, for every 100 direct jobs, another 480 are created. In the latter, there is a multiplier effect in the chain, which is not the case with the mineral extraction industry, since the number of jobs along the chain is less than the number of direct jobs⁵.

DEFORESTATION

With regard to deforestation, the results confirmed that gold and diamond extraction increased forest loss in the municipalities of the Legal Amazon in which this activity took place. The deforestation attributed only to this activity, in isolation, was statistically confirmed after two years of exposure to the activity, ceasing to exist after seven years. That is not to say there was no deforestation before two years, but rather that, statistically, it was possible to attribute the forest loss to mining based on the two years during which the activity took place in the municipalities.

Thus, this study generates a complementary result to what can already be captured by the DETER alert system from the National Institute for Space Research (INPE), which includes alerts for the deforestation caused by mining and statistically confirms the particular effect of gold and diamond extraction on deforestation in those municipalities over time.

The study statistically proves that gold and diamond mining causes an increase in deforestation in municipalities of the Legal Amazon. And what has already been cleared, remains cleared.

⁴ According to data from the Annual List of Social Information (Relação Anual de Informações Sociais - RAIS), from the Ministry of Economy.

⁵ According to a study by Carvalho and Carvalho (2018), "Analysis of the Multiplier Effects Indexes and Backward and Forward Linkages from Income, Product and Employment: An Approach based on Brazil's Social Accounting Matrix," which analyzed 12 sectors, among which the mineral extractive industry sector occupied the 11th position in terms of job creation along the production chain.



Understand how the socioeconomic impact was calculated



1. To understand the impact of gold and diamond extraction on the socioeconomic status indicators of municipalities in the Legal Amazon, a

robust statistical methodology for the assessment of public policies was adopted. This methodology allows for the analysis of an activity in an isolated way, that is, despite other activities that may occur in the municipalities and that can also change the indicators.



2. For this, computational simulations were carried out with Stata software, using the Generalized Propensity Score and dose-response function.



3. First, all municipalities in the Legal Amazon in which gold and diamond extraction took place were selected and identified based on the payment of the Financial Compensation for Exploration of Mineral Resources (CFEM)⁶⁷, collected for gold and diamonds during the period 2005-2016⁸ (73 municipalities).



4. Those municipalities were grouped according to the number of years during which the activity occurred, and they were assigned a variable treatment group (treatment group). For example, in municipalities in which extractive activity took place for the entire period analyzed (12 years), the variable is equal to one and, in municipalities without activity, the variable is zero.



5. Next, through the use of algorithms, for each of the municipalities in which gold and diamond extraction took place,

other municipalities in the Legal Amazon, but without minerals extraction and with similar socioeconomic conditions, were identified in order to carry out a comparison (control group).

6. The algorithms found the ideal pairs for the comparison⁹, taking care to compare only municipalities with and without mining, provided that they had a similar baseline socioeconomic situation¹⁰. This was essential to ensure that the effects of gold and diamond extraction were captured in isolation. In addition, control variables (covariates), such as the municipalities's tax collection capacity, other natural resources, physical capital, violence etc. were also included in the calculations, ensuring that compared municipalities were, in fact, similar.



7. To assess the existence of impacts arising from gold and diamond extraction, a dose-response function was applied

to the treatment group (municipalities with gold and diamond extraction) and the control group (similar municipalities, but without mineral extraction) was used for comparison. That is, in light of the existence of mining activity for a given number of years (*dose*), was there an impact (*response*)? For how long was it statistically significant?



8. Thus, pairs of municipalities in the Legal Amazon, with and without gold and diamond extraction, and with similar socioeconomic situations, were compared,

and their trajectories were evaluated so as to understand the isolated effect of extractive activity on the indicators of municipalities that were exposed to this activity.

9. This assessment was carried out for municipal health, education, per capita GDP, employment and income,

and deforestation indicators. The results reflect the set of municipalities evaluated (73 municipalities) as a whole, rather than the reality of individual municipalities.

10. Impacts were calculated for per capita GDP, using IBGE municipal data. For health, education, and employment and income indicators, data from the FIRJAN Municipal Development Index (IFDM), which has an annual historical series for all Brazilian municipalities¹¹. As for deforestation, the analysis was based on data from PRODES, from INPE.



Ibama deactivates illegal mining machines in the Munduruku Indigenous Land, in Pará. Photo: Vinicius Mendonça / Ibama.

⁶ CFEM, currently regulated by Law 13540/2017, is paid to the Federal Government for the economic use of mineral resources. For gold, it corresponds to 1.5% and, for diamond, 2% of the gross sales revenue (after deducting taxes) or, if it comes from a gold mining permit, on the value of the first acquisition. Depending on the operation, CFEM can also be applied to gross revenue from consumption or export revenues. Most of the collected amount goes to the municipalities: 60% to the municipalities where production occurs and 15% to those affected by the activity. Of the remainder, 15% go to states where production takes place, 7% to the regulatory agency, 1% to the National Fund for Scientific and Technological Development (FNDCT), 1.8% for the Mineral Technology Center (Cetem) and 0.2% for the Brazilian Institute for the Environment and Renewable Natural Resources (Ibama).

⁷ Between 2003 and October 2020, the collection of CFEM in the Legal Amazon for diamonds was only 0.17% of the amount collected for gold. CFEM data by municipality is reported at the end of the document.

⁸ Period analyzed according to the availability of data for the evaluated indicators.

