

# Historical Potential of Pollution in the Brazilian Mining Industry

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**Abstract:** The history of environmental disasters involving the mining industry in Brazil has not been very favorable to the sector. The rupture of tailings dams has been a recurring disaster, where the country has recently felt the consequences of the overload of the mining industry for the supply of raw materials to the sector on a global scale. In this context, the country has experienced impacts in the socio-environmental, economic spheres, and in public health, raising important questions regarding the model of economic and social development adopted in the world. Reflections and measures must be taken to strategically improve living standards to make the sector more sustainable.

**Keywords:** Environmental disaster. Dam rupture. Mining.

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## 1. Introduction

Currently, the relentless pursuit of global economic development, linked to the excessive consumption of human beings, generates the pollution of water resources due to poor management of the industrial sector. Among the possible anthropic polluting sources, we can highlight the effluents from industrial processes, which can cause serious losses when not treated and disposed properly.

In this context, mining, which is an industrial activity that involves sectors designed to research, measure, extract, benefit and transform mineral resources, making them economic and social benefits (IBRAM, 2016). The sector has grown due to strategies that foster national development (BARRETO, 2001), being an indispensable activity for maintaining the standard of living and technological advances in the modern world.

This sector consumes large amounts of water in the beneficiation stage, separation of materials with removal of the tailings. Due to the need to increase the efficiency of the beneficiation process, there is an intensification of the use of chemical products at this stage (SILVA, 2009). These chemicals are contained in the process waste that is destined for containment dams, which can be a form of contamination. Chemical pollution from the mining industry can seriously affect the environment. In this context, Brazil has collected,

in its history, some environmental disasters that have drastically affected the adjacent ecosystem.

## 2. Development

### 2.1. The mining sector

Brazil has a geological diversity that provide the existence of deposits of various minerals, gaining a prominent position in the global scenario, both in reserves and in mineral production (IBRAM, 2015).

The country is the second largest exporter of iron ore in the world (COLLING and RIZZO, 2017), being mined mainly in the states of Minas Gerais and Pará (BRASIL, 2019). The mining sector of Minas Gerais contributed in 2017 with 63.83% of the trade balance of the entire State, with iron being the main exported mineral product, representing 71% (IBRAM, 2018a).

The mining process consumes large amounts of water in the beneficiation stage, and due to the need to increase the efficiency of this stage, there is an intensification of the use of chemical products (e.g. depressants, dispersants, flocculants, collectors, among others) (SILVA, 2009). These chemicals used are contained in the processed waste that is destined for containment dams and can be a form of environmental contamination.

Despite being an essential industrial activity, concerns arise in relation to the mining activity due to its potential polluting impact. The rupture of tailings dams, for example, is a risk inherent to the mining industry related to the economic dynamics

of the sector (MANSUR et al., 2016). However, the attention given to this problem has not been sufficient, given the repeated events of mining dam ruptures in Brazil and in the world.

The present study aims to gather, making a criticism and a reflection, the environmental disasters of the mining industry showing that the look at nature as a mere condition of production by the sector is no longer admissible. Perspective evidenced from the several cases of negligence that caused environmental disasters in the sector over the years and that will be promptly addressed now.

## 2.2. History of disasters involving the mining sector

The most recent example of environmental disaster experienced by the mining sector was the rupture of three dams at the “Córrego do Feijão” mine in January 2019, in Brumadinho (MG) (MMA, 2019), causing a commotion in Brazil and in the world for the lives lost and consequences for the environment, leaving a trail of destruction of at least 269.84 hectares (IBAMA, 2019). From the cited area, IBAMA identified that the tailings devastated 133.27 hectares of native Atlantic Forest vegetation and 70.65 hectares of Permanent Preservation Areas (APP), along affected water courses.

The dam was 720 meters long, 87 meters high and stored about 12 million m<sup>3</sup> of tailings, having gone through ten stages of upstream raising since its construction in 1976. This dam raising method is considered cheaper and more vulnerable to accidents due to the forces of water percolation, with greater susceptibility of internal erosive processes of piping and liquefaction, being the main responsible for accidents (CASTRO, 2008).

