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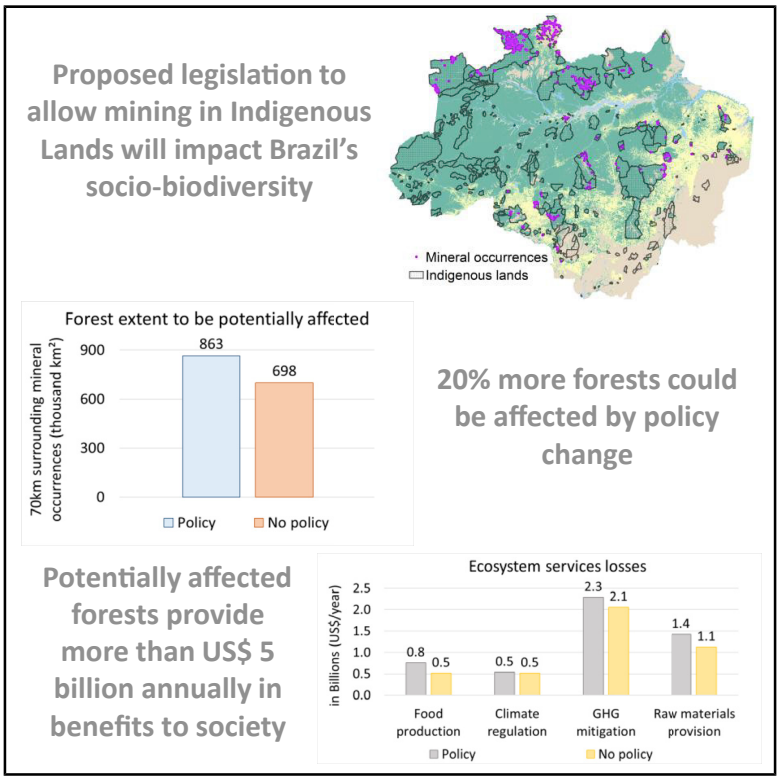
# Proposed Legislation to Mine Brazil's Indigenous Lands Will Threaten Amazon Forests and Their Valuable Ecosystem Services

## Graphical Abstract




## Highlights

- Mining within Indigenous Lands may impact 20% more forests than the current scenario
- Proposed bill could affect forests providing at least $5 billion in ecosystem services annually
- Impact assessments must comply with best practices to safeguard ecosystems and people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## In Brief

The impacts of proposed legislation to allow mining within Indigenous Lands in the Brazilian Amazon could affect a large extent of forests—up to 20% more than the potentially affected area under current trends of mining expansion. These forests are home to 222 culturally unique indigenous groups, and it is estimated to provide more than US $5 billion annually in benefits for society; their loss will impact Brazil's socio-biodiversity.


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Article

# Proposed Legislation to Mine Brazil's Indigenous Lands Will Threaten Amazon Forests and Their Valuable Ecosystem Services

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**SCIENCE FOR SOCIETY** In February 2020, Brazilian President Bolsonaro signed a bill (PL 191/2020) that would permit mining inside Indigenous Lands, a unique category of protected area covering 23% of the Legal Amazon. In this study, we assess the potential impacts of this proposed legislation. We find that this proposal threatens 863,000 $km^2$ of Amazon forests. These forests are home to 222 culturally unique indigenous groups and provide more than US $5 billion annually to society. The social and environmental impacts caused by new mines will unlikely be mitigated given the lack of environmental requirements and safeguards to indigenous rights in the current proposal. This policy could have long-lasting negative effects for Brazil's socio-biodiversity.

## SUMMARY

A recent proposal to regulate mining within Indigenous Lands (ILs) threatens people and the unique ecosystems of Brazil's Legal Amazon. Here, we show that this new policy could eventually affect more than 863,000 $km^2$ of tropical forests—20% more than under current policies—assuming all known mineral deposits will be developed and impacts of mining on forests extend 70 km from lease boundaries. Not only are these forests home to some of the world's most culturally diverse communities, they also provide at least US $5 billion each year to the global economy, producing food, mitigating carbon emissions, and regulating climate for agriculture and energy production. It is unclear whether new mines within ILs will be required to compensate for their direct and indirect environmental and social impacts but failing to do so will have considerable environmental and social consequences.

## INTRODUCTION

On February 5, 2020, Brazil's President Bolsonaro signed a bill (PL 191/2020) that will permit mining inside Indigenous Lands (ILs)—a unique category of protected area (PA)[1] covering 1.2 million $km^2$ (23%) of the Legal Amazon. ILs are home to 222 indigenous groups speaking a combined 160 languages.[2] The current political context is unfavorable to indigenous people[3,4] and, if approved by Congress, the proposed policy changes have the potential to not only permanently transform the lives of indigenous communities,[5,6] but also negatively impact a large extent of biodiverse forests and the ecosystem services they provide.[3]

Along with Brazil's other PA categories, such as national parks and biological reserves, ILs not only safeguard indigenous people and their traditional knowledge, but also protect ecosystems.[1,7,8,9] There are 332 officially designated ILs in the Brazilian Amazon, with another 92 in earlier stages of legal and administrative approval (see Note S1 and Figure S1).[3] However, many of these areas are also known to contain valuable undeveloped mineral deposits (including a range of commodities, such as gold, copper, and iron ore; see Note S1 and Table S1). Under current legislation, mining inside ILs requires Congressional authorization—a Constitutional shield that has effectively deterred all industrial mining within these sites to date, albeit far less effective at deterring illegal small-scale mining activities.

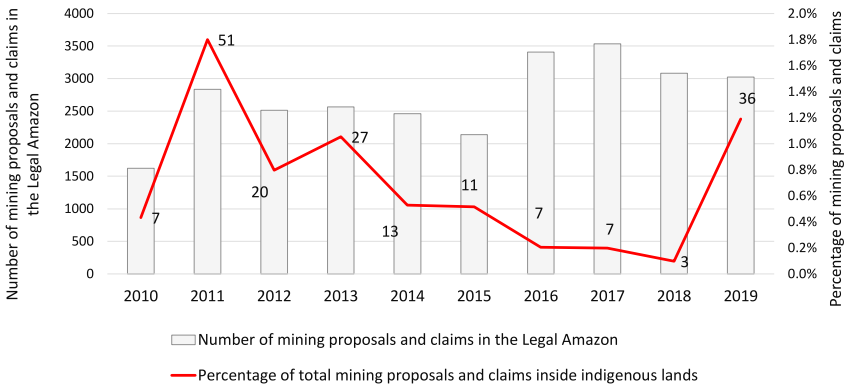


**Figure 1. Mining Proposals and Claims Registered with the National Mining Agency (Accessed in February 2020)**

The bars indicate the number of mining proposals and claims in the Legal Amazon per year and the red line indicates number and the percentage of total proposals inside Indigenous Lands. Source: Mining claims (National Mining Agency, 2020); Indigenous lands (FUNAI, 2020).

