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Policy Forums

Mining activity in Brazil and negligence in action

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HIGHLIGHTS

- A new disaster in Brazil involving the rupture of a tailings dam reopened the discussions about socio-environmental impact.
- The absence of actions by the companies and the lack of a management plan can imperil the efforts for environmental recovery.
- The slowdown of Brazilian environmental legislation can generate a future darker scenario.

GRAPHICAL ABSTRACT

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ABSTRACT

The number of disasters involving tailings storage facilities has increased in Brazil. Only in the last six years, there have been six disasters involving this type of structure. Despite the vast socio-environmental impacts, little has been done to mitigate the damage caused. The negligence of mining companies and the lack of efficient management approaches at river basin-level have greatly hampered efforts for environmental recovery. In addition, although Brazil has signed the 2030 Agenda for Sustainable Development, there has been a slowdown in Brazilian environmental legislation, which can facilitate the implementation of mines and tailings storage facilities. To finish, we suggest some options to turn this situation around.

Brazil is the second-largest producer of mineral ores in the world (National Minerals Information Center/ U.S. Geological Survey, 2017). This prominent position in the global market comes with a downside, the immense environmental liabilities generated along the production chain (Mechi and Sanches, 2010). Tailings storage facilities (TSF), usually reservoirs, are one of the main liabilities associated with mining activities, and approximately 600 of these structures are found in Brazil (ANA, 2016). When they fail, the environmental impacts can be huge, and recently the number of collapsed dams has increased both globally and in Brazil (Abdelouas, 2019; Escobar, 2015; Fernandes et al., 2016; Pereira et al., 2019).

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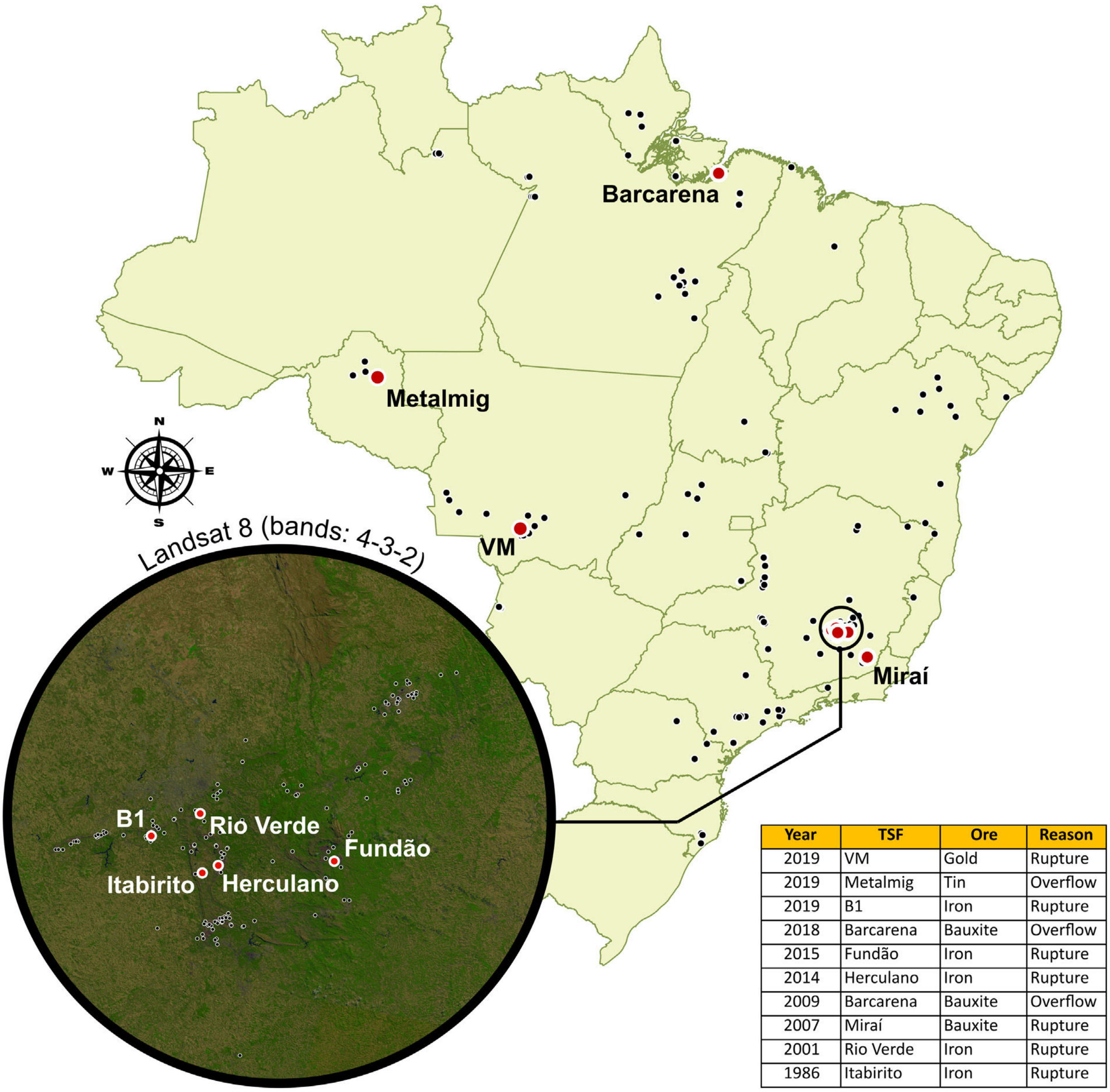

