Tailing Dam Closure with Revegetation: Use of Green Manure for the Improvement of Technosoil Built from Bauxite Tailings

Mayra Barral[1], Jonilton Paschoal[2] and Vicente Souza[3]
1. Environment Analysts
2. Environment Manager
3. Environment Analysts
Hydro Paragominas, Paragominas – PA, Brazil
Corresponding author: mayra.barral@hydro.com

Abstract

The closure process of tailing dams is today one of the great concerns related to tailing dam management in the mining sector, which can be noticed by the latest changes on international standards and federal legislations (specially in Brazil) regarding the topic. To close tailing dams applying revegetation as a technique of dam recharacterization is a great challenge, mainly because the organic material (OM) in the substrate is very poor or nonexistent. In agriculture one of the techniques used to improve nutrients availability in soil is green manure, based on that, we tested the application of green manure on a pilot area filled with bauxite tailing. The species used were *Crotalaria spectabilis* Röth and *Canavalia ensiformis* (L.) DC, which are mentioned in many studies as great biomass producers. We prepared three different treatments to evaluate the biomass production in different conditions of organic material pre-availability: T1 – OM added; T2 – no OM added; and T3 – control. The biomass production by *Crotalaria spectabilis* was 110 % higher in T1 than in T2. From *Canavalia ensiformis* the biomass production was only 18 % higher in T1 than in T2. Even though biomass production was lower in T2, we count as positive the result obtained considering that no additional OM was included to this treatment, which means we got to have biomass production directly over the bauxite tailing. Additionally, the study shows that green manure is a possibility of improving technosoil quality for the initial phase of tailing dam closure in the bauxite mining industries and it can be tested for other minerals tailing.

Keywords: Tailing, Bauxite, Leguminous cover, Green manure, Technosoil.

1. Introduction

Bauxite is currently the main raw material globally used in the aluminum production chain [1]. For the generation of bauxite pulp that is used in the production of alumina, the ore undergoes a physical processing process of grinding and washing from where two materials are generated: the product (bauxite pulp) and a clay pulp that is not usable in the process (tailings) [2].

Although new technologies for tailings disposal are emerging, according to the Brazilian Aluminum Association - ABAL [3] the main form of bauxite tailings disposal in Brazil still occurs in large reservoirs, in which the tailings go through a drying and accommodation process over time until the end of the reservoir's useful life.

Since 2017, after the occurrence of accidents with tailings dams, both Brazilian legislation and international standards for mining companies have undergone revisions and creation of new requirements, which are linked to the maintenance, operation, and closure processes of these structures. International standards applied to companies in the aluminum chain, such as the performance standards of the Aluminium Stewardship Initiative – ASI and the guidelines that support the principles of the International Council on Mining & Metals – ICMM, have become more restrictive regarding the application of the best environmental practices and long-term stability in the closure and post-closure of tailings dams [4, 5, 7].

Given this scenario, there is a need for companies in the sector to develop dam closure plans that contemplate viable, sustainable practices, in accordance with socio-environmental issues and that meet the new standards imposed by legislation and certification entities, which directly influences financing processes in national and international banks [6].

To apply revegetation as a technique for tailings dam closure, the process of improving the availability of nutrients in the substrate is a key step. In this sense, the application of cover leguminous has been widely applied and indicated as a green technique to increase nutrients in poor or degraded soils, for its fast-growing cycle (fast soil coverage), its capacity of nitrogen fixation into the soil, its contribution for nutrients cycling, and the possibility of using it as additional organic matter input [8, 9].

2. Methods

This study was performed in the city of Paragominas, Pará, Brazil in the bauxite mine of Hydro Paragominas (Figure 1). The experiment was implemented in a pilot dyke filled with bauxite tailing, the height of the tailing was about 1 meter, and the last tailings disposal occurred in December 2016.

