



# Mining Impacts on Aquaculture and Fisheries in the Doce River Basin, Minas Gerais-Brazil



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## Characterization

The Doce River is one of the most important watercourses in the Southeast region of Brazil, running through the states of Minas Gerais and Espírito Santo with more than 835km in length and of great socioeconomic relevance for the region [1]. The Doce River Watershed has a population of approximately 3.5 million inhabitants, comprising 226 municipalities [2]. Also, the basin is recognized as a conservation hotspot with high biological and sociocultural diversity as the region has four indigenous territories, and three descendants of slaves and artisanal fishermen territories, thus showing a thriving cultural diversity present in the region [3].

## Degradation Historical

Since the mid-1930s, the basin region has been impacted by several factors, with vegetation suppression largely responsible for the erosion and silting process throughout the basin [4]. Subsequently, a continuous process of pollution of river waters began, from mineral extraction, industrial activities such as steel mills, pulp mills, sugar and alcohol plants, refrigerators, tanneries and domestic sewage, causing the loss of the quality of the water of the Doce river and its main tributaries [4]. From the second half of the 20<sup>th</sup> century, several dams were built on the main rivers, mainly for the installation of hydroelectric plants, modifying the lotic systems and causing several impacts to the aquatic biota [4,5]. On November 5, 2015, the Fundão tailings dam (property of the Samarco Company, joint venture between BHP Billiton Brazil Ltd. and Vale S.A. Companies), located in Mariana, in the state of Minas Gerais burst, unloading approximately 60 million cubic meters of iron mining tailings over the Gualaxo River, flowing into the Doce River and affecting the entire length downstream,

up to Espírito Santo state in the estuarine region in the municipality of Linhares [6,7]. Even before the accident, the Doce River was not healthy, as the mining companies had been surreptitiously dumping mud waste into the river [23].

## Impacts on Aquaculture and Fisheries

Before the disaster, despite the various forms of pollution of its waters, the ichthyofauna of the Doce River was still abundant, sustaining the activity of all the fishermen who took their livelihood from its waters until the dam collapsed. There are records from the same year, in the Integrated Water Resources Plan for the Doce River Basin (Consórcio Ecoplan-Lume, p. 166), that there were about 174 industrial establishments linked to fishing in the surroundings of the basin, in the state of Minas Gerais, with an annual growth percentage of 12.40%, in addition to 50 establishments in Espírito Santo, with an annual growth rate of 8.02%. It is noteworthy that the years 2015 and 2016 also correspond to the drought period faced by Minas Gerais (MG) and Espírito Santo (ES) states. Thus, for these two years, both availability (reduced by the drought) and water quality (reduced by the release of mining tailings into the Doce River) would have acted concurrently [8].

Immediately after the disaster, high levels of manganese, arsenic and lead were recorded in the water, and aluminum and iron in sediments constituted by the mud formed by the tailings [9]. As consequence of the disaster the water quality of the Doce River was altered [10,11] resulting in the death of thousands of fish and invertebrates, in addition to making fishing, the use of water in agriculture and even, plant growth in the region turned impossible [12]. After the entire course of the river was

contaminated, 11 tons of dead fish were collected from the Doce River [13].

The release of ore tailings to the Doce River Basin has considerably increased the concentration of heavy metals in water, soil and sediments, which can consequently lead to the bioaccumulation of these toxic elements, especially in aquatic organisms, which are directly in contact with these contaminants [7]. Two years after the tragedy, the water in the Doce River remains outside legal standards, according to SOS Mata Atlântica Foundation, and has high concentrations of suspended solids and heavy metals, such as manganese, copper, aluminum and iron, in different monitored stretches [14]. When the mud reached the Doce River, near Governador Valadares, the water supply to the city of 28,000 inhabitants had to be suspended for a week. For six months, there was also a total ban on fishing in the region. A court decision ordered the mining company Samarco, controlled by Vale and BHP Billiton, to provide the population with 550,000 liters of drinking water per day until the situation was normalized [15].

Despite the analyzes and the possible health effects in the short and medium term, the capture and distribution of water from the Doce River was gradually reestablished and people along the Basin added to their daily lives new risks, uncertainties and doubts. The damages, social and economic losses, however, were not restricted to just water quality. The passage of mud also generated other impacts, among them: loss of agricultural areas and pastures; interruption of electrical generation; destruction of permanent preservation areas (APP) and native vegetation of Atlantic Forest; mortality of aquatic and terrestrial fauna; silting up of water courses; interruption of fishing; interruption of tourism and sense of danger and helplessness in the population [6].

About 80 species were considered native to the Doce River, 11 classified as threatened with extinction, and 12 that only existed in this river. In a desperate race, the fishermen tried to remove the fish from the river and transport them to lagoons in Linhares and Marilândia, where they could stay alive. The objective shown in the report was to remove as many fish as possible from the river, before the arrival of the mud in Espírito Santo waters. The researchers will create a gene bank with the rescued fish [16]. Finally, the impact on fishing is pointed out in several aspects: contamination, fishing ban, devaluation of fish, difficulty in repairing and recognizing the damage caused. These factors are aggravated by the conditions presented in other studies presented here, such as low social conditions, lack of infrastructure, low investment in artisanal fishing to the detriment of large works [3].

To compensate for the losses caused to Doce River, financial compensation was paid to these professionals by the Samarco, BHP Billiton and Vale companies. These companies must pay a monthly pension for property damage and loss of profits, in the amount of one minimum wage, counted from the time of the disaster, in 2015, until recovery of the river fauna is proven

[17]. Life in the fishing communities has been transformed into disillusionment. A year and seven months had passed since the brown mud invaded the river and its mouth, and reporter Kaio Henrique found in Regência, rotting boats, unusable freezers, and the desolation of people who didn't even know when fishing would return to be released, and if the fish would not be contaminated [18].

After more than five years, many of the fishermen have not received any kind of compensation yet. The cleaning carried out by the company failed to restore the river and the hydrographic basin. According to residents, fishing and plantations remain poisoned and less productive. Access to clean water is still difficult, and health problems for no apparent reason have increased [19].

### Conclusion

The Doce River Hydrographic Basin is a region highly impacted by human activities, and after the Fundão dam rupture, the effects on the local biotic environment intensified, drastically affecting their communities.

On the future of artisanal fishing in the region after the disaster, fishermen believe that the activity will eventually end, as there is still the problem of contamination and fish populations have declined. In addition, there was a reduction in the commercial value of the local capture, given the contamination. It is pointed out that fishermen still do not understand the real extent of the disaster [20-22].

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