Year	TSF	Ore	Reason
2019	VM	Gold	Rupture
2019	Metalmig	Tin	Overflow
2019	B1	Iron	Rupture
2018	Barcarena	Bauxite	Overflow
2015	Fundão	Iron	Rupture
2014	Herculano	Iron	Rupture
2009	Barcarena	Bauxite	Overflow
2007	Miraí	Bauxite	Rupture
2001	Rio Verde	Iron	Rupture
1986	Itabirito	Iron	Rupture

Fig. 1. Distribution of all tailing's dams along Brazilian territory. Red dots: tailing dams failures; Black dots: tailing dams. Source: Agência Nacional de Mineração (ANM).

Since 1986, ten TSFs have failed in Brazil, six in just the last six years (Abdelouas, 2019 (Fig. 1). The country sets among the record holders of this kind of disaster, behind the USA (29) and China (12) (Abdelouas, 2019). One of the major ones occurred in January 2019, the rupture of the B1 dam at the Córrego do Feijão mine complex in Brumadinho, state of Minas Gerais. With 700 m in length and 86 m in height, Brumadinhoś dam was used by the company Vale (2019) to store waste produced during the enrichment of iron ore. Its failure dumped much of the 12 million m^3 of waste into the surrounding landscape, killing hundreds of people (259 dead and 14 missings; Defesa Civil de Minas Gerais, 2019). The number of deaths in Brumadinho is unprecedented, even considering the worst environmental disaster in Brazil, the Fundão dam rupture, also in state of Minas Gerais, when 19 people were killed (Escobar, 2015). The loss of human lives in Brumadinho is comparable to the records for the dam collapse in Stava, Italy, considered one of the world's worst mining tragedies (Luino and de Graff, 2012). The magnitude of the disaster in Brumadinho, and the fact that it happened just over three years after the Fundão dam disaster in Mariana (Escobar, 2015), reopened the discussions about the social and environmental impacts of ore tailings storage.

The waste from Brumadinho's dam wiped out the Ferro Carvão stream and its surroundings, reaching the Paraopeba River, which is one of the main tributaries of the Upper São Francisco River basin. Immediately after the disaster, water contamination spread over 271 km downstream, up to the Retiro Baixo Hydroelectric Plant (IBAMA/IEF, 2019) (Fig. 2). The Paraopeba River is critical for biodiversity, being considered of high conservation priority since 1998 due to the presence of endangered and migratory fish species (Alves and Leal, 2010; Costa et al., 1998; Drummond et al., 2005). The region is also important for river-dwelling bird species, like the endangered Black-collared swallow, *Pygochelidon melanoleuca* (Silva et al., 2017). The waste also jeopardized the water supply of cities along the Paraopeba river, reducing the amount of water for human consumption and agriculture irrigation (da Silva et al., 2015).

