FIRST AS TRAGEDY, SECOND AS NORM: GLOBAL STANDARDS AND BRAZILIAN POLICIES ON MINING TAILINGS SAFETY

Rita de Cássia Barros[*]
Talles Girardi de Mendonça[*]

[*]Universidade Federal de São João Del Rei, Programa de Pós-Graduação em Desenvolvimento, Planejamento e Território, São João Del Rei, MG, Brazil

Abstract

This article seeks to analyze the regulatory framework that regulates the safety of tailings dams on an international, national and state scale, with emphasis on the management of mining dams built in Minas Gerais using the upstream design – considered the most critical for the risk of collapse. We argue that the standards which have gained the most support from the industry, by not expressly prohibiting the existence of upstream dams, show contradictions that reproduce rather than remedy the vulnerability of territories exposed to the social and environmental risks produced by mining in Brazil and in the world. Based on the analyses proposed here, we aim at understanding how the problem of tailings management has been addressed by institutions at the national and international level, thus identifying the effectiveness of standards and policies related to the problem of upstream dams.

Keywords

Mining; Safety Standards; Tailings dams; GISTM; Safety First.

PRIMEIRO COMO TRAGÉDIA, DEPOIS COMO NORMA: OS PADRÕES GLOBAIS E AS POLÍTICAS BRASILEIRAS DE SEGURANÇA DE REJEITOS DE MINERAÇÃO

Rita de Cássia Barros[*]
Talles Girardi de Mendonça[*]

[*]Universidade Federal de São João Del Rei, Programa de Pós-Graduação em Desenvolvimento, Planejamento e Território, São João Del Rei, MG, Brasil

Resumo

Este artigo busca analisar o quadro normativo que regula a segurança de barragens de rejeitos em escala internacional, nacional e estadual, com destaque para a gestão de barragens de mineração construídas em Minas Gerais pelo método de alteamento a montante – considerado o mais crítico para o risco de rompimento. Para isso, realizamos uma análise dedutiva a partir da revisão de literatura, combinada à análise indutiva procedente de fontes secundárias (notícias, relatórios e normas). Nosso argumento é de que os padrões que conquistaram maior adesão da indústria, ao não proibirem expressamente a existência de barragens a montante, evidenciam contradições que reproduzem mais do que remediam a vulnerabilidade dos territórios expostos aos riscos sociais e ambientais produzidos pela mineração no Brasil e no mundo. Esperamos, a partir das análises aqui propostas, compreender como o problema da gestão de rejeitos vem sendo endereçado pelas instituições em âmbito nacional e internacional, identificando a efetividade dos padrões e políticas relacionados ao problema das barragens a montante.

Palavras-chave

Mineração; Padrões de Segurança; Barragens de rejeitos; GISTM; Safety First.

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Introduction

According to the National Mining Agency (ANM), there are 263 tailings dams classified as having high Potential Associated Damage (DPA) on Brazilian territory (ANM, 2023). Of these, 153 (58% of the total) are located in the State of Minas Gerais (MG), representing a significant accumulation of risks for the population and the environment of the state, compared to the rest of the country. The geological characteristics of Minas Gerais, added to the profitability of iron ore exports, signify that this state has one of the highest concentrations of tailings dams in Brazil, particularly those classified as high risk and with potential associated damage (ANM, 2022; 2023).

The high exposure to risks, resulting from an extremely high concentration of these dams located close to traditional communities, urban and/or environmental preservation areas, has brought with it disastrous social, economic and environmental consequences, including the tragedies at Mariana (2015) and Brumadinho (2015; 2019), towns located in the State of Minas Gerais, and which stand as emblematic, paradigmatic cases. Mining activities are responsible for a series of undesirable socio-environmental impacts due to the use of these dams, many of them built upstream of watercourses, a predominant technique in the

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region and recognized worldwide both for its lower costs and greater vulnerability and potential for collapse (Luckeneder; Giljum; Krisztin, 2019; Reuters, 2020; EM-DAT CRED, 2020; Islam; Murakami, 2021; Niquito et al, 2021).

Seeking to respond to social pressure for regulatory changes against the increasing frequency and severity of disasters associated with tailings dams over recent years, four independent initiatives took shape in order to create and consolidate safety standards on a state, national and international scale. These were: 1) The National Policy on Dam Safety (PNSB), enacted in 2010 and modified in 2020; 2) The State Dam Safety Policy (PESB), valid in the territory of Minas Gerais, enacted in 2019; 3) Safety First: Guidelines for Responsible Mine Tailings Management, with an international scope, launched in June 2020, and which herein we will call 'Safety First'; and 4) The Global Industry Standard on Tailings Management, also called 'The Standard', of an international scope, launched in August 2020, and which for this article we will use its acronym, GISTM.

We therefore propose to understand the effects of international standards (GISTM and Safety First) and of national and state standards (PNSB and PESB) in light of the factual context in which they were configured. To this end, we conducted a deductive analysis based on a literature review, combined with an inductive analysis using news items, reports, standards and secondary indicators. The argument formulated is that the PNSB and PESB, on the one hand, are relatively assertive standards in relation to the problem of upstream dams, but have met resistance from mining companies, whether in adherence or in meeting deadlines. The GISTM, on the other hand, has obtained broad support from the sector due to the institutional weight of the market in devising the standard, which is reflected in guidelines that are more ambiguous, fragile, arbitrary and flexible than the guidelines of the 'competing' global standard, Safety First, prepared by another institutional procedure, made up of scientists, community groups and human rights and environmental organizations. Thus, adopting the GISTM, when compared to Safety First, relativizes and perpetuates socio-environmental vulnerability in territories affected by mining. The main contribution of this work, therefore, consists of outlining a genealogical and hermeneutical critique of official dam safety standards on different scales, in order to inform public and private agents interested in socio-environmental security about the implications contained in these standards, so that, who knows, they may be perfected.

