

# Challenges of mine closure as a tool for reconciling mining with local communities and conservation units in the Amazon

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## Abstract

*The Amazon is a beautiful region renowned for its vast biodiversity and mineral wealth. Notably, it hosts the world's largest iron mine, which not only generates thousands of jobs and local income but also drives the regional economy. However, it is crucial to emphasise that the exploitation of these resources must be balanced with environmental conservation and respect for the indigenous communities inhabiting the area. Unfortunately, illegal mining activities pose a significant threat to the Amazon, causing irreparable damage to the environment and directly affecting local communities. It is essential to combat this harmful practice and promote a sustainable mining model that prioritises people's wellbeing and ecosystem preservation. In this context, mine closure in the Amazon region emerges as a crucial tool to mitigate the environmental impacts of mining activities. Adopting progressive closure practices not only reduces the impact during operation but also contributes to the conservation of mineral resources, preventing disorderly land occupation and the unchecked expansion of agriculture and livestock farming. It is fundamental to recognise that when conducted responsibly and sustainably, mining in the Amazon can be an ally in conserving mineral resources. Therefore, it is imperative to promote policies and practices that ensure an integrated and balanced approach between economic development and environmental preservation in the region. This paper presents an analysis of data regarding mining activities around significant conservation units, local communities, and indigenous territories, with a focus on the main existing conflicts.*

**Keywords:** Amazon, mining, mine closure, environmental conservation, local communities, indigenous territories

## 1 Introduction

Mining causes cumulative impacts on forests not only through direct deforestation to build its facilities, but also through the associated infrastructure, such as transmission lines, access roads, railroads, attracting labour and expanding urban centres (Siqueira-Gay 2021).

The Amazon rainforest, which covers some 7 million km<sup>2</sup>, is home to approximately one third of all terrestrial life forms on the planet and represents the greatest concentration of biodiversity in the world. This vast rainforest, with its dense broadleaf cover, stretches across eight Amazonian countries – Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname and Venezuela – as well as the French territory of French Guiana (Imazon 2024). The Amazon is home to more than 40 million people, including 2.2 million Indigenous peoples of more than 300 ethnicities, as well as afrodescendent and local traditional communities. Indigenous peoples and local communities would be harmed by forest loss in terms of their livelihoods, lifeways and knowledge systems that inspire societies globally (Flores et al. 2024).

The Amazon rainforest is a complex system of interconnected species, ecosystems and human cultures that contributes to the wellbeing of people around the world. The Amazon biome has already lost 13% of its original forest area due to deforestation. Among the remaining old-growth forests, at least 38% have been degraded by land use disturbances and repeated extreme droughts, with impacts on moisture recycling still

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uncertain (Flores et al. 2024). Therefore, to avoid large-scale ecosystem transitions due to uncontrolled forest loss, a safe cumulative deforestation limit of 10% of the original forest biome cover is suggested, which requires an end to large-scale deforestation and the restoration of at least 5% of the biome. Between 2017 and 2020, the rate of deforestation caused by illegal mining increased by more than 90%, from 52.9 km<sup>2</sup> per year in 2017 to 101.8 km<sup>2</sup> per year in 2020. During this period, deforestation from illegal mining grew faster than within formal mining leases.

The Amazon rainforest is considered to be the most biodiverse region on the planet and the largest biome in Brazil (Tofeti & Campos 2019). It is fundamental for regulating the world's climate, balancing the rainfall cycle, stabilising temperatures and absorbing a large amount of carbon dioxide; the main gas responsible for global warming. Deforestation in this biome affects various ecosystems around the world, generating severe consequences that can become irreversible. The main agent of this wave of deforestation is humans, who remove native vegetation for economic reasons. Of the remaining forest area in the Amazon, 17% has been degraded by human disturbances, such as logging, edge effects and understory fires. If we also consider the impacts of repeated extreme drought events in recent decades, 38% of the Amazon could be degraded (Borges 2023).

According to the National Confederation of Agriculture (CNA), agriculture occupies around 10 million hectares, approximately 2.3% of the Amazon Biome, covering 65 different crops (Entre Solos 2022).