Despite the increasing number of collapsed dams in Brazil, little has been done to mitigate environmental damages and pre-

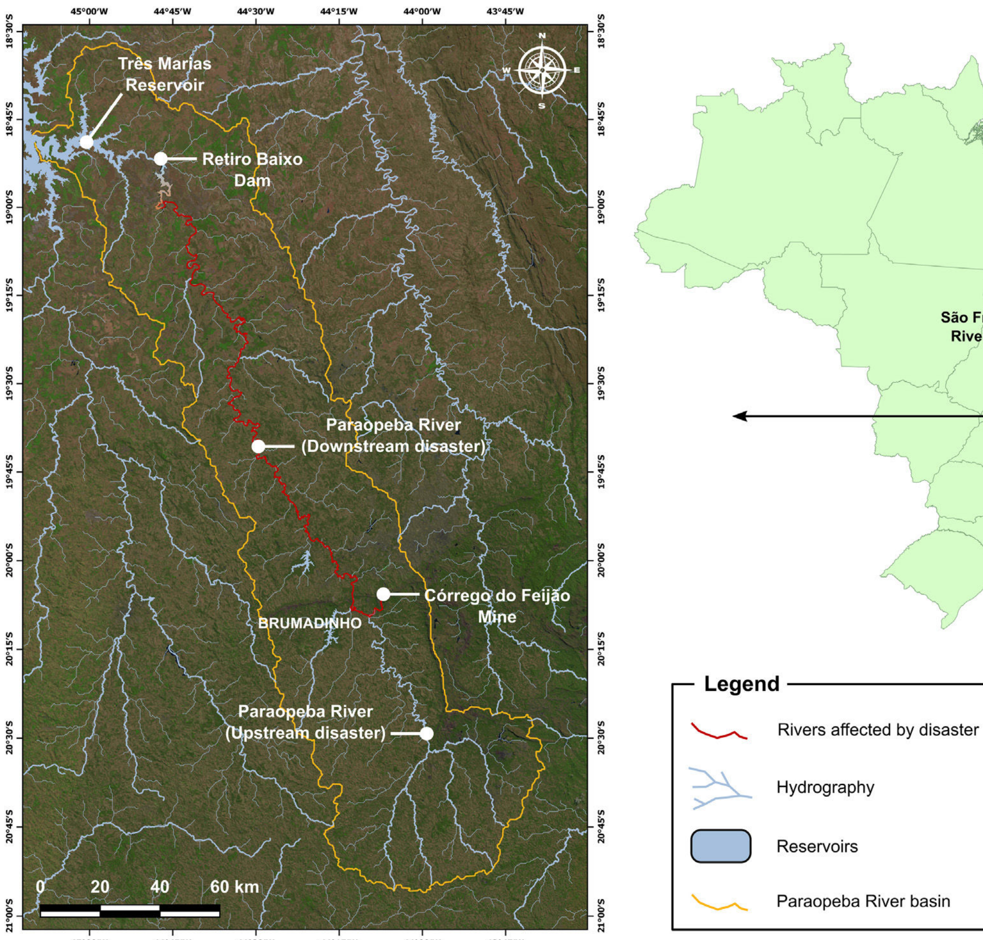

Fig. 2. Iron ore waste way along Rio Paraopeba basin after the rupture of B1 dam at the municipality of Brumadinho, Minas Gerais, Brazil.

vent future disasters. The creation of the Renova Foundation, an independent entity funded by the mining company Samarco to investigate the environmental impacts and propose solutions of the Fundão TSF Failure, did not bring the answers expected by the society. Despite the amount of money spent by Renova, the information produced by their studies is poorly available for academics and society. Most of the reports available on the foundation's site does not have deep content or look like advertising for Samarco's company, leaving doubts about their independence from the mining company (for details see Fundação Renova, 2019).

Relevant information about the Doce River basin can be found in independent studies, which includes reports and scientific publications. Some of those include data from prior to the collapse, using a before-after control-impact approach, enabling a more accurate estimate of the environmental impacts (e.g. Hatje et al., 2017; Omachi et al., 2018). However, these studies are limited in their time scale and scope (e.g. focusing on single taxonomic groups) or only covering a proportion of the overall affected area, like one of the Doce River reaches (e.g. Cordeiro et al., 2019; Hatje et al., 2017; Marta-Almeida et al., 2016; Omachi et al., 2018; Valeriano et al., 2019). Once this kind of information is essential to create an environmental recovery plan, these spatial and temporal limitations should have been met quickly by the mining company as a mandatory counterpart, for instance as a robust integrated assessment of all affected ecosystems, including freshwater, terrestrial and, when necessary, marine.