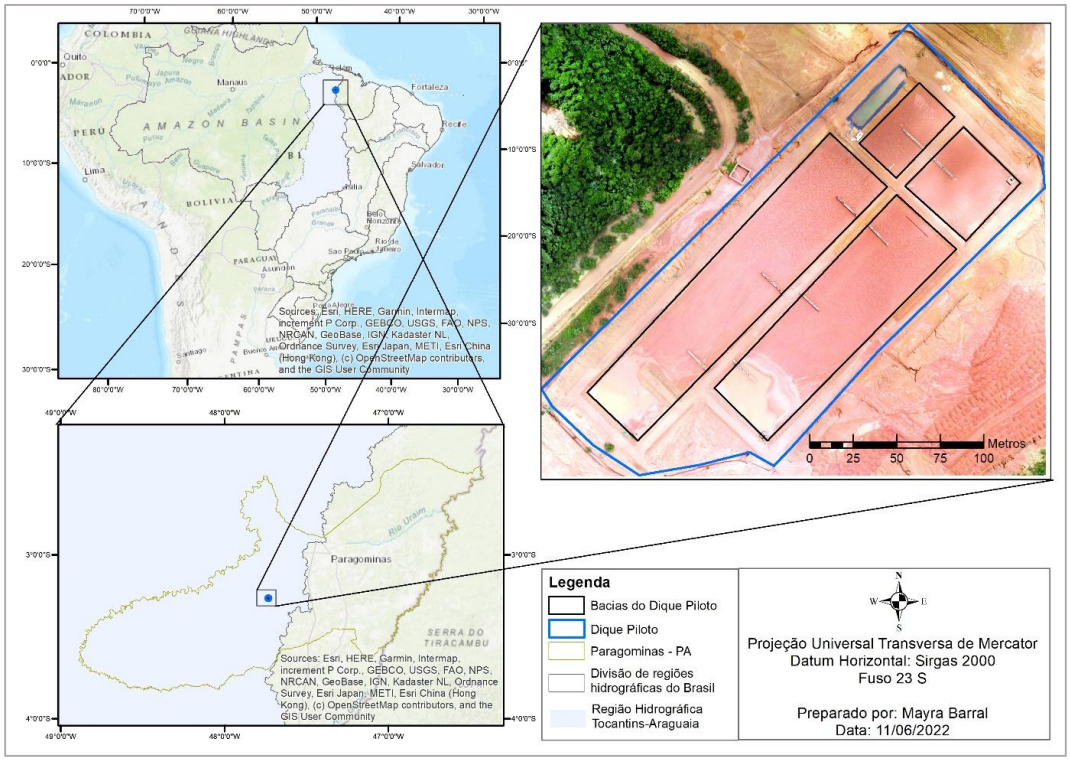

Figure 1. Location of the experiment area

To characterize the chemical attributes of the pilot dyke material before the experiment, we collected samples on August 2nd, 2021. This analysis demonstrated that the tailing has characteristics of acid soil with very low or nonexistent macronutrients and organic material content.

The area was prepared in January 2022, when deposited tailing was submitted to soil decompaction, acidity correction and fertilization. To correct the soil pH, 0.302 t/ha (302 kg ha-1) of dolomitic limestone with 91 % PRNT was applied.

5. References

1. CRU Consulting. *Opportunities for aluminium in a post-Covid economy*. Prepared for the International Aluminium Institute (IAI). CRU Reference: ST2342-21. 28/01/2022. Available at: https://international-aluminium.org/resource/opportunities-for-aluminium-in-a-post-covid-economy/?_thumbnail_id=6715. Access 09/06/2022.
2. ABAL, Associação Brasileira do Alumínio. *Alumínio. Cadeia Primária*. Available at: http://abal.org.br/aluminio/cadeia-primaria/. Access 09/06/2022.
3. ABAL, Associação Brasileira do Alumínio. *Bauxita no Brasil. Mineração Responsável e Competitividade*. São Paulo, SP: Gráfica Mundo. Abril/2017. 66 p. Available at: http://www.abal.org.br/downloads/ABAL_Relatorio_Bauxita_2017_1.pdf.Access 08/06/2022.
4. ICMM, International Council on Mining & Metals. *Global Industry Standard on Tailings Management. GISTM*. August 2020. Available at: https://www.icmm.com/en-gb/our-principles/tailings/global-industry-standard-on-tailings-management. Access 10/06/2022.
5. ICMM, International Council on Mining & Metals. T*ailings Management. Good practice guide.* May 2021. Available at: https://www.icmm.com/website/publications/pdfs/environmental-stewardship/2021/guidance_tailings-management.pdf. Access 10/06/2022.
6. IFC, International Finance Corporation. *Environmental, Health, and Safety Guidelines for Mining.* December 10, 2007. Available at: https://www.ifc.org/wps/wcm/connect/595149ed-8bef-4241-8d7c-50e91d8e459d/Final%2B-%2BMining.pdf?MOD=AJPERES&CVID=nPthex1&id=1323153264157.Access 10/06/2022.
7. ASI, Aluminium Stewardship Initiative. *ASI Performance Standard. Version* 3 – May 2022. 33 p. Available at https://aluminium-stewardship.org/wp-content/uploads/2022/05/ASI-Performance-Standard-V3-May2022-2.pdf. Access 09/06/2022.
8. Selma Regina de Freitas Coelho et al., *Crescimento, nutrição e fixação biológica de nitrogênio em plantios mistos de eucalipto e leguminosas arbóreas*. Pesquisa Agropecuária Brasileira [online]. 2007, v. 42, n. 6 [Access 26/07/2021], pp. 759-768. Available at: https://doi.org/10.1590/S0100-204X2007000600001. ISSN 1678-3921.
9. Vitor moreira et al., *Características adaptativas da associação simbiótica e da fixação biológica do nitrogênio molecular em plantas jovens de Lonchocarpus muehlbergianus Hassl., uma leguminosa arbórea nativa do Cerrado*. Rodriguésia [online]. 2014, v. 65, n. 2 [Access 26/072021] , pp. 517-525. Available at: https://doi.org/10.1590/S2175-78602014000200013. ISSN 2175-7860
10. J. A. ACOSTA et al., *Decomposição da fitomassa de plantas de cobertura e liberação de nitrogênio em função da quantidade de resíduos aportada ao solo sob sistema plantio direto.* Ciência Rural, 44(5), 801–809. (2014). Available at: https://doi.org/10.1590/S0103-84782014005000002. Access 02 Jun. 2023.
11. R. A. ANDRADE et al., *Taxas de cobertura e decomposição de adubos verdes na Amazônia Sul Ocidental*. Revista em Agronegócio e Meio Ambiente, [S.L.], v. 15, n. 1, p. 1-15, 21 fev. 2022. Centro Universitário de Maringá. Available at: https://doi.org/10.17765/2176-9168.2022v15n1e8600. Access: 28/02/2022.