Mining plays a crucial role in the Brazilian economy, especially in the Amazon region which has the largest iron ore mine in the world, but it is also responsible for significant environmental damage. In order to minimise this damage, it is essential that operators implement measures such as degraded area recovery plans (DARP), as well as mine closure plans (MCP), and strictly respect the environmental and mineral legislation in force in the country. The importance of environmental protection is emphasised by Brazilian legislation, which determines the preservation of especially important areas. In this context, the Constitution prohibits 'any use that compromises the integrity of the attributes that justify their protection' (Brazil 1988).

Because this is an activity that involves the use of land for a predetermined period of time and, when terminated, can cause a number of problems and losses to the population, many of which last for decades or even centuries, society in several countries has demanded that governments adopt legal measures to regulate the closure of mines, rehabilitate the mined area, protect the interests of the affected populations, guarantee the means for the community directly involved to continue developing after the end of the mining activity and plan new uses for the area, whether economic, environmental, cultural or touristic. The definition of this new use must take into account the topography of the location and the study of the natural vocation of the region and, above all, involve the populations of the territories and the governments in the identification of alternatives that meet the needs of all interested parties (Araujo 2016).

The growing demand for gold in the Brazilian Amazon, driven by rising prices and political pressure, has fuelled the expansion of illegal mining. This illicit practice threatens not only forests and biodiversity, but also the rights and way of life of Indigenous peoples, as well as compromising the effectiveness of protected areas. Illegal mining, characterised by a lack of compliance with legal regulations and the absence of MCPs, is emerging as one of the main challenges for environmental conservation in the Amazon.

While formal mining is subject to strict environmental regulations and requires the preparation of MCPs, many small-scale or artisanal mining operations, especially illegal ones, are abandoned after the reserves are exhausted, leaving behind degraded areas without adequate rehabilitation. The trend of increasing deforestation due to illegal mining is worrying, although we must recognise that deforestation from agricultural and livestock activities still potentially exceeds the impacts of mining, whether legal or illegal. Decisions about the future uses of the area will generally not please the community that depended on the mine. As such it's necessary for a large debate on the socio-economic issues arising from the closure of the mine. Therefore, more than good practice, communication with the population is becoming essential to prevent conflicts, and the State plays a leading role in this context by promoting conditions for the population's participation in dialogue with the mining sector (Viana 2019).

Bowman et al. (2021) concluded that the three main causes of indigenous morbidity and mortality due to illegal mining activities are:

1. environmental contamination (mainly through mercury) causing the population to become ill and a decrease in the food supply, leading to malnutrition and vulnerability to various diseases
2. the spread of infectious diseases, mainly malaria and COVID, due to the transit of miners from urban regions to the villages – as well as an increase in population density in the region
3. conflicts and violence by illegal miners, leading to direct deaths from attacks on villages, sexual abuse and conflicts between miners.

With regard to state responsibilities and the acknowledged vulnerability of Indigenous peoples, it is important to stress that measures such as monitoring mining activities, as well as regularising the areas occupied by Indigenous peoples, is provided for by law, guaranteed by the *Federal Constitution of 1988* and also by the *Indian Statute*, in order to protect against possible invasions and occupations by non-Indigenous people, are essential to alleviate the problem (Miranda et al. 2024). It is also necessary to recognise the value and importance of Indigenous peoples in preserving biodiversity and maintaining ecosystems – as well as their territorial and cultural rights. It is estimated that Indigenous peoples and local communities would be harmed by the loss of forests – in terms of their livelihoods, ways of life, and their knowledge systems that inspire societies worldwide.

Conservation units (CUs) are prime examples of these protected areas. Defined by *Law n. 9.985/2000 (Law of the National System of Nature Conservation Units)* (Brazil 2000), CUs are territorial spaces and their environmental resources, including jurisdictional waters, with relevant natural characteristics, legally instituted by the government. Their conservation objectives are clear and their boundaries well defined, subject to a special management regime that ensures adequate protection (Article 2 [Brazil 2000]).