Mining can affect forests through various pathways, either by directly clearing vegetation to establishing open pits, mineral processing plants, and ancillary installations,[10] or indirectly due to the need to build infrastructure to access mine sites and transport minerals. Such infrastructure facilitates access to otherwise barely accessible land and can result in cumulative impacts from multiple mining operations and other surrounding land users.[11] In the Brazilian Amazon, mining has been found to indirectly affect forests up to 70 km from large-scale mining sites.[12] Indeed, this offsite deforestation was 12 times larger than the mines' local footprint between 2005 and 2015.

Forest loss also affects valuable ecosystem services.[13] Tropical forests provide benefits to society as a whole, for example, by storing carbon[14] and regulating regional and global climate;[15] providing food and raw materials, such as nuts and rubber,[13] for both domestic use and export; securing freshwater quality and quantity;[16] and providing recreational opportunities.[16] All these ecosystem services, along with a unique socio-biodiversity[17] (i.e., the biological and cultural diversity sheltered by Amazonian ecosystems, as well as the products obtained by traditional extractives activities), may be affected by future policy changes that could unleash mineral exploration and extraction across the Brazilian Legal Amazon.

In this study, we assess the impacts of the proposed policy[18] by quantifying associated threats to forests and their ecosystems. We outline what is needed to safeguard indigenous rights, forest biodiversity and the services these places provide, for consideration by the National Congress when should they vote on this bill. In the following sections, we present our results and discuss foreseeable effects of the proposed policy change.

## MINING IMPACTS ON FORESTS AND ECOSYSTEM SERVICES

### Current Context of Mining within Indigenous Lands

This is not the first time a policy change has seen mining interests threaten Brazil's PAs—many previous bills have been presented (PL 1610/1996;[19] PL 3642/2012)[20] (see Note S2). However, the exponential growth in mining proposals inside ILs in 2018 (Figure 1) suggests that prospectors have anticipated and planned to exploit this opportunity in recent years.

We found that 115 ILs (31%) contained at least one claim or mining proposal and most were already under application for exploration (the initial stage of mineral permit process) (Figure 2).

In addition to legal mining activities, we found 148 ILs (45%) that already contain illegal mining activities (Figure 2), which may also eventually be influenced by an increase in legal operations. These activities may impact uncontacted and currently isolated groups living within these ILs, requiring a special attention in future research.

### Impacts on Forests and Their Ecosystem Services

If all 4,600 known mineral deposits and known occurrences outside current PAs were to be developed, and assuming indirect impacts extent up to 70 km from mining sites, 698,000 $km^2$ of forest may be affected by mining (Figure 3). However, the approval of the proposed policy (i.e., also permitting mining inside ILs) could increase this area by 20% (up to 863,000 $km^2$; Figure 4). Using a more conservative 10 km buffer to capture indirect effects reduces the total estimates of affected forests under our "policy" and "no policy" scenarios to 222,000 and 182,000 $km^2$, respectively; but this still represents a 22% increase in the area affected by the policy change.

Considering the provision of only four ecosystem services (food production, raw materials provision, greenhouse gas [GHG] mitigation, and climate regulation), we estimated that affected forests provide at least US $5 billion of value each year to the global economy (Figure 5). Our analysis reveals particularly large consequences for GHG mitigation reaching more than US $2.2 billion annually of losses. We found that raw materials provisions of rubber and timber would have considerable monetary losses (up to US $1.4 billion) in the scenario of policy implementation.

### Other Factors Influencing the Impacts

Two major factors need to be considered to fully appreciate the implications of the proposed policy on forests and ecosystem services. Firstly, the construction of transportation infrastructure and the emergence or growth of urban centers will add to the effects of mining on forests and ecosystems. Mine output (usually a concentrate, i.e., an enriched product for further metallurgical or industrial processing) requires bulk transportation to reach markets and in some cases construction of large mines requires a large labor force, hence attracting many migrants in search of jobs or opportunities. The size and impacts caused by infrastructure may change according to the commodity (see Note S1; Table S2; Figure S3).

Secondly, most ILs are located in remote areas, sheltering some of the world's most pristine ecosystems[1] and Brazil's socio-biodiversity (see Note S1; Table S3). Establishing even one new mine in these areas could trigger a cascade of further forest