The tailings reached the Paraopeba River, a tributary of the São Francisco River, immediately interfering with the quality of the water that was used for supply and for obtaining food from the surrounding communities. Likewise, the soil has also experienced damage to its composition due to the chemicals that were used in the ore processing.

The rupture of the Vale S/A tailings dam in 2019, was preceded by another event that occurred just four years before, at the time considered the biggest environmental disaster in the history of Brazil. In November 2015, the tailings dam of “Fundão”, owned by the mining company “Samarco”, broke down, causing the destruction of the Bento Rodrigues sub-district, in Mariana, in the Central Region of the state of Minas Gerais, Brazil (MANSUR et al., 2016).

In addition to destroying the culture and history of communities, the accident unbalanced an entire adjacent ecosystem, also affecting the economy and the life of society dependent on the Doce River basin. The effects were observed from downstream of the breached dam, to the mouth of the Doce River, in the coastal region of the state of Espírito Santo.

According to IBAMA (2015), the “Fundão” dam contained 50 million m<sup>3</sup> of mining waste, classified as solid, non-hazardous and non-inert, such as iron and manganese. Of this total, 34 million m<sup>3</sup> were launched immediately with the rupture and the remaining 16 million were gradually carried downstream from the accident.

Initially, this tailing reached the Santarém dam, causing it to overflow and forcing mud through 55 km on the Gualaxo do Norte river until it flows into the Carmo river (IBAMA, 2015). The Carmo river is 134 km long and its mouth is in the municipality of Rio Doce, and when it meets the Piranga River, they form the Doce river (BARBOSA et al., 2005). Once on the Carmo river, the tailings traveled 22 km to the Doce river, where they were carried to their mouth in the Atlantic Ocean, reaching the municipality of Linhares, in the state of Espírito Santo, totaling 663.2 km of impacted water bodies (IBAMA, 2015).

According to Lopes (2016), the tailings were formed by a large amount of chemical substances used in the flotation process, in addition to metals and sand. As the sensitivity to contaminants in the aquatic environment is different for each species and for each stage of animal development (RIBEIRO et al., 2009), both fauna and flora suffered different consequences resulting from the dam rupture.

The national news showed that these were the biggest disasters with tailings in Brazil, the causes being considered multifactorial and the consequences were far-reaching, immeasurable and with great environmental, economic, social and political impact.

Bowker and Chambers (2015), when analyzing dam breaks occurring between 1910 and 2010, noted the increase in these occurrences, identifying more than 30 breaches after the year 1990 in the world. The authors believe that this is a reflection of the modernization of the mining sector, and technologies have been applied to extract ores in increasingly concentrations, increasing the amount of waste from the activity.

In Brazil, only in the last 14 years, the same company (Samarco S.A.) was involved in three environmental disasters caused by the mining

activity, such as: in Barra Longa (MG) in 2006; in Anchieta (ES) in 2008; and in Espera Feliz (MG) in 2010, where the leaking of the ore slurry contaminated water courses, compromising, in particular, the supply for human consumption (MANSUR et al., 2016). In addition, the authors claimed that the mining company had accumulated 19 environmental violations, from 1996 until “Fundão” dam rupture (in 2015), accounting for an average of one infraction per year.

In addition to these episodes, the country also has previous accidents. According to a history of ruptures in the newspaper “O TEMPO”, in 1986 there was a rupture of the tailings dam at the Fernandinho Mine, in the municipality of Itabirito (MG), leading to the death of seven people, the oldest record of this type of accident in the State. In June 2001, the “Macacos” tailings dam in Nova Lima (MG), owned by the mining company Rio Verde, broke down, causing the death of five people in the district of São Sebastião das Águas Claras (MG) and the silting up of 6.4 km from the bed of the Taquaras stream.

