

From Samarco in Mariana to Vale in Brumadinho: mining dam disasters and Public Health

Da Samarco em Mariana à Vale em Brumadinho:
desastres em barragens de mineração
e Saúde Coletiva

De la Samarco en Mariana a la Vale en Brumadinho:
desastres en presas mineras y Salud Pública

Carlos Machado de Freitas ¹

Christovam Barcellos ²

Carmen Ildes Rodrigues Fróes Asmus ³

Mariano Andrade da Silva ¹

Diego Ricardo Xavier ²

doi: 10.1590/0102-311X00052519

Introduction

Brumadinho, Minas Gerais State. Friday, January 25th, 2019. At 12h 28min 25s, the tailings dam (B1) of the Córrego do Feijão mine, owned by Vale S.A., ruptures. Immediately thereafter, the company's president, Fabio Schvartsman, declared "*the environmental damage will be much smaller than that of Mariana, but the human tragedy will likely be bigger*" ¹. On the first day, it was established that 13 million m³ of mining rejects had been released into the environment. After one month of searches, the number of deaths exceeds 300, with 179 located bodies and 131 missing persons. In this specific case, the term "missing" can also represent an attempt to downplay the magnitude of the event, since there is no hope of finding these individuals alive more than a month after the event.

Disasters, by nature an definition, are events that result "*...in a serious interruption of a community or society's normal functioning, affecting their everyday lives (...) simultaneously [involving] material and economic losses, as well as damaging the environment and the health of the population, through harms and diseases that can result in immediate or later deaths...*". Furthermore, some also exceed "*...the capacity of an affected community or society to deal with the situation using their own resources, potentially resulting in the amplification of losses and environmental and health damages beyond the limits of the locality where the event took place*" ² (p. 9).

From the Public Health perspective, the importance of understanding disasters is connected not only to the number of immediate deaths and health harms, but also to the identification of the emergence of new health problems and needs over time, which means they mobilize almost the entire Public Health structure. Additionally, since technological disasters involve contaminants, they demand urgent decisions, loaded with uncertainties, in order to end or reduce exposures and risk, as well as to address short, medium and long-term harms and diseases ³. This article seeks to discuss the complexity of this type of event for Public Health and the Brazilian Unified National Health System (SUS, in Portuguese), using the recent disasters as a reference.

¹ Escola Nacional de Saúde Pública Sergio Arouca, Fundação Oswaldo Cruz, Rio de Janeiro, Brasil.

² Instituto de Comunicação e Informação Científica e Tecnológica em Saúde, Fundação Oswaldo Cruz, Rio de Janeiro, Brasil.

³ Instituto de Estudos em Saúde Coletiva, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brasil.

Correspondence

C. M. Freitas
Centro de Estudos e Pesquisas em Emergências e Desastres em Saúde, Escola Nacional de Saúde Pública Sergio Arouca, Fundação Oswaldo Cruz, Av. Brasil 4036, sala 916, Rio de Janeiro, RJ 21040-361, Brasil.
caco.de.freitas@gmail.com



What lessons can we learn from the recent disasters?

Disasters such as the ones caused in 2015 by Samarco in Mariana and in 2019 by Vale in Brumadinho represent an important qualitative change. On the one hand, they update past risk scenarios, including both intensive, safety-related risks in the operation of mining activities and their dams, with all the licensing, monitoring and auditing procedures that failed sequentially; and those related to existing health situations and environmental risks. On the other, from the moment they take place, they produce new environmental risk scenarios which extend over space, moving from the local to the regional, as well as over time, producing a multiplicity and overlap of exposure situations, health risks and effects, ranging from the immediate to the long-term ⁴.

Thus, the impacts of these disasters cannot be reduced to the municipalities where they took place, nor can those affected by them be reduced to the immediate number of deaths (even if this number is high, as is the case in Brumadinho, where it exceeds 300) and injured (even if it is low, such as the 6 recorded in each disaster), or even that of those left homeless (504 in the first and 138 in the second). Their impacts go beyond and include the environmental contamination and alterations they produced in the affected areas (impacts on biodiversity and alterations in the disease vector, host and reservoir cycles) and rivers, as well as the abrupt change of the social organization and the historically-constructed ways of living and working in the territories, with effects over health. Beyond the number of those “affected” in the traditional civil defense definition (displaced, homeless, dead, injured and sick) recorded during the rescue period, we should consider all those whose living and working conditions were affected in the different territories.