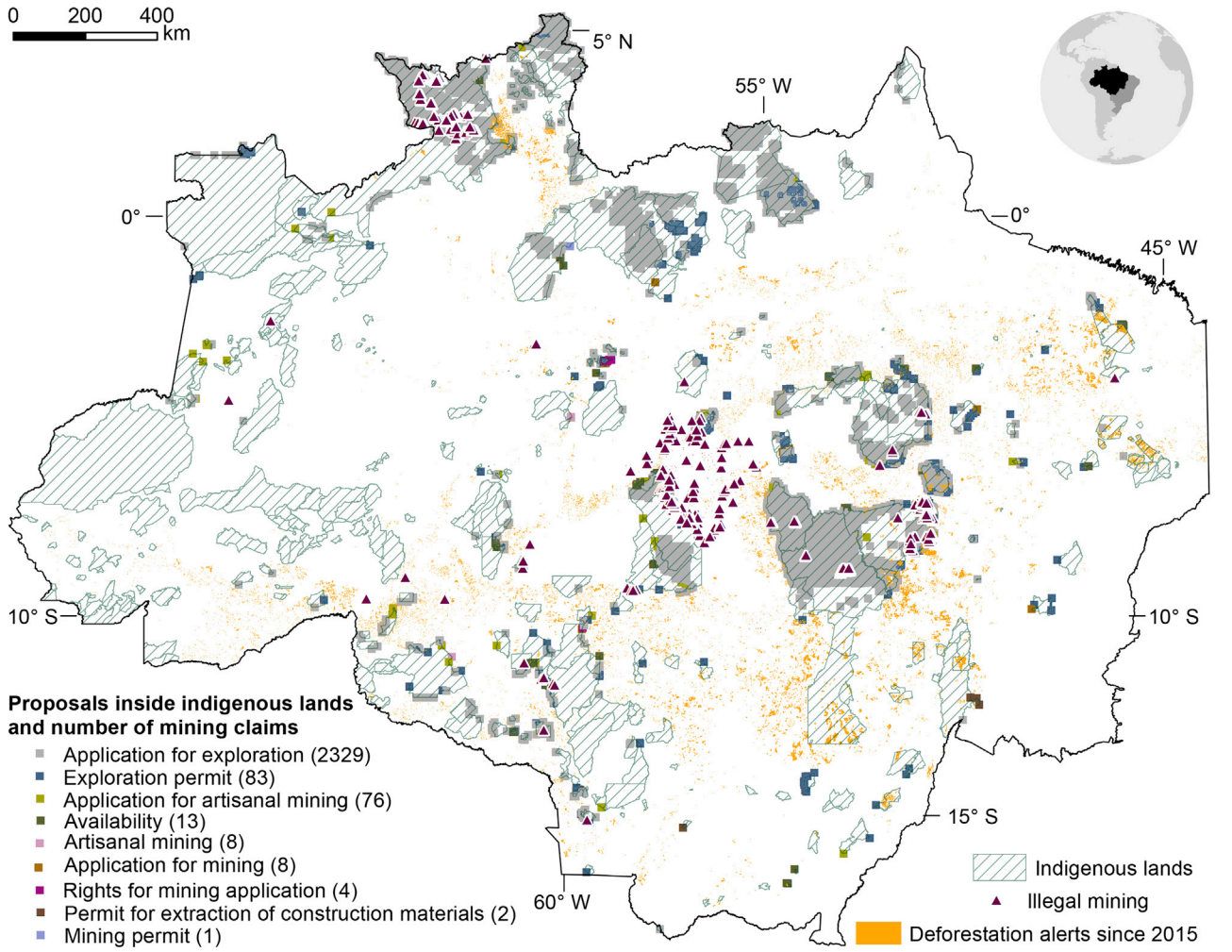


**Figure 2. Current Mining Proposals and Claims (Accessed February 2020) inside Indigenous Lands and the Location of Illegal Mining (Accessed April 2020)**

Source: Mining proposals and claims (National Mining Agency, 2020); Indigenous lands (FUNAI, 2020); Illegal mining (RAISG, 2020); Deforestation alerts (DETER-B, 2020).

loss due to growth-inducing infrastructure,[21] and potentially send many yet-to-be discovered species and ecosystems to extinction in addition to degrading traditional livelihoods.

In addition to the impacts of this proposed policy on forests and ecosystems, the presence of illegal gold miners within ILs and their related activities trigger other impacts. These additional pressures include degradation and pollution of the environment with mercury,[22] and potentially more worrisome, transmission of diseases,[23] such as the COVID-19.[24] Given that the policy changes would increase the outside access to indigenous groups, a public health problem has potential to be intensified.

Moreover, there is currently a push to dismantle policies that protect the rights of indigenous groups,[4,25] as exemplified by recent government initiatives. Changes in the Ministry of Environment and National Indian Foundation-FUNAI's policies follow an extensive roadmap of setbacks:[3,25] the emptying of the institution's functions[26] and budget,[4,25] granting of environmental authorizations with no indigenous consultation,[25] a willingness to comply with requests for the extinction or reduction of PAs,[4] and defending non-compliance of the law against illegal logging and mining.[27] The faulty interpretation that the rights of indigenous people currently depend on the completion of the IL demarcation process confronts the Constitution and ignores the jurisprudence of the Supreme Court.[28]

## MANAGEMENT AND MITIGATION REQUIREMENTS

The proposed bill does not contain any environmental or social safeguards and is silent about whether mining within ILs will require Environmental Impact Assessment (EIA). Considering the current regulatory status of mining claims in the Legal Amazon, less than 2% require a comprehensive EIA for licensing (see Note S3; Tables S4 and S5). Developing a mine in some claims may require only a simplified environmental assessment and licensing process,[29] while other types of requirements are currently uncertain (see Note S3; Tables S4 and S5).[30]

While the proposed policy does suggest that some financial compensation will be provided by companies to indigenous associations and leaderships for the use of the ILs, there are no

