BOLETIM DO INSTITUTO DE PESCA
Review Article

Socio-environmental and economic impacts due to the disaster at Vale S.A. in Brumadinho, MG, Brazil: A systematic review

Vanessa de Oliveira Gaudereto Guimarães[1]*, Paula Maria Gênova de Castro Campanha[1], Maria Letizia Petesse[2], Cláudia Maris Ferreira[1]

[1] Instituto de Pesca – São Paulo (SP), Brazil.
[2] Fundação de Desenvolvimento da Pesquisa do Agronegócio – São Paulo (SP), Brazil.
*Corresponding author: vanessaogaudereto@gmail.com

ABSTRACT

Significant socio-environmental and economic impacts on fishermen and fish farmers in the Três Marias reservoir arose from the collapse of the mining tailings dam in the municipality of Brumadinho, MG, Brazil, in 2019. To help assess this situation, we carried out a systematic review to find information that scientifically documents these impacts. To this end, we used the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior Journal Portal, accessed through the Federated Academic Community, to search for data indexed between 2019 and 2023, in the following databases: Web of Science, Scopus, and CAB Direct. We used Brumadinho as the central keyword and linked to it 25 other secondary keywords, such as environmental disaster, fishermen, fish farmers, and Três Marias dam. To screen and select the results, we used Rayyan software and the Preferred Reporting Items for Systematic reviews and Meta-Analyses methodology. The search resulted in 990 articles, 61 theses, and 251 dissertations. Among them, only 26 articles, 19 theses and 66 dissertations were eligible as contributions to the topic, but very few reported the situation of fishermen and fish farmers. We concluded that there is a lack of information on the damage suffered by these people, and that more scientific studies and attention to this public are needed.

Keywords: Dam failure; Artisanal fishermen; PRISMA; Socio-environmental damage; Mining company.

Impactos socioambientais e econômicos em virtude do desastre da Vale S.A. em Brumadinho, MG, Brasil: uma revisão sistemática

RESUMO

O rompimento da barragem de rejeitos de mineração no município de Brumadinho, MG, Brasil, em 2019, gerou impactos socioambientais e econômicos significativos para pescadores e aquicultores do reservatório de Três Marias. Para ajudar a avaliar essa situação, realizamos uma revisão sistemática para encontrar informações que documentem cientificamente esses impactos. Para tanto, utilizamos o Portal de Periódicos da Coordenação de Aperfeiçoamento de Pessoal de Nível Superior, acessado por meio da Comunidade Acadêmica Federada, para buscar dados indexados entre 2019 e 2023, nas seguintes bases de dados: Web of Science, Scopus e CAB Direct. Utilizamos Brumadinho como palavra-chave central e vinculamos a ela outras 25 palavras-chave secundárias, como desastre ambiental, pescadores, piscicultores e barragem de Três Marias. Para triagem e seleção dos resultados, utilizamos o *software* Rayyan e a metodologia Preferred Reporting Items for Systematic reviews and Meta-Analyses. A busca resultou em 990 artigos, 61 teses e 251 dissertações. Entre eles, apenas 26 artigos, 19 teses e 66 dissertações eram elegíveis como contribuições para o tema, mas muito poucos relatavam a situação dos pescadores e piscicultores. Concluímos que há carência de informações sobre os danos sofridos por essas pessoas e que são necessários mais estudos científicos e atenção a esse público.

Palavras-chave: Rompimento de barragem; Pescadores artesanais; PRISMA; Danos socioambientais; Mineradora.

Received: November 8, 2023 | **Approved:** May 27, 2024
Section editor: Raniere Garcez C. Sousa

INTRODUCTION

The state of Minas Gerais, Brazil, was the scene of two major sociotechnological and socioenvironmental disasters resulting from the disruption of mining tailings dams with an upstream raising of contaminants. Both, in a certain way, were under the responsibility of the company Vale S.A., the primary mining company in the state and one of the largest in the world. The disruptions occurred in a temporal gap of less than four years, with the first one being on November 5, 2015, in the municipality of Mariana, and the second one on January 25, 2019, in the municipality of Brumadinho.

The Mariana disaster carried approximately 44 million m^3 of mining tailings slurry through the Doce River to the Atlantic Ocean, affecting part of the coast of the state of Espírito Santo and causing the death of 19 people. The Brumadinho disaster, on the other hand, dragged about 13 million m^3 of tailings through the Ferro Carvão stream and the Feijão stream, resulting in the death of 272 people (Governo do Estado de Minas Gerais, 2021). In Brumadinho, the disaster also impacted the Paraopeba River, one of the most significant tributaries of the Três Marias reservoir (São Francisco River basin), directly affecting 26 municipalities in Minas Gerais, causing damage to the ecosystem, diversity, human health, employment, income, tourism, leisure, social relations, heritage, among others (Freitas et al., 2019; Costa et al., 2020; Brandão et al., 2021; Governo do Estado de Minas Gerais, 2021; Da Silva et al., 2022; Blanco et al., 2023). These disasters resulted in an immeasurable socioenvironmental and economic damage, cumulative and exacerbating impacts on the health of those affected, trauma and emotional issues, financial, economic, political, and social losses, both individually and collectively, among others (Freitas et al., 2019; Azevedo-Santos et al., 2021; Brandão et al., 2021; Fabrício et al., 2021).

Since the disasters, a series of studies have been conducted by different organizations and researchers, including the Government of the State of Minas Gerais, aiming to provide comprehensive information in various areas related to contamination and impacts in the Três Marias reservoir region (Pereira et al., 2021; Amaral, 2022). These research efforts not only report relevant data but also anticipate the need for ongoing monitoring and the possibility of seeking legal redress (Governo do Estado de Minas Gerais, 2021). However, the importance of transforming this information into actionable knowledge cannot be underestimated. In many cases, numerous pieces of information are collected and produced, and, if they are not constantly analyzed and systematized, knowledge becomes confusing and difficult for society to interpret, thereby complicating the proper implementation of public policies.

