Furthering the understanding of a mine's area of influence in Amazon

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ABSTRACT

The area of influence (AoI) of a project encompasses the spatial extent where direct and indirect impacts are observable or likely to occur, including the project site, associated facilities, and beyond. Monitoring is a critical tool for reducing uncertainties inherent to any impact prediction due various reasons, including biodiversity complexity. It also contributes to validating and refining initial forecasts, including the AoI delineation. Despite its importance, the concept of AoI and its methodological guidance remains underexplored within the scientific literature on impact assessment. In mining projects, characterized by dynamic operational changes, as extraction progresses and the ongoing rehabilitation of mined areas, the AoI may change over time. In this context, this study aimed to reflect upon the current AoI of a bauxite mining operation since 2009 in the Brazilian Amazon, by examining AoI polygons and data from selected monitoring programs of flora and fauna components. The findings suggest that current field-based monitoring could be complemented by adopting landscape pattern measures. This would provide a more comprehensive understanding of landscape configuration changes and their effects on biodiversity components, allowing for improved identification of direct and indirect impacts and supporting the refinement of the AoI.

Key-words: Monitoring grid, biodiversity, bauxite mining, environmental impacts

Introduction

The area of influence (AoI) of a project encompasses the spatial extent where direct and indirect impacts are observable or likely to occur, including the project site, associated facilities, and beyond (Sánchez, 2020). Since AoI depends on the expected impacts, it can only be delimited after impact assessment ex-ante studies (Peeters et al., 2018; Sánchez, 2020). Due to the predictive nature of the EIA process, there is a certain degree of uncertainty inherent to the process and the difficulty of predicting ecological responses (Treweek, 1999; Lees et al., 2016) may make the area of influence delimited in previous studies obsolete and should be reassessed over time (Santos; Fonseca, 2016). Monitoring in impact assessment follow-up is a critical tool for reducing such uncertainties (Morrison-Saunders et al., 2021). It also contributes to validating and refining initial forecasts, including the AoI delineation. Despite its importance, the concept of AoI and its methodological guidance remains underexplored within the scientific literature on impact assessment (Menin et al., 2017; Emberton, Wenning, Treweek, 2018; Sánchez, 2020; Antonaccio et al., 2020).

In mining projects, characterized by dynamic operational changes, as extraction progresses and the ongoing rehabilitation of mined areas, the AoI may change over time, requiring periodic updates of the monitoring plan to ensure that mitigation measures are accurately targeted. In this context, this study aimed to reflect upon the current AoI of a bauxite mining operation since 2009 in the Brazilian Amazon by examining AoI polygons and data from selected monitoring programs of flora and fauna components.

Material and Methods

The study area is the Juruti bauxite mine, located in the western of the State of Pará, in the Brazilian Amazon. The mine installation began in 2006, and the operations started in 2009 by Alcoa World Alumina Brazil (Alcoa, 2022). It includes several structures, such as the mine, a processing plant, and respective auxiliary facilities, including thickening and disposal ponds, a railroad for the flow of production to the port, also owned and used by Alcoa, in addition to having road access through a state highway (Figure 1).

