Using Soil Bioengineering to Recover a Gully in the Amazon Forest

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Abstract

During the dam construction process, sites adjacent to the construction work are licensed and called Borrow Areas. Due to the intensification of anthropogenic actions, these areas are more susceptible to erosive processes that result in soil movement, silting of water resources, loss of natural habitat, alteration of water quality, loss of local fauna and flora and alteration of the natural environment. Traditionally, the control of erosion processes on slopes is carried out using conventional civil engineering techniques (gabion walls, slope reshaping, etc.). However, Hydro Bauxite & Alumina, which is driven by more sustainable and environmentally friendly actions, takes care of neighboring communities and future generations, and decided to implement techniques with a lower environmental impact. The aim of this case study was to demonstrate soil bioengineering techniques. The target area (borrow area) of the intervention project consists of a large gully with an area of approximately 575 m^2, 35.5 m long at its central axis and 9.0 m deep at its highest point, with slopes of 77° there are also negative effects visible at various points. Soil bioengineering focuses on a set of techniques that combine living/inert constructive materials, which can be applied as constructive solutions to structural problems of geotechnical and hydraulic stabilization, control of surface erosion processes, and simultaneously design ecosystems in dynamic balance, environmentally friendly and with less damage to nature. In this way, the following techniques were implemented: 1- Earthworks; 2- Live wooden cribwall; 3- Live slope grid; 4- Vegetated coir logs; 5- Selection of suitable plants. This case study presents the techniques used to stabilize the gully. The results were totally effective in controlling erosion and stabilizing the slope, withstanding high volumes of precipitation (82.70mm). There is no need for decommissioning works, as the structures will be integrated into the environment and are more economically viable than traditional molds.

Keywords: Soil Bioengineering, Gully Control, Environmental Recovery, Nature Based Solutions, Slope Stabilization.

1. Introduction

According to data consolidated by Instituto Brasileiro de Mineração do Brasil (IBRAM – Brasilian Institute of Mining) [1], the mineral sector raised 58 billion USD in Brazil in 2021, playing a fundamental role in the balance of the economy, considering exports and imports for that reference year. More specifically, the export of bauxite from Brazil accounted for 184 million USD in 2021, equivalent to 1.48 million tonnes of the ore exported [1].

Bauxite is currently the main raw material used in the global aluminum production chain [2]. For the generation of bauxite slurry used in the production of alumina, the ore undergoes a physical beneficiation process involving grinding and washing, which generates the product and a bauxite slurry that is not usable in the process (tailings material) [3]. Despite the emergence of new tailings material disposal technologies, according to the Brazilian Aluminum Association - ABAL [3], the main method of bauxite tailings material disposal in Brazil occurs in large reservoirs, where the tailings material undergoes a process of drying and settling over time until the end of the reservoir's useful life.

According to data from Integrated Mining Dam Management System/National Mining Agency (SIGBM/ANM) updated until July 2023, Brazil has 928 mining dams registered in the system, distributed across 20 Brazilian states, with 461 included in the National Dam Safety Policy - PNSB [4]. The state of Pará has the highest representation in the collection of the Financial Compensation for the Exploration of Mineral Resources (CFEM) in the country, equivalent to 45.6 % of the total collected [1]. According to ANM data (2017), Pará has 37 companies that explore metallic minerals, including 18 of medium or large size, with 3 large bauxite mining companies.

During the process of dam constructions, adjacent areas to the work are licensed and called Borrow Areas. These perimeters are used for the installation of construction sites, traffic, and parking of equipment, removal, transport, and deposit of substrates from soil horizons (laterite) among other utilities. These actions can lead to erosive processes resulting in soil movement, silting of water resources, loss of natural habitat, alteration of water quality, loss of local fauna and flora, and changes in the natural environment. Natural factors such as soil susceptibility to erosion, high rainfall levels, and undulating relief strongly influence the dynamics of erosive processes [5]. Although erosion is a continuous and natural process that contributes to the distribution of sediments on the Earth’s surface, its acceleration due to human action results in environmental and economic losses.

Traditionally, the control of erosive processes on slopes is carried out with conventional civil engineering techniques, such as slope reshaping through cutting, which can even intensify existing erosive processes, or the application of gabion walls, soil cement bags, concrete linings, rockfill, among others. However, Hydro Bauxite & Alumina, driven by more sustainable and environmentally correct actions, as well as care for neighboring communities and future generations, decided to implement techniques with lower environmental impact.

Thus, to correct erosive processes on slopes, projects of soil bioengineering were developed. Soil bioengineering proves to be a viable solution compared to traditional techniques, as considerers technical criteria in the design of works, and also values ecological and environmental factors [6, 7]. Moreover, the correction and/or mitigation of erosive processes through conventional engineering approaches can be more costly from a technical, economic, and especially ecological standpoint [8]. According to various authors, soil bioengineering presents more economical construction solutions than traditional engineering solutions [6, 9, 10].

Soil bioengineering primarily uses living construction materials (seeds, plants, plant parts, etc.) that may or may not be combined with inert materials. It can be used as a substitute, but mainly as a useful and sometimes necessary complement to classic civil engineering techniques [11]. Soil bioengineering techniques can be applied in the hydraulic field for stabilization and protection of slopes, as well as to increase the morphological diversity in stretches or sections of watercourses, or to increase biodiversity and connectivity of ecological networks [9]. They offer more flexible and permeable construction schemes, which can be more easily integrated into nature, do not suffer from soil settlements and movements, and also do not alter the soil’s hydraulic conductivity. Furthermore, since these techniques use natural construction materials, there is no need for decommissioning of the works, as the structures will perfectly incorporate and integrate into nature. The lack of need for decommissioning also results in lower operation costs and mainly bioengineering execution activities, and Facility for the execution of the soil bioengineering activities.

6. References

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