There are currently 117 full protection CUs and 212 sustainable use CUs. These units are distributed among various subcategories, according to the need for preservation and use of natural resources. These areas represent a highly effective tool for preserving the integrity of ecosystems and the environmental services that depend on them. These services are associated with soil preservation, watersheds, pollination, nutrient recycling, and climate balance (Wagner & Abreu Lima 2024).

The big challenge today is to invest in the implementation and enforcement of protected areas. According *Law n. 9.985/2000* these areas in the Amazon region have been important instruments for conserving and preserving biodiversity, as well as helping to create, expand and strengthen protected areas, the fact is that a large part of the Amazon does not have areas protected by law therefore, it is necessary to improve the subsistence conditions of the available resources and reduce the pressure on protected areas and all these problems can be avoided by inserting and improving best practices, especially by mining companies. In this way, it is possible to achieve a balance between economic development and environmental conservation, provided that effective and responsible measures are adopted.

In order to address the economic development of the Brazilian Amazon region, The Legal Amazon was legally established. One of the objectives of establishing The Legal Amazon was to promote the socio-economic development of the municipalities within its boundaries, through planning actions designed for various sectors. These actions range from fostering local economic activities, to expanding the infrastructure network that serves its population. Given the objectives that led to the delimitation of The Legal Amazon, it can be defined as a region of territorial and strategic planning (Brasil Escola 2024). The Legal Amazon is home to 98% of the 573 Indigenous Lands (ILs) recognised by National Foundation for Indigenous Peoples (FUNAI) (Soares 2023). The Legal Amazon is an area that corresponds to 59% of Brazilian territory and encompasses eight states (Acre, Amapá, Amazonas, Mato Grosso, Pará, Rondônia, Roraima and Tocantins) and part of the state of Maranhão (west of the 44°W meridian), making up 5.0 million km<sup>2</sup>. It is home to 56% of Brazil's Indigenous population. The concept of the Legal Amazon was established in 1953 and its territorial limits derive from the need to plan the economic development of the region and, therefore, is not limited to the humid jungle ecosystem (which occupies 49% of the national territory) and extends into the territory of eight neighbouring

countries. The boundaries of the Legal Amazon have been altered several times, as a result of changes in the country's political division (Instituto Brasileiro de Geografia e Estatística [IBGE] 2022a)

Mineral exploration in the Serra dos Carajás –a mountain complex located in the southeast of the state of Pará, Brazil, characterised by its rich mineral resources, rugged terrain and the presence of isolated plateaus of ferruginous rock outcrops (Viana et al. 2016) – reflects a robust management structure and differentiated institutional support provided by Vale to the CUs. According to the management plans, the establishment of the first CUs in the region was motivated by the government need to control the territory in the face of discoveries of mineral wealth and environmental requirements. Based on the analysis of interviews and the experience lived in this territory, the CUs in the Serra dos Carajás exemplify a legacy of success (de Abreu Monteiro 2024). These units inherited a well-preserved area from a state-owned company and, in addition, have conditions that make them unique in Brazil. The size of the mining area – the largest open pit iron mine in the world – raises questions about the compatibility between high environmental impact mining and the effectiveness of a protected area (PA) in these circumstances. Although there seems to be an incompatibility, there is evidence that the effectiveness of PAs in implementing appropriate environmental practices is significant. In addition, PAs support technical improvement policies for farmers living around and within them, as is the case in the environmental protection area. In this way, they have managed to mitigate both the pressures on the remaining natural resources and the use of burning in soil preparation (de Brito 2021).

## 2 Review methodology

For this study, mining titles in the Legal Amazon were selected, including mining concessions, research authorisations, license registrations, extraction registrations and mining permits. Using this data, cross-references were made with the ILs and CUs (both sustainable use and full protection) located in the same region. Based on these analyses, areas with potential conflict risks were identified due to the overlap or interference of mining titles with ILs and CUs.

## 3 Eventual conflicts in the Legal Amazon

The Legal Amazon is the target of intense mining activity. There are currently approximately 19,000 mining titles in the region, ranging from research authorisations to mining concessions (Figure 1).