Manouselis et al. (2010) emphasize the critical importance of collecting, systematizing, and organizing data in a manner accessible to the community. This process aims to optimize data utilization to effectively address scientific inquiries and demands. Furthermore, the analysis and proper management of remotely obtained data can enhance opportunities for sharing and reusing information, both internally among different government and private entities and externally with society.

The terms systematic review and meta-analysis are often used interchangeably, but they represent distinct processes. A systematic review denotes a study design conducted with a systematic approach and an objective description of the summarized evidence, while meta-analysis refers to the statistical method of systematically analyzing gathered evidence (Moher et al., 2009; Ercole et al., 2014). Therefore, a systematic review is considered a type of scientific investigation that aims to gather, critically evaluate, and synthesize results based on various primary studies, answering a specific pre-established question using systematic methods, and selecting and evaluating relevant works to inform the research (Cordeiro et al., 2007).

The relevance of this research, particularly concerning the impacts on fishermen and fish farmers in the Três Marias reservoir area, warrants significant consideration. The region has a dense population of fishermen, including a notable contingent of women, for whom fishing is the primary source of income. Fishing is crucial for the subsistence of many individuals. Additionally, fish farming is a promising activity in the area, providing employment and income, while both activities significantly contribute to the supply of essential protein. Moreover, the reservoir itself hosts valuable biodiversity and offers various essential uses for these communities.

To optimize the application of scientific information related to the Vale S.A. disaster in Brumadinho, we conducted a systematic literature review with the focus on fishermen and fish farmers. Our objective was to identify articles, theses, and dissertations addressing the socioenvironmental and economic impacts faced by these groups in the vicinity of the Três Marias reservoir.

MATERIALS AND METHODS

For the collection and consolidation of studies, we gathered indexed scientific articles related to Brumadinho, impacts, environmental disaster, fishermen, fish farmers and the Três Marias reservoir. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 methodology (Page et al., 2021) was used to logically systematize the information selection process. However, this review was not recorded as

required by the protocol. The time frame covered the last four years and four months (January 1, 2019 to May 22, 2023).

Access was conducted through the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior Periodicals Portal, via the Federated Academic Community, and advanced searches were performed using secondary data extracted from the following databases:

- Web of Science: a multidisciplinary database maintained by Clarivate Analytics, encompassing 9,000 national and international journals with selective editorial policies. It recently incorporated articles from journals cataloged in the Scientific Electronic Library Online database;
- Scopus: the largest abstract and citation database in the peer-reviewed literature. It covers approximately 19.5 thousand titles from over 5,000 international publishers;
- CAB Direct, or Centre for Agriculture and Bioscience International: the most comprehensive and extensive reference source in applied life sciences. It provides access to over 11 million bibliographic records and over 340 thousand full-text articles.

For the collection and systematization of theses and dissertations, we used information from the Brazilian Digital Library of Theses and Dissertations. We defined keywords or search terms (*i.e.*, tags) based on the research objective, focusing on the environmental disaster in Brumadinho and its impacts on fishermen and fish farmers. We used a central keyword (Brumadinho) and 25 secondary tags, connected by the Boolean operator AND to ensure the presence of all keywords in the articles, as detailed in Table 1. The search was conducted in two languages: Portuguese and English.

The information extracted from the databases regarding the articles included elements such as title, abstract, keywords, authors. The search strategies were the same for all the databases. After the definition of keywords, we used the PRISMA methodology, that suggests several successive stages, such as document selection through screening (duplicate and out-of-scope documents are excluded), eligibility, and final inclusion (Fig. 1).

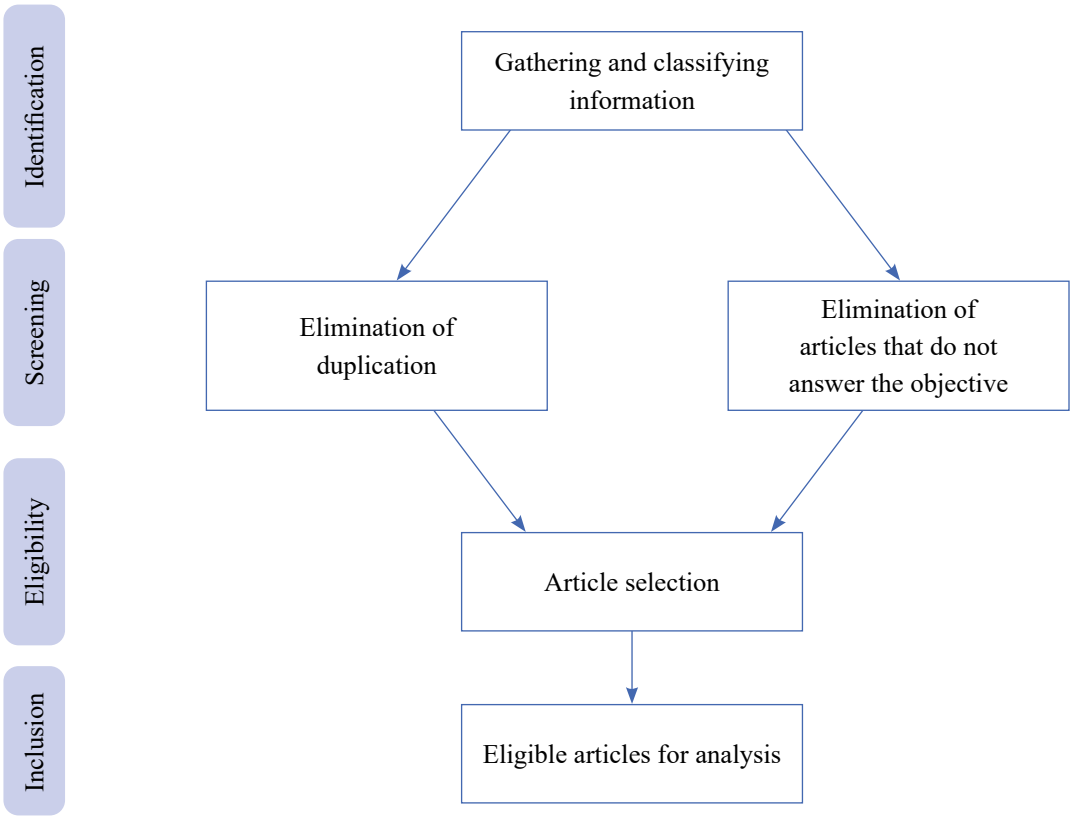
The inclusion criteria and eligibility considered the socio-environmental and economic damage on fishermen and fish farmers in the Três Marias reservoir. Basically, if a study reported how this target audience reacted to this damage, it was included. Studies related to ecotoxicology and governance, as well as those referring to other study locations, duplicate* and repeated** articles were also excluded. Consequently, not all initially identified articles were chosen for the final analysis, resulting in a more limited selection of eligible articles for the study. The review process was conducted using a double-blind testing method, in which none of the researchers had prior knowledge of the other's results.

