Brumadinho disaster: contributions to public policies and sanitation management in emergency periods

Desastre de Brumadinho: contribuições para políticas públicas e gestão do saneamento em períodos emergenciais

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ABSTRACT This article aimed to analyze the vulnerability of post-disaster sanitation, adopting as a case study the experience of Brumadinho, in the state of Minas Gerais, in January 2019. It was developed from qualitative, descriptive and exploratory research, carried out through documentary analysis and a case study, through the collection of data published on institutional websites. The analysis of the components took place after the critical reading, based on aspects relevant to the approach of the article. After assessing the material collected it was concluded that the lack of urban planning as well as the precarious investment in actions involving basic sanitation and the lack of inspection at the Córrego do Feijão dam were determining factors in the outcome of the disaster. The mining company Vale S.A. did not have an emergency plan, which could assist in the reduction of damages and in making post-disaster decisions. Sanitation measures are essential to prevent the spread of diseases and thus minimize impacts on the affected population. Disasters from mining areas underline the importance of stricter environmental policies that promote healthy and safe environments.

KEYWORDS Disasters. Sanitation. Public policy. City planning.

RESUMO *Este artigo objetivou analisar a vulnerabilidade do saneamento pós-desastre, adotando como estudo de caso a experiência de Brumadinho, no estado de Minas Gerais, em janeiro de 2019. Desenvolveu-se a partir da pesquisa qualitativa, de natureza descritiva e exploratória, realizada por meio de análise documental e de um estudo de caso, mediante coleta de dados publicados em sítios eletrônicos institucionais. A análise dos componentes se deu depois da leitura crítica, pautada em aspectos relevantes para a abordagem do artigo. Após a apreciação do material coletado, concluiu-se que a falta de planejamento urbano assim como a precariedade de investimentos nas ações que envolvem o saneamento básico e a ausência de fiscalização na barragem Córrego do Feijão foram fatores determinantes no desfecho do desastre. A mineradora Vale S.A. não dispôs de um plano emergencial, que poderia auxiliar na redução dos danos e na tomada de decisões pós-desastre. Medidas de saneamento são fundamentais para evitar a propagação de doenças e, assim, minimizar os impactos na população atingida. Os desastres provenientes das áreas de mineração acentuam a importância da adoção de políticas ambientais mais rígidas, que possibilitem a promoção de ambientes saudáveis e mais seguros.*

PALAVRAS-CHAVE *Desastres. Saneamento. Política pública. Planejamento de cidades.*

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Introduction

According to the United Nations World Report on Water Resources Development, the right to

> clean, safe and adequate drinking water is vital for the survival of all living organisms and for the functioning of ecosystems, communities and economies[1(84)].

However, more than two million people worldwide do not have access to safe drinking water and the number doubles when it comes to proper sanitation facilities and proper disposal of sewage, which further aggravates the unavailability of water resources[1].

According to the World Health Organization (WHO), access to sanitation impacts a nation's economy and health by providing a healthier environment and reducing investments in the area. This access generates better indicators of education, real estate and tourism valuation, disease reduction, less waste of resources and greater job creation[2].

The lack of adequate sanitation is one of the aggravating factors of natural disasters in Brazil, given that few cities have an efficient system to support heavy rainfall and/or other extreme natural events[3].

From 1999 to 2009, Brazil witnessed a solid economic growth cycle, in which GDP grew at an annual rate of 3.27%, while the employed population increased at an annual rate of 2.29%[4]. This process has also brought internal migratory movements and rapid and disorderly urban growth. This scenario associated with the deficiency of essential services—mainly basic and sanitation infrastructure—contributed to the increase of anthropogenic origin disasters, which shows the vulnerability and fragility in risk management[5,6].

This article aims to analyze the vulnerability of post-disaster sanitation and propose actions to be implemented in emergency situations, adopting as a case study the experience of Brumadinho, in the state of Minas Gerais, which occurred in January 2019.