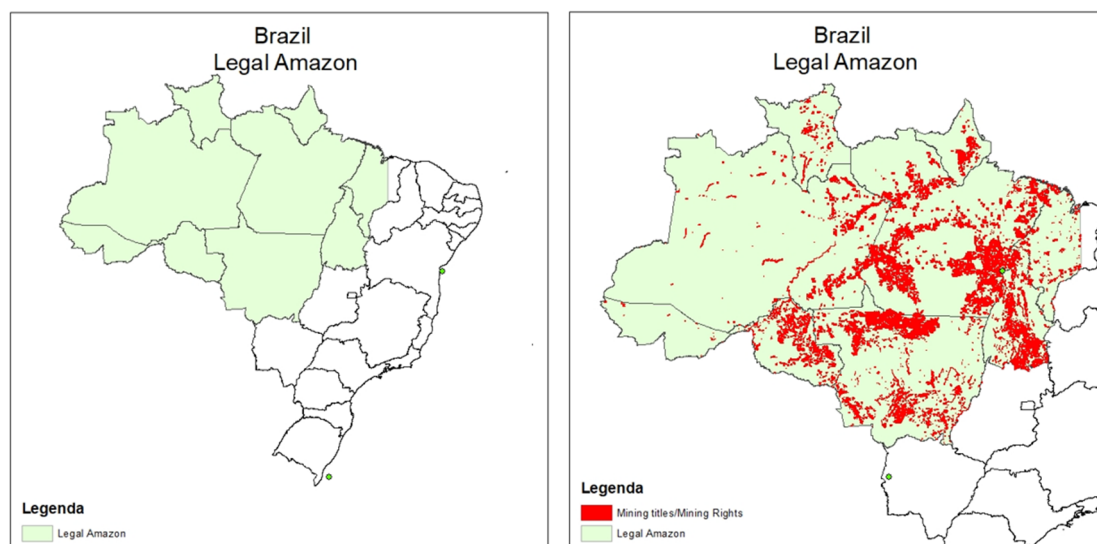
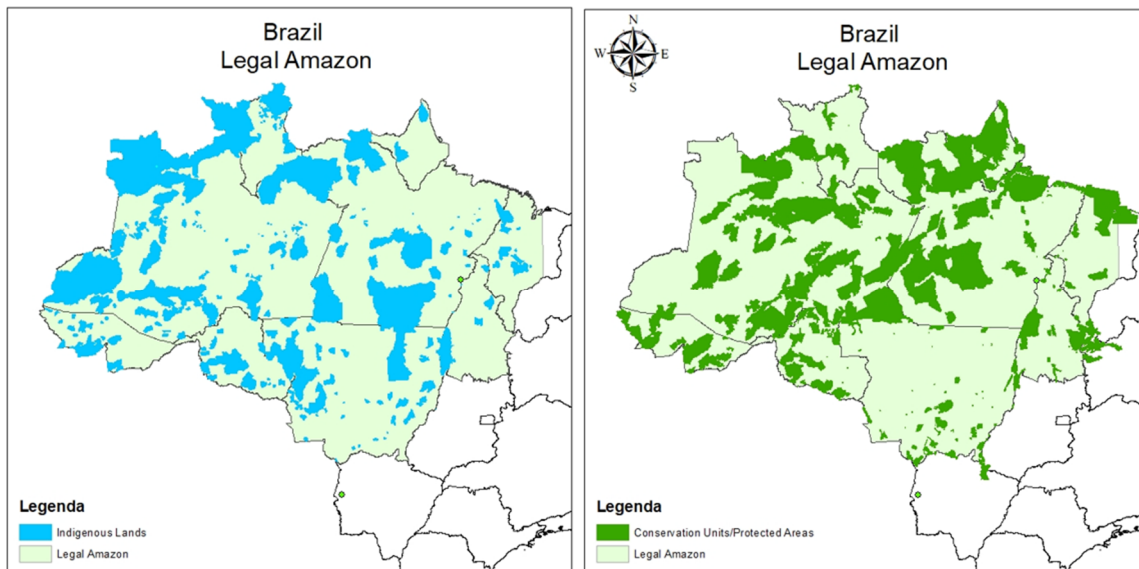


Figure 1 Brazil and the Legal Amazon area and mining titles (National Mining Agency [NMA] 2024)