In the specific case of Brumadinho, using data from the 2010 *Demographic Census*, the tailings slurry reached 9 census tracts with an estimated population of 3,485 individuals and 1,090 households, which represents more than 10% of the population affected either directly or indirectly. Using data from the 2017 *Agricultural Census* and considering a radius of 500 and 1,000 meters across the 18 municipalities in which the slurry reached the Paraopeba river, covering approximately 250km, it is estimated that there are respectively 147 and 424 affected communities (indigenous, quilombola and artisanal foresters and fishers) ⁵. Beyond the 138 individuals officially designated as homeless, there are many populations who, in their living and working territories, experienced multiple ruptures and losses, whether symbolic, cultural, economic, in terms of infrastructure, family structure (as the hundreds of children who instantly became orphans), friends, neighborhoods and reference places. And the number of those exposed can be even greater if we consider populations who benefit from ecosystem services (rivers, soils and woods) for their different ways of life, soil use and occupation, such as, for example, water consumption and agricultural production at risk from contamination along the Paraopeba river.

In these kinds of disasters, for the populations exposed to the new risk scenarios, there are two groups that must be more clearly identified. The first is related to the (material and affective) losses, ruptures and/or interruptions to the ways of living and working, with effects over living and health conditions. Their effects on mental health can be immediate and become more extensive and prolonged as uncertainties and insecurities regarding the future are combined with the absence of solutions for their problems and needs from the public agencies and companies that produce the disasters (more than three years after the Samarco disaster, the inhabitants of the Bento Rodrigues, Gesteira and Paracatu de Baixo districts of Mariana continue to live in rented homes without the community life they previously enjoyed), accentuating emotional and psychic suffering. The second is related to exposure to contaminants found in the tailings slurry or re-mobilized by the disaster, which are present in the soil (including suspended particulates from the dry slurry), rivers and sediments. Their health risks and harms tend to appear in the medium and long term, particularly affecting more vulnerable population groups, such as pregnant women, children and the elderly, potentially resulting in negative health outcomes that are not necessarily acute, and with possible delayed clinical repercussions.

The Samarco disaster in Mariana affected 36 municipalities with its tailings slurry, in a 663km extension until the mouth of the Doce river. Investigations carried out in Barra Longa, a neighboring municipality, revealed a multiplicity of health effects, combining the worsening and broadening of preexisting diseases with the emergence of new ones, in a scenario of overlapping risk, disease and

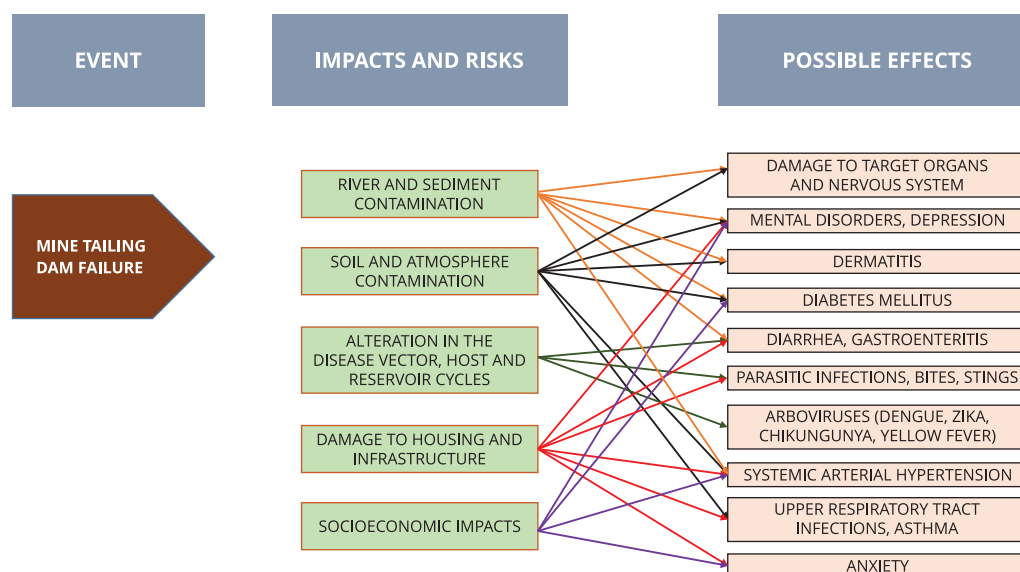
harm^{6,7}. Based on this disaster, Figure 1 attempts to systematize the set of environmental impacts and risks, as well the overlapping health effects.

