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ENVIRONMENTAL RECOVERY OF AREAS DEGRADED BY MINING. CASE STUDY: COMPANY JJG ITABORAÍ LTDA.

RECUPERAÇÃO AMBIENTAL DE ÁREAS DEGRADADAS POR MINERAÇÃO. ESTUDO DE CASO: EMPRESA JJG ITABORAÍ LTDA.

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Abstract

This paper presents a case study of the environmental recovery of an old sand extraction area located in the municipality of Itaboraí, Rio de Janeiro state, Brazil, owned by JJG ITABORAÍ AREAL LTDA and covering 49.79 hectares. Growing concern about environmental preservation has led Brazilian mining and environmental management authorities to require the mining sector to recover mined areas during and, particularly, after the completion of extraction. The area studied is an open-cast extraction site with shallow pits averaging 70 cm in depth, without reaching the water table and with environmental controls intended to maintain ecosystem balance. Mining activities ended in 2020, and by 2024 the area had been fully recovered. In some of the reclaimed areas, the landscape returned to a condition similar to that existing before the mining project. Environmental controls included the replanting of orange and banana crops, the establishment of grass plantations and the recovery of pasture areas. The study was based on documentary research using information provided by the company, a technical field visit, photographic records and descriptive observations, complemented by consultations with company owners and employees. The results demonstrate that environmental recovery of a degraded mining area is feasible when recovery measures are progressively implemented during the mining operation and maintained after its closure.

Keywords: Mining, Environmental Recovery, Environment

Resumo

O presente trabalho apresenta um estudo de caso relacionado com a recuperação ambiental de uma antiga área de extração de areia, localizada no município de Itaboraí, estado do Rio de Janeiro, Brasil. Trata-se da empresa JJG ITABORAÍ AREAL LTDA, cuja área concessionada possui 49,79 hectares. As crescentes preocupações com o meio ambiente e a preservação ambiental levaram os órgãos brasileiros responsáveis pela mineração e pela gestão ambiental a exigir do setor de mineração a recuperação ambiental das áreas mineradas durante e, sobretudo, após a conclusão da extração. A área estudada corresponde a uma jazida de extração a céu aberto, em cavas rasas, com profundidade média de 70 cm, sem atingir o lençol freático e com a adoção de controles ambientais destinados à manutenção do equilíbrio do ecossistema. Os trabalhos de extração foram encerrados em 2020 e, em 2024, a área encontrava-se totalmente recuperada. Em parte dos locais recuperados, a paisagem retornou a uma condição semelhante à existente antes do empreendimento minerário. Entre as medidas adotadas destacam-se os controles ambientais, o replantio de laranja e banana, o cultivo de capim e a recuperação das áreas de pastagem. A metodologia baseou-se em pesquisa documental, utilizando informações disponibilizadas pela empresa, visita técnica de campo, registros fotográficos e observações descritivas, complementadas por consultas aos proprietários e funcionários da empresa. Os resultados demonstram que é possível recuperar uma

área degradada pela mineração quando as medidas de recuperação são implementadas de forma progressiva durante a exploração e mantidas após o encerramento da atividade.

Palavras-Chave: Mineração, Recuperação Ambiental, Meio Ambiente, Areia.

1 - Introduction

Regardless of its great importance for the development of humanity over time, and its necessity for human technological advancement, it is common for mining to be considered a great environmental villain that irreversibly destroys the environment. Still, over the years, with the growth of environmental concern, thanks to the various environmental regulations created not only by environmental management bodies, but also by mining management bodies, mining has become one of the sectors most concerned with environmental recovery, since each and every mining venture already carries out environmental recovery of the mined area during the advancement of the mining front, and also after its closure.

This study presents the results of the environmental recovery work undertaken by the sand extraction company JJG ITABORAÍ AREAL LTDA, located in the municipality of Itaboraí, in the state of Rio de Janeiro, Brazil. The aim of this work is to present another aspect related to mining activity, demonstrating that mining not only can, but under current legislation in Brazil, has an obligation to recover, recompose or readjust the environment into which it is inserted, either by reutilizing the area for the same activities already conducted before the mining activity began, or for another type of utilization, such as reforestation, cultural activities, the implantation of allotments, among others.