The article is divided into three sections. The first addresses the institutional characterization of GISTM and Safety First as international standards that represent and reproduce narratives or political projects in dispute. The second section contextualizes the emergence and some developments of the PNSB

and PESB, the advent of which is marked by the temporal mismatch between norm and tragedy. The third and final section, in turn, presents a set of recognized empirical evidence that corroborates the hypothesis that the GISTM, as a hegemonic standard, highlights contradictions that reproduce socio-environmental vulnerability in territories exposed to risks arising from mining waste, particularly those which have a high concentration of upstream dams, as is the case of Minas Gerais.

Thus, we hope to highlight the relationship between the production of standards as an a posteriori element and the production of disasters as an a priori element in the management of mining risks, seeking, at the same time, to understand how such a relationship represents a problem that is expressed in contradiction between market narratives, the role of institutions and the protagonism of facts.

1. Characterization of the international standards on tailings management: narratives in dispute

Issued on August 5, 2020, GISTM is a safety standard convened by the Global Tailings Review (GTR), an initiative of three international collective organizations – the International Council on Mining and Metals, ICMM), the Principles for Responsible Investment (PRI) and the United Nations Environment Program (UNEP) – which claims to be a project "that sets a new benchmark for dam safety as the industry's first global model"[2] (ONU, 2020; PNUMA/UNEP, 2021).

The first signs of articulating the initiative were given at the end of 2015, as a result of the Mariana tragedy, which occurred in November of that year (Earthworks, 2015). The official announcement for opening the working groups to create the then future GISTM, however, only occurred after the Brumadinho tragedy (Islam; MurakamI, 2021, p. 2), more than four years later. In June 2019, ICMM, PRI and UNEP formalized the convening of a panel of experts and a multi-sector advisory council composed of interested parties impacted by mining, through the release of a scope and governance document entitled 'Independent review of global best practices to inform an international standard on mine tailings storage facilities' (GTR, 2019).

In this document, the GTR limited the composition of the panel down to seven experts, and that of the advisory council (i.e. non-deliberative) to 15 representatives, among: 1) human rights entities, 2) community and environmental NGOs, 3) indigenous people, 4) labor organizations, 5) investors, 6) insurance companies, 7) multilateral development banks, 8) tailings experts, 9) mining associations, and

2. This and all other non-English citations hereafter have been translated by the authors.

10) supervisory institutions for global codes or standards, but did not specify how many representatives or experts would be accepted by category of interest, nor the objective selection criteria. The document established the three convening entities (ICMM, PRI and UNEP) as being responsible for defining the governance and review of deadlines, for selecting the president of the GTR and the panel of experts, and to "[R]eview and comment on the international standard to be developed, to ensure it is fit for purpose", in addition to appointing – without detailing the selection criteria – a group of "Technical experts on tailings within **ICMM members**" to be convened "according to the needs" of the president and the panel of experts (GTR, 2019, emphasis added). The global public consultation stage for the review lasted just one month and a half, from November 15th to December 31st, 2019 (GTR, 2019).

It is evident that there exists an initial arbitrariness and conflict of interests, since the ICMM represents the global mining and metals industry in relation to the environment, and is made up of companies in the sector (Alcoa, Anglo American, BHP, Vale, among others) and commercial associations from different countries – including the Brazilian Mining Institute (IBRAM), propagator of GISTM in Brazil –, calling itself "a global leadership organization for sustainable development" (ICMM, [n.d.]). The PRI, in turn, is an international group with 5,311 signatories, made up of investment managers (76%), asset owners (14%) and service providers (10%) (PRI, [s.d.a]). This institution, which works in partnership with the United Nations, describes itself as

> the world's leading proponent of responsible investment. (...) The PRI is truly independent. (...) engages with global policymakers but is not associated with any government; it is supported by, but not part of, the United Nations. (...) The Principles were developed by investors, for investors. (PRI, [s.d.b])

The list of PSI signatory investors includes the Pension Fund of the Anglican Church of the United Kingdom (Church of England), one of Vale's shareholders at the time of the Brumadinho disaster, and which after the tragedy, for ethical reasons (Bloomberg, 2019), decided to sell its stake in the Brazilian mining company and lead a movement toward the creation of the Mining and Tailings Investor Security Initiative (Mining and Tailings Initiative), calling on more than 700 international investors to join,[3] but only achieved the adhesion of just 114 (PRI, 2020). The poor

3. "The Mining and Tailings Initiative emerged after the failure of the Brumadinho dam in 2019. The Church, which at the time was a Vale shareholder, used its strength by bringing together a group of international investors and talking to 726 companies asking for more transparency about their dams." Tweet by the British Embassy and Consulate in Brazil on August 5, 2020 at 16:35. Available at: https://twitter.com/ukinbrazil/status/1291095418521169922. Viewed on: Nov. 15, 2022

adhesion of investors demonstrates, reaffirming the obvious, that the financial market does not respond to ethical and moral issues, which is why it is important to recognize the limits of the expectation that investors define what constitutes a responsible investment or not.

Lastly, the third institutional member of the GTR, the formulator of the GISTM, is the United Nations Environment Program (UNEP). According to GTR,

> UNEP's mission is to provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations. (...) The Global Industry Standard on Tailings Management is an important milestone towards the ambition of zero harm to people and the environment from tailings facilities. Its impact will depend upon its uptake and UNEP will continue to be engaged in its rollout.

Safety First, on the other hand, the second international standard analyzed, was launched on June 30, 2020 and is an initiative led by three institutions – Earthworks, MiningWatch Canada and London Mining Network – together with scientists, universities, NGOs, social movements and traditional communities from different countries, including Brazil, represented by institutions such as: the Movement of People Affected by Dams; Socioenvironmental Institute; Socio-environmental Studies and Research Group (GEPSA) at the Universidade de Federal de Ouro Preto; and the Research and Extension Group for Politics, Economy, Mining, Environment and Society (Poems) at the Universidade Federal de Juiz de Fora.