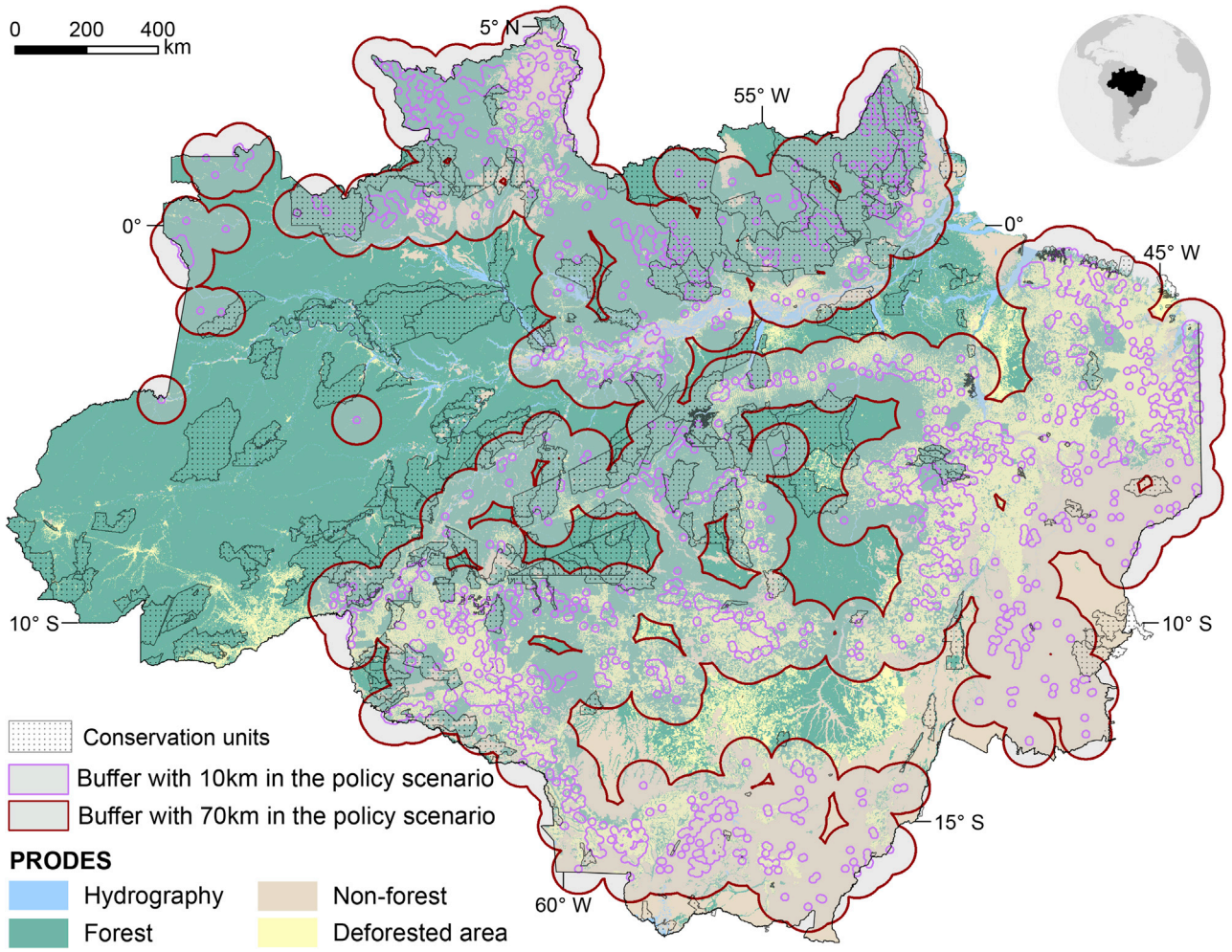


**Figure 3. Forest Cover and the Extent of Forests that Could Be Affected in the Policy Scenario**

Buffers of 10 and 70 km surround mining occurrences inside ILs and exclude areas outside other conservation units. Sources: Forest cover (PRODES, 2018); Indigenous lands (FUNAI, 2020); Conservation units (MMA, 2020).

guarantees to ensure free, prior, and informed consent (FPIC), as established by the UN Declaration on the Rights of Indigenous Peoples.[31] Under the terms of PL 191/2020, if the application for exploration is within a non-regulated IL, it is not mandatory to consult the impacted communities. It is also unlikely that the compensation payment, calculated on the basis of net revenues and commodity type, will come even close to the value of ecosystem services lost due to mining (Figure 5).

We urge those involved in designing and approving this bill to seriously consider the impact it could have on ecosystems and people—not only indigenous people, but the society—as impacts will not be restrained to the boundaries of ILs because many traditional communities could be displaced. If approved, at the very least, a mechanism for assessing and mitigating impacts must be established and compliant with best practice.[32] All new mines must require a comprehensive EIA, including mitigation plans that comply with the mitigation hierarchy. Explicitly requiring FPIC would not only contribute to safeguard the rights of indigenous people but also benefit environmental protection and mitigation outcomes if linked to EIAs.

While Brazil decides on whether or not approve this bill, environmental NGOs can build awareness of these threats both in the country and internationally in order to protect such valuable environmental resources. Just like proposals to open Renca (National Reserve of Copper and Associates in Brazil)—a mineral rich biodiverse region—to mining were overturned,[11] the values of ILs can too be protected from unchecked long-term damage.

## EXPERIMENTAL PROCEDURES

### Resource Availability

#### *Lead Contact*

Further information and requests for the datasets should be directed to and will be fulfilled by the Lead Contact, Juliana Siqueira-Gay (siq.juliana@gmail.com).

#### *Materials Availability*

This study did not generate new unique materials.

#### *Data and Code Availability*

Data on mining claims and proposals were accessed from the official spatial database of the Brazilian government's National Mining Agency (AMN): http://sigmine.dnpm.gov.br/webmap/. These data provide the current status (accessed on February 10, 2020) of all mineral claims and proposals covering

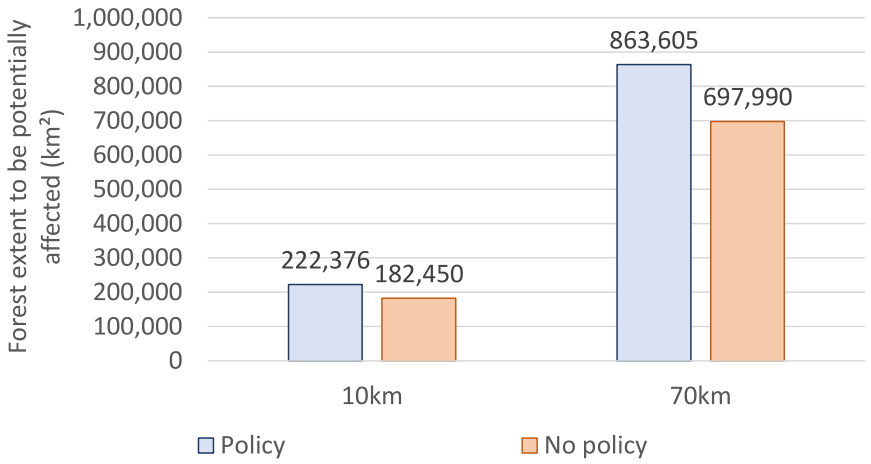


**Figure 4. Consequences of Mining All Known Mineral Deposits on Forest Extent under Two Alternative Scenarios—No Policy and Policy Implementation**

The area of forests potentially affected by mining increased by 20%, considering both an upper (70 km) and lower (10 km) buffer of indirect impacts.

the Brazilian territory. The data on mining deposits and occurrences were provided by the Brazilian Geological Survey (CPRM): http://geosgb.cprm.gov.br/. The PA's limits of sustainable use and full protection units were obtained from the Environmental Ministry website: http://mapas.mma.gov.br/i3geo/datadownload.htm. The Indigenous Lands boundaries are from the official database of the National Foundation of Indigenous People, containing the polygons, the current status, types, and ethnicity of each land: http://www.funai.gov.br/index.php/shape. The forest cover was provided by the National Institute for Space Research (INPE): http://terrabrasilis.dpi.inpe.br/. The spatial database of ecosystem services is from the study of Strand and colleagues[13] available at https://csr.ufmg.br/amazones/. The illegal mining information is a data summary from different sources (such as studies and management plans) provided by Amazon geo-referenced socioenvironmental information network (RAISG): https://www.amazoniasocioambiental.org/en/.