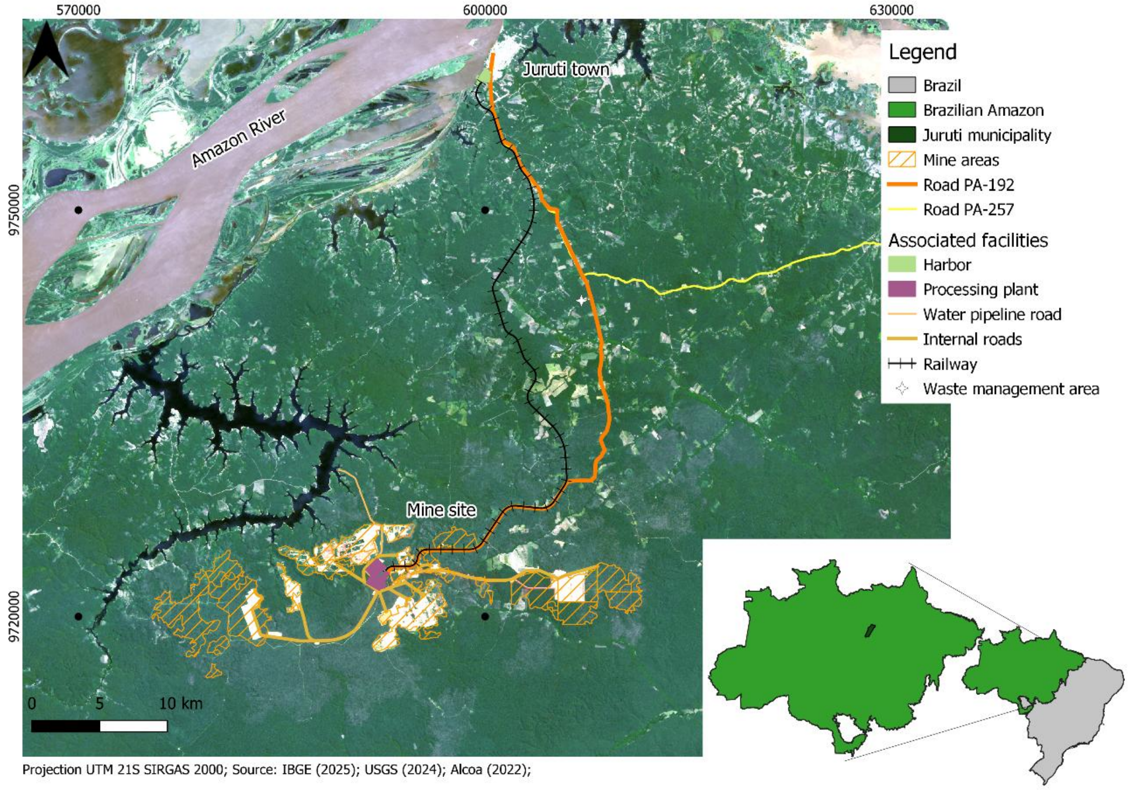

Figure 1 – Location of the Juruti Mine and Main Structures

In Brazil, the environmental impact assessment is a requirement for the environmental licensing of projects, and the delimitation of the AoI is regulated by CONAMA Resolution No. 01 of 1986. The AoI is typically divided into three according to the extent of the impacts: the Directly Affected Area, the Area of Direct Influence, and the Area of Indirect Influence. The Directly Affected Area corresponds to the area where the implementation, operation, and closure activities of a given project occur and directly interfere with the environment. The Area of Direct Influence, which encompasses the Directly Affected Area, is where direct project impacts are observed, and the delimitation must be based on the characteristics of the surrounding environmental components. Finally, the Area of Indirect Influence includes both the Directly Affected Area and Area of Direct Influence and represents the area where indirect impacts of the project can potentially occur due to changes in adjacent regions (IBAMA, 2006).

The documentary review primarily focused on the Environmental Impact Statement (EIS) presented in 2004 to understand how the AoI was initially delineated. In addition, annual monitoring reports submitted to the environmental agency from 2016 to 2023 were analyzed to gather information on the sampling grid and results related to biodiversity. This information has been organized through GIS-based maps to support discussions about AoI.

Results and Discussion

The EIS of the Juruti Project introduces the AoI at the beginning of the document, outlining the Area of Direct Influence and Area of Indirect Influence for both the physical-biotic and socioeconomic environments. However, the present study focuses on solely on the physical-biotic aspects. The Area of Direct Influence for the physical-biotic components corresponds to the area directly affected by the operation of the project, encompassing the areas of concession for research of the plateaus to be mined, the processing plant, and the transportation of the ore. The Area of Indirect Influence of the physical-biotic environment was delimited based on the set of hydrographic basins in the region of the project. It is important to highlight that the EIS indicates that the AoI were delimited for the development of the project's environmental studies, and the area indicated as being considered as the study area, a common source of confusion to the delimitation of the AoI (Sánchez, 2020). While the EIS does not explicitly an Directly Affected Area, later documents, such as the annual reports, refer to this area as the mining concession granted by the Brazilian National Mining Agency (Figure 2).