Created in 1988, the NGO Earthworks is the only national organization in the USA focused exclusively on preventing the destructive impacts of oil, gas and mineral extraction, and is funded by individual donations (20%) and philanthropic foundations (80%) (Earthworks, [s.d.]). MiningWatch Canada ([n.d.], in turn,

> works in solidarity with Indigenous peoples and non-Indigenous communities who are dealing with potential or actual industrial mining operations that affect their lives and territories, or with the legacy of closed mines, as well as with mineworkers and former workers seeking safe working conditions and fair treatment. (...) Membership in MiningWatch Canada is comprised of not-for-profit organizations working on environmental, social justice, international development and aboriginal issues.

Funded by seven philanthropic institutions, including the Ford Foundation and the Jesuit Fund for Social Justice, the London Mining Network is a network of 22 organizations "concerned about human rights, social justice and the

ecological integrity of the planet", and an integral part of its scope is "enabling organisations concerned about the impacts of London-based mining companies to share information and learn from each other's experiences" (London Mining Network, [n.d.]).

With the motto "The safest tailings facility is the one that is not built," the Safety First initiative recognizes that "Tailings facilities, which contain the processed waste materials generated from mining metals and other materials, are failing with increasing frequency and severity" and openly criticizes current industry standards, unified in the global GISTM standard, stating that they "do not go far enough to adequately protect communities and ecosystems from tailings failures" (Earthworks, [n.d.]).

The comparison between the two international standards, within the scope of this article, highlights some contradictions in GISTM in relation to what it rhetorically proposes to do. While Safety First establishes that the construction of upstream dams should be prohibited (Morrill et al, 2022, p. 22-23), GISTM does not recommend their prohibition at any point in the document (UN, 2020). Furthermore, Safety First also recommends that dams should never be built close to communities (Morrill et al., 2022, p. 21-22) and that any potential loss of human life signifies that a dam must adhere to the strictest technical standards (Morrill et al., 2022, p. 24). The GISTM, respectively, presents no recommendation for maintaining a specific distance between communities and dams, applying the most rigorous technical standards only if the failure of the dam could cause the loss of 100 lives or more, the disruption of 5 thousand people or more, or financial losses of US$1 billion or more (UN, 2020, Annex 2). Here the "million-dollar" question arises: based on what economic, scientific and ethical foundations does GISTM establish limits that are as arbitrary as they are scandalous between life and death, peace and disturbance, stability and "acceptable" financial loss?

Before the initiative was articulated to create Safety First, a group of 12 representatives from different technical, political and scientific associations related to the defense of the environment – a group headed by Earthworks – followed ICMM's first moves to make GISTM viable from the time of the Mariana disaster, in 2015. Such movements, however, as previously mentioned, were only actually resumed after the Brumadinho tragedy, in 2019. The concerns of these 12 representatives were summarized in a letter sent on December 17, 2015, to the then president of ICMM, Tom Butler:

> We recently learned that in response to the Samarco tailings dam failure, ICMM will conduct a global review of tailings storage standards and critical controls. (...) Therefore, in its review of tailings management standards, we call on the Council to:

> • Select reviewers with both technical expertise and independence from industry;
> • Publicize and make transparent the review's findings
>
> (...)
>
> We urge ICMM to conduct a transparent review that will yield objective analysis and robust, binding recommendations for its members. (Earthworks, 2015)

Five years later, eight months after closing the public consultation, when the GTR finally launched the GISTM, on August 5, 2020, MiningWatch Canada spoke out through an opinion article entitled 'New Global Industry Standard Will Not End Mine Waste Disasters' in which it is asserted that

> The group notes that very few of their submitted recommendations were followed. It calls for an urgent international multi-stakeholders meeting with leading state regulators to determine the next steps, including the commissioning of an independent study regarding the best model for implementing and regulating a mine tailings standard at a global scale. (Miningwatch Canada, 2020)

The article closes its considerations by directly citing the opinion of some of its members and collaborators. According to Bruno Milanez, coordinator of Poemas (UFJF), "The Global Industry Standard is too flexible and vague", running the risk of functioning "will act as a smokescreen behind which the industry can continue business as usual" (Miningwatch Canada, 2020). For Steven Emerman, from Malach Consulting (USA), "In almost every area, the Global Industry Standard essentially chose the least common denominator of existing tailings regulations and guidance documents" and is therefore "effectively less protective of people and the environment than many other existing documents" (Miningwatch Canada, 2020). Tara Scurr, from Amnesty International (Canada), in turn, stated that "Voluntary initiatives and self-monitoring have never been enough to protect human rights and they never will be" (Miningwatch Canada, 2020). The perceptions of this group of independent experts also endorse our argument that GISTM, as a 'new' 'sustainable' standard and internationally accepted by the mining industry, ultimately reproduces rather than remedies the socio-environmental vulnerability of territories exposed to mining risks.

2. Characterization of dam safety policies in Brazil: a posteriori disaster regulation

The National Policy on Dam Safety (PNSB) was established during the government of President Luiz Inácio Lula da Silva by Federal Law No. 12,334/2010.

The bill (referred to in Portuguese as PL) that made this order possible, authored by Federal Deputy Leonardo Monteiro (PT/MG), however, spent seven years being processed in the National Congress (PL 1181, of June 3, 2003) before being finally promulgated. In addition to the PNSB, Law No. 12,334 also enabled the implementation of the Dam Classification System according to Risk (CRI) and Potential Associated Damage (DPA), the Dam Safety Plan (PSB), the Information System on Dam Safety Dams (SNISB), the National Environmental Information System (Sinima) and the Dam Safety Report (RSB), representing a significant advance in relation to the dam safety legislation in force since the end of the 1970s (ANM, 2022, p. 3-6).