The lack of organization and access to the information maintained by environmental agencies, for both federal and state spheres, hampers our ability to learn from the past. Data generated in studies carried out along river basins required by the Brazilian government for the licensing and monitoring of mining activities could provide information about the impacts of mining activities. However, even if the companies allocate large amounts of money for this purpose, often this expense does not return good quality data, and this is not an exclusive problem from mining companies (da Silva Dias et al., 2017). Therefore, it can be a result of both low-skilled labor and poorly elaborated benchmark from environmental agencies to companies. When the results obtained in the monitoring are reliable and can be published in scientific journals, it is necessary to comply with confidentiality agreements, which prevents publication without the consent of the companies involved. However, mining companies are generally not keen on making available data that could damage their public image. We could expect that at least these data could be used for a more effective decision-making by Brazilian environmental agencies. However, after being delivered to government agencies, studies are rarely systematically compiled, or used for the development of evidence-based management practices. The reason for this is the lack of governmental employees, that already are overworked in their functions.

In a historical context, all these disasters were not enough to bring governments and society to a serious debate about the risks of mining activities in Brazil, including the problem of TSFs. What we observe is a process of privatization of regulatory powers in this sector (Santos and Milanez, 2017), where the whole process of licensing, monitoring, and assessment of environmental recovery following disasters is led by the companies themselves, clearly raising several conflicts of interest. This is also true for the Brazilian national dam safety plan, which aims to assist the companies in managing the safety of their dams (Brasil, 2010). Again, companies are responsible to implement the plan and to provide the information about the stability of its own dams to the government, which in turn must supervise those structures. However, the lower number of surveillance officers to analyze more than 600 Brazilian TSFs put the supervision capacity in check.

After both huge disasters, we expected a stronger answer from the Brazilian government. The Brazilian environmental legislation, considered one of the most advanced in the world (Borges et al., 2009), is suffering a weakening by our own lawgivers. Large-scale measures, carried out by executive and legislative powers, have the potential to relax environmental licensing for these activities (see Azevedo-Santos et al., 2017). Furthermore, the reduction of the power of the Brazilian National Council of Environment ("Conselho Nacional de Meio Ambiente" - CONAMA) (Brasil, 2019), facilitates these measures. CONAMA is a public agency aiming at supporting the government on decision-making in the exploration and preservation of the environment and natural resources (to details see O ECO, 2014). The weakening of CONAMA is underscored by the fact that many politicians support the idea of mining in protected areas and in indigenous and "quilombola" territories (Lopes and Oliveira, 2018). This idea was already being put into practice through the provisional measure 790 (MP 790, in portuguese acronym). It was valid during 120 days (Brasil, 2017), allowing mining in protected areas and simplifying the environmental licensing for mining. Although the MP 790 expired in 2018, the current Brazilian President, Jair Bolsonaro, is largely favorable to reissue this provisional measure. If that happens, it would open a freeway for natural resource exploitation without any proper socio-environmental responsibilities, even in conservation units and indigenous territories.

Several Brazilian states, particularly Minas Gerais and Pará, are economically-dependent on mining activities (Reis and Silva, 2015; Milanez et al., 2019). The complex relationships between individual states' and municipalities' financial rewards, policies, and liabilities for environmental damage from mining makes this an extremely thorny issue. For instance, Mariana disaster was not enough to stop or engender in-depth discussions about the MP 790. Even after Brumadinho disaster, the discussions were still superficial, only being based on the decommissioning of dams raised by the upstream method (for larger details of construction methods, see Cardozo et al., 2016). Although important, decommissioning would only encompass 20% of all TSFs included in the Brazilian national dam safety plan (ANM, 2019). With the development of more efficient methods of storing mining tailings and recycling (Edraki et al., 2014; Franks et al., 2011; Kinnunen et al., 2018), companies should be required to adopt more environmentally sound measures. The arguments of higher operational costs for mining companies are not acceptable, especially when so many human lives and the preservation of the natural resources are at risk.

