Dredging of Basins for Geobags - An Innovative Solution for Sediment Management in Alumina Production

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https://doi.org/10.71659/icsoba2025-br005

Abstract

The Bayer process, used to obtain alumina (Al_2O_3), generates large volumes of a residue characterized by high alkalinity, requiring careful management to prevent environmental impacts. At Alunorte, in Barcarena, the residue is disposed of in impermeabilized dry stacking facilities, bauxite residue disposal area (BRDA), while effluent control basins retain rainwater for treatment. Due to its fine-grained nature and susceptibility to erosion when exposed to rainfall, the material can be transported by water into the basins, settling down and reducing the available storage capacity. As a result, frequent maintenance of these basins is required. Maintaining these structures requires periodic sediment removal, traditionally carried out through mechanical cleaning. However, desilting the basins requires significant effort, in terms of removing, transporting and dispose of the sediments in the BRDA, fixing the lining system, impacting in operational downtime. Another challenge faced in tropical region is the limitation due to rainy season, meaning that maintenance can only be performed during the dry season. To overcome these challenges, a dredging system with confined disposal of underflow residues from treatment plant in Geobags was implemented, ensuring the water security of the storage facility and maintaining the available capacity in the basins. These woven-geotextile tubes retain sediments while allowing water to drain, ensuring safe and controlled deposition and performing a structural component of the stack stability. This study evaluates the performance of dredging sediments basins and disposing of the underflow in Geobags compared to the conventional mechanical method, analyzing its benefits in terms of safety, operability, and storage capacity maintenance. The methodology demonstrated operational efficiency and adequate environmental protection, standing out as a sustainable and innovative solution for bauxite residue sediments management.

Keywords: Bauxite residue, Dry stacking, Geobags, Sediment dredging, Sustainable waste disposal.

1. Introduction and Context

1.1 Climatic Characteristics

Located in Barcarena, in the northern region of Brazil, the Alunorte refinery produces alumina and operates under particularly challenging climatic conditions. Between 2021 and 2024, the average annual rainfall in the region was 2869 millimeters [1] a value significantly higher than the global average, which is around 990 millimeters per year [2].

This reflects the humid equatorial climate characteristic of the Amazon region as we can see in Figure 1. Due to the high volume of precipitation and the sensitive environmental context, Alunorte manages its filtered bauxite residue by compacting during disposal at the engineered Bauxite Residue Disposal Areas (BRDAs). The company is continuously committed to making its operations increasingly safe and more sustainable, to protect the environment and enhance reliability.

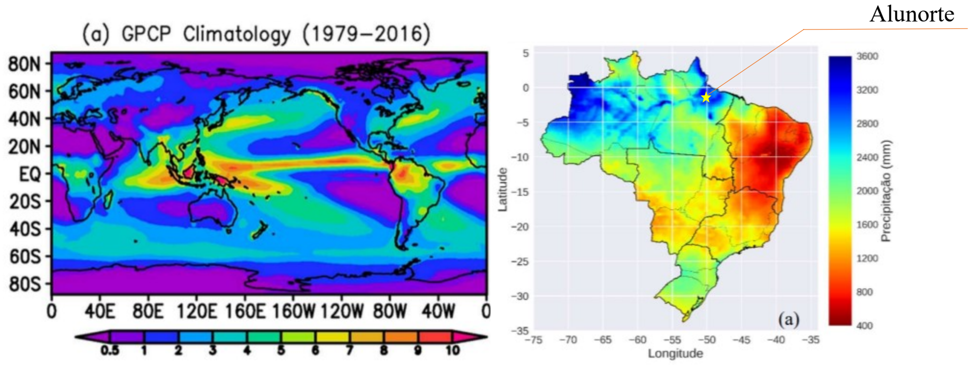

Figure 1. Global Precipitation. Left: Climatology Project (GPCP) (1979–2016) mean precipitation (mm/day) [2], Right:Historical average precipitation in Brazil in mm [1].

The Figure 2 shows the local hydrological regime recorded in Alunorte between the years 2021 and 2024, with a well-defined dry and wet seasons, directly influencing industrial operations – specially the management of waste generated by the Bayer process, which represents a significant portion of alumina production costs [3]. Owing to the rain regime shown in Figure 2, the more complex interventions are performed preferably during the second half of the year.

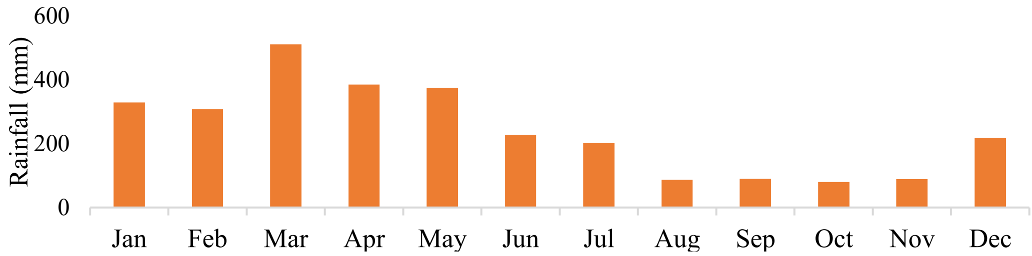

Figure 2. Recorded data from 2021 to 2024 at Hydro Alunorte in mm.

1.2 Operational Characteristics

In the context of bauxite processing, the Bayer process is widely used for alumina production, employing caustic soda under high temperatures and relatively low pressure. As a result of this process, a solid residue is generated, this residue is typically fine-grained and caustic [3].

Until 2018, Alunorte used drum filters for bauxite residue dewatering, reaching up to 64 % solids content, disposed of in the BRDA named Solid Residue Deposits 1 (DRS1) and Solid Residue Deposits 2 (DRS2) as illustrated in Figure 3. Commissioned in 2017, the filter press technology increased process efficiency, producing drier residue with 78 % solids content approximately, making it possible to employ the residue as a compacted layer that shapes the rehabilitation geometry of DRS1 and to be dry stacked in DRS2, using mechanical compaction.

For uncovered surface deposits areas, the rainwater generates a caustic effluent. This effluent is directed to control basins—lined ponds designed to temporarily store effluent composed of rainwater and bauxite residue sediments until it can be properly treated. These basins are lined with impermeable systems that promotes watertightness and the mitigating percolation to the environment.

5. References

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