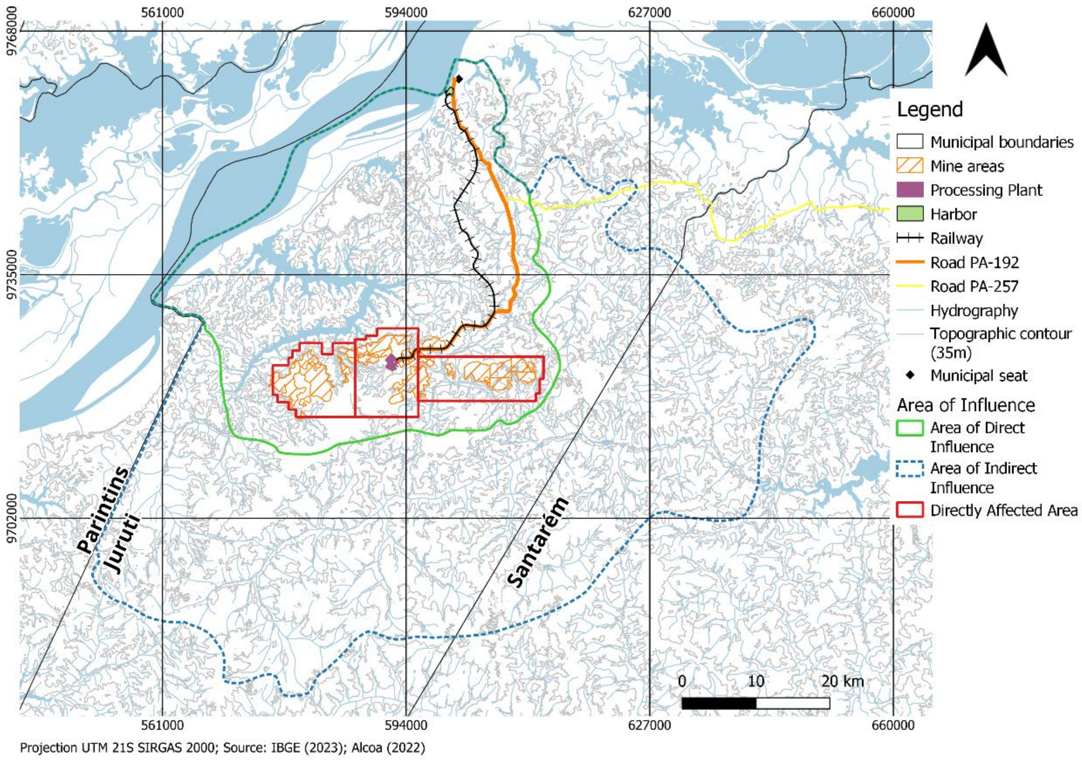

Figure 2 – Area of Influence of the Juruti Mine

Despite considering the limits of the hydrographic basins of the region for the delimitation of the area of influence of the physical-biotic environments, as guided by CONAMA Resolution (No. 01 of 1986), it is important to note that this limit was not fully applied. Specifically, the western boundary of the AoI was defined by the municipal and state administrative limits - political boundaries that do not represent a physical barrier to biodiversity. This delimitation may be justified by directives issued by the state environmental agency.

To delineate the AoI, it is first necessary to identify the area affected by the project, where the activities that interact with the environment will be carried out (Gullison et al., 2015). In the case studied, the main activity that induces environmental impacts on biodiversity is the suppression of vegetation for mining (Nascimento, 2023), and the flora and fauna components will be impacted mainly within these areas and along their edges, which, for the Amazon Forest, can extend up to 300 meters.