### Analysis of Impacts on Forests and Ecosystem Services

We calculated the total number of claims made each year between 2010 and 2019 and determined the proportion of these claims that occurred inside ILs. To determine current threats, we overlaid ILs with spatial data on legal mineral claims, illegal mining activities, forest cover, deforestation trajectories, and ecosystem services.

We investigated two alternative scenarios for comparison with the current situation: (1) without policy implementation ("no policy"): developing all known mineral deposits and occurrences outside PAs and (2) "policy implementation": developing all mineral deposits and occurrences outside other PAs (conservation units of full protection and sustainable use) but permitting development inside ILs. For both scenarios, we quantified the area of forests potentially influenced by mining—i.e., the forests that occur within a buffer surrounding each mineral occurrence using an upper limit of 70 km and a more conservative lower limit of 10 km[12] (Figure 6). To estimate the forest extent potentially affected by mining under each scenario, we used data from 2018 of PRODES and overlaid this with our four scenario masks (Figure 6).

To estimate the impacts on ecosystem services, we used spatially explicit monetary valuations for four key services provided by Amazon forests: food production (Brazil nut), raw material provision (timber and rubber), GHG mitigation (reduction in $CO_2$ emissions), and climate regulation (rent losses to soybean, beef, and hydroelectric production due to reduced rainfall).[13] These ecosystem services maps were overlaid with our areas of forests affected by mining (for each the 10 and 70 km buffers) to quantify the monetary value of ecosystem services provided by forests potentially influenced by the proposed policy.

## SUPPLEMENTAL INFORMATION

Supplemental Information can be found online at https://doi.org/10.1016/j.oneear.2020.08.008.

## ACKNOWLEDGMENTS

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## AUTHOR CONTRIBUTIONS

Conceptualization, J.S.-G., L.J.S., and B.S.-F.; Methodology, J.S.-G. and L.J.S.; Resources and Data Curation, J.S.-G., B.S.-F., and A.O.; Formal Analysis, J.S.-G.; Writing – Original Draft, J.S.-G., L.J.S., L.E.S., and B.S.-F.; Writing – Review & Editing, J.S.-G., L.J.S., L.E.S., B.S.-F., and A.O.; Visualization, J.S.-G. and B.S.-F.; Supervision, J.S.-G., L.J.S., and L.E.S.

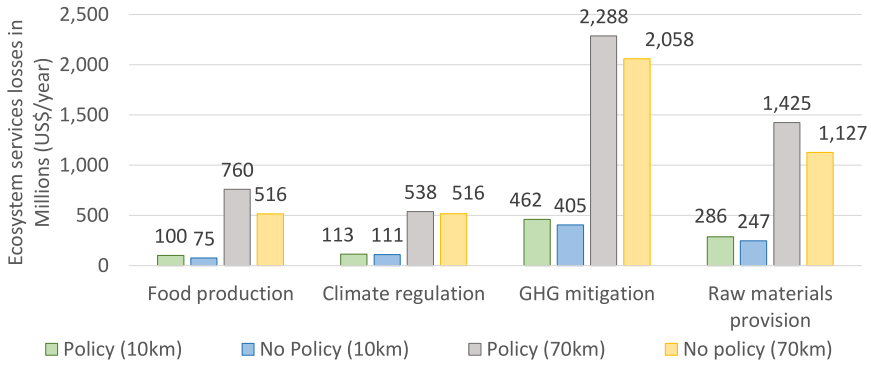


**Figure 5. The Monetary Value of Ecosystem Services Losses Provided by Potentially Affected Forests, Assuming Indirect Impacts Extend 10 and 70 km from Potential Mining Occurrences in Both Scenarios**

