Optimization of the Environmental Recovery Process - An Alternative for Rehabilitating Failures in Recovered Areas

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Abstract

The Program for the Recovery of Degraded Areas - PRAD is one of the most challenging processes for a bauxite mine. After executing environmental recovery activities in large mined areas, some locations may present less satisfactory results, becoming areas of exposed soil (islands without vegetation), which occur due to factors related to the terrain conditions. This work aimed to make a new methodology of area recovery feasible, specifically targeting the islands without vegetation with satisfactory coverage like the other areas rehabilitated after mining. The objective is to return to society a forest as close as possible to those found in the Paragominas region in Pará. The initially proposed technique for the recovery of islands without vegetation was nucleation, a methodology that reuses the residue generated in vegetation suppression and disposed of in already-mined areas. However, the logistics of transport, equipment availability, and mainly safety stimulated the search for a different operational strategy. The analysis focused on a methodology for recovering mined areas that corresponded to environmental expectations. The development of the new soil preparation methodology provided favorable conditions for vegetation development in the fault islands, achieving the initial objective of fully rehabilitating the degraded areas.

Keywords: Environmental restoration, Sustainability, Safety, Process optimization, CO_2 emission reduction.

1. Introduction

With the evolution in research and technology, geological knowledge advances exponentially with new discoveries of metallic mineral deposits. In Brazil, mining occurs more frequently in ecologically important regions, such as tropical forests, savannahs, mangroves and coastal areas, given the great diversity of ecosystems in this country. These discoveries positively influence the country's economy, in addition to promoting advances in the industrialization process [1].

The Brazilian mineral production consists of 89 % of its total value of metallic substances, moving R$ 312.9 billion. Among this total, the expressive participation of 80.1 % of iron stands out and aluminum assumes the participation of 1.74 % in the commercialized production scenario, having as base year 2021, according to the national mining agency - ANM [2]. Even with the positive balance for the Brazilian economy and its productive potential with high quality bauxite reserves, mining activities are not exempt from legal and environmental obligations. During the licensing process, it is necessary to propose strategies for mine closure, a mandatory step for the approval of mining projects in Brazil, undergoing approvals and inspections by the competent environmental agencies, in order to obtain the authorization for mineral exploitation. Among the strategies is the Degraded Areas Recovery Plan - PRAD [3].

Mineração Paragominas S. A. - MPSA, a company of the Norsk Hydro group, a Norwegian company integrated in aluminum production and with a global presence, is among the main producers of bauxite, the raw material for aluminum, in Brazil [4]. The exploitation of the mineral has increased in response to the global demand for aluminum. The Brazilian Aluminum Association - ABAL [3] - conducted a survey on global aluminum consumption and found that there was an increase of 10.9 % in relation to 2020, reaching the highest volume ever recorded since the beginning of the survey, the year 1972. After the extraction of the ore of interest, the areas are available for the beginning of the environmental recovery process [5].

Each site that must be vegetated has its specificity and, therefore, a more appropriate recovery technique. It is necessary to seek alternatives according to the specific characteristics of each area, thus obtaining satisfactory results. As recovery practices for areas altered by open-pit mining activity on flat lands, the most used alternatives and techniques are: direct planting with native tree species and natural regeneration [6].

The MPSA has also implemented a third technique, nucleation [7]. According to environmental legislation, mining companies are required to restore degraded areas after the extraction of minerals of interest has ceased [4]. In anticipation of social commitments and with the aim of restoring ecological functionality and enabling the reintegration of affected ecosystems, MPSA has undertaken to recover within a maximum period of three years the mined areas. One of the challenges in this scenario is to simultaneously develop innovations for the recovery of degraded areas, considering the sustainability of the mining activity itself, reducing costs and ensuring the mitigation of negative environmental impacts caused by mineral exploration [8].

2. The Project Area

The project area is located on the bauxite deposit belonging to the Norwegian group Norsk Hydro (3° 15' 38"S e 47° 43' 28" W) a 70 km of the seat of the municipality of Paragominas (2° 59' 42" S - 47° 21' 10" O), Northeast region of the State of Pará - Brazil [9]. The MPSA mine is composed of two bauxite deposits on contiguous plateaus called Miltonia 3 (M3) and Miltonia 5 (M5), Figure 1.

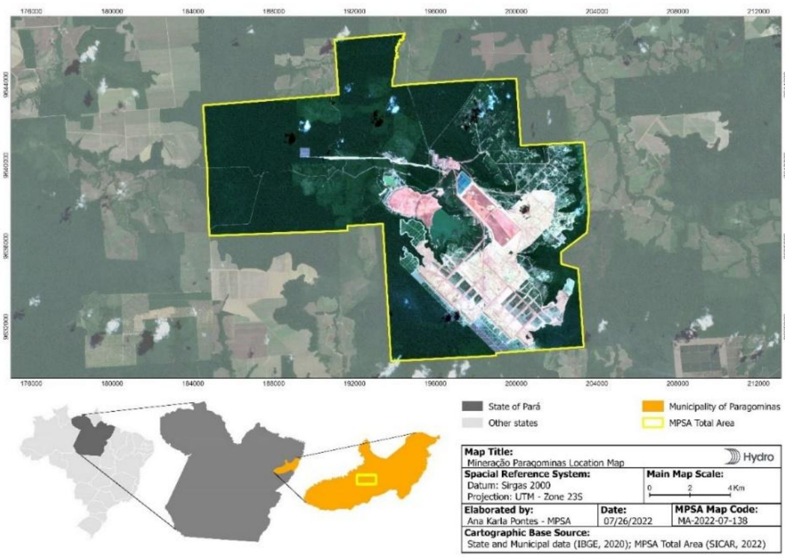

Figure 1. Mineração Paragominas location map.

This reduction in consumption avoided 95% of the emission of greenhouse gases (CO_2) into the atmosphere in an annual cycle (6 months of operation) of the activity.

4.4 Vegetation Suppression Activity

The method developed for soil preparation for planting allowed the execution of the activity without requiring plant suppression to open accesses and maneuvering areas for trucks. The suppression activity was eliminated from this process, resulting in less impact and preservation of areas already in the process of advanced recovery.

4.5 Financial Saving

The reduction in the operating cost of the activity caused by the reduction of equipment, contracting of services, reduction of fuel consumption and the number of steps performed ensured a financial expenditure 63 % compared to the execution of the nucleation technique with transportation of more than 10 km. The cost, applied to the same reclamation area, for nucleation that was 12.7 million BRL, reduces to 4.6 million BRL. The savings achieved with the new methodology was around 8 million BRL (~1.5 million USD).

5. Conclusion

The implementation of new methodology for rehabilitation of reclaimed areas with occurrences of fault islands at high transportation distances provided gains in different technical aspects - soil restructuring, reduction of equipment and exposure of people, reduction of fuel consumption and CO_2 emissions, preservation of reclaimed areas in the surroundings, satisfactory rehabilitation of fault islands, as well as financial savings.

The effectiveness of the soil preparation technique with tracked tractor ensured competent performance in the development of planting, the monitoring of the mapped areas shows significant evolution in the growth of vegetation cover. The higher productivity of the new methodology conferred 220 % of the planned target (83.2 ha), 183 ha of recovery of area with deficiency in the development process were executed.

The optimization carried out is in line with the commitment of companies to pursue the industry's decarbonization goals, with the social responsibility of returning fully recovered areas to society and with the search for a more viable and sustainable society. It has the potential to be multiplied or adapted in other mining companies, as well as to inspire new development tests of the environmental recovery process.

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