Material and methods

The study is based on qualitative, descriptive and exploratory research, conducted through document analysis, and a case study, through the collection of data from materials published on institutional websites such as the United Nations (UN), the Pan American Health Organization (Paho), Brazilian Ministry of Health (MoH), Brazilian Institute of Geography and Statistics (IBGE), Instituto Trata Brasil (ITB), National Health Surveillance Agency (ANVISA), National Information System on Sanitation (SNIS), Brazilian Ministry of Justice (MoJ), National Sanitation Policy (PNS – Política Nacional de Saneamento Básico) and the legal framework on sanitation. The set of laws, decrees and resolutions was considered as an integral part of the study.

The bibliographic research was based on the search for authors who wrote about the topic of interest, in order to support the discussion of the theoretical framework.

For the case study, we used data extracted from Brumadinho City Hall, the Municipality Register (2015) and the public hearing of the state of Minas Gerais, referring to the sewage treatment of Brumadinho (2018) and the Regulatory Agency for Water Supply and Sanitary Sewer Services of the state of Minas Gerais (Arsae – Agência Reguladora de Servicos de Abastecimento de Água e de Esgotamento Sanitario).

The analysis of all these components was grounded on critical reading, based on aspects relevant to the approach of the article, being alternatives in response to the proposed objective.

Results

Urbanization in Brazil, which began after the 1929 Great Depression and World War II, brings challenges to be overcome. The national industries sharply expanded with the policies promoted by Getúlio Vargas and Juscelino Kubitschek, after the shortages generated by the war. With the production expansion, as a result of the industrialization process, there was a disorderly population growth in the cities[7,8].

According to data from urbanized areas in Brazil, provided by IBGE, the Brazilian urbanization rate jumped from 31.24% in the 1940s to about 85% in 2018; encouraged mainly by the attraction that life in the city exercised over the rural environment—where the migrant populations sought quality of life, health, education and employment. This fact, driven by the mass media of that period, made the urban environment a paradise for those unaware of its dynamics[7-9].

As a direct consequence of the urbanization process, the lack of urban planning afflicted the cities in the country. Rapid growth has contributed to the emergence of subnormal clusters, places without infrastructure, unhealthy housing conditions, vulnerable to risks and disasters[4,8,9].

The consequences of the lack of urban planning are marked in space: excess of vertical buildings, for better use of urban land; narrow, winding streets causing mobility problems for pedestrians and vehicles; poorly spaced recreational areas, located only in upper-middle-class neighborhoods; intense slum process; housing deficit; constructions in landslide and flooding risk areas and lack of sanitation[5].

Urban legislation

In response to the problems of cities, on July 10, 2001, Federal Law No. 10,257, known as the City Statute, was enacted. This Law determines the responsibility of municipalities for their development and expansion[10].

Chapter 1, Art. 2 addresses urban planning, aiming to organize the spatial distribution of population and economic activities to correct distortions in the urban growth process and control the negative effects on the environment.

Also noteworthy is Art. 4, Chap. 2, Section I, on the goals of urban planning, the parceling of land use and occupation; environmental zoning; multiannual plan; budget guidelines and annual budget; participatory budget management; sector plans, programs and projects; and economic and social development plans.

Art. 41, Ch. 3 of this Law shows the master plan as an instrument of urban planning, making it mandatory for cities with more than 20,000 inhabitants and which are integrated in metropolitan regions and urban agglomerations.

In 2012, Federal Law No. 12.608, which discusses the National Policy of Protection and Civil Defense, in its art. 42-A, incorporates the promotion of diversity of uses and the generation of employment and income in urban planning[11].

The challenge of urbanization in Brazil is largely associated with the need for territorial reorganization, so that the laws cited are put into practice to promote a fair and equal territory for the entire population, without discrimination of social class, income and skin color. Integration actions between the political, economic and social sectors can bring satisfactory results if interventions are planned, well executed and more perennial.

Sanitation

Most Brazilians do not have access to basic sanitation services such as water supply, sewage system and solid waste collection. The lack of these services brings health risks and cooperate with environmental degradation. The transmission of diseases such as cholera, dysentery, hepatitis A, dengue,

malaria, zika, chikungunya and typhoid is linked to problems related to poor sanitation and contaminated water[12].