The potential impacts on flora and fauna in the Juruti bauxite mine are addressed by the monitoring programs currently executed – Flora Conservation Program: Monitoring of Secondary Forest and Fauna Monitoring Program, which is encompasses all faunal groups. These programs have monitoring points distributed according to the AoI and are expected to provide insights for confirming this area.

The Secondary Forest Monitoring is conducted in five permanent plots, implemented in 2015, representing different vegetation formations present in the AoI, to provide subsidies to the forest restoration process (Figure 3). Although the program seeks to monitor the impact of 'Modification of floristic composition' as a result of the edge effect (Nascimento, 2023), the current allocation of monitoring points may not be optimal for detecting this impact, since only one plot is in the vicinity of the extraction area, where such effects are most likely to occur (Emberton; Wenning; Treweek, 2018).

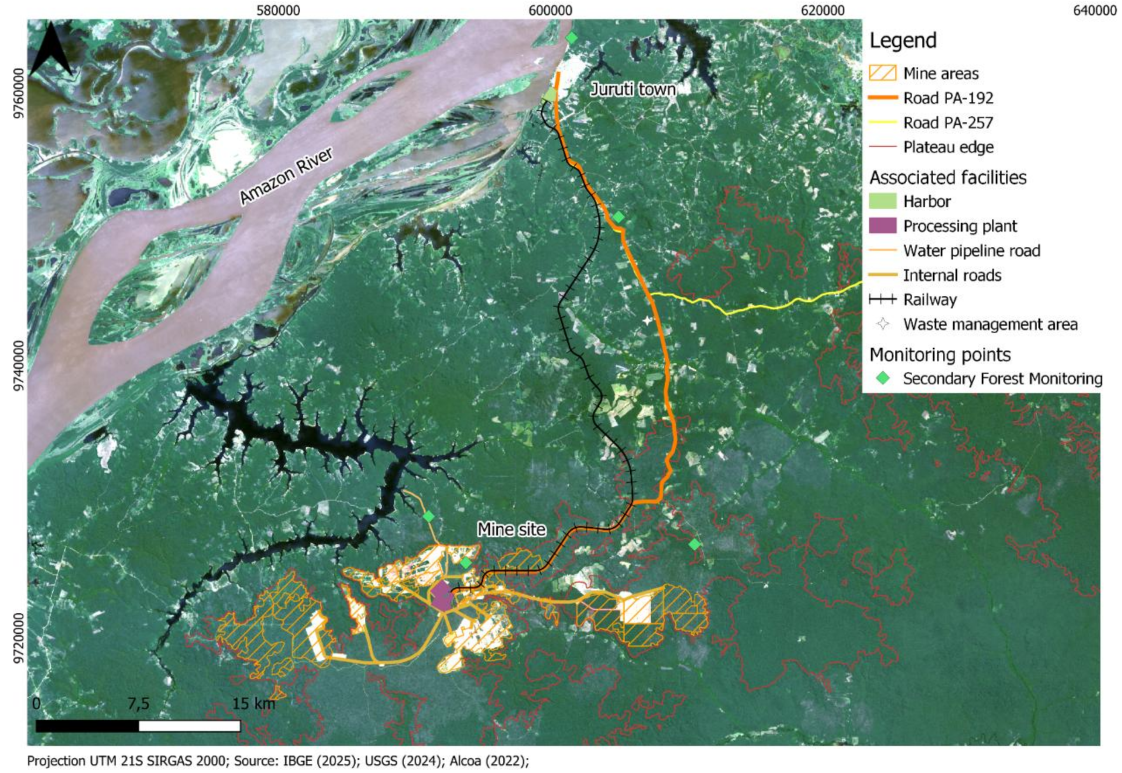

Figure 3 - Location of flora monitoring points

The Fauna Monitoring Program is conducted along six transects of 1 kilometer each to cover the vegetation formations present in the AoI (Figure 4). These transects are positioned to track the progress of mining and the effectiveness of the restoration in previously mined areas, as well as to monitor a designated control area. The inclusion of a control area for biodiversity monitoring is important for a better understanding of the impacts, but if allocated outside the limits of the AoI, it can provide information about trends external to the influence of the project (Gullison et al., 2015).