The methodology used in this study comprised documentary research and fieldwork. The documentary stage involved the analysis of technical and environmental information made available by JJG ITABORAÍ AREAL LTDA, including documentation related to the mining operation and environmental recovery. The fieldwork consisted of a technical visit to the area where the environmental recovery described in this case study was carried out. During the visit, photographic records and descriptive observations of the conditions of the site and the recovered areas were obtained. To complement the documentary and field information, consultations were held with the company's owners and employees, allowing additional information about the mining operation and the recovery measures to be incorporated into the study.

2 - Study Area

The area in question was a mining project for silty-clay sand (areola), owned by JJG ITABORAÍ AREAL LTDA, covering 49.79 hectares in Itaboraí, Rio de Janeiro, Brazil. Figure 1 presents the location of the State of Rio de Janeiro in Brazil, while Figure 2 presents the location of the Municipality of Itaboraí within the State of Rio de Janeiro. The mineral resource was of sufficient quality and quantity to be characterized as a deposit and could be extracted by open-cast methods in shallow pits with average

depths of 70 cm, without reaching the water table. Environmental controls were implemented throughout the operation.

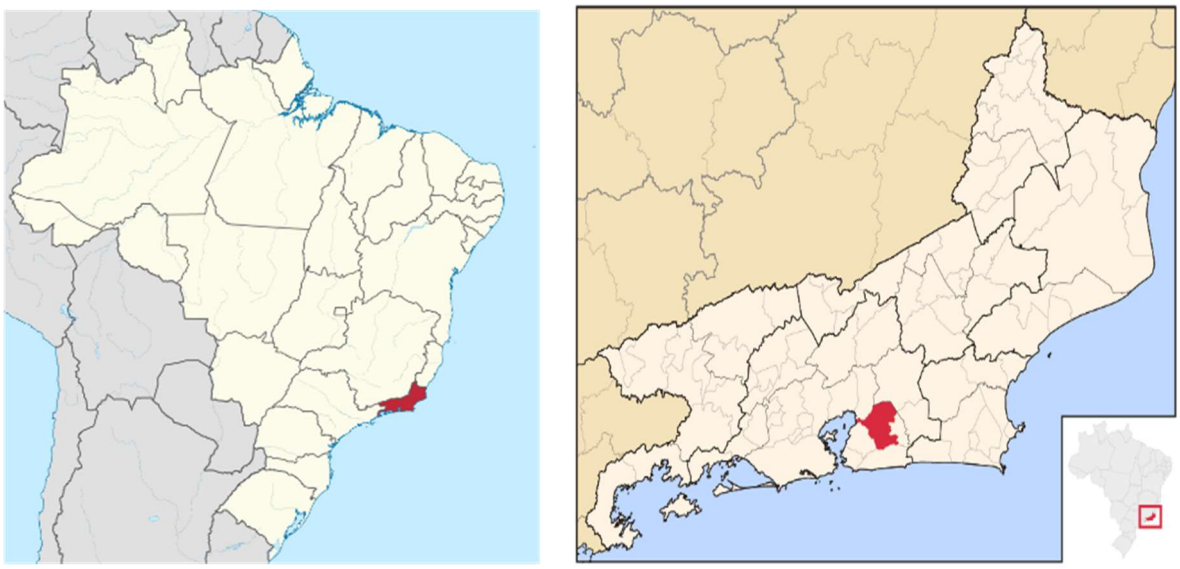


Figure 1. Location of the State of Rio de Janeiro, Brazil. Figure 2. Location of the Municipality of Itaboraí, State of Rio de Janeiro. (Source: Abreu, 2006).

Note: The scales of Figures 1 and 2 must be included according to the original cartographic files.

The plan for the economic use of the area was submitted to the National Department of Mineral Production (DNPM), now the National Mining Agency (ANM), for the “areola” mineral resource. This plan contains the history of exploitation during the mining phase, as well as the procedures for environmental recovery of the area. The mining phase began in 2013, and extraction of the mineral resource was carried out using a relatively simple method. Mining ended in February 2020 due to the exhaustion of the mineral resource at the site.