In the country, investment in sanitation is short. According to the National Plan for Basic Sanitation (Plansab – Plano Nacional de Saneamento Básico), approximately 40% of the Brazilian population has no water supply; 60% do not have sanitary sewer; and 40% lack proper management of municipal solid waste. Limitations in service management are responsible for it[13]. The most common problems are the poor capacity of planning adequacy and the execution of the works; the precarious inspection system regarding the use of public resources; the inability to promote sustainable interventions; the difficulty of long-term planning; inappropriate tariffs; lack of services regulation and difficulty in integrating proposals from government spheres[14].

All of these limitations result in ineffective and unavailable service. It also alludes to high spending, whether due to mismanagement of public resources or even inefficiency in their application[14].

Plansab projects the possibility of universal access to water and waste collection in urban regions by 2030. Water supply in rural areas could be increased by 2033, from 61% to 80%; sewage collection from 53% to 93% in urbanized areas and from 17% to 69% in rural areas; the volume of treated sewage from 53% to 93%; from 27% to 70% the collection of solid waste in rural areas and a reduction of losses in water supply systems, from 39% to 31%[13].

According to the Instituto Trata Brasil, the cost of universal access to sanitation services will be R$ 508 billion from 2014 to 2033, with 50% of Federal investments and 41% by other agents. Annually, the government should invest R$ 13.5 billion. Resources from non-federal agents would come from international loans and from state and local governments. Currently, the largest investments occurred in the states of São Paulo, Minas Gerais, Paraná, Rio de Janeiro and Bahia, totaling 63.3%. And the worst investments, about 1.7%, occurred in the states of Amazonas, Acre, Amapá, Alagoas and Rondônia[13,15].

The Plansab also suggests that there has been a readjustment in service fees, which have been frozen for years and do not correspond to the socioeconomic and demographic changes that have occurred in the country in recent decades.

In this sense, it is essential to rethink how sanitation services can operate in emergency situations.

Disasters

According to the Civil Defense command and operations system, disaster is the result of a phenomenon, whether natural (such as drought, hurricanes, extreme temperatures, forest fires), or caused by man or even by the combination of both, which is called an adverse event, a disaster-causing phenomenon. Thus, a particular episode such as heavy rain, chemical explosion, fires, dam disruption, or a prolonged period without rain may turn into disaster, depending on the consequences and vulnerability of the affected system[16]. They are also associated with the intensity of human, material or environmental losses due to the phenomenon and the economic and social losses. In emergency situations, health issues take on special characteristics. First, basic data on the affected area should be gathered after the impact of the adverse event, such as sanitation and health infrastructure and the affected population[17].

Disasters require immediate response actions by public bodies to minimize loss of life, as well as the definition of a location unaffected by the event to be used as a support area, where provisional shelter work will begin[17]. Adequate facilities and technologies for restoring sanitation, such as the management of solid waste, wastewater, and drinking water, should

be quantified. Establishing a suitable burial site, as well as vector control, also become important health measures, as it minimizes disease transmission[17].

An environment with sanitation is one of the fundamental needs in emergency situations to protect the health of the population. Thus, it is crucial for the immediate recovery of the affected population the reestablishment of the local sanitation system[15].

The occurrence of a disaster, such as the one that occurred on January 25, 2019, with the rupture of the ore tailings dam B1, at the Córrego do Feijão Mine complex, in the municipality of Brumadinho, Minas Gerais, owned by Miner Vale SA, reinforces the importance of adopting a structured policy that enables the preservation and maintenance of a safe and healthy environment, especially regarding the compromise of rivers and springs around the cities, as in the case of Brumadinho-MG[18,19].

Case study: the Brumadinho disaster

Brumadinho is a municipality located in the metallurgical area of the Belo Horizonte Metropolitan Region (BHMR), state of Minas Gerais. Its economic activity is mining and small agriculture. Its urbanization rate corresponds to 72.8% of its population, which is estimated at 39,520 inhabitants[20].