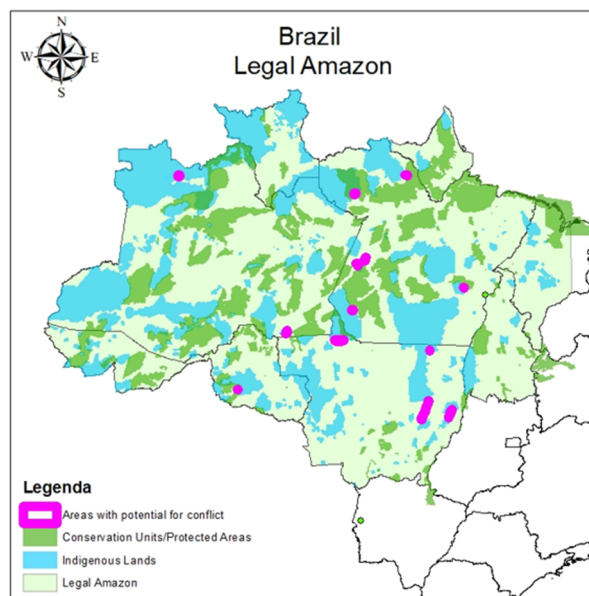
These titles, in many cases, interfere directly with PAs and ILs (Figure 2), raising important questions about the environmental and social impacts of mining. Spatial cross-references were made with mining titles, according to data from the NMA (2024), The CUs were taken from the website of the Chico Mendes Institute for Biodiversity Conservation, linked to the Brazilian Ministry of the Environment (MMA 2024).



**Figure 2 Indigenous lands and conservation units in the Legal Amazon**

The boundaries of the Legal Amazon were taken from the website of the IBGE (2022b).

The boundaries of the IL were extracted from the FUNAI (2024), as illustrated in Figure 3, around 1.8% of mining titles in the Legal Amazon interfere with ILs. In addition, approximately 2.2% of these titles affect full protection CUs, while around 17% interfere with sustainable use CUs.



**Figure 3 Possible areas of conflict with mining titles, Indigenous lands and conservation units**

Among the mining titles that interfere with ILs, 6.95% also affect full protection CUs, and 13% affect sustainable use CUs.

The results obtained from this analysis are crucial for pinpointing potentially conflicting areas, as well as for developing environmental and mining management policies aimed at mitigating conflicts and preserving ecosystems and indigenous communities in the Legal Amazon (Figure 4).



**Figure 4 Integration of legal instruments to minimise possible conflicts**

With potential areas for conflicts related to land use, conservation, and the housing of local communities and Indigenous peoples, it becomes crucial to coordinate local and regional policies. This coordination can ensure that development and conservation goals do not undermine Indigenous land rights or disrupt community livelihoods. Strengthening institutional frameworks and fostering participatory governance can create a balance between environmental protection and the socio-economic needs of local populations. It is equally important to integrate traditional ecological knowledge in decision-making processes, empowering these communities to manage their lands sustainably while safeguarding their cultural heritage.

This multi-level policy approach should also focus on conflict resolution mechanisms, particularly in areas where land use overlaps between conservation zones and community settlements. By ensuring clear legal frameworks and inclusive planning, potential tensions can be minimised, leading to sustainable coexistence and mutual benefit.

Certification schemes can help curb illegal mining and mitigate its environmental and social impacts by contributing to better local diagnosis. However, the important thing is the widespread use of the MCP, as well as the progressive rehabilitation or reclamation included in this plan, to ensure that present and future generations do not experience a loss of biodiversity and quality of life.

CUs, created to protect biodiversity and ecosystems, have restrictive regimes for the use of natural resources. On the other hand, ILs are demarcated to guarantee the territorial rights of Indigenous peoples, allowing the sustainable use of natural resources in accordance with their customs and traditions. The overlap can lead to conflicts between strict environmental protection and traditional indigenous ways of life.

In some cases, indigenous territories can overlap with CUs, creating a complex legal situation. Examples include national parks, biological reserves, and other CUs that have very restrictive rules on use and occupation. When these areas overlap, there can be restrictions on the traditional use of natural resources by indigenous communities.