Table 1. Search terms in Portuguese and English, used in the Web of Science, Scopus, and CAB Direct databases for the selection of scientific articles, and in the Brazilian Digital Library of Theses and Dissertations for theses and dissertations.

Keywords	Portuguese OR English
Brumadinho	desastre ambiental or environmental disaster
	pescado or fishing; fisheries, fishery
	pescador or fisherman
	peixe or fish
	ictiofauna or ichthyofauna
	perfil socioeconômico or socioeconomic profile
	pesca artesanal or artesanal fishing
	pesca profissional or commercial fishing
	recurso pesqueiro or fisheries resource
	legislação pesqueira or fishing law, regulation
	Vale
	represa de Três Marias or Three Maries reservoir
	barragem or dam
	rompimento or disruption
	reservatório or reservoir
	contaminação or contamination
	qualidade de água or water quality
	mineração or mining
	rejeito or waste
	segurança alimentar or food security
	afluente or affluent
	rio São Francisco or São Francisco River
	aquicultura or aquaculture
	rio Paraopeba or Paraopeba River
	viveiro or hapas

*Articles were considered duplicate when appeared more than once in different databases.

**Articles published in multiple languages or in multiple dissemination channels were considered as repeated articles.



Source: adapted from Moher et al. (2009) and Galvão et al. (2015).

Figure 1. Information flow with the different phases of a systematic literature review.

To help this selection process, we utilized the open-source Rayyan — Intelligent Systematic Review software, funded by the Qatar Foundation, primarily used for support in systematic review research.

After the selection of eligible articles, theses, and dissertations for reading, we created a spreadsheet containing the main information from these studies:

- Publication journal;
- Article title;
- Year of publication;
- Authors;
- Objectives;
- Keywords;
- Main conclusions;
- Link;
- Relevance to the topic (a = high, m = medium, b = low).

It is worth noting that the relevance to the topic was developed and defined according to the following discretionary criteria: articles classified as *a* explicitly included impacts and/or socio-environmental and/or socio-economic damages resulting from the dam rupture in Brumadinho to fishermen and fish farmers in the Três Marias reservoir, or presented real contributions to the research objectives; those classified as *m* were articles that provided some information related to impacts and damages, environmental, social, and/or the rights of fishermen/fish farmers in the vicinity of the Três Marias reservoir; and those classified as *b* were those that made no reference to the Três Marias reservoir and did not present any impact that could relate to these issues, but were included in the process because they apparently addressed this approach and contributed to the development of the research.

The information consolidated by the PRISMA methodology was complemented using the Connected Papers tool. This is a visual tool that helps researchers and scientists find and explore relevant articles in their field of work. Unlike other search mechanisms, Connected Papers operates by selecting manuscripts based on their similarity to a chosen reference article. The similarity metric is based on the concepts of cocitation and bibliographic coupling. According to this measure, it is assumed that two articles with highly overlapping citations and references

are more likely to deal with a related subject. The algorithm then constructs a force-directed graph to arrange the articles in a way that visually groups similar manuscripts and separates less similar ones. This means that even articles that do not directly cite each other can be strongly connected and positioned very close. It presents graphs in which each ball (node) is an academic work related to the original article used in the search. The size of the node indicates the number of citations for each article, and the color represents the publication year. The higher the similarity between articles, the shorter the distance of the connection lines, leading to greater clustering among them. The Connected Papers database is connected to the Semantic Scholar Paper Corpus (licensed under ODC-BY). Despite being essentially visual, Connected Papers allows downloading the list of all related articles, also indicating the percentage of similarity of each one with the initial search article.

Additionally, to assess the trends or predominant axes of interest in the selected research, we conducted a graphical analysis based on word hierarchization using the Wordclouds platform. This platform allows the formation of a cloud of words, with each word's font size proportional to its frequency. For this purpose, we used the keywords from all eligible articles. The other categorized information was quantified and analyzed graphically and expressed in percentages.

RESULTS

The data with the information from the articles have been tabulated and are available at the Suppl. Material. From the reading and analysis of their information, we obtained the results described ahead.

Scientific Articles

A total of 990 articles were identified in the three consulted databases (Table 2), of which 244 were excluded for being duplicates (100% similarity). This left 746 articles, of which 348 did not have exact similarities, but were also duplicated, and 213 were repeated articles. All of them were excluded in the Screening stage. The remaining 185 articles were subsequently screened, eliminating articles that did not address the main research question, namely, the relationship between the environmental disaster in Brumadinho and the damage to fishermen and fish farmers in the vicinity of the Três Marias reservoir. This process led to the inclusion of only 26 articles in the qualitative synthesis. In Fig. 2, we can visualize the steps of the PRISMA methodology applied to this study.

Figure 3 presents the 26 eligible articles in this study, categorized by journals and impact factor.