Its territorial extension is 639.4 km², being one of the largest cities of BHMR in terms of area. Its territory is divided into 5 districts: Brumadinho, Aranha, Conceição do Itaguá, Piedade do Paraopeba and São José do Paraopeba. It has a tropical climate and its biome is the Atlantic Forest[20].

The Brumadinho City Hall prepared in 2010 the Municipal Plan for Basic Sanitation (PMSB – Plano Municipal de Saneamento Básico) in order to plan the actions and define the priorities of the Municipality[19]. However, regarding basic sanitation, there is no total coverage in the municipality. According to data from the Municipal Secretariat of the Environment[13], about 95% of urban households had solid waste collection at that time. However, the percentage decreases when addressing the water supply and sewage sewer requirements, 76.4% and 65.2%, respectively, only in the urban area. The rural area has a rudimentary pit to collect its sewage and the water supply is made by insurgency capture, with shallow (up to 20 meters deep) and deep wells (more than 20 meters deep). In addition, there is no separation between the urban drainage network and the sewage system; which together with unplanned urban sprawl, population densification and riparian forest clearing, contribute to flooding.

The city has two wastewater treatment plants (WWTP): Mirante and Ecológica, located in the Retiro das Pedras condominium (north sector, sub-basin 1 and 2; south sector, sub-basin 3, respectively). Both are privately owned but have a 30-year service agreement with Copasa, since 1995. The method used is the septic tank followed by an anaerobic filter. The average flow, according to data from the Municipal Secretariat of the Environment[21], was between 3.09 and 3.96 l/s. The receiving bodies are the Mirante Stream and the Ribeirão Retiro das Pedras River, belonging to the Paraopeba River Basin.

A third WWTP was built in 2010, serving about 170 households (approximately 760 people) and biologically treats, from anaerobic digestion, domestic effluents and rainwater, which reach the same gallery. The treatment consists in the generation of a bacterial colony (primary treatment), where they are stabilized, pass through biological filtration and aeration. Afterwards, all bacteria originating from filtering are retained[21].

The last survey by Copasa, conducted in 2008, showed that 61% of the population had sewage collection system, and 87% in urban areas. In locations where there is no network, especially in rural areas, septic tanks have been adopted as a means of collecting and treating effluents[21].

Water supply in the urban region is provided by Copasa through the Brumadinho Water Treatment Plant (WTP). The catchment takes place in the lake originating from the Manso River Basin. Conventional type treatment was used in the WTP, covering about 3.8 m³ of water per second. The sludge production is about 50 m³/day. As mentioned, in the rural area, households are supplied from wells, and there are no restrictions on the use of municipal groundwater[21].

Solid waste is appropriately disposed of, as the city has the only BHMR landfill (which has a wastewater treatment plant), which was built with resources from the Growth Acceleration Program (PAC – Programa de Aceleração do Crescimento) and started its activities in 2012. About 710.1 t/day of organic waste is collected and since 1998, about 6.17 t/day of recyclable waste has been collected by selective collection[21].

In 2017, a public hearing was held with representatives of Copasa, the executive and legislative powers and the population of Brumadinho to clarify the agreement between Copasa and the Municipality to obtain information on the progress of the implementation of the system for wastewater treatment and the lack of water in several neighborhoods and localities of the city[22]. This contract signed in 2008, with a 30-year term, for the implementation of a complete sanitary sewer system: collection networks, interceptors, pumping stations and WWTP; encompassing the headquarters of Brumadinho and other areas. But only in 2015 the company signed the commitment term with the public prosecutor to provide the municipality with a sanitary sewer system suitable for the region. This agreement was canceled and, in 2018, another public hearing was held to discuss the environmental and social impacts that could occur in the implementation of the WWTP, since the deadline for the implementation and operation of the WWTP would be January 2019[22].

Although COPASA did not conclude the contract for sanitation of the Municipality, in 2019, the Dam 1 broke containing mining tailings from the Córrego do Feijão Mine, located in the Ferro-Carvão stream, in the Córrego do Feijão region[18,19].