The creation of CUs and the demarcation of ILs involve different processes, often without the proper consultation and participation of the affected communities. The lack of dialogue and consideration of the rights and interests of indigenous populations can aggravate conflicts.

In some regions, economic interests such as mining, agriculture and urban development exert pressure on PAs and ILs. The creation of PAs, or the demarcation of ILs can be seen as an obstacle to economic development, generating tensions between communities, governments and companies.

Brazilian legislation recognises both the importance of environmental conservation and the rights of Indigenous peoples. The 1988 Federal Constitution guarantees the territorial rights of Indigenous peoples (Article 231) and the protection of the environment (Article 225). However, the implementation of these guarantees can be conflicting, especially when areas of environmental and indigenous interest overlap. In addition, inconsistent or conflicting public policies can exacerbate the problems.

Social participation in the planning of MCPs is also an essential and coherent aspect of sustainability concepts. Mining operations are activities that temporarily occupy territories. These areas are often home to traditional communities or those that depend economically on mining. In some cases, these communities are negatively impacted in various ways by mining activities. When mining operations close and the company withdraws, the adjacent communities remain, often facing the consequences left by mining; if this closure is not carried out with the required social responsibility. It is therefore essential that these communities are heard and have an active role in defining the future use of mined areas. Such actions reinforce the increasingly demanded 'Social License to Operate', which mining companies (even if informally) must obtain in order to coexist peacefully and sustainably; with the aim of helping to leave a positive legacy for these communities after the mine closes.

To mitigate these conflicts, it is essential to promote dialogue between the parties involved, guarantee the participation of indigenous communities in the processes of creating and managing protected areas, and seek solutions that reconcile environmental conservation with respect for the rights and traditional ways of life of Indigenous peoples.

One of the main obstacles for companies in achieving effective and sustainable mine closure is the costs involved in the process, as most only begin closure-related activities near the exhaustion and shutdown of operations. Progressive closure helps reduce and spread out these costs, as well as prevent the proliferation of abandoned mines. By carrying out the closure simultaneously with operational activities, in the case of an unexpected and/or sudden shutdown, liabilities will be smaller and future land use options will be greater. It should be noted that the significant increase in abandoned or suspended mines can largely be explained by an expensive or non-existent mine closure process. By considering local communities and indigenous peoples in the MCP (before, during, and after the mine closure) not only are the final closure costs reduced, but it also ensures that funds are properly allocated to prepare these communities to face the minimum possible impact from the closure – such as reducing environmental impact and local pollution.

## 4 Conclusion

MCPs can include solutions that reconcile environmental recovery from mining activities during the mine cycle and at the end of mining activities, with the active participation and integration of stakeholders. These plans should take into account data from the Conservation Unit's Management Plan, as well as the perception and treatment of information regarding ILs – as a way of helping to minimise impacts and future conflicts. MCPs for areas potentially at risk of conflict must take into account the Management Plans of the CUs and also the Territorial and Environmental Management Plans of ILs. The MCPs must be developed according to the specificity of each indigenous territory, the political, social, cultural and economic characteristics of the people, as well as according to the environmental specificities of their territories and adjacent areas. In Brazil, there is still no consolidated integration between MCPs and Indigenous Land Territorial and Environmental Management Plans - ILTEMP, since the regulations dealing with mine closure are relatively new (dating from 2021). However, integrating elements of the ILTEMPs such as the Territorial

Protection Plan and the Sustainable Use of Natural Resources Plan, into MCPs represents a strategic opportunity to ensure that mining activities do not result in territorial conflicts or long-term negative impacts.

This collaborative approach can bring benefits to both mining companies and indigenous communities. For companies, adopting practices that take into account the Indigenous Land Territorial and Environmental Management Plans helps to avoid reputational damage, legal disputes and possible sanctions; while demonstrating a commitment to sustainability and respect for the rights of traditional populations. For indigenous communities, this integration guarantees the protection of their territorial rights, ways of life and culture, as well as ensuring that the natural resources of their territories are preserved and used sustainably, both during and after mining operations.