In March 2003, three months before the bill was filed by Leonardo Monteiro in Congress, an industrial tailings dam belonging to Florestal Cataguazes Ltda., in Cataguases, Zona da Mata in Minas Gerais, collapsed, spilling 1.4 billion liters of black liquor – industrial waste from cellulose production – in the Paraíba do Sul River, leaving 600,000 people without water across different municipalities in Minas Gerais and Rio de Janeiro. The following month, the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA) fined Florestal Cataguazes 50 million BRL (Brazilian Real) , but the fine was not paid. The company, years later, signed a Conduct Adjustment Term (TAC) with the Public Prosecutor's Office in Rio de Janeiro (Estado de Minas, 2011; G1, 2014).

In March 2006, three years after this disaster, the spillage from the São Francisco Dam, owned by Mineração Rio Pomba Cataguases Ltda., in the same region, contaminated a tributary of the Paraíba do Sul River with 130 thousand cubic meters of mud from bauxite washing. In January 2007, another disaster, this time even more severe, occurred at the same dam. There was a spillage of 2 million liters of tailings, covering the Muriaé River and the neighboring cities of Muriaé and Miraí with mud, leaving at least 4,000 people homeless. Rio Pomba was fined R$75 million by the Minas Gerais State Environmental Foundation (FEAM). The mining company signed a TAC committing themselves, among other measures, to compensate the victims. However, the compensation varied between just 1,000 and 6,000 BRL. The mining company attributed the collapse to the high volume of rain that morning (Estado de Minas, 2011; G1, 2014).

The disasters that occurred, their consequences and the response to them, left little doubt as to the inadequacy of the legislation in force at that time, and to the alarming vulnerability of the population exposed to the risks of upstream dam failure in Minas Gerais (Figure 1). Whether because it was proposed by a deputy from Minas Gerais, or because it was motivated by the Cataguases disaster in 2003, the PNSB was a direct, albeit late, response to the high risk that tailings dams represent for the country and the region in the state of Minas Gerais known as the

Iron Quadrangle. Before the PNSB, Resolution ANM 4/2019 was in force, replaced by Resolution ANM 13/2019 (ANM, 2019), which prohibited the construction of new upstream dams, along with an order for deconstruction of the dams, in accordance with deadlines subsequently amended by Resolution ANM 95/2022. The use of resolutions to govern the matter reflected the noticeable difficulty in managing the economic and socio-environmental consequences of technological disasters without an adequate judiciary framework (ANM, 2022).

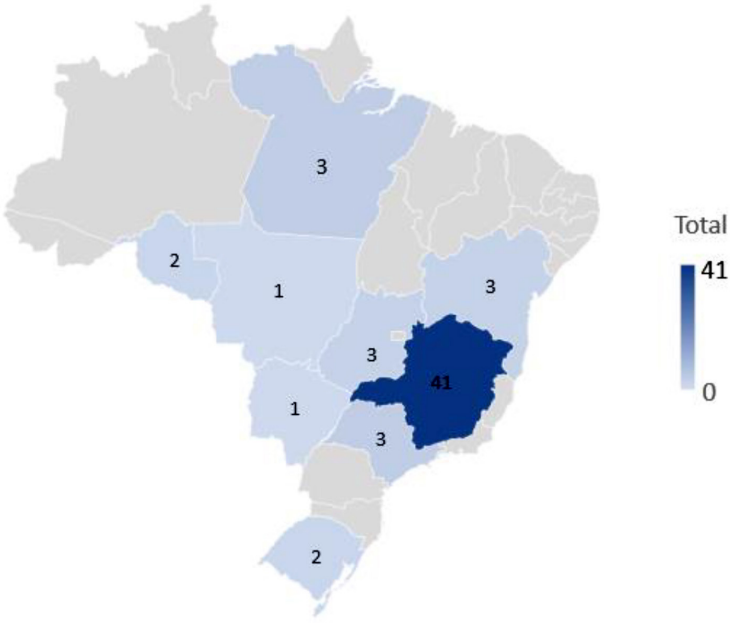

Figure 1. Geographic distribution of upstream dams registered with ANM.
Source: ANM, 2022.

Known as the "Sea of Mud – Never Again" Law (State Law No. 23,291/2019), the State Policy on Dam Safety (PESB), in turn, was established in Minas Gerais on February 25, 2019, one month after the tragedy at Brumadinho (State of Minas Gerais, 2019). The proximity of the dates could suggest that the processing was speedy, given its urgency, but PL 3676, which gave rise to the PESB, was filed with the Legislative Assembly of Minas Gerais by the Extraordinary Commission for Dams on July 5, 2016, that is to say, eight months after the tragedy at Mariana, and three years before the disaster in Brumadinho.

Table 1 summarizes the aforementioned standards, with their respective authors, and the associated bills and disasters. In relation to the content of the standards, there are some differences between the PNSB and the PESB, among which we may highlight the parameters that separate those structures that are covered or not by the standard, and the definition of the deadlines for the de-characterization and decommissioning of dams built by the upstream method. In the

de-characterization, the dam structure, in addition to no longer receiving tailings, also "no longer has characteristics or functions as a dam", and is destined for some other purpose. Decommissioning is one of the stages of the de-characterization process and corresponds to "terminating operations with the removal of associated infrastructures (...) except those intended to guarantee the safety of the structure" (ANM, 2019; Brasil, 2020; Minas Gerais, 2019).

