GIS-Based Optimization of Fill Material Transport and Allocation for Progressive Mine Closure

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# ABSTRACT

This study presents an optimization approach for transporting fill material and topsoil in the context of mine closure and rehabilitation of impacted areas based on a case study in bauxite mining. The proposed transport optimization model is developed using data processed in a Geographic Information Systems (GIS) environment and route optimization algorithms from open-source Python libraries. It enables the creation of a distance matrix between sources (material stockpile locations) and destinations (demand points such as roads, final mine surfaces, and infrastructure areas) and the optimal solution of the associated transportation problem.

A key feature of the model is its integration with specialized software that incorporates the actual road network of the mining site, allowing for the inclusion of operational restrictions and road closures. This ensures that distance values accurately reflect actual operational conditions. The model allows for the incorporation of dummy sources, making it possible to identify gaps between material supply and demand and suggest strategic locations for stockpile locations.

The case study results showcase insights for strategic and operational decision-making in progressive mine rehabilitation, including identification of material concentration clusters and peripheral regions dependent on dummy sources, route and volume assessment and improved fleet selection.

This study demonstrates how integrating GIS-based optimization and rehabilitation practices can transform logistical challenges into opportunities, fostering a more efficient and sustainable mine closure process.