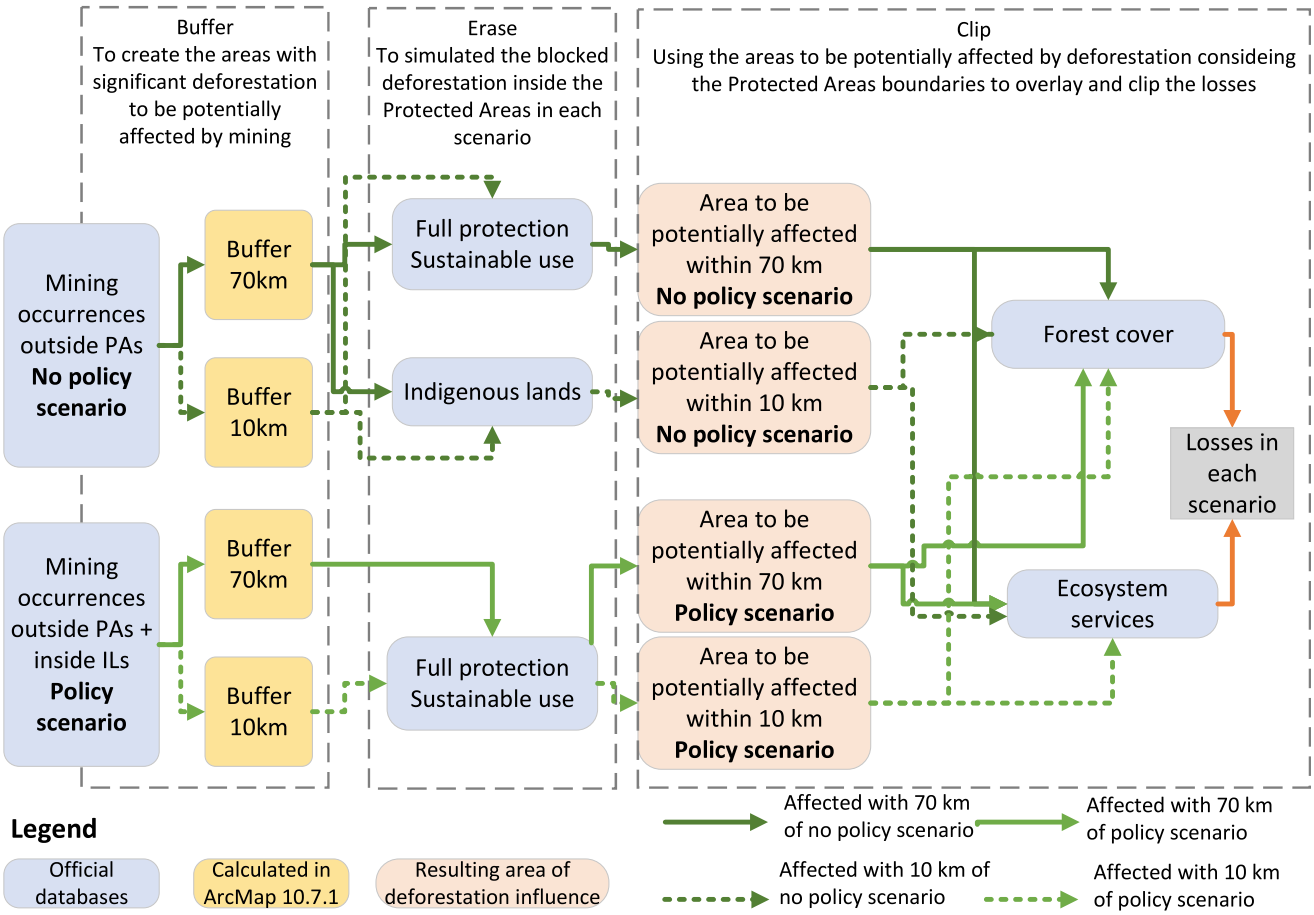


**Figure 6. Main Steps of Data Analysis Considering the No-Policy and Policy-Implementation Scenarios**

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## Supplemental Information

# Proposed Legislation to Mine Brazil's Indigenous Lands Will Threaten Amazon Forests and Their Valuable Ecosystem Services

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**Notes S1: Detailed information about mineral occurrences and the status of Indigenous Lands in the Legal Amazon**

Figure S1. Spatial distribution and status of ILs in the Legal Amazon in February 2020.

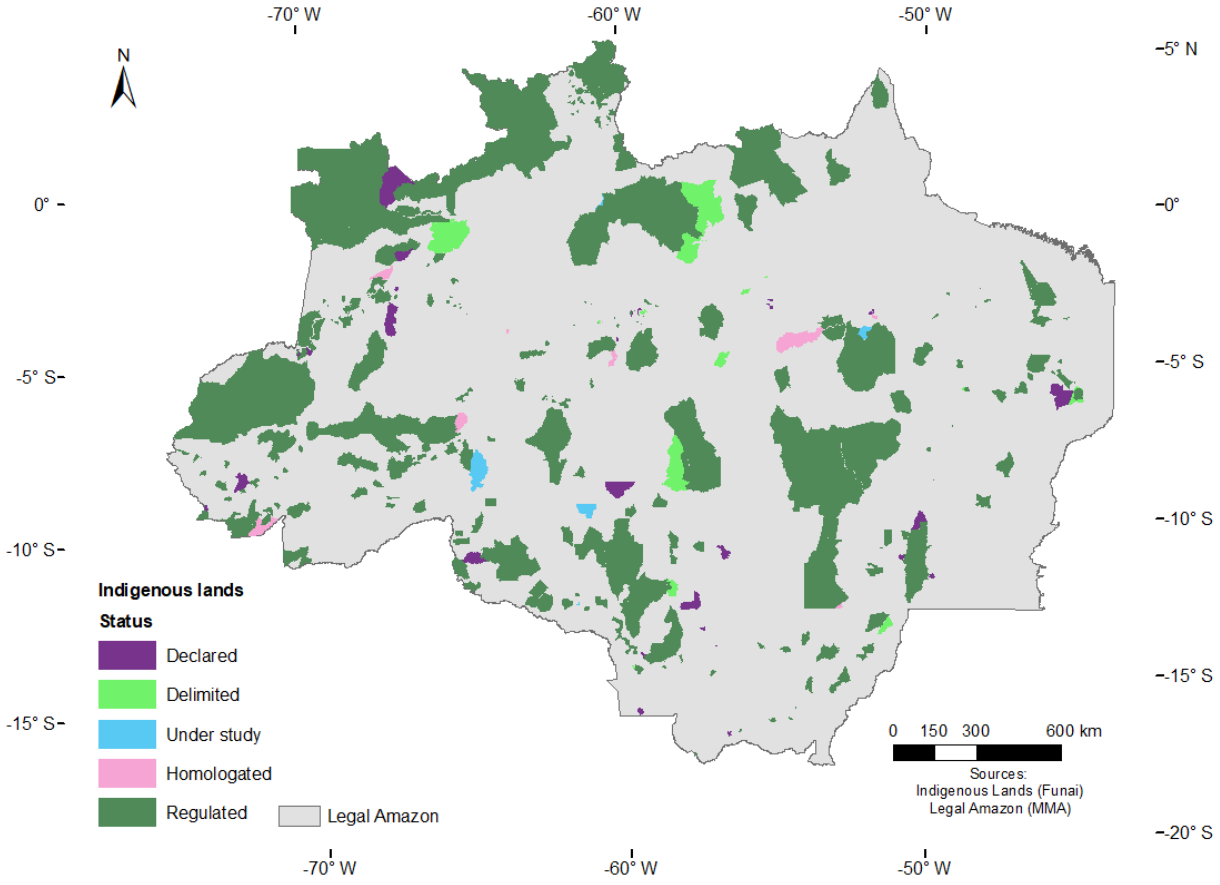

Table S1. Minerals claims and proposals within Indigenous Lands (ILs) and other protected areas (PAs) in the Legal Amazon by substance (All records – from 1944 until February 2020)

| Substance (1) | Legal Amazon | Inside IL | Inside other PAs |
|---|---|---|---|
| Aluminum | 73 | 21% | 62% |
| Sand | 3970 | 0% | 11% |
| Bauxite | 840 | 1% | 23% |
| Lead | 70 | 64% | 26% |
| Copper | 201 | 42% | 36% |
| Diamond | 898 | 2% | 11% |
| Iron | 36 | 14% | 47% |
| Aluminum ore | 159 | 3% | 46% |
| Copper ore | 2345 | 2% | 23% |
| Tin ore | 297 | 8% | 21% |
| Iron ore | 1148 | 2% | 25% |
| Manganese ore | 7 | 1% | 6% |
| Nickel ore | 184 | 2% | 5% |
| Gold ore | 15625 | 3% | 38% |
| Niobium | 35 | 66% | 20% |
| Gold | 9612 | 10% | 60% |
| Silver | 65 | 26% | 3% |