Standard	Validity	Associated Bill (No/Date)	Authorship	Associated Disaster	Object
Federal Law No. 12.334	2010/09/20	1181 – 2003/06/03	Deputy Leonardo Monteiro (PT/MG)	Ind. Papel e Celulose Cataguazes, Rio Paraiba do Sul, MG, black liquor. March 2003	Establishes the National Policy on Dam Safety (PNSB)
State Law No. 23.291	2019/02/25	3676 – 2016/05/07	Extraordinary Dams Commission	Samarco (Vale/BHP Biliton), Rio Doce (Fundão), Mariana, MG, iron mining cmpany. November 2015	Establishes the State Policy on Dam Safety (PESB) in Minas Gerais ("Sea of Mud –Never Again" Law)
Federal Law No. 14.066	2020/09/30	550 – 2019/03/20	Senator Leila Barros (PSB/DF)	Vale, Rio Paraopeba (Córrego do Feijão), Brumadinho, MG, iron mining company. January 2019	Changes to the PNSB standards, the National Environmental Fund (FNMA), the National Water Resources Policy (PNRI) and the Mining Code.

Table 1. Chronological summary of the standards that regulate dam safety in Minas Gerais, per bill, authorship and associated disaster[4]

Source: Own elaboration.

In short, the PESB parameters, by establishing a minimum height of 10m and a minimum volume of 1,000,000m^3, cover a greater number of dams in the Minas Gerais territory, compared to those of the PNSB, which establishes a minimum height of 15m and a minimum volume of 3,000,000m^3. Furthermore, the classification criteria and scope of risk differ. While the PESB only defines a medium or high potential associated damage (DPA) as a criterion, the PNSB also considers, in addition to the medium or high DPA, the high-risk category (CRI), further limiting the universe of inspectable dams. It is possible to note, however,

4. In Brazil, there is no hierarchy relating to federal, state, municipal and district laws. It is possible that conflicts of competence may eventually occur. In the event of a conflict between a federal, state or municipal standard, that which is more competent, more specific, to govern the matter will prevail. If a federal law, for example, "invades" the jurisdiction of a municipality, constitutionally, the municipal law prevails.

that item IV of the PNSB (DPA "in economic, social, environmental terms or loss of human life") is more comprehensive and inclusive than item IV of the PESB ("potential for medium or high environmental damage, according to regulation") with regard to the issue of socio-environmental vulnerability (Brasil, 2010; 2020; Minas Gerais, 2019).

The difference between the DPA and CRI, according to the PNSB, is that DPA "may occur due to failure, spillage, infiltration into the ground or malfunction of a dam, regardless of the probability of occurrence", being graded or classified "according to the loss of human life and the social, economic and environmental impacts". The CRI, in turn, classifies the dam "according to the aspects that may influence the possibility of an accident or disaster occurring". Lastly, the upstream tailings method is defined, according to the PNSB, as "the dam construction methodology in which the containment dikes rest on the tailings or sediment previously released and deposited" (Brasil, 2010; 2020). Even with specific differences, the most important aspect in which both policies, or legislation, coincide is, above all, the prohibition of building dams using the upstream tailings technique, and the obligation to deactivate those already built.

3. Upstream dams on a local, national and global scale: prohibition, neglect, lethality

Initially, this section discusses the current material situation of upstream dams in Brazil and Minas Gerais after the advent of PNSB and PESB (Brasil, 2010; 2020). Secondly, a recent, relevant and comprehensive study is discussed, from the University of Tokyo, Japan, which provides indicators to measure the lethality of tailings dams per construction method, type of ore explored and country of origin, highlighting their contradictions and spatial inequalities.

In terms of the difference in the deadlines for the de-characterization of upstream dams, it is observed that the PESB establishes a deadline only for active dams ("within three years from the date of publication of this law"), placing it at the discretion of FEAM, together with other competent environmental bodies, the definition of deadlines and rules for the de-characterization in detail, including in relation to inactive dams[5] (Minas Gerais, 2019). The PNSB, in turn, establishes practically the same deadline defined by the PESB, but with the possibility of an extension. According to paragraph 3 of article 2-A of the aforementioned law:

5. Inactive or deactivated dams are those where new tailings from the mining process are no longer deposited, regardless of whether the de-characterization process exists or not. Active dams, in turn, are those that continue to operate, receiving tailings. This understanding is also common to the federal laws cited in this article.

> § 3º The entity that regulates and supervises the mining activity may extend the period provided for in § 2 of this article due to the technical unfeasibility of carrying out the de-characterization of the dam within the foreseen period, provided that the decision, for each structure, is endorsed by the licensing authority of the Sisnama. (Brasil, 2020)

According to the State Government of Minas Gerais, as of February 2022, 54 upstream dams were recorded in the state. Of these, only seven had completed the de-characterization process within the official three-year deadline established by PESB. The ANM/SNISB survey counted 43 upstream dams in Mina Gerais in February 2022, a number that does not coincide with the Minas Gerais government survey, mainly due to the different dam classification parameters for each standard, as evidenced in the previous section.

In 2019, ANM had also issued a resolution with similar content to that of the PESB (ANM Resolution 13/2019), although the document established longer deadlines, according to the volume of the dams: dams with less than 12 Mm^3 had to be de-characterized by September 15, 2022; between 12 and less than 30 Mm^3, by September 15, 2025, and those with more than 30 Mm^3 would have until September 15, 2027, to complete the works. On February 22, 2022, however, ANM issued Resolution 95/2022 formalizing the alignment of its deadline with those of the PNSB and PESB, both set on February 25, 2022, but reiterating the possibility of flexibility, as long as the request was received before the end of the established deadline (Agência Brasil, 2022; ANM, 2022).

The extension of the de-characterization deadlines made possible by the PNSB and ANM (Figure 3) has the direct consequence of extending the risks and, consequently, the socio-environmental vulnerability of the population that lives close to these dams, when not displaced from their homes, and who live in a constant state of tension. Many of the upstream dams in the state are in an emergency situation, some, over recent years, even requiring the evacuation of the population living around these structures. Vale is responsible for the majority of these dams, whereby 30 of the 54 listed dams belong to this company. According to the mining company, seven of them were decommissioned within the initial deadline, with the promise was that another five would be decommissioned by mid-2022 (Agência Brasil, 2022; ANM, 2022).