The tailings dam, classified as 'low risk' and 'high potential for damage', was controlled by Vale S.A company. It is understood as dam: any structure in a permanent or temporary watercourse for the purpose of containment or accumulation of liquid substances or mixtures of liquids and solids.

The dam break released about 12 million cubic meters of tailings, forming giant waves that reached a speed of about 80 km/hour, advancing over the refectory and the administrative area of the Company, heading towards cars, houses, trees, animals and people. The mud contaminated the Paraopeba River, leaving the water unfit for consumption in at least 20 municipalities[19,23].

This has resulted in one of the largest mining tailings disasters in Brazil, classified as an industrial, humanitarian and environmental disaster, as well as the largest workplace accident in the country. To date, more than 228 people have been found dead and about 49 people are still missing, creating a situation of public calamity[24,25].

Discussion

In disaster situations, sanitation-related illnesses can lead to preventable diseases and deaths. To this end, sanitation management contingency actions must be preventive to avoid accidents that may compromise the quality of services provided and the safety of the workers involved. Such actions require strategic maintenance, planning, operational management, quality control, communication support and supply. A contingency plan addresses scheduled actions

with specialized labor, materials and equipment to recover sanitation services in the shortest possible time[12,26-28].

For a better response to services, post-disaster emergency stages are reported, divided into 3 periods *(chart 1)*. In the immediate phase (1 to 2 months), immediately after the disaster, the sanitation program is initial, because of the great instability in the provision of sanitation service due to the event and the high mortality rates. The objective of this phase is to find a safe place to receive sanitation infrastructure to prevent disease. In the short term, within 6 months, services are expected to stabilize. It seeks to reduce morbidity and mortality by taking preventive actions so that diseases do not spread. Finally, in the long term (which may last for years), it is expected that everything will be normalized, that the affected populations can already return to their homes or be moved to other appropriate places. The goal of sanitation in this period is to promote the health and well-being of the inhabitants, as well as their self-sufficiency[12].

Chart 1. Activities, emergency program stages and duration of disaster actions

Activity	Goal	Phase
Complete assessment checklist to set priorities.	Rapid assessment and priority setting	Immediate
Produce program outline incorporating logical study, estimating sanitation requirements, costs, staff and time.	Design a program	Immediate
Work with experts to produce detailed program and action plan.	Program detailing	Immediate
Select and implement immediate actions.	Immediate action	Short-term
Implement, monitor and evaluate sanitation program.	Implementation	Short/long term

Source: Adapted[12].

Water supply management in emergency situations

Not enough drinking water may be available to meet the basic needs of all those affected by the disaster. Therefore, the first aspect of sanitation to have emergency measures is the water supply system. In this case, the correct administration of the resource is important to ensure survival[28].

Before supplying water, it is necessary to assess the quality of raw water and possible sources of contamination; to carry out a treatment process that will provide enough for everyone; post-emergency treatment; need for disinfection of drinking water; water acceptance; need for places to collect and reserve water; epidemiological considerations; reliability at source; quantity and equitable access to water[12,26-28].

Regarding the quality of groundwater captured by underground wells, no evidence of change in quality is noticed, although it is recommended to intensify quality monitoring, making sure the population receive potable water.

Water monitoring can be done primarily in two ways: sampling and analysis (through kits for a small amount; or laboratory for a large amount, which can be assembled on site)[12].

In the analysis, the quality of the water is evaluated considering the pH, turbidity and residual chlorine parameters. In the sampling, a sanitary inspection is made, based on some indicators: proximity to sources of fecal contamination, color, smell, presence of dead fish or animals, debris, etc.; thus, water quality can be deduced[27].

Sanitary sewer management in emergency situations

After establishing the parameters for water collection and treatment, sanitary sewer must be a priority. Some points should be considered, such as: socio-political issues; area availability; soil conditions; material availability; cultural issues; financial issues; human resources; system operation and maintenance[12,28].

The area reserved for toilets must meet some criteria, such as: distance from water reservoirs and water treatment units to avoid contamination (minimum distance is 50 meters); they should be installed in locations below subdivisions and water sources; away from roads and public buildings; outside agricultural fields; far from water, food and places of food preparation[28].