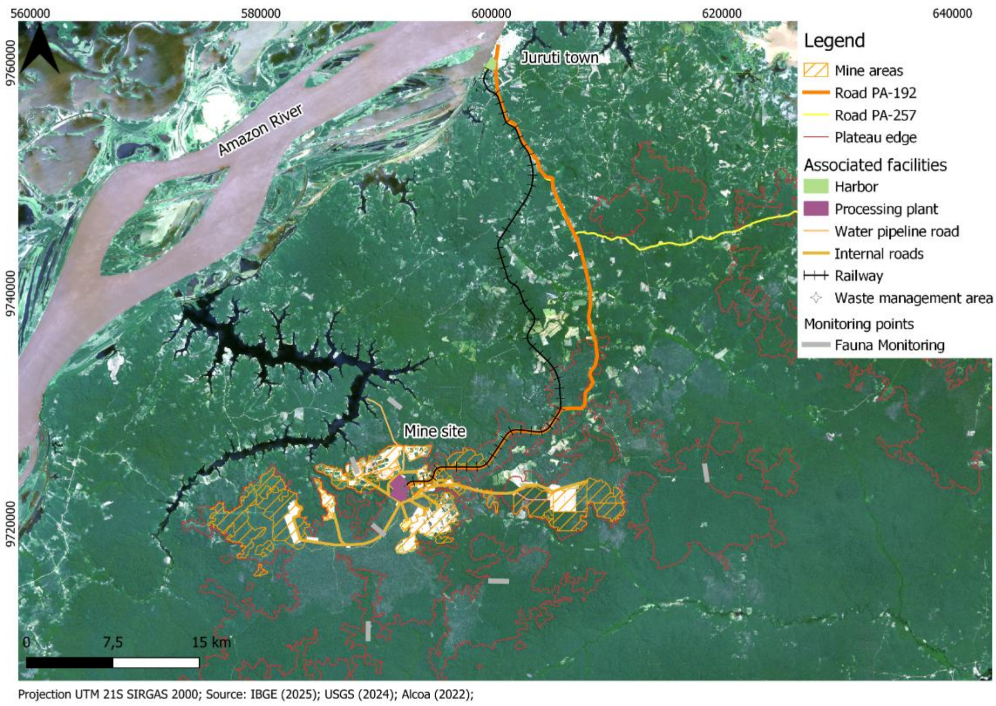

Figure 4 - Location of fauna monitoring transects

Both monitoring carried out for biodiversity in the AoI of the Juruti Bauxite Mine involve data collection on a local scale. This monitoring provides answers about the direct impacts of mining in different vegetation formations, informing the differences in the characteristics of the areas. However, indirect impacts are more complex to detect as they can reach great distances from the source (Sonter et al., 2017).

For a broader understanding of the changes in the component over time, it is possible to use multiscale monitoring, also adopting landscape-scale monitoring assessing habitat fragmentation and connectivity (Watkins et al., 2015). Understanding the changes in spatial patterns that occur within AoI can corroborate the understanding of the ecological processes of that landscape, since some ecological phenomena cannot be explained on a single scale (Koblitz et al., 2011). In this context, it is recommended that the biodiversity monitoring programs at the Juruti bauxite mine be complemented with monitoring of landscape patterns, collaborating with the identification of indirect and cumulative impacts within the AoI, following the recommendation of the International Finance Corporation (IFC, 2012) and pointing to the coherence of its delimitation.

Conclusion

The absence of technical guidelines and appropriate spatial scales for the AoI of projects raises concerns regarding the accuracy of their delimitation. Since this delineation is based on the prediction of impacts, monitoring plays a crucial role in validating or indicating the need for revision. In the case of the Juruti bauxite mine, this research found that biodiversity monitoring currently conducted in the field could be complemented by adopting landscape pattern measures and provide a better dimension of the changes in the landscape configuration and the interference in the components of biodiversity, identifying the occurrence of direct and indirect impacts and point out to refining the AoI.

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