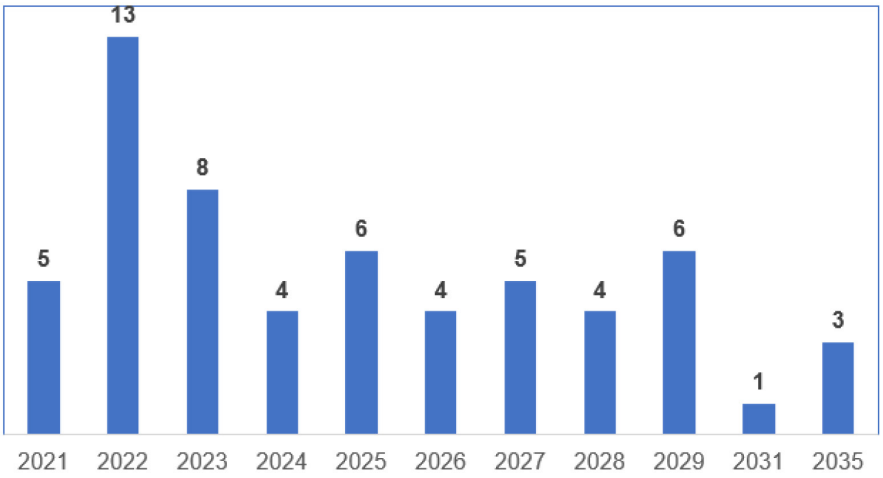

Figure 2. Temporal distribution of the expected completion of works to de-characterize upstream dams in Brazil.

Source: ANM, 2022.

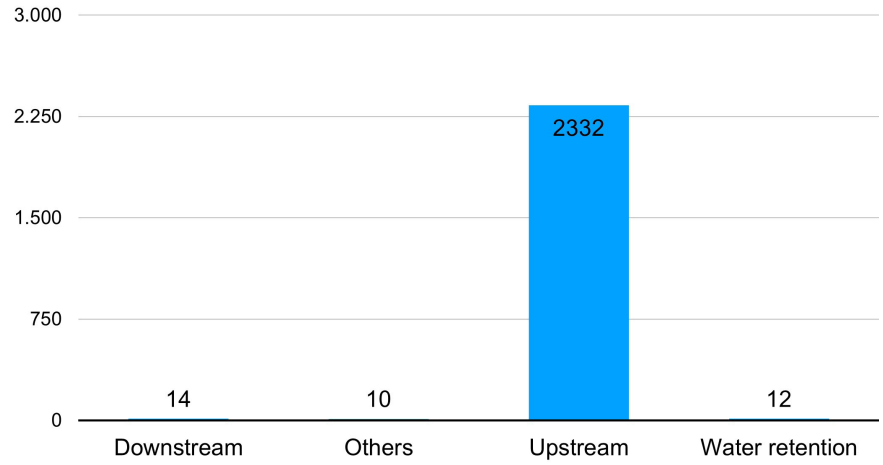

Figure 3. Number of deaths, according to the tailings dam project (1915-2020).

Source: Adapted from Islam and Murakami, 2021.

Although the ANM and PNSB standards accept flexible deadlines – the effect of which is evident in the permanence and projection of risks and damage for a period of up to 15 years (Figure 2) –, the same does not occur with the PESB: the mining companies present in the state that did not meet the deadline were forced to compensate the Minas Gerais government. In the case of Vale, it signed an agreement with the State Government of Minas Gerais and the State Public Prosecutor's Office (MPMG), and the company had to pay compensation set at 236 million BRL. However, before the agreements, the mining companies made several attempts to change legislation and extend the deadline through legal measures,

although unsuccessfully. Samarco even filed a lawsuit, but ultimately adhered to the agreement so as not to be sued by the MPMG. According to the Government of Minas Gerais and the MPMG, the resources collected from compensation "will be directed to the basins where these projects are located, either to serve the communities, or possibly to structure the inspection of the projects themselves" and are based on technical studies that consider the volume of tailings stored in each dam (Agência Brasil, 2022).

In a note, Vale stated, among other things, that, after the collapse of the 'B1' dam, in Brumadinho, it began to adopt the infamous "Global Industry Standard for Tailings Management (GISTM), which establishes requirements for the safe management of tailings disposal structures and aims to avoid any harm to people and the environment" (Agência Brasil, 2022). The challenges to making tailings dams safe, however, are enormous, not only for financial reasons – in other words, the decision of mining companies to adopt more dangerous methods, because they are cheaper –, but also for legal and technical reasons (Beluzzo; Sarti, 2019; Mininwatch Canada, 2020). The global-scale analysis of the impacts of dam failures over the last 100 years, prepared by Islam and Murakami (2021), makes it possible to identify and measure the lethal effects of technical failures prevalent in mining tailings dams, by construction method (Figure 3), country of origin (Figure 4) and explored minerals (Figure 5).