After a thorough reading of the articles in their entirety, only seven articles met the defined criteria, meaning they were classified as *a* in terms of relevance. Three articles were classified as *m*, and 16 as *b*. These articles with *m* and *b* relevance did not provide any significant contribution to the identification and relationship of the main socio-environmental and/or economic impacts on the fishermen/aquaculturists in the vicinity of the Três Marias reservoir.

It's worth noting that articles on this topic (included) began to be published in 2019 (7.7%), with the majority published in the year 2020 (38.5%), and no article specifically addresses the impacts on the fishermen and aquaculturists of the municipalities around the Três Marias reservoir. These manuscripts report possible impacts that may have affected the fishermen and fish farmers in the vicinity of the Três Marias reservoir in the future. However, even though the impacts raised are relevant to the specific audience and location defined by our research criteria, it is imperative to highlight that none of the articles presented socio-environmental and socio-economic impacts specifically suffered by fishermen and fish farmers in that location.

The articles with *a* relevance are the citations of the following authors/years:

- Gonçalves (2020);
- Peixoto and Asmus (2020);
- Azevedo-Santos et al. (2021);
- Parente et al. (2021);
- Da Silva et al. (2022);
- Lopes et al. (2022);
- Melo et al. (2022).

The results from Connected Papers applied to the seven highly relevant articles confirmed our findings that there is a lack of scientific studies conducted with the community of fishermen and aquaculturists in the Três Marias reservoir region as a result of the Brumadinho disaster. The tool generated similarity graphs for only three of the seven articles, and the similarity occurred

Table 2. Quantity of articles divided by database and keyword, used in the systematic review on the environmental impacts on fishermen/aquaculturists caused by the Vale S.A. disaster in Brumadinho, MG, Brazil, from January 2019 to May 2023.

Database	Scopus	Web of Science	CAB Direct	Total
Keywords (25)	481	332	177	990

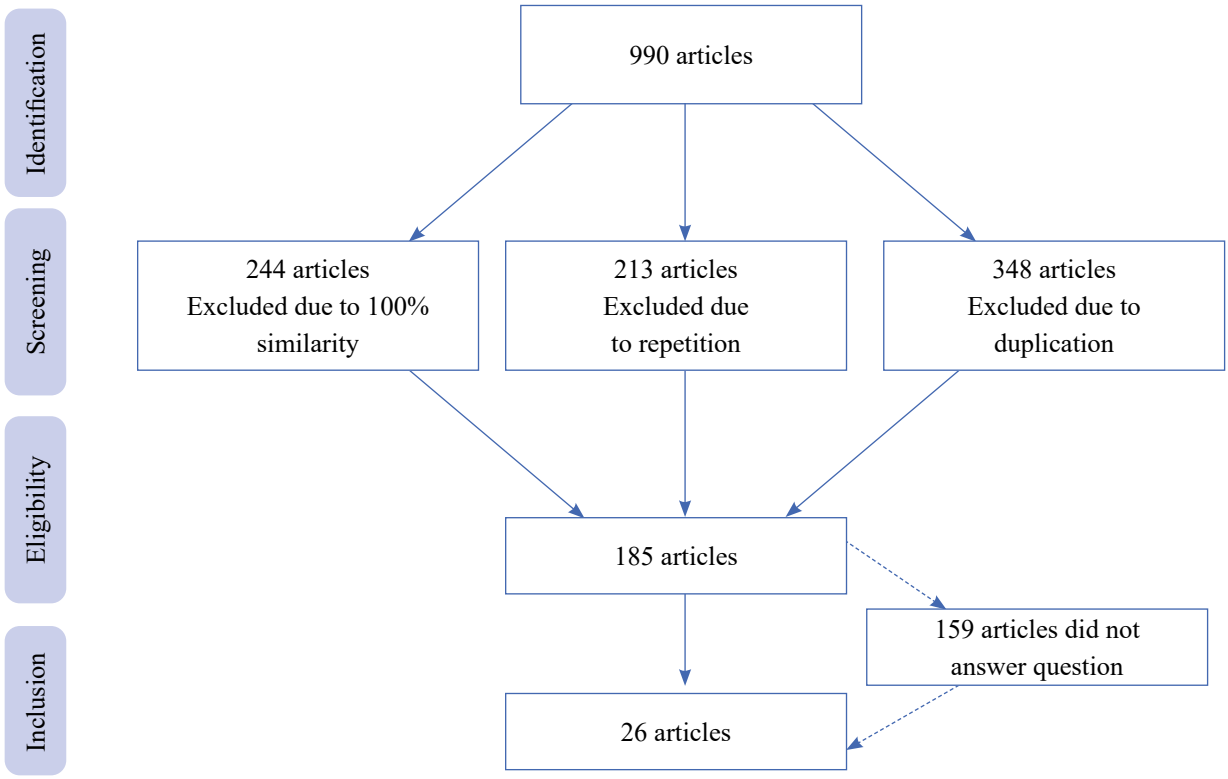


Figure 2. Results of the systematic review of data on the socio-environmental and/or socio-economic impacts on fishermen and fisher farmers in the vicinity of the Três Marias reservoir, caused by the Vale S.A. disaster in Brumadinho, MG, Brazil, over a period from January 1, 2019 to May 22, 2023, using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses methodology.