Note: (1) denomination of substances according to the ANM database

Figure S2. Mineral claims and proposal and Protected Areas (February 2020)

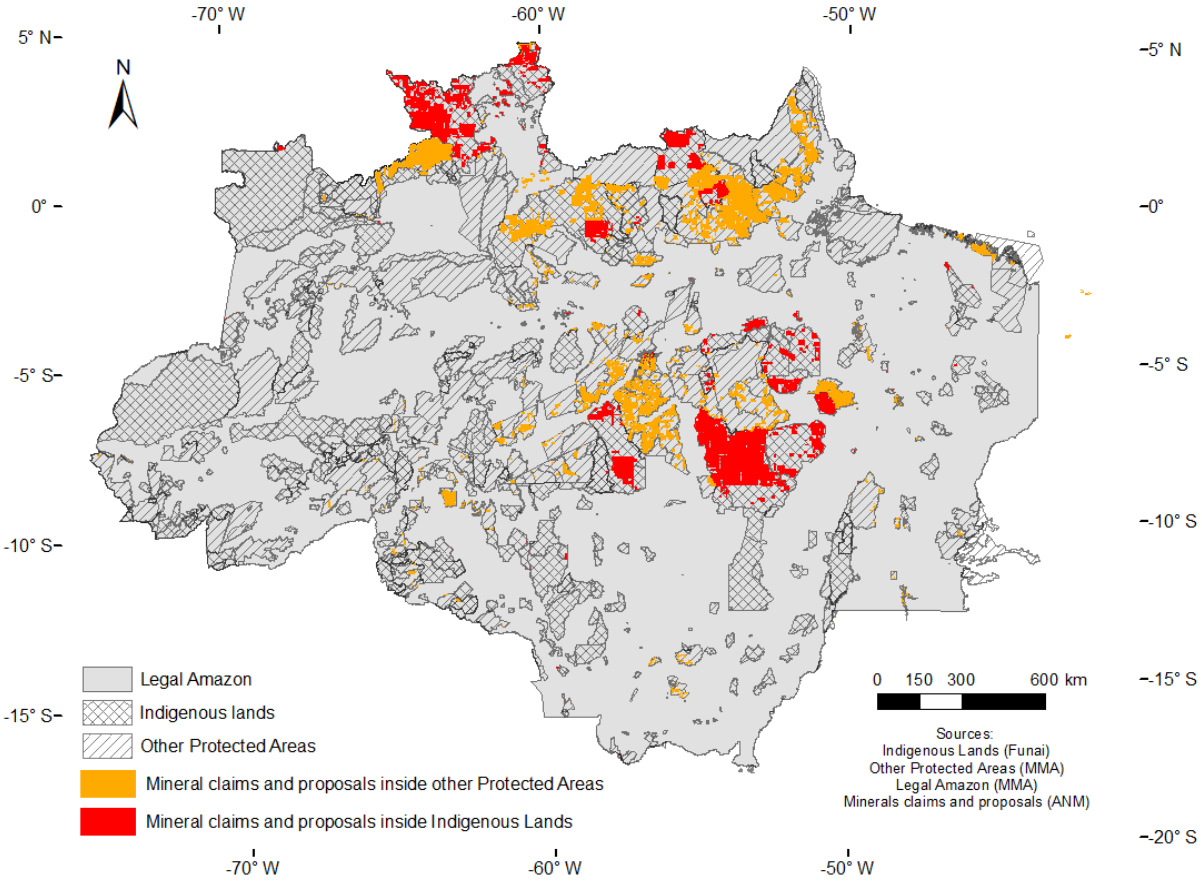

Figure S3. Mineral occurrences by substance and indigenous lands (February, 2020)