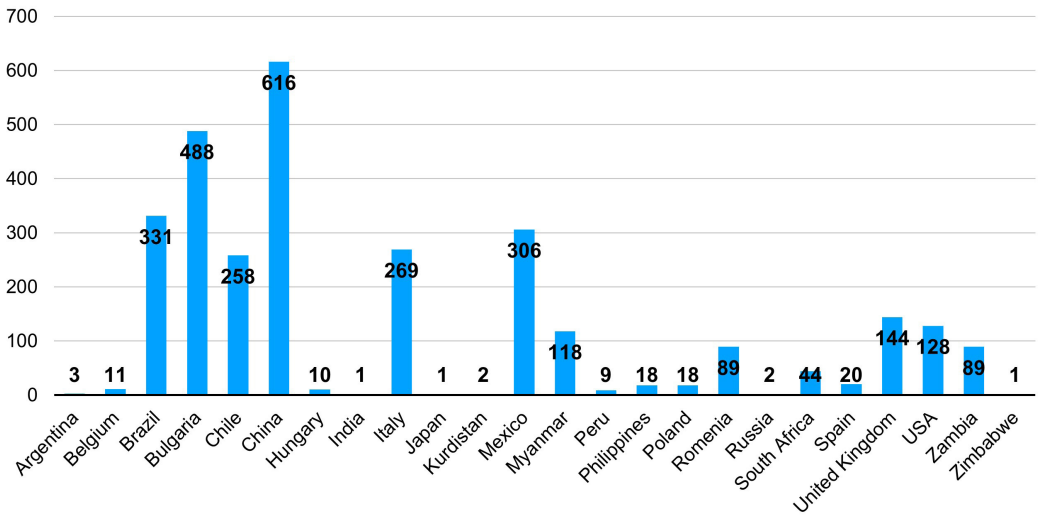

Figure 4. Official number of deaths resulting from tailings dam failures in different countries (1915-2020).

Source: Adapted from Islam and Murakami, 2021.

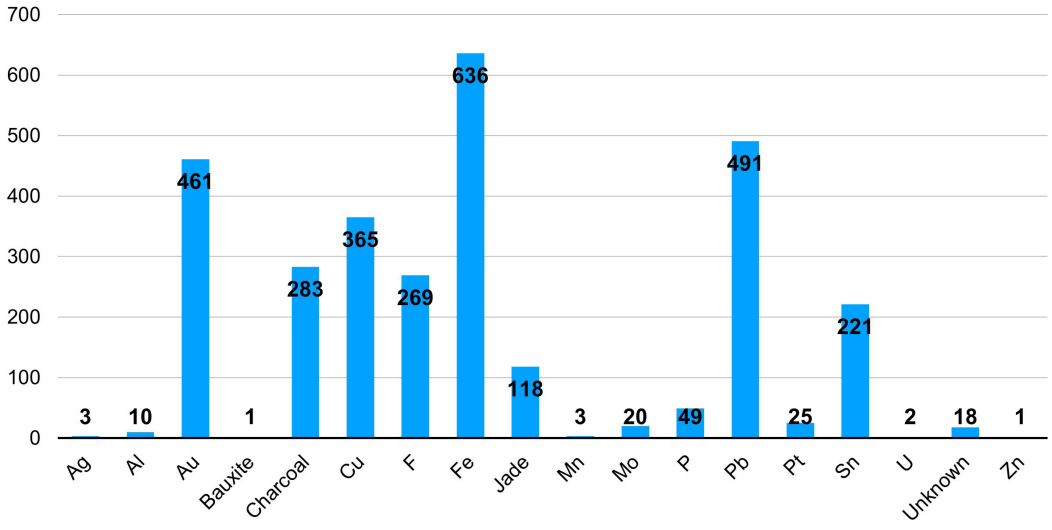

Figure 5. Number of deaths per primary product
Source: Adapted from Islam and Murakami, 2021.

The study demonstrates that the number of failures is increasing and that "the trajectory of dam failures has shifted from developed to developing countries" (Islam; Murakami, 2021). Weak environmental regulation coincides with many of the most recent disasters in mining dams, located in emerging or developing countries that have adopted neo-extractivism among their productive activities (Santos; Milanez, 2013). The impacts of failures, when they occur in these countries, are devastating. Recurrent failures at jade mines in Myanmar have killed hundreds of people; Papua New Guinea and Indonesia still deposit tailings in rivers and oceans (Islam; Murakami, 2021). Among the biggest failures that have resulted in tragedies, and which occurred over the last two decades, most are located in countries with this profile:

> Baia Mare and Baia Borsa (Romania), in 2000, San Marcelino Zambales (Philippines) in 2002, Karamken (Russia) in 2009, Ajka (Hungary) in 2010; Padcal (Philippines) in 2012, Mount Polley (Canada) in 2014, Fundão (also known as Samarco; Brazil) in 2015, Luoyang Xiangjiang Wanji (China) in 2016, Vedanta (India) in 2017, Mina Córrego do Feijão (also known as Brumadinho; Brazil) in 2019, and Tieli (China) in 2020 (Islam; Murakami, 2021).

Due to inaccurate and missing information, as well as "the lack of a statutory body that maintains updated records of tailings dams" (Islam; Murakami, 2021) on a global scale, the exact number of dams and tailings dam failures is unknown, but

"there are thought to be 18,000 tailings dams worldwide, although this has not been confirmed" (Islam; Murakami, 2021). The problem of lack of access to correct and complete information regarding this type of dam further aggravates the problem of resistance on the part of the mining companies to abandon potentially lethal methods of tailings disposal. As the authors assert:

> Although safer technologies are available to manage mine waste, most extractive industries are yet to adopt such technologies into their standard practices. Moreover, the reluctance of mining companies for the public disclosure of information related to tailings dams and dam failures hinders efforts to establish a complete tailings dam database. (...) [which is] a major obstacle that must be overcome. The influence of investors, insurers, and governments may prove to be crucial in this regard. (Islam; Murakami, 2021, p. 14)

Among the techniques available for the disposal of tailings, the use of upstream dams has proved to be the most lethal (Figure 3), cheapest and also the most commonly used option in the exploration of iron ore, which in turn is a primary product with greater lethality (Figure 5). Furthermore, Brazil ranks third in the number of deaths resulting from tailings dam failures, after China and Bulgaria (Figure 4). The prognosis for the future is also not optimistic. The amount of tailings stored in dams around the world is substantial, according to the authors, "and is evidently going to increase over the next five years" (Islam; Murakami, 2021, p. 15).