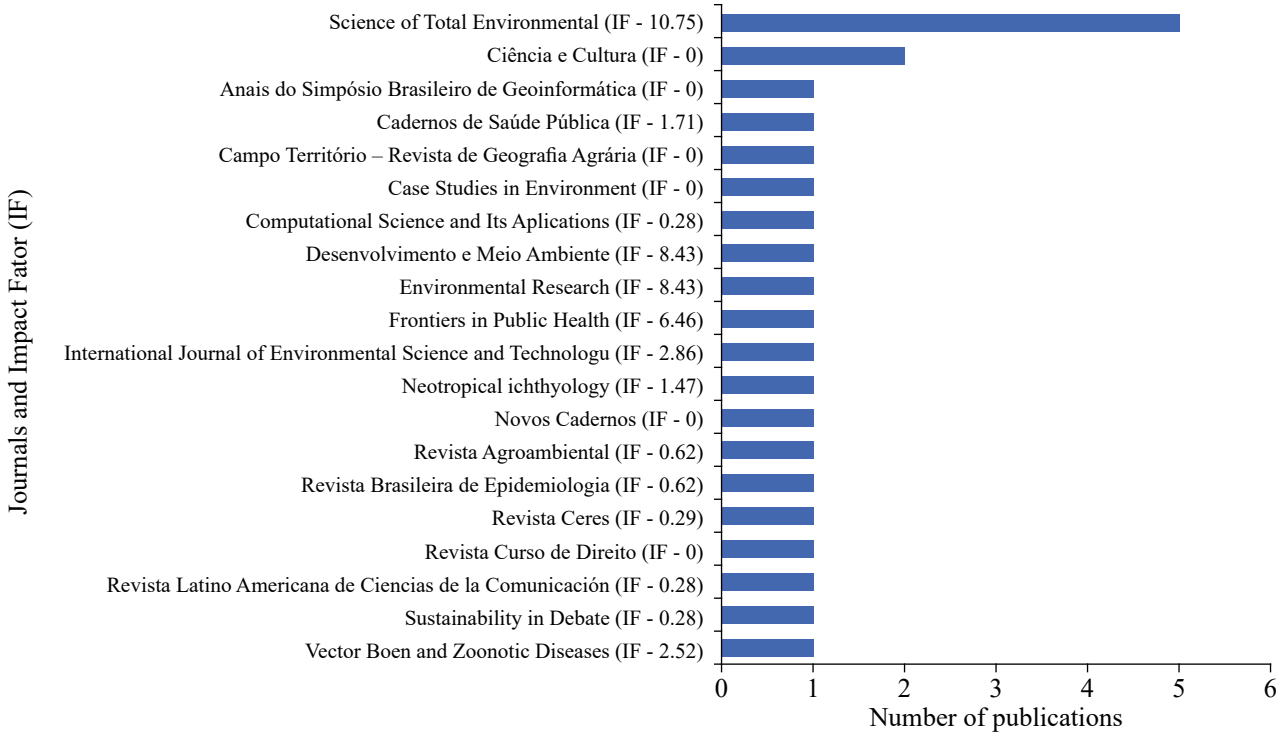


Figure 3. Number of eligible scientific articles, by journal and respective impact factor, of selected articles in the systematic review on the dam rupture in Brumadinho, MG, Brazil, with a time frame of four years and four months (2019 to 2023) (n = 26).

with articles very distant from the primary focus of our study, which is socio-environmental and socio-economic impacts specifically suffered by fishermen and fish farmers in that delimited location.

To reinforce these findings, we used the Wordclouds platform to evaluate the studies based on the keywords of the selected scientific articles. In the hierarchy of tags, 224 keywords were analyzed from the 26 eligible scientific articles, with data collected from 2019 to May 2023. The hierarchy of words shows that the trend of the studies revolved around the Paraopeba River, Brumadinho, and mining, which are the keywords that repeated the most among the articles (Fig. 4).

Keywords such as "viveiro," "afluente," "pescador," "ictiofauna," "perfil socioeconômico," "pesca artesanal," "pesca profissional," "recurso pesqueiro," and "aquicultura" either do not appear or appear only once in the research. Specifically in the CAB Direct database, the words "fisherman" and "commercial fishing" appear only once. Among all the articles identified, there are fewer than five that mentioned the words "pescado" or "fishing," and only one related to "insegurança alimentar" or "food security." This demonstrates the lack of scientific publications addressing these topics, reflecting the urgency of studies and monitoring that focus on the effects of the disaster on the population of fishermen and fish farmers. Another observation is that, over the years, indexed scientific journals have started publishing exclusively in English, making it unnecessary to search with native language words.

Figure 4. Frequency analysis conducted using the Wordclouds platform of the 224 keywords from 26 eligible articles selected through the Preferred Reporting Items for Systematic Reviews and Meta-Analyses methodology, relating to the Brumadinho disaster and fishermen and fish farmers from the Três Marias reservoir, MG, Brazil. Time frame from January 2019 to May 2023.

Theses and dissertations

Following the PRISMA methodology using the recommended keywords related to the proposed theme, we found 312 documents in the Brazilian Digital Library of Theses and Dissertations. Out of them, only 19 theses and 66 dissertations answered the initial question of this study. However, upon closer examination, we found that only four had a direct connection to the research objective and were classified as *m*, meaning they provided some information related to environmental and social impacts and damages related to fishermen and fish farmers, thus highlighting the absence of works on this topic. It is important to note that the results of these studies began to be published in 2019 (21.2%), 2020 (22.3%), 2021 (29.3%), 2022 (25.7%), 2023 (1.5%), and by various universities and research institutes, with the Universidade Federal de Minas Gerais publishing the majority of the theses and dissertations (29.41%).

DISCUSSION

Using systematic review tools, we conducted a meticulous search for scientific information that was peer-reviewed and addressed the socio-environmental and economic impacts faced by communities of fishermen and fish farmers in the eight municipalities near the Três Marias reservoir (São Gonçalo do Abaeté, Três Marias, Felixlândia, Morada Nova de Minas, Paineiras, Biquinhas, Abaeté, and Pompéu). These impacts were triggered after the tragic disruption of the Vale S.A. dam in the municipality of Brumadinho January 25, 2019.