Since the area has predominantly flat topography, the excavation and transportation of the material were facilitated. The measured reserves of areola in the studied area were estimated at 934,458 tons, which were mined at a rate of 8,000 tons/month, giving the project an estimated useful life of approximately seven years. (Source: Archive of JJG ITABORAÍ AREAL LTDA.)

3 - Machinery, equipment, installations and supplies

In line with the intention of the company to preserve the property as much as possible, the site was divided into several modules, and the sand was extracted from module to module. This technique allowed environmental recovery to be carried out progressively, so that whenever mining ended in a module, its recovery began immediately. The sand was extracted by scraping to an average depth of 70 cm, in order to protect the water table.

The following operational methodology was followed during extraction:

- Initially, stripping was performed with the removal of soil and organic material;
- Afterwards, the material was extracted, always aiming for the progressive recovery

of each module mined;

- The sterile material (soil mixed with organic material) was placed in appropriate locations for the preparation of seedlings in a nursery; subsequently, all the organic soil, already with the seedlings, was replaced on the top layers of the modules that had already been mined.
- The small elevations were lowered by pushing the material with the help of a tractor to form piles aiming to fill in the open pits that remained shallow after mining;
- The sand was transported by third-party trucks;
- The production was commercialized for immediate use in civil construction, without the need for further processing.

The materials used during the mining phase included the following (Source: Archive of JJG ITABORAÍ AREAL LTDA):

- A crawler bulldozer tractor;
- A backhoe, for mining and loading the trucks;
- A wheel loader;
- Various trucks;
- Shovels, hoes, picks, etc

4 - Open-cast mining

In order to make extraction possible, it was necessary to remove the vegetation and the shallow soil layer to expose the areola, in a process called stripping. This process involved removing the sterile material (organic soil) and storing it in an orderly manner, without obstructing access roads and service areas. The material was subsequently reused after mineral extraction for levelling, soil recomposition and replanting of the mined areas (Vieira Filho, 2011).

The material resulting from stripping and coming directly from the mining front is referred to as sterile soil. The material removed from the site varied in granulometry, from clayey and silty particles to psephitic material, and also contained mixed organic remains. These materials were deposited in areas selected for temporary storage and later use in environmental recovery. The extraction and recovery procedures were conducted progressively throughout the mining operation.

For loading and transporting the mineral resource, the extracted material was loaded by wheel loaders and transported by trucks from the mining area to consumer centres. The transport was carried out by third-party trucks. The impacts associated with vehicle traffic, including noise and emissions, were considered insignificant under the conditions observed at the site (Vieira Filho, 2011).

5 - Follow-up and Monitoring Programs for Environmental Factors

During the entire mining process, various environmental parameters were monitored according to a pre-established schedule, such as:

- Vegetation monitoring;
- Water quality monitoring;

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- Environmental and generic aspects;

In relation to vegetation, monitoring aimed to verify its development, and sampling was undertaken in the replanted areas, where the stage of plantation development was verified, the percentage of individual loss and the detection of pests and diseases.

The monitoring of water quality was carried out by taking samples at critical locations, such as the settling tanks and the drainage network. The parameters considered were water pH, settleable solids, turbidity, water color, oil and grease.

The environmental and general aspects monitored included possible erosion on the slopes of the area, repairs to structures and improvements to access routes, among others. If any monitored factor presented an unexpected result, remediation measures would be required to mitigate the resulting impact. However, all the results analysed were reported as satisfactory.

In order to implement the mining in question, it became necessary to devise the development of a plan to control the possible pollution resulting from this process. In relation to the soil, the objective of the plan was to verify soil losses at the mining sites, sampling sectors under exploitation, mainly where alterations were performed to the topography, and in other sectors where the soil was bare, unprotected and without vegetation cover.

The sampling was used to assess the following:

- Soil loss;
- The aggregation conditions of the material;
- The presence of sediment in the drainage channels;
- The recurrent topographical modifications

Sampling was conducted on a quarterly basis.

Due to the type of activity performed, atmospheric pollution could occur as a result of excessive dust on the roads and service routes within the property. As this factor is more likely to occur on days with strong winds and during prolonged periods of drought, the roads were successively watered in these circumstances until sufficient moisture was reached to prevent dust from rising. The company also maintained the machinery, vehicles and equipment in good operating condition, reducing the potential for gaseous emissions.