Lastly, it is important to remember that Brazilian safety policies for dams, unlike international standards, have the force of law, and as such are constituent elements of national sovereignty. Thus, it is useful for reflection to recognize law as one of the territorial expressions of the State, since it is the territorial State that creates "normative and infrastructural conditions to guarantee success for investments, especially those of large capital" (Cataia, 2011, p. 123), based on the four foundations of the modern State: 1) monopoly on violence; 2) monopoly on the creation and application of laws; 3) monopoly on the creation and management of currency; and 4) monopoly on tax collection (Pinto; Cardoso Jr.; Linhares, 2010, p. 19). In the Brazilian case, it may be observed that "the fragmentation of interests articulated around the State and the laxity of bureaucratic and procedural institutions" in relation to management and conflict resolution "limit the effective autonomy of crucial state decisions", causing the Brazilian State to be both "the locus of condensation and of processing disputes over strategic resources" and "the ultimate decision-making agent through which, in fact, the political projects of the winning dominant groups materialize or become viable" (Pinto; Cardoso Jr.; Linhares, 2010).

The dialectic of the historical and political process observed herein – both the innovations in the national legal system and the emergence of international standards that affect the security of dozens of countries – thus demonstrates the relationship between the production of standards as an a posteriori element, and the production of disaster as an a priori element in mining risk management, thereby representing a problem that is expressed in the contradictions between market narratives, the role of the State and the protagonism of facts.

Final considerations

The study has analyzed four standards, or norms, that provide for the safety of mining tailings dams in Brazil and around the world, seeking to understand and highlight, on the one hand, the context from which such standards emerge and, on the other, some of their consequences in relation to the existence of dams built by the upstream method, which is considered to have the greatest risk, predominant in the exploration of iron ore, and very concentrated in the State of Minas Gerais. We have undertaken an introductory characterization of the aforementioned normative frameworks, identifying the main actors and events directly related to their emergence, and observing compliance with the schedule for the de-characterization process of upstream dams on the national territory. To this end, we conducted a deductive analysis based on a literature review, combined with an inductive analysis from secondary sources (news items, reports and standards).

It was observed that important regulatory changes for the mitigation of risk – the prohibition of the existence of upstream dams being the most significant, first on a state scale (PESB), then national (PNSB, updated by Law 14.066/20) and, finally, on a global scale (Safety First) – only occurred as a posteriori (repair) and not a priori (prevention) of the tragedies, motivated mainly by the commotion and social pressure on a local, national and global scale. The case of GISTM, considered the official global standard for the mining and metals industry, is a cause for concern for the scientific community and, above all, for the population exposed to technological risks and disasters – in which there is a fragile responsibility and accountability of the market and of the State for its security. Furthermore, in the case of Brazil, the relaxation of guidelines and deadlines in favor of mining companies tends to prolong the socio-environmental vulnerability of territories threatened by the risk of failure of upstream dams. Thus, it is important to reiterate that the upstream technique is recognized worldwide as being the least safe, and the cheapest, and is therefore prohibited in several mining countries (Luckenedera; Giljuma; Krisztinb, 2019; Reuters, 2020; EM-DAT CRED, 2020; Islam; Murakami, 2021; Niquito et al., 2021).

These analyzes have enabled us to understand, therefore, how the problem of dams has been addressed by institutions and mining companies, where the standard is improved by the State and, partially, by the market a posteriori the disasters. We identified that the effectiveness of national and state standards promulgated after the Mariana and Brumadinho disasters – although more assertive than the hegemonic international standard GISTM – encounters difficulties in applying the necessary urgency with regard to the mandatory process of the de-characterization of upstream dams. These difficulties are related, on the one hand, to the flexibility of deadlines granted by the federal government (via ANM and PNSB) – flexibility that benefits mining companies to the detriment of communities affected by the risks –, and on the other hand, to the resistance of mining companies in accepting deadlines and rules established by the state regulation of Minas Gerais (PESB) – particularly the mining company Vale, owner of the largest number of these dams in the state. Compliance with the initially established schedule would require a greater volume of resources – i.e., the reallocation of capital for extraordinary expenses with negative externalities – on the part of Vale, reducing the level of investor remuneration, which is undesirable for the company (Beluzzo; Sarti, 2019). These are reasons why we consider that the application of such standards still faces obstacles – fundamentally political – that reproduce socio-environmental vulnerability in the state. It is ultimately in the field of political articulation, through institutions, that both socio-environmental negligence, flexibility of deadlines and resistance to prohibition impose themselves on sovereignty, democracy and life. Security, monitoring, inspection and punishment are, therefore, indispensable and inseparable actions so that new norms and standards actually advance in what they rhetorically propose to change.

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Rita de Cássia Barros

Graduated with a teaching degree in Geography from the Universidade de São Paulo (USP). Currently undertaking a master's degree in Development, Planning and Territory (PGDPLAT) at the Universidade Federal de São João Del Rei (UFSJ) with a scholarship from the Minas Gerais State Research Support Foundation (FAPEMIG).

Email: ritacbarros@gmail.com
ORCID: 0000-0001-5682-6328
Authorship contribution: Conception; Investigation; Methodology; Visualization; Writing – First Draft.

Talles Girardi de Mendonça

PhD in Applied Economics from the Universidade Federal de Viçosa (UFV). Permanent Professor on the Postgraduate Program in Development, Planning and Territory (PGDPLAT) at the Universidade Federal de São João Del Rei (UFSJ) and Associate Professor II in the Department of Economic Sciences at the same University.

Email: tallesgm@ufsj.edu.br
ORCID: 0000-0003-4379-1562
Authorship contribution: Supervision; Writing – Review and Editing.

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