When implementing an alternative method for the disposal of human excreta, some basic precautions should be taken beforehand, especially regarding availability. In the immediate term, 50% of the affected population is expected to have access, especially in medical centers and cafeterias. In the short term, 75%; in the long term, 95%, being 100% in medical centers and cafeterias[12,28].

For the sanitary sewer, some measures are a priority: 1) in post-disaster assembled settlements, sanitation facilities should be established immediately; 2) to design and build sanitary facility shelters after an assessment of the topography, location of groundwater reserves to avoid contamination; 3) to design the sanitary facilities aiming to avoid any contact with possible vectors; 4) to evaluate all technical options for the construction of toilets, with aimed at minimizing threats to users, especially women, children, people with mobility impairment and those in charge of maintenance; 5) to collect data on the affected population to build an adequate number of toilets that minimize risks to public health (*chart 2*); 6) to include a soapy water reservoir for hand cleaning, as well as intimate hygiene material; 7) if possible, to accommodate people with chronic diseases and older adults closer to the toilets[12,26,28].

Chart 2. Quality criteria, quantity and use of sewage disposal sites

Criterion	Immediate	Short Term	Long Term
Quality	Latrine with technically basic material; Socially acceptable; Basic health protection; Sustainable Technology up to 1 month.	Appropriate and sustainable technology such as Biodigester Septic Tank (BST) and Evapotranspiration Basin (ETB) up to 6 months; Socially acceptable; Minimal Health Risk.	Appropriate technology; Socially accepted; Without Risk to Health; Up to 3 Years.

Chart 2. (cont.)

Criterion	Immediate	Short Term	Long Term
Quantity	For medical centers: 1 latrine per 50 beds or 100 patients. For schools, 1 latrine for 50 girls and 1 for 100 boys. Cafeterias: 1 latrine for 100 adults and 1 latrine for 50 children.	For medical centers: 1 toilet for 20 beds or 50 patients. Schools: 1 toilet for 30 girls and 60 boys. Cafeterias: 1 toilet for 50 adults and 1 toilet for 20 children.	For medical centers: 1 toilet for 10 beds or 20 patients. Schools: 1 toilet for 15 girls and 30 boys. Cafeterias: 1 toilet for 20 adults and 1 for 10 children. Offices: 1 toilet to 20 employees.
Usage	50% of the affected population; 100% medical centers and cafeterias.	75% of the affected population; 100% medical centers and cafeterias.	95% of the affected population; 100% medical centers and cafeterias.

Source: Adapted[12].

Regarding sanitary sewer in the municipality of Brumadinho, it was not affected by the dam rupture, although the company responsible, Copasa, has not yet completed the sanitation work, as provided for in the contract.

Proper and efficient decision-making of emergency actions involving basic sanitation has great importance to public health. Mainly, the spread of sanitation-related diseases is to be avoided, which are transmitted via the fecal–oral route (diarrhea, bacillary dysentery, shigellosis and hepatitis), skin and eye diseases (scabies and other skin infections), soil (hookworm diseases), diseases spread by rodents (typhus, leptospirosis and bubonic plague), and also by water transmission, vectors that reproduce in poor sanitation environments (malaria, dengue, yellow fever, zika and chikungunya)[28].

Management of solid waste and tailings in emergency situations

Solid waste management, as well as water supply and sanitary sewer, are essential in a disaster situation[28].

According to the National Solid Waste Policy, Law No. 12.305, waste can be discarded materials, substances, objects or goods that result from community activities and are classified according to their origin and hazardousness[29]. For this discussion, we will consider only the waste from the Dam 1 disruption, since the solid waste from the Municipality of Brumadinho already has proper disposal, that is, the BHMR landfill. Solid waste from mining activity is divided into: sterile and tailings. Barren are excavated materials from mining activity in the mine stripping, and are usually arranged in piles. The tailings are the result of the beneficiation process to which the mineral substances are submitted. The disposal of tailings in reservoirs created by dikes or dams is the most commonly used method in the country. These dams or dikes may be made of natural soil or constructed from the tailings themselves and are classified in this case as tailings-containing retention dams, and in the other case as conventional dams[30].