In this region, fishing is a traditional activity, and the Três Marias reservoir stands out not only bringing together a considerable number of fishermen, but also fish farmers. According to information from the Federation of Fishermen, Fisherwomen, and Aquaculturists of Minas Gerais (obtained by personal communication), in 2021, there were 3,190 registered fishermen in the mentioned municipalities. This significant number of affiliated fishermen is an evidence of the importance of fishing activity in the areas surrounding the Três Marias reservoir. However, it is equally important to consider that this number represents only a portion of the professionals involved in fishing in the region. When we include fishermen not affiliated with the federation and other participants in the fishing production chain, we observe a specific increase in the number of individuals who play a vital role in this long chain in the region.

Aquaculture, on the other hand, is primarily driven by entrepreneurial initiatives, mostly individual, with few cooperatives, associations, and societies. Nevertheless, the sector has grown and has become the second-largest tilapia production center in the country, driving the state's production, which ranks fourth among Brazilian states in tilapia production, according to data from the municipal livestock production (IBGE, 2019), with production in the years 2018, 2019, 2020, and 2021 of 16,024.99; 17,138.28; 17,252.01; and 14,653.50 tons, respectively (IBGE, 2022).

The analysis of articles, theses, and dissertations conducted in our study reveals a significant volume of works related to the disaster related to the dam disruption in Brumadinho. However, when we narrow our research to specifically examine the impacts on fishermen and fish farmers, we observe a lack of articles addressing these topics in isolation. Most studies encompass a wider range of impacts, covering cultural, tourism, heritage, and social issues faced by those affected by the disruption. We believe that uncertainties about the affected area, as well as the limitations imposed by the COVID-19 pandemic, which led to quarantine shortly after the disaster, are clearly one of the reasons for this reduced number of research studies, as they hindered field surveys and *in-situ* studies.

However, it is a fact that the main impacts related to the tailings mud from the disaster directly affected the fishing, aquaculture, and tourism chain in the region, resulting in material and immaterial damages, among others, and condemning, indefinitely, work and income relationships, food security, leisure, and access to water and ecosystem services. It is the duty of all involved to investigate and identify the impacts suffered by the fishermen and fish farmers in the region, which is essential for the construction of a damage matrix that guarantees full compensation to the entire community affected by the disaster.

Azevedo-Santos et al. (2021), in a review of the Brumadinho disaster, gathered information on the main impacts of mining for crude oil, gold, iron, copper, and bauxite on neotropical freshwater fish. They concluded that mining resulted in direct and indirect losses of fish diversity in various bodies of water. When the focus is particularly on the contamination of the Paraopeba River waters, which is used by riverside communities, Melo et al. (2022) emphasized that there are irreparable damages to the survival, daily life, and health of the residents, in addition to deepening the marginalization and vulnerability of this audience. Da Silva et al. (2022) reported that the environmental impacts of the disaster directly led to alterations in the metabolism and functioning of the natural ecosystems in that region due to the contamination of environmental compartments and damage to biodiversity. They also concluded that, in terms of human health, there were evident risks of intoxication, mental health issues, worsening of existing diseases, arboviruses, and zoonoses.

Gonçalves' study (2020) is one of the few articles that reported direct observations and interviews conducted with the population of farmers, fishermen, and riverside residents in the vicinity of the reservoir. Conducted between February 4th and 6th, 2019, shortly after the disaster, the expedition in the Paraopeba River basin allowed direct contact with territories and individuals impacted by the tailings mud. The result of the interviews, which began in the municipality of Felixlândia and proceeded towards Brumadinho, revealed that residents immediately experienced fear and despair when they learned of the disaster, as well as a great deal of insecurity due to the lack of information regarding the use of water for consumption, animal hydration, agricultural production, and for fishing and leisure.

Melo et al. (2022) also highlighted, as a result of qualitative research conducted *in loco* with the affected populations, including riverside communities, that the health damages are irreparable. Passos (2020) conducted a study to understand the process by which riverside residents affected by mining tragedies in Brazil between 2015 and 2019 rebuilt their lives. He used a city in Espirito Santo as a model. The study concluded that, when evaluating the mining activity, its benefits, and drawbacks, it is necessary to consider the circumstances and seek what each region presents by vocation. Each location has its specificities, its ways of life.

While there were several studies related to ecotoxicology in the region, they were not the focus of our research and were therefore disregarded. However, it's worth highlighting the research conducted by Parente et al. (2021) in the first year after the disruption of the tailings dam in Brumadinho. The authors analyzed the spatial and seasonal variation of trace elements in sediments, fish, and macrophytes in the Paraopeba River. França (2019) conducted modeling work to explore scenarios of this type of environmental disaster involving dam disruptions. The study concluded that disasters like these will cause a significant and irreversible impact on species richness, affecting social and economic areas, as well as directly affecting water quality and consumption by the population of the basin and its tributaries. They also found that concentrations of arsenic and lead exceeded safety limits for fish consumption in 3 and 41% of the samples, respectively, according to Brazilian laws, indicating a public health problem.

Lopes et al. (2022) described the situation of food insecurity in families based on socio-economic characteristics and dimensions of the food system in the region after the disaster. The authors concluded that the condition of food insecurity was high and associated with reports of reduced family income after the dam disruption. We agree with the suggestions of Peixoto and Asmus (2020), who state that it is important to monitor the evolution of these conditions over time to provide systematic information to the local health service and contribute to its organization, so it can adequately meet the needs of the population residing in the affected municipalities.

Defining and identifying the impacts, whether direct or indirect, short-, medium-, or long-term, as well as gaining a comprehensive understanding of all those affected by this environmental disaster, constitute a process with the potential to become cyclical, persisting over many years. This occurs due to the effects of bioaccumulation and biomagnification of trace elements, transformations in the ecosystem and the watershed, as well as the traumas and consequences for social, cultural, and professional relationships. Vulnerable populations and communities, such as indigenous people, *quilombolas*, artisanal fishermen, among others, who depend more directly and intensely on ecosystem services, are being affected and require comprehensive support (Freitas et al., 2019).