The implementation of an integration between these two plans must take place through constant dialogue and the active participation of indigenous communities in the mine closure process. By doing so, mining operations can be conducted in a fairer, more sustainable and collaborative way; promoting a balance between economic development and environmental and cultural conservation.

The interaction between mining titles and protected areas in the Legal Amazon highlights the need for effective management and inspection policies to balance economic development with environmental conservation. Understanding the complex interactions between different land uses is crucial to creating strategies that minimise the negative impacts on ILs and CUs, promoting sustainable development in the region.

Brazilian legislation on mine closure is relatively new, having been published in 2021. However, this resolution is currently being revised, and must take into account all these aspects, such as social license, in order to be in line with the regulatory frameworks applied in countries where the issue is more mature, which are also countries where mining has a strong share of GDP – such as Australia, Canada and the United States.

MCPs in Brazil, especially in the Legal Amazon, must take into account the matrix instruments of each complex, such as the Management Plan for CUs, the Management Plan for ILs, as well as consultation with local communities, and the master plans of the municipality and of the State.

Essential elements must be included in the new mine closure resolution, in addition to being included in the company's MCP such as: prior, free and informed consultation: Respect International Labour Organization Convention 169, which provides for prior and informed consultation with affected indigenous and local communities, and active participation: Ensuring that communities are involved in decisions about land use after the mine closes and in monitoring environmental recovery activities.

Although the Federal Constitution obliges the miner to recover the area degraded by mining, the legal framework for mining and the environment is very fragmented and sometimes there is no direct communication. However, with the new review of mine closure legislation underway at the National Mining Agency (ANM), it is hoped that joint understandings and procedures with federal, state and municipal entities and bodies will be optimised. As this is a region sensitive to environmental impact and conflicts with local communities, more specific policies should be promoted in the Legal Amazon.

Currently, the socio-economic diagnosis is carried out by the technical study of the environmental agency responsible, and the ANM (in its MCPs) is only responsible for the chemical and physical stability of the enterprises at the end of the activities. A technical cooperation agreement came into force in July, between the ANM (which is responsible for mining), the Brazilian Institute for the Environment and Renewable Natural Resources (which is responsible for environmental licensing), and the Chico Mendes Institute for Biodiversity, (which is responsible for managing CUs), both at federal government level. One of the aims of this agreement is to define regulatory and technical procedures for the synchronous analysis of MCP, required by the ANM, and their correlation with DARP, and required by the environmental agency; observing their respective legal attributions. It is necessary to include synchronous actions with ILs in the MCPs, together with the management body for these areas. These synchronous actions should resolve current conflicts and prevent and avoid future conflicts.

Effective mine closure and rehabilitation measures, when carefully planned, must address both environmental and social aspects. Future land use planning for mined areas should go beyond ecological restoration, focusing



on the establishment of solid foundations for the development of new local economies while also preserving the cultures of Indigenous peoples. This process requires the integration of a long-term sustainability vision, encompassing not only environmental recovery but also the promotion of socio-economic growth in regions impacted by mining activities.

The active participation and engagement of local communities are critical for the success of this transition. It is essential that the ANM ensures these communities are heard and their interests are incorporated into decision-making processes, particularly regarding the future use of post-mining areas. This includes incorporating specific provisions into the MCP for projects not only in the Amazon region but throughout Brazil.

Key questions that must be addressed and clarified in the modernisation of NMA Resolution nº. 68/2021, which has not yet fully addressed the mitigation of conflicts through the MCP, include:

- How can the effective participation of local communities in decisions about mine closure and future land use be ensured?
  - A transparent and inclusive process is crucial to strengthening local governance and fostering a sense of ownership and co-responsibility.
- What strategies can be adopted to encourage local communities to adapt to changes resulting from mine closures, ensuring a fair and sustainable transition?
  - Capacity-building initiatives and the promotion of new economic activities must be integral to this process, ensuring that the transition benefits all stakeholders.
- What role and specific procedures should be followed when mine closures involve territories occupied by Indigenous peoples?
  - The protection of their rights and respect for their cultures and traditions must be prioritised, ensuring that the transition process is carried out in a collaborative and culturally sensitive manner.

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