For the waste from the dam rupture, there is no management plan for the tailings so far. They are still at the disaster site and Vale, according to the Arsae-MG report, has not notified any measures for

the final disposal of these wastes.

According to information from the State Secretariat for the Environment and Sustainable Development (Semad – Secretaria de Estado de Meio Ambiente e Desenvolvimento Sustentável), the Vale dam tailings have traveled for 125 km from the rupture site to the Paraopeba River. This river flows into the Três Marias Dam reservoir, 330 km from Brumadinho. Officials and public agencies expect these wastes to be contained by the Retiro Baixo Power Plant, located on the Paraopeba River (300 km from the catastrophe site), thus preventing pollution from reaching the Três Marias Lake and the São Francisco River. This mud from ore tailings has a high concentration of heavy metals, which can cause a series of harms to human health, as well as irreversible damage to the environment.

As previously reported, the planning of disaster risk reduction actions is critical to the success of life-saving activities and emergency operations, as it enables them to prepare in advance the actions required to minimize the impacts of disaster relief[17,31].

In emergency situations caused by a disaster, such as the one in Brumadinho, it is common for the water supply to be interrupted due to damage that may be caused to the distribution network. Therefore, the time needed to restore conditions prior to the event imply the need to carry out alternative ways of water supply and/or storage. The same is true for the sewage system[13,16].

In Situation Report No. 01, by Arsae-MG, an agency that acts in the regulation and supervision of water supply and sewage services in the municipalities, it was informed that the headquarters of Brumadinho has, so far, a system of water supply, which is collected in the Águas Claras stream. The information is that the water supply system was interrupted only for a few hours due to unavailability of electricity. As soon as electricity was restored, water distribution was normalized[19].

Final considerations

The lack of adequate urban planning proves to be an aggravating factor in disaster situations, as it leads to population occupation in more vulnerable areas, such as river banks, hillsides and areas near tailings dams.

Proper management of post-disaster environmental sanitation is essential for public health actions, as it can minimize the impacts that could aggravate the scenario in disaster situations.

Another important factor that should be considered is the lack of investments in basic sanitation, since every R$ 1.00 invested in sanitation saves R$ 9.00 in health[32]. With this investment it is possible to reduce the incidence of diseases and make the care of those most affected a priority, resulting in optimization of time, material and labor, as well as reducing hospitalizations and spending on public health.

In Brazil, there are 24,000 dams, according to the Dam Safety Report, of which only 13,997 (58%) are in good standing. Also, 204 dams have structural problems, 45 of which are located in the state of Minas Gerais. Emergency measures need to be carried out so these dams can go through specific technical inspection processes more often, in order to avoid other human-induced disasters, such as those at Brumadinho and Mariana. Those disasters caused deaths, as well as endangering neighboring populations, and caused environmental degradation in these areas. Reduction of vulnerability can be achieved through mitigation and preparedness measures[17,24].

In the country, many factors contribute to the increase of vulnerability and impacts of disasters due to lack of urban planning. When analyzing the vulnerability of a community, human factors must be considered, as they generally influence the severity of a disaster.

Thus, in order to reduce the risk of disasters, the relations between sanitation, public

health and the environment constitute an initial and important step in the development of a health planning model. In terms of plans, the identification and analysis of the effects of implementing a particular system—be it water supply, sewage and solid waste collection/treatment—should provide the means to establish priorities and point the most appropriate direction, since each beneficiary population has distinct characteristics and sanitation actions cannot always be oriented in the same way.

Considering the severity of the event at the Córrego do Feijão dam, it is currently impossible to measure the impacts caused to the springs of the affected municipalities. The municipal and state spheres should prepare, together with the company responsible for the BHMR water supply system, a quality monitoring study on the waters from the region's watershed.

Disasters from mining areas underline the importance of stricter, better structured and enforced environmental policies that promote healthy and safer environments.

Collaborators

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