⁹ Ideal pairs are not always a single municipality, since the computer simulation can find groups of municipalities that are used as control of one in treatment.

¹⁰ State capitals were not included in the simulations in order to ensure the necessary comparability.

¹¹ IFDM monitors indicators from official public statistics. The employment & income indicator includes: generation of formal employment, market formalization rate, income generation, real wages in the formal labor market, and Gini index of income inequality in formal work. The education indicator includes: attendance in early childhood education, dropout in elementary school, distortion of grade-grade in elementary school, teachers with higher education in elementary school, the average of daily class hours in elementary school, and the result of the Basic Education Development Index (IDEB) in elementary school. The health indicator includes: proportion of adequate prenatal care, deaths by unspecified causes, infant deaths from preventable causes, and primary care-sensitive hospitalization.

TREATMENT GROUP - MUNICIPALITIES OF THE LEGAL AMAZON IN WHICH GOLD AND DIAMONDS WERE EXTRACTED BETWEEN 2005 AND 2016 AND DURATION OF ACTIVITY IN YEARS

1 year	Alenquer-PA, Almas-TO, Amapá-AP, Anapu-PA, Belém-PA, Borba-AM, Caracaraí-RR, Cumaru do Norte-PA, Espigão D'Oeste-RO, Ferreira Gomes-AP, Itaúba-MT, Laranjal do Jari-AP, Pedra Preta-MT, Pontal do Araguaia-MT, Sinop-MT, Água Azul do Norte-PA
2 years	Boa Vista-RR, Jaru-RO, Juruena-MT, Jutaí-AM, Monte do Carmo-TO, Novo Aripuanã-AM, Parauapebas-PA, Urupá-RO
3 years	Chapada da Natividade-TO, Colíder-MT, Curionópolis-PA, Manaus-AM, Nova Santa Helena-MT
4 years	Oiapoque-AP, São Paulo de Olivença-AM
5 years	Apiacás-MT, Guarantã do Norte-MT, Macapá-AP, Natividade-TO, Nortelândia-MT, Nova Bandeirantes-MT, Nova Guarita-MT, Nova Xavantina-MT, Porto Esperidião-MT, Porto Grande-AP, Rosário Oeste-MT, Senador José Porfírio-PA
6 years	Almeirim-PA, Altamira-PA, Apuí-AM, Carlinda-MT, Godofredo Viana-MA, Mazagão-AP, Nova Canaã do Norte-MT, Nova Mamoré-RO, Novo Mundo-MT, Paranaíta-MT, Terra Nova do Norte-MT, Várzea Grande-MT
7 years	Humaitá-AM, Jacareacanga-PA, Matupá-MT, Novo Progresso-PA, Pontes e Lacerda-MT, Rio Maria-PA
8 years	Alta Floresta-MT, Cuiabá-MT, Floresta do Araguaia-PA, Porto Velho-RO
9 years	Calçoene-AP, Nossa Senhora do Livramento-MT, Nova Lacerda-MT
10 years	-
11 years	Itaituba-PA, Pedra Branca do Amapari-AP
12 years	Peixoto de Azevedo-MT, Poconé-MT, Vila Bela da Santíssima Trindade-MT

CFEM COLLECTION VALUES FOR GOLD AND DIAMONDS IN THE MUNICIPALITIES OF THE LEGAL AMAZON (R \$) (2003-2020)

COLLECTION FOR GOLD			COLLECTION FOR DIAMONDS		
Municipality	CFEM (R\$)	% Total	Município	CFEM (R\$)	% Total
Itaituba, PA	93.322.993	22,2%	Juína, MT	268.175	38,5%
Pedra Branca do Amapari, AP	77.315.646	18,4%	Torixoréu, MT	139.793	20,0%
Godofredo Viana, MA	33.500.556	8,0%	Chapada dos Guimarães, MT	101.232	14,5%
Vila Bela da Santíssima Trindade, MT	33.262.883	7,9%	Poxoréu, MT	71.946	10,3%
Peixoto de Azevedo, MT	24.040.894	5,7%	Guiratinga, MT	56.467	8,1%
Poconé, MT	20.308.989	4,8%	Nortelândia, MT	29.315	4,2%
Pontes e Lacerda, MT	15.416.208	3,7%	Itaituba, PA	14.652	2,1%
Nossa Senhora do Livramento, MT	13.849.038	3,3%	Diamantino, MT	4.500	0,6%
Nova Xavantina, MT	13.700.874	3,3%	Espigão D'Oeste, RO	4.330	0,6%
Nova Lacerda, MT	10.929.197	2,6%	Ribeirãozinho, MT	3.695	0,5%
Novo Progresso, PA	9.820.768	2,3%	Alto Paraguai, MT	2.403	0,3%
Matupá, MT	9.495.519	2,3%	Itiquira, MT	611	0,1%
Porto Velho, RO	9.386.432	2,2%	Apuí, AM	256	0,0%
Other municipalities	55.437.293	13,2%	-	-	-
Total	419.787.291	100%	Total	697.375	100%

Source: National Mining Agency. Note: 1) values deflated for 2020 by the IPCA. 2) Year 2020: only until October.



Ibama deactivates illegal mining machines in the Munduruku Indigenous Land, in Pará. Photo: Vinícius Mendonça / Ibama.

See the full study at:

<http://escolhas.org/biblioteca/estudos-instituto-escolhas/>

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