Likewise in Minas Gerais, in January 2007, dikes by the mining company Rio Pomba/Cataguases in Mirai (MG) broke down and dumped ore tailings into the waters on the Muriaé river, leaving more than 4 thousand people homeless, in Mirai (MG) and Muriaé (MG), and at least 1,200 houses were affected.

In September 2014, in the municipality of Itabirito (MG), a dam of the Herculano Mineração burst, burying the workers who were carrying out maintenance on the slope of a deactivated tailings dam. The breach of the dam killed three people.

Regardless of the company, some events have been happening over the years, such as: the monitoring failure, the risk analysis and reliability of these structures, the failure to adopt precautionary evacuation measures, the lack of preventive actions, and perhaps the lack of supervision or greater speed and accuracy in identifying and judging those responsible for these disasters.

These facts alert the need for a better political and environmental management between mining companies, the government and society, so that the activity acts in an orderly manner with a view to preventing and minimizing risks, in addition to social and environmental damages. (BORGES, 2018).

### 2.3. Impacts

In the context of an environmental disaster, in addition to human losses, physical space can be affected, destroying the culture and history of the communities surrounding the accident. The rupture of dams can also affect the economy and life in a society dependent on the region, changing the physical and mental health conditions of the population.

In the cases mentioned, many families lost people and were displaced by environmental disasters. In addition to the environmental damage, the victims suffered psychological and material damages, usually without the support of the public administration and the companies that caused the disasters.

In addition to violating the rights of workers, farmers, fishermen and indigenous people, the dependence on water resources is a reality for many groups that have been affected by the disaster because water bodies have become a source of income, leisure and even a form of subsistence for many riverside communities.

When indigenous communities adjacent to mining companies are highlighted, there are incalculable losses in the history of the tribes after the ruptures that occurred in the dams. The Krenak indigenous tribe, for example, depended heavily on the Rio Doce and with the disaster in Mariana, the rituals, the healing processes, the very daily life of the Indians, leisure, the dependence on the river for survival, and even the preservation of their social identity and culture have been affected.

Due to the solid discharge and density of the tailings after a dam rupture, immediate consequences can be found such as: burial of the fauna and flora present in the aquatic environment; interference with water turbidity, which can negatively influence the photosynthesis process. Affecting primary producers, the biota dependent on this trophic level can be harmed, interfering negatively in the food web. In addition, the large amount of particulate material can cause the collapse of the gills of fish and crustaceans, followed by death by asphyxiation.

The tailings from the dams still have the potential to cause damage, such as: silting up water courses; destruction of habitats; contamination of water; destruction of breeding areas for aquatic organisms; interruption of the gene flow of species between bodies of water; loss of endemic species already listed as threatened; compromising the structure and function of ecosystems; and fishing stock. The consequences to the impacted environment will depend on the permanence of the

sediments in the environment, the resilience of the organisms and the anthropic actions taken to mitigate the disaster.

According to Faria (2020), accidents like those described leads us to demand a change in the Brazilian regulations regarding tailings dams with more safety factors for the conditions of the dams and making it impossible to adopt flexible and non-transparent criteria in the assessment of their stability conditions structures. Another important point that should avoided would be self-monitoring carried out by companies, situations that have already proven to be harmful and ineffective for the control of these complex and risky structures. From the point of view of inspection, the criteria for regulation, licensing and control of these structures must be changed, with the empowerment of state and federal licensing and inspection bodies. In addition, companies must work with stricter criteria for the operation, control and monitoring of dams, regarding primarily life and the environment.

### 3. Conclusion

A social dilemma in the modern world would be the application of actions that reduce the waste generated daily, maintaining acceptable standards of living. This same dilemma puts pressure on the mining sector, where efficiency in the use of resources and the development of technologies for the use of waste are strategic.

The mining industry has left marks of destruction wherever it goes, and the tragedies highlighted here are the result of a mining sector management system full of failures. That is why it is necessary to have many changes in the management of the mining sector in a world panorama, in order to cease the several existing cases of disasters involving ruptures of mining tailings dams.

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