In Mariana (the Brazilian Institute of Geography and Statistics – IBGE – estimate was of 58,802 inhabitants in 2015 and 60,142 in 2018, indicating almost a 2.5% increase in the municipality's population in 3 years), the disaster affected the previously-mentioned districts, whose houses were destroyed and whose inhabitants were exposed to the slurry and were then displaced to the urban municipal center. Despite the impact, the disaster did not overburden the health response capacity of the municipality, which receives mining royalties and where 95% of economic activities depend directly or indirectly on mining, its main productive activity⁸. In Barra Longa (the IBGE estimate was of 5,710 inhabitants in 2015 and 5,250 in 2018, indicating an 8% reduction in the municipality's population in 3 years), a municipality almost 10 times smaller than Mariana that receives no financial compensation from mining activities and whose local health system was in a vulnerable condition, the disaster affected nearly all urban inhabitants and sharply impacted their living and health conditions. It resulted in an increase in various health problems, such as parasitic infections, diarrhea and gastroenteritis; dermatitis and upper respiratory tract infection due to contact with the slurry dust, especially among children; anxiety, systemic arterial hypertension and diabetes mellitus; re-emergence of previously-controlled diseases, such as dengue⁶.

The lessons learned from the Samarco disaster regarding how companies act (with the main concern being reducing or eliminating, as much as possible, any civil or criminal liabilities while also guaranteeing the value of their stocks in the global markets), the environmental impact, risks, damages, diseases and health sector responses contributed to a set of immediate and integrated SUS responses in the Vale disaster, which has led, so far, to a reduction in disease risks and an increase of surveillance and health care actions. Additionally, the fact that Brumadinho has a well-organized local health system enabled the implementation of an integrated set of prevention actions (educational and communication campaigns regarding contact with the slurry, water and fish consumption, as well vaccination of military personnel and communities directly exposed to the risks of diphtheria, tetanus, hepatitis A and B, measles, mumps, rubella, yellow fever), health surveillance (with the main focus on chemical contamination and mental health, articulating epidemiological and health surveil-

Figure 1

Potential effects related to the impacts and risks caused by the disaster.



lance with primary, Emergency Care Units – UPA, and hospital care) and health care (UPA, hospital care, laboratories, Centers for Psychosocial Care – CAPs, Center of Integrative and Complementary Practices in Health – NUPIC, primary health units – UBS, Family Health Strategy – FHS, and Centers for the Support of Family Health – NASF). This set of actions received support both from the Ministry of Health (emergency health care support, health care through the national SUS and health surveillance) and the Minas Gerais State Health Secretariat, which also enabled articulating actions for immediately collecting and identifying contaminants present in the slurry soon after the disaster (this step is crucial to future surveillance and care actions); identifying hundreds of firefighters who came into contact with the slurry during search and rescue operations in order to monitor their health state; guaranteeing in the courts that the company that caused this disaster pay the costs of temporarily hiring 142 (health and social service) professionals by the Brumadinho municipality, as well as the costs of laboratory analyses of samples of water for human consumption along the Paraopeba river, involving articulations with water quality surveillance in the 18 municipalities traversed by this river.

Challenges to Public Health and SUS

In addition to the good experience by the Brumadinho municipality and SUS in terms of the post-disaster actions and the medium and long-term contaminant and mental health risks to those who were affected, disasters like this one create a series of challenges both for the municipalities and for Public Health and SUS.

Mariana and Brumadinho are municipalities that depend on mining for their revenues, 80% and 60%, respectively. The disaster does not only involve the tailings slurry that reached them, but also the loss of revenues, which is reflected on their capacity to provide essential services, such as health, education, sanitation, among others. Furthermore, there is an interruption in the economic chain formed by small and middle-sized companies that gravitate around providing services to mining companies, leading to a systemic decline of the local/regional economy. These two processes affect populations and territories more widely and systemically, generating impacts on living conditions and health situations (tensions, depressions, insecurity, broadening and worsening of chronic diseases, such as those reported in Barra Longa), with an increase in health problems and needs, demanding more financial investments for service expansion precisely when revenues tend to decrease over time. Thus, after disasters, an ambiguous relationship is established, involving feelings of revulsion and betrayal and the desire to increase punishments and costs for companies, along with the economic dependence of individuals and municipalities that demand that productive activities not be interrupted. It was within this ambiguous context that those affected in the Mariana districts, who lost their homes and neighborhoods, started to experience discrimination in the city, with the victims being blamed for the harms caused by Samarco's temporary interruption of activities and its large impacts on the economy, jobs and income in the municipality ⁹.