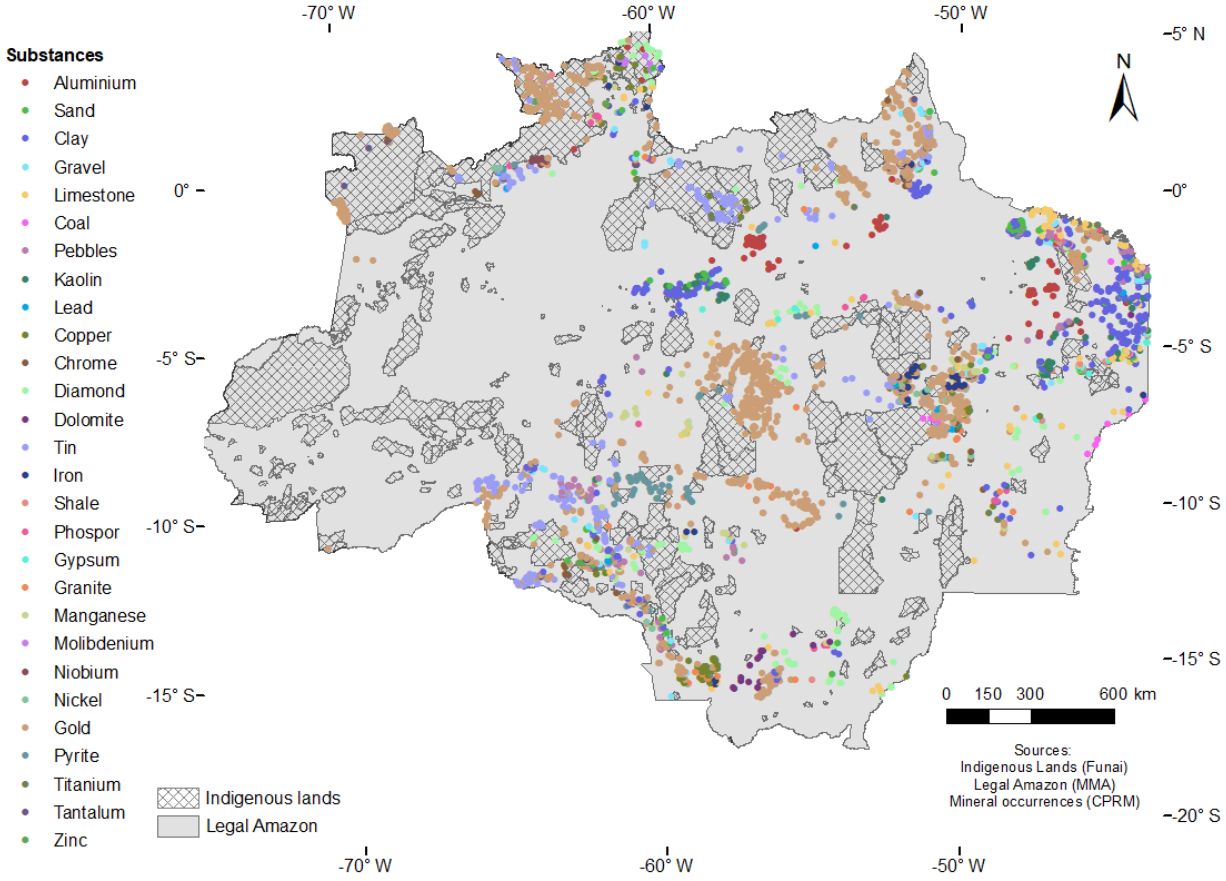

Table S2. Minerals occurrences within Legal Amazon and Indigenous Lands, and those included in each of our analysis scenarios (Policy and BAU)

| | **Number of minerals occurrences and percentage of the number of occurrences in relation to the total number in each area and scenarios** | | | |
|---|---|---|---|---|
| | **Legal Amazon** | **Inside IL** | **Policy Scenario** | **BAU scenario** |
| Gold | 1954 (33.43%) | 346 (52.97%) | 1859 (34.06%) | 1513 (31.65%) |
| Clay | 503 (9.03%) | 2 (0.42%) | 432 (8.26%) | 429 (9.25%) |
| Tin | 325 (5.50%) | 98 (17%) | 311 (5.66%) | 213 (4.22%) |
| Sandstone | 151 (2.63%) | 1 (0.25%) | 148 (2.81%) | 147 (3.13%) |
| Diamond | 135 (2.52%) | 25 (4.2%) | 128 (2.60%) | 103 (2.4%) |
| Sand | 117 (2.26%) | 3 (0.88%) | 111 (2.36%) | 108 (2.55%) |
| Copper | 93 (1.59%) | 15 (2.66%) | 93 (1.75%) | 78 (1.64%) |

Table S3. Cleared area inside each PA category

| **Protected Area category** | **Area cleared since 2000 (km²)** |
|---|---|
| Sustainable use | 27,822 (4.35%) |
| Full protection | 2,683 (0.57%) |
| Indigenous lands | 7,054 (0.73%) |

**Notes S2: Detail of bill proposals mentioned in the manuscript**

PL 1610/96 available at: **www.camara.gov.br/proposicoesWeb/fichadetramitacao?idProposicao=16969**

PL3682/2012 available at:
**www.camara.gov.br/proposicoesWeb/fichadetramitacao?idProposicao=541161**

PL191/2020 available at:
**https://www.camara.leg.br/proposicoesWeb/fichadetramitacao?idProposicao=2236765**

**Notes S3: information about the Environmental Impact Assessment requirements for the minerals claims and proposals**

According to Brazilian legislation, mineral resources belong to the federal government and any claim for exploration or mining requires a valid title issued by the National Mining Agency. There are different kinds of titles depending on the stage, from exploration to mining, and on the type of minerals. Additionally, there is one particular authorization that entitles "artisanal" mining (*permissão de lavra garimpeira*).

The competent authority for environmental review is an environmental agency (a State agency in most cases), that issues an environmental license upon approval of required environmental studies. Although requirements vary across states, no environmental license is required for exploration, while to start a mine, an environmental impact assessment must be filed and approved. However, stone quarries and sand pits may be licensed on the basis of a simplified procedure and corresponding simplified environmental assessment, as applied also to artisanal mining.

The simplified environmental licensing requires only simplified reports for issuing the permit for the project and extraction development. The complete environmental licensing is a three-stage process that requires an Environmental Impact Study and mitigation plan for issuing the environmental license.

In Table S4, as an exploration claim moves to a mining claim, environmental licensing becomes necessary and the category "uncertain" was assigned to all claims in the initial stages, because it is unknown whether or not they will evolve to a mine proposal. In such cases, either a simplified or a complete (i.e. an environmental impact assessment) review will be necessary as a requirement for issuing an environmental license.

Table S4. Type of Environmental Impact Assessment required for each stage of mining proposals and claims.

| **Types of exploration and mining claims** | **Environmental impact assessment for environmental licensing** |
|---|---|
| Application for exploration (*Requerimento de pesquisa*) | Uncertain |
| Exploration permit (*Autorização de pesquisa*) | Uncertain |
| Application for mining (*Requerimento de lavra*) | Uncertain |
| Application for artisanal mining (*Requerimento de lavra garimpeira*) | Simplified |
| Application for extraction of construction materials (*Requerimento de registro de extração*) | Simplified |
| Artisanal mining (*Permissão de lavra garimpeira*) | Simplified |
| Permit for extraction of construction materials (*Registro de extração*) | Simplified |
| Mining permit (*Concessão de lavra*) | Complete |

Table S5. Number of processes under each category of Environmental Impact Assessment considering each PAs category, outside PAs and all Amazon

| **Protected area category** | **Under simplified environmental licensing** | **Uncertain** | **Require a complete Environmental and Social Impact Assessment** |
|---|---|---|---|
| Strictly protected | 291 (47.9%) | 307 (50.6%) | 9 (1.5%) |
| Sustainable use | 9929 (64.2%) | 5373 (34.7%) | 171 (1.1%) |
| Indigenous lands | 89 (3.5%) | 2420 (96.4%) | 1 (0.04%) |
| Outside all PAs | 12158 (40.8%) | 16994 (57.0%) | 645 (2.2%) |
| All Amazon | 22467 (46.4%) | 25094 (51.9%) | 826 (1.7%) |