However, some actions in the sector have taken different paths, and show that companies can be more committed to pay for their environmental impacts. After media reports of ore tailings overflow during a high precipitation event in the state of Pará, the company responsible for the ore beneficiation has partnered with NGOs and public universities to assess the environmental impacts (pers. obs.: Salvador, G. N.). These studies, if truly independent from the company involved, are powerful tools to understand the real extent of the socio-environmental impacts of such disasters. Without this kind of knowledge, drawing up environmental recovery plans is very difficult. An example of how the lack of knowledge can hamper effective post-disaster actions was what happened following the Mariana disaster (Escobar, 2015). Preliminary measurements using satellite images showed that the plume of waste would not reach the Abrolhos archipelago (Marta-Almeida et al., 2016). However, three years after the disaster, studies indicated the contamination of corals in Abrolhos by Mariana's tailings (Floresti, 2019). In Brumadinho disaster, data generated both by independent and official organizations in Paraopeba River are conflicting, and the misinformation produces more apprehension among the general public. An example was the extent to which the plume affected the Paraopeba River. While the public agency (Instituto Mineiro de Gestão das Águas – IGAM) reported the plume reaching the reservoir of the Retiro Baixo hydroelectric, independent organizations (e.g. SOS Mata Atlântica NGO reported it reaching the Três Marias reservoir (IBAMA/IEF, 2019; SOS Mata Atlêntica, 2019). The Três Marias reservoir is located 30 km downstream from Retiro Baixo dam and is an important fishery area. It is formed by the São Francisco River and some tributaries, like the Paraopeba River. Despite the lack of consensus between those institutions, it is plausible to expect further medium and long-term consequences for the ichthyofauna in the Paraopeba River, for instance, changes in the species composition and increases in contamination by heavy metals, especially near the dam collapsed.

Governmental negligence occurs around the world (Hyndman, 2001; Luino and De Graff, 2012; Smith and Morris, 1992), and Brazil is no different. Little has been learned from the disasters of the last two decades, on both how to avoid problems and how to monitor the environmental impacts and restoration efforts. Brazil is one of the 193 signatory countries of the 2030 Agenda for Sustainable Development (United Nations, 2017), and it is important to draw attention to the impact on achieving the Sustainable Development Goals (SDGs) arising from this kind of environmental disaster. The SDGs related to the biosphere (6. Clean Water and Sanitation; 13. Climate Action; 14. Life Below Water; and 15. Life on Earth) are the foundation of 2030 agenda, sustaining society's goals, which in turn supports the economic goals. The dimension of environmental impacts resulting from TSFs collapse may be so large that in the near future mining activity will no longer be viable as it is currently practiced. In this sense, it is fundamental for mining companies to call special attention to SDGs 8 (Decent Work and Economic Growth, especially to the target 8.4) and 12 (Responsible consumption and production, especially to the targets 12.2 and 12.4), to promote sustained, inclusive and sustainable economic growth ensuring sustainable consumption and production patterns of natural resources.

In this context, it is necessary to reflect on which paths to follow: one where the environment is as important as economy and hard lessons learnt from past mistakes are incorporated or another, where economy prevails over environment, with the reduction of operating costs of mining companies trumping socio-environmental impacts. For us, the latter option is a dangerous and irresponsible route that was taken so far, and the chance that new disasters happen is well-known and extremely high. It is necessary to discuss the limitations of the actual method of licensing and monitoring of the potentially polluting activities, which is financed and conducted by the own company. The governments also need to apply the Brazilian assessment of priority areas for the conservation of biomes (MMA, 2007) as public policy, which can help the planning before the licensing process starts. It is also necessary to create a database of information provided by companies about environmental monitoring and break confidentiality rules, even for datasets, with full access of society to raw data. These measures could help the environmental agencies to identify methodology shortfalls, as sample design, helping the definition of a standardized methodology, facilitating the implementation of a before-after control-impact protocol. It is also important to rig inspection agencies to improve surveillance.

For the companies, it is important to look at two main points. First, they need to grant research to dry stacking methods of ore beneficiation (for details about dry stacking methods, see

Davies, 2011; Tessarotto, 2015), with the intention of reducing the methods' prices and study the specificity of each method (e.g. geotechnical specificity). Second, they need to give a new destination for more than 600 TSFs already built in Brazil. It could be done through dam decommissioning or dam reinforcement by safety methods (e.g. concrete dam).

The path to change is not easy. It involves many hard adjustments for companies and governmental agencies, which is expensive and demands time. However, choosing this path and maintaining some good practices could guarantee the sustainability of mining activities, as well as decrease the number of disasters involving TSFs in Brazil.

Conflict_of_Interest

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