If mining activities are one of the economic pillars of hundreds of municipalities in the country, we are faced with the challenge of a development project whose pillars are the reduction of municipalities' economic dependence, as well as environmental sustainability and social justice as the bases of a national project. Mining disasters, their socio-environmental impacts and health effect are not the exception, but are part of the externalized environmental and social costs (which are left to the territories and their inhabitants) of the sale of commodities for the lowest price in the global market and greater shareholder profits in the financial market. Now is the time to undo this pattern, pointing to a development model that promotes health instead of generating disease and death. And, in this process, the Sustainable Development Goals, which are part of the 2030 Agenda, such serve as a reference.

The challenges facing Public Health are also not small. Studies on the disasters and their effects over the course of the post-disaster months have shown a rise in hospital admissions ¹⁰ and excess mortality (up to 46 times higher than the initial official records) up to 6 months after the events ¹¹. For hospital admissions, cardiovascular diseases are especially significant, mainly affecting older and poorer individuals ^{12,13}. Considering that mining dam disasters are complex and dynamic, in their multiple and overlapping social, economic, environmental, cultural and health processes, whose spatial and time borders are diffuse, depending on scenarios of environmental variability and alterations

(degradations), exposures, risks harms and diseases, we are faced with the challenge of producing knowledge and training professionals in a systemic, interdisciplinary and intersectoral perspective. Considering the context of climate change and rise and combination of natural and technological disasters, we must invest in research and in training professionals who work on disasters in a systemic perspective.

Another challenge is that of disaster risk reduction policies and management that also include Public Health. In March 2015, Brazil formally adopted the Sendai Framework for Disaster Risk Reduction 2015-2030. The Sendai Framework is a kind of Agenda 21 for this subject and introduces two themes that are relevant to our discussion. The importance of addressing natural disasters, technological disasters and public health emergencies in an articulated fashion, since they are increasingly interconnected and demand an intersectoral articulation for prevention, effect mitigation during and rehabilitation/recovery/reconstruction after events. Using this framework as a reference, we point out some processes that are relevant to Public Health.

The first is the intersectoral work with the goal of reformulating fragmented and sectoral models of understanding risk governance. In addition to transparency, it demands strengthening government agencies (with the necessary human, technical and financial resources), the articulation and integration of the involved sectors (environment, water resources, mining, labor, health, social service, civil protection and defense) and broadening social participation through representatives of exposed and affected communities, NGOs connected to the subject (such as the Movement of Persons Affected by Dams) and academic institutions.

In Brazil, there are 769 mining dams, and the two which led to the worst disasters in the country's history and among the largest in the world were classified as low risk. The participation of Occupational Health in the municipalities and states for mining inspections and audits should be integrated into licensing and auditing agencies (environment, water resources and mining).

In the disasters caused by Vale and Samarco, it became clear that emergency plans existed only on paper and that warning and alarm systems were nonexistent and ineffective. Beyond the sectors involved in licensing and auditing, the proactive participation of the health, occupational and civil protection and defense sectors, as well as workers, communities and NGOs, would certainly have kept the Vale company restaurant, with a capacity of around 200 people, from being built in a location (around 1km and 1 minute from the slurry's arrival) that made it impossible to save lives. Additionally, plans specify risk scenarios, and it is absolutely necessary that the health sector, in the municipalities where the 769 mining dams are located, be aware of whether health units are on the slurry's path, which represents both a threat to health professionals and a compromise of the health sector's capacity to respond to the population's needs in the disaster's aftermath.

Plans, warnings and alarms must not be treated simply as bureaucratic licensing instruments, but must rather involve an effective and transparent intersectoral planning process, with social participation, strengthening municipalities' preparation and response capacities through transparency and regular drills. This change would avoid the recent situations that followed the Vale disaster, such as those experienced in the municipalities of Ouro Preto, Nova Lima and Barão de Cocais, among others, where, suddenly, alarms blared and families were removed from their homes, with their territories no longer being considered safe, without taking into consideration that the uncertainties and insecurities triggered by this would have reflexes on these communities' health situations.