Drainage control was implemented by surrounding the entire site established by ditches, preventing the disordered flow of rainwater, in order to avoid the start of erosion processes and the disordered carrying of the material. These ditches converged at two points chosen as the discharge point for the lower areas, and the dimensioning was based on an analysis of the stretch that received the greatest contribution of waters.

6 - Environmental Recovery Works

6.1- Waste or Sterile Disposal

The pits resulting from extraction were filled with the inert material stockpiled during the period in which the project was active. The organic sterile soil layer, approximately 15 cm thick and covering the

mineralized layer, was removed mechanically and reserved for subsequent soil recomposition in the same area. Alternatively, this material was spread by tractor (Figure 3) over an area that had already been mined, allowing environmental recovery to take place progressively during the mining operation.



Figure 3: Tractor spreading sterile soil to recover areas that have already been mined.
(Source: own authorship, 2021.)

6.2- Soil Recovery

The original soil recovery was implemented by applying dolomitic limestone in the soil utilizing a tractor (Figure 4), in order to correct its pH, thus enabling the grasses applied to adapt to the soil.



Figure 4: Tractor spreading dolomitic limestone in order to correct the pH of the soil
(Source: own authorship, 2021.)

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6.3- Mitigating physical and hydraulic impacts

The topography suffered a slight alteration, remaining so that it did not change the local drainage. The stream closest to the area is at a much lower level, about 2.00 m below the lowest level in the area (Figure 5), not allowing any type of accumulation of local and surrounding rainwater.



Figure 5: Figure showing the difference in elevation between the river and the mined area. (Source: own authorship, 2021.)

6.4- Effluent release control

No chemical products were used in the extraction, and no gaseous emissions or solid tailings were generated as part of the extraction process. Consequently, no liquid, solid or gaseous effluents were discharged from the operation.

6.5- Area Reutilization

After the operation was completed, the entire area was recovered, allowing the owner to continue using the property in ways similar to those that existed before extraction. Pasture areas were restored (Figure 6), together with orange plantations (Figure 7), grass plantations (Figure 8) and banana plantations (Figure 9). Thus, the post-mining use of the area remained compatible with its previous occupation.

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Figure 6: Recovered area with current pasture occupation. (Source: own authorship, 2021.)



Figure 7: Orange trees planted in the recovered area. (Source: own authorship, 2021.)



Figure 8: Grass plantation in the recovered area. (Source: own authorship, 2021.)



Figure 9: Banana trees planted in the recovered area. (Source: own authorship, 2021.)

6.6- General Status of the Mining Concession

The sand extraction area was completely recovered as a result of the shallow depth of the mineral resource exploited (approximately 70 cm), the extraction method used and the immediate recovery of areas after mining. An overview of the recovered area is presented in Figures 10 and 11.

Furthermore, with the completion of mining activities in February 2020, the former mined area was restored to a condition similar to that existing before mineral extraction. This was achieved through the replanting of orange, banana and grass crops and the restoration of pasture areas.



Figure 10: Overview of the post-recovery area. (Source: own authorship, 2021.)



Figure 11: Overview of the post-recovery area. (Source: own authorship, 2021.)

7 - Conclusion

The results obtained from the environmental recovery of the area in this case study were satisfactory. The entire mined area was recovered and returned to a use compatible with its previous occupation, in accordance with the environmental and mining legislation applicable to the project. The main difference was the change in topography: after extraction, the area was approximately 70 cm lower than its original level.

The case study demonstrates that a legally authorized mineral extraction operation can incorporate environmental recovery measures during and after mining. Depending on the characteristics of each site and the requirements established by the competent authorities, recovery may include reforestation, restoration of agricultural or pasture uses, or other forms of land use compatible with environmental requirements.

It should also be pointed out that mining is a temporary activity, operating only while economically mineable mineral reserves are available, and that environmental recovery can be undertaken progressively during operation and after closure. The case presented here illustrates how progressive recovery measures can contribute to restoring the environmental and productive functions of a mined area.

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List of Acronyms:

1. National Department of Mineral Production (NDMP)[1]
   Departamento Nacional de Produção Mineral (DNPM)

2. National Mining Agency (NMA)[2]
   Agência Nacional de Mineração (ANM)