In summary, we report that the results of our searches show that:

- there is a lack of information about the impacts suffered by this professional category in the affected area itself;
- the event that occurred is neither unique nor rare, as several others have occurred in Brazil, indicating the need for updates to policies (or actions) for permitting, monitoring, preventing, and managing large-scale disasters;
- the impacts generated by this type of disaster are long-term, both in terms of the recovery of landscape and environmental aspects and in terms of the bioavailability of heavy metals harmful to living organisms;
- the limited area related to the municipalities surrounding the Três Marias reservoir, due to its social, cultural, environmental, economic, and geographical significance, requires constant and systematic monitoring and full support from an independent technical advisory service, working directly in the region.

These last two points are of particular importance, considering the fishing and fish farmers activities addressed in this study and in light of the prolonged effects on the socio-economic component and food security.

It is worth noting that, although there is a lack of articles, theses, and dissertations explicitly addressing the subject of this research, organized social movements, independent technical advisory services (highlighting the Guaicuy Institute), some parliamentary mandates, and other authors have presented substantial work, even if not scientific, that deserves consultation for further reading and research.

CONCLUSION

Despite identifying a high number of articles, theses, and dissertations referencing the disruption of the dam in Brumadinho, none of the researched articles strictly focused on the impacts and/or damages to fishermen and fish farmers in the vicinity of the Três Marias reservoir. It is important to recognize that the lack of research on this topic does not mean that the impacts do not exist. Thus, the need for more studies and attention to this population, which is numerous and crucial for the region and the state, is evident.

CONFLICT OF INTEREST

Nothing to declare.

DATA AVAILABILITY STATEMENT

The data are available in a data repository (https://doi.org/10.5281/zenodo.11427406).

AUTHORS' CONTRIBUTION

Conceptualization: Guimarães VOG, Campanha PMGC, Ferreira CM; **Methodology:** Guimarães VOG, Campanha PMGC, Petesse ML, Ferreira CM; **Investigation:** Guimarães VOG, Petesse ML, Ferreira CM; **Software:** Guimarães VOG, Ferreira CM; **Data curation:** Guimarães VOG, Ferreira CM; **Formal analysis:** Guimarães VOG, Ferreira CM; **Supervision:** Guimarães VOG, Campanha PMGC, Petesse ML, Ferreira CM; **Writing – original draft:** Guimarães VOG, Campanha PMGC, Petesse ML, Ferreira CM; **Writing – review & editing:** Guimarães VOG, Ferreira CM; **Final approval:** Guimarães VOG.

FUNDING

Conselho Nacional de Desenvolvimento Científico e Tecnológico

Grant No.: 440026/2023-7

ACKNOWLEDGMENTS

Not applicable.

REFERENCES

Amaral, C. 2022. Boletim informativo: alterações nos peixes após o rompimento da barragem da Vale. Instituto Guaicuy. Available at: https://guaicuy.org.br/boletim-informativo-alteracoes-peixes/. Accessed on: May 30, 2023.

Azevedo-Santos, V.M.; Arcifa, M.S.; Brito, M.F.G.; Agostinho, A.A.; Hughes, R.M.; Vitule, J.R.S.; Simberloff, D.; Olden, J.D.; Pelicice, F.M. 2021. Negative impacts of mining on Neotropical fresh water fishes. *Neotropical Ichthyology*, 19(3): 1-25. https://doi.org/10.1590/1982-0224-2021-0001

Blanco, G.D.; Llamazares, A.F.; Baker, J.; Tagliari, S.N.; Hayata, M.A.; Campos, M.L.; Hanazaki, N. 2023. The impacts of mining on the food sovereignty and security of Indigenous Peoples and local communities: A global review. *Science of the Total Environment*, 855: 158803. https://doi.org/10.1016/j.scitotenv.2022.158803

Brandão, A.P.D.; Sussai, S.; Germine, J.A.L.; Eltz, D.D.; Araújo, A. 2021. Social Sciences in One Health: Insights From Multiple Worlds Perspectives on the Dam Rupture in Brumadinho - Brazil. *Frontiers in Public Health*, 9: 649355. https://doi.org/10.3389/fpubh.2021.649355

Cordeiro, A.M.; Oliveira, G.M.; Renteria, J.M.; Guimarães, C.A. 2007. Revisão sistemática: uma revisão narrativa. *Scientific Electronic Library*, 34(6): 428-431. https://doi.org/10.1590/S0100-69912007000600012

Costa, D.S.C.; Barbosa, K.F.M.; Bastos, M.A.; Oliveira, S.F. 2020. Responsabilidades Decorrentes de Desastres Ambientais em Minas Gerais. Caso do Rompimento de Barragens da VALE S/A. *Revista do Curso de Direito do UNIFOR*, 11(2): 242-263. https://doi.org/10.24862/rcdu.v11i2.1147

da Silva, F.L.; Cunha-Santino, M.B.; Fushita, A.T.; Mininel, V.A.; Bianchini Jr., I. 2022. Relations between health and the environment: potential impacts resulting from the disruption of tailings dams – a literature review in the cases of Mariana and Brumadinho, MG. *Desenvolvimento e Meio Ambiente*, 59: 94-109. https://doi.org/10.5380/dma.v59i0.74469

Ercole, F.F.; Melo, L.S.; Alcoforado, C.L.G.C. 2014. Revisão integrativa versus revisão sistemática. *Revista Mineira de Enfermagem*, 18(1): 9-11. Available at; https://periodicos.ufmg.br/index.php/reme/article/view/50174. Accessed on : May 30, 2023.

Fabrício, S.A.; Ferreira, D.D.M.; Borba, J.A. 2021. A panorama of Mariana and Brumadinho disasters: what do we know so far?. *Revista Eletrônica de Administração*, 27(1): 128-152. https://doi.org/10.1590/1413-2311.310.102806

França, L.E. 2019. *Barragens de rejeito não-seguras da bacia do Paraopeba, Minas Gerais: risco para recursos hídricos e ictiofauna* (Master's dissertation, Universidade Federal de Minas Gerais, Belo Horizonte). Available at: https://hdl.handle.net/1843/33812. Accessed on: Aug. 23, 2023.