Lastly, Public Health and SUS as a whole must work upon the health effects caused by disasters and the health rehabilitation and recovery processes, as well as disease prevention, integrated with reconstruction efforts. Slurry removal and reconstruction activities in Barra Longa broadened the effects on the population's health, including an expressive increase in respiratory diseases caused by the slurry dust. The long delay in reconstructing houses in the rural districts of Bento Rodrigues, Gesteira and Paracatu de Baixo not only prolongs the suffering and stigma experienced by these communities, who were displaced to urban areas in Mariana and who lost their neighborhoods and territories, but also produces a second disaster. We should not only adopt the Sendai Framework's principle of a better and safer reconstruction of affected communities, but Public Health and SUS should actively participate in these processes, because, depending on the way they are carried out or even delayed by the companies that caused the disasters, they may reduce or increase health risks in the medium and long-term.

Contributors

C. M. Freitas, C. Barcellos, C. I. R. F. Asmus, M. A. Silva, and D. R. Xavier Participated in conceiving and drafting the article.

Additional informations

ORCID: Carlos Machado de Freitas (0000-0001-6626-9908); Christovam Barcellos (0000-0002-1161-2753); Carmen Ildes Rodrigues Frões Asmus (0000-0002-9864-6656); Mariano Andrade da Silva (0000-0002-6021-4794); Diego Ricardo Xavier (0000-0001-5259-7732).

1. Barragem se rompe e casas são atingidas em Brumadinho, Grande BH. Folha de S.Paulo 2019; 25 jan. <https://www1.folha.uol.com.br/cotidiano/2019/01/barragem-se-rompe-e-casas-sao-atingidas-em-brumadinho-grande-bh.shtml>.
2. Organização Pan-Americana da Saúde; Ministério da Saúde. Desastres naturais e saúde no Brasil. Brasília: Organização Pan-Americana da Saúde/Ministério da Saúde; 2014.
3. Lucchini RG, Hashim D, Acquilla S, Basanets A, Bertazzi PA, Bushmanov A, et al. A comparative assessment of major international disasters: the need for exposure assessment, systematic emergency preparedness, and lifetime health care. *BMC Public Health* 2017; 17:46.
4. Freitas CM, Silva MA, Menezes FC. O desastre na barragem de mineração da Samarco: fratura exposta dos limites do Brasil na redução de risco de desastres. *Ciênc Cult (São Paulo)* 2016; 68:25-30.
5. Romão A, Barcellos C, Xavier DR, Saldanha R, Gracie, R, Pascoal V. Nota técnica: avaliação dos impactos do desastre de Brumadinho sobre a saúde. Rio de Janeiro: Observatório de Clima e Saúde; 2019.
6. Secretaria de Vigilância em Saúde, Ministério da Saúde. Estudo sobre o perfil epidemiológico da população de Barra Longa – MG, pós-desastre, 2016. Relatório final. Brasília: Ministério da Saúde; 2017.
7. Instituto Saúde e Sustentabilidade. Avaliação dos riscos em saúde da população afetada pelo desastre de Mariana. São Paulo: Instituto Saúde e Sustentabilidade; 2018.
8. Secretaria de Estado de Desenvolvimento Regional, Política Urbana e Gestão Metropolitana. Relatório: avaliação dos efeitos e desdobramentos do rompimento da Barragem de Fundão em Mariana – MG. Belo Horizonte: Secretaria de Estado de Desenvolvimento Regional, Política Urbana e Gestão Metropolitana; 2016.
9. Neves MGL, Roque M, Freitas AA, Garcia F, organizadores. PRISMMA. Pesquisa sobre a saúde mental das famílias atingidas pelo rompimento da barragem de Fundão em Mariana. Belo Horizonte: Corpus; 2018.
10. Xavier DR, Barcellos C, Freitas CM. Eventos climáticos extremos e consequências sobre a saúde: o desastre de 2008 em Santa Catarina segundo diferentes fontes de informação. *Ambiente & Sociedade* 2014; 17:273-94.
11. Milken Institute School of Public Health. Ascertainment of the estimated excess mortality from Hurricane María in Puerto Rico. Washington DC: George Washington University; 2018.
12. Morita T, Nomura S, Tsubokura M, Leppold C, Gilmour S, Ochi S, et al. Excess mortality due to indirect health effects of the 2011 triple disaster in Fukushima, Japan: a retrospective observational study. *J Epidemiol Community Health* 2017; 71:974-80.
13. Becquart NA, Naumova EN, Singh G, Chui KKH. Cardiovascular disease hospitalizations in Louisiana parishes' elderly before, during and after Hurricane Katrina. *Int J Environ Res Public Health* 2018; 16:E74.

Submitted on 18/Mar/2019

Approved on 19/Mar/2019