Freitas, C.M.; Barcellos, C.; Asmus, C.I.R.F.; da Silva, M.A.; Xavier, D.R. 2019. Da Samarco em Mariana à VALE em Brumadinho: desastres em barragens de mineração e Saúde Coletiva. *Cadernos de Saúde Pública*, 35(5): 1-7. https://doi.org/10.1590/0102-311X00052519

Galvão, T.F.; Pansani, T.S.; Harrad, D. 2015. Principais itens para relatar Revisões Sistemáticas e Meta-análise: a recomendação PRISMA. *Scientific Electronic Library Online*, 24(2): 335-342. Available at: https://www.scielo.br/j/ress/a/TL99XM6YPx3Z4rxn5WmCNCF/?lang=pt. Accessed on: May 30, 2023.

Gonçalves, R.J. de A.F. 2020. Vale de lama, rio de histórias: uma expedição geográfica no contexto do desastre da mineração na Bacia do rio Paraopeba, Minas Gerais. *Revista Campo-Território*, 14(34): 338-352. Available at: https://seer.ufu.br/index.php/campoterritorio/article/view/48851. Accessed on: May 30, 2023.

Governo do Estado de Minas Gerais. 2021. Comitê Pró-Brumadinho. *Entenda o Acordo Judicial*. Governo do Estado de Minas Gerais. Available at: https://www.mg.gov.br/pro-brumadinho/pagina/entenda-o-acordo-judicial. Accessed on: May 30, 2023.

Instituto Brasileiro de Geografia e Estatística (IBGE). 2019. *Produção Pecuária Municipal 2019*. IBGE. Available at: https://biblioteca.ibge.gov.br/visualizacao/periodicos/84/ppm_2019_v47_br_informativo.pdf. Accessed on: July 11, 2023.

Instituto Brasileiro de Geografia e Estatística (IBGE). 2022. SIDRA. Pesquisa da Pecuária Municipal. IBGE. Available at: https://sidra.ibge.gov.br/tabela/3940#notas-tabela. Accessed on: June 26, 2023.

Lopes, M.S.; Freitas, P.P. de; Nascimento-Souza, M.A.; Peixoto, S.V.; Lopes, A.C.S. 2022. Brumadinho Health Project: food and nutrition insecurity versus socioeconomic status es and dimensions of the food system after the dam rupture. *Revista Brasileira de Epidemiologia*, 25(12): 1-8. https://doi.org/10.1590/1980-549720220007

Manouselis, N.; Najjar, J.; Kastrantas, K.; Salokhe, G.; Stracke, C.M.; Duval, E. 2010. Metadata interoperability in agricultural learning repositories: *Analysis. Computers and Electronics in Agriculture*, 70(2): 302-320. https://doi.org/10.1016/j.compag.2009.07.007

Melo, T.L.; Medeiros, R.P.; Teixeira, R.C. 2022. Quando o rio não Vale mais: o dilema de comunidades às margens do rio Paraopeba após o desastre em Brumadinho. *Novos Cadernos NAEA*, 25(1): 37-58. https://doi.org/10.18542/ncn.v25i1.8796

Moher, D.; Liberati, A.; Tetzlaff, J.; Altman, D.G. 2009. Itens de relatório preferidos para revisões sistemáticas e meta-análise: a declaração PRISMA. *British Medical Journal*, 339: b2535. https://doi.org/10.1136/bmj.b2535

Page, M.J.; Moher, D.; Bossuyt, P.M.; Boutron, I; Hoffmann, T.C.; Mulrow, C.D.; Shamseer, L.; Tetzlaff, J.M.; Akl, E.A.; Brennan, S.E.; Chou, R.; Glanville, J.; Grimshaw, J.M.; Hróbjartsson, A.; Lalu, M.M.; Li, T.; Loder, E.W.; Mayo-Wilson, E.; McDonald, S.; McGuinness, L.A.; Stewart, L.A.; Thomas, J.; Tricco, A.C.; Welch, V.A.; Whiting, P.; McKenzie, J.E. 2021. PRISMA 2020 explanation and elaboration: updated guidance and exemplars for reporting systematic reviews. *BMJ*, 372: n160. https://doi.org/10.1136/bmj.n160

Parente, C.E.T.; Lino, A.S.; Carvalho, G.O.; Pizzochero, A.C.; Azevedo-Silva, C.E.; Freitas, M.O.; Teixeira, C.; Moura, R.L.; Ferreira Filho, V.J.; Malm, O. 2021. First year after the Brumadinho tailings' dam collapse: Spatial and seasonal variation of trace elements in sediments, fishes and macrophytes from the Paraopeba River, Brazil. *Environmental Research*, 193: 110526. https://doi.org/10.1016/j.envres.2020.110526

Passos, R.A. 2020. *Entre tragédias: percepção e experiências de ribeirinhos atingidos por rompimento de barragens no Brasil - 2016/2020* (Doctorate thesis in Global Health and Sustentability, Faculdade de Saúde Pública, Universidade de São Paulo, São Paulo). Available at: https://teses.usp.br/teses/disponiveis/6/6140/tde-21012021-123525/publico/PassosRA_DR_O.pdf. Accessed on: Aug. 22, 2023.

Peixoto, S.V.; Asmus, C.I.R.F. 2020. O desastre de Brumadinho e os possíveis efeitos na saúde. *Ciência e Cultura*, 72(2): 43-46. https://doi.org/10.21800/2317-66602020000200012

Pereira, D.M.; Guimarães, H.O.R.; Freitas, S.M.C. de; Mangia, A.A.M. 2021. Brumadinho: muito mais que um desastre tecnológico. *Revista da Universidade Federal de Minas Gerais*, 27(2): 332-355. https://doi.org/10.35699/2316-770X.2020.21649