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Changes in dietary and water use habits after the Doce River contamination with mining tailings

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Abstract

The Fundão dam burst polluted watercourses with mining tailings and harmed cities bathed by Doce River, that might have changed eating habits. This study evaluated changes in dietary habits and water use in Araújos Island, Governador Valadares, Minas Gerais, southeastern Brazil, after contamination of the Doce River with mining tailings. Data were collected in residences through interviews using semi-structured questionnaires. Seventeen months after disaster, 73% of habitants changed water use habits, mainly for cooking (53%). Public supply water (PSW) was partially replaced for other sources, mainly mineral water. Additionally, 54% changed their dietary habits by reduction or interruption of the consumption of freshwater fish (50%), fruit (28%), vegetables (27%) and food made outside the home (40%). Most of them (96%) perceived an addition risk to food production after disaster. Financial (69%) and psychological (55%) damages as well as health risk (39%) were the negative effects most frequently mentioned. Only 13% positively evaluated the quality of PSW while 77% believe PWS may cause some type of damage in foods. Part (59%) did not believe in information regarding potability of PSW. These changes would be associated with healthier lifestyle habits, health risk perception about water quality and safety and lack of confidence about water potability.

Keywords: eating behavior; environmental disaster; Fundão tailings dam; perception; public water supply.

Practical Application: Study provides insights for elaboration of strategies and guidelines for minimizing negative health impacts on population lives due to Fundão dam collapse.

1 Introduction

The worst environmental disaster in Brazil's history was caused by the collapse of the Fundão tailings dam, located in Bento Rodrigues, a sub-district of Santa Rita Durão, in the city of Mariana, Minas Gerais state, Brazil, on November 5th of 2015 (Figure 1). As a result, over 40 million cubic meters of iron ore mining tailings polluted 668 kilometers of watercourses from the Doce River to the Atlantic Ocean, affecting at least 39 cities from Minas Gerais and Espírito Santo states (Carmo et al., 2017; Felippe et al., 2016).

Several cities bathed by Doce River was seriously harmed, including Governador Valadares, which is the hub city in eastern Minas Gerais, with 263,689 habitants in 2010 (Instituto Brasileiro de Geografia e Estatística, 2010). Once tailings mud reached the city, water supply was interrupted and the Araújos Island was one of the most affected neighborhoods in Governador Valadares because it is entirely bathed by the Doce River, which is the only available source of water supply in the region (Figure 2).

The enormous volume of pollutants from Fundão dam caused severe impacts on ecosystems, involving Brazilian Atlantic Forest, marine, coastal and estuarine environments and areas for the conservation of the Brazilian biodiversity as the Parque Estadual do Rio Doce (Doce River State Park), located near Governador Valadares, Minas Gerais. The Doce River forms the easter boundary of the Doce River State Park (Figure 1), that protects a large remnant of Atlantic Forest. Furthermore, the disaster has caused social, economic and health impacts as well as hams in physical and cultural integrity of the many communities (Carmo et al., 2017; Felippe et al., 2016; Milanez et al., 2015; Vormittag et al., 2018; Wanderley et al., 2016a, b).

As a result of Doce River contamination, severe environmental damages to aquatic ecosystems, soil, fauna and flora have occurred (Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis, 2015). Furthermore, several governmental and non-governmental organizations released that Doce River was contaminated with high levels of toxic metals, varying from low to high toxicity (aluminum, barium, manganese, selenium, chromium, zinc, arsenic, cadmium, lead and others)

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(Carvalho et al., 2017; Sylvio et al., 2018; Dias et al., 2018; Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis, 2015; Milanez et al., 2015). The presence of these substances in Doce River might threats human health over time and affects especially children (Kravchenko et al., 2014; Kumar et al., 2020; Palma-Lara et al., 2020; Sall et al., 2020).

The negative perception of flood affected population regarding health risks associated with water and food contamination, after Fundão collapse, might stimulate changes in dietary and water use habits. For example, in Regência and Povoação, districts located in Linhares city, Espírito Santo state, Brazil, most of the habitants declared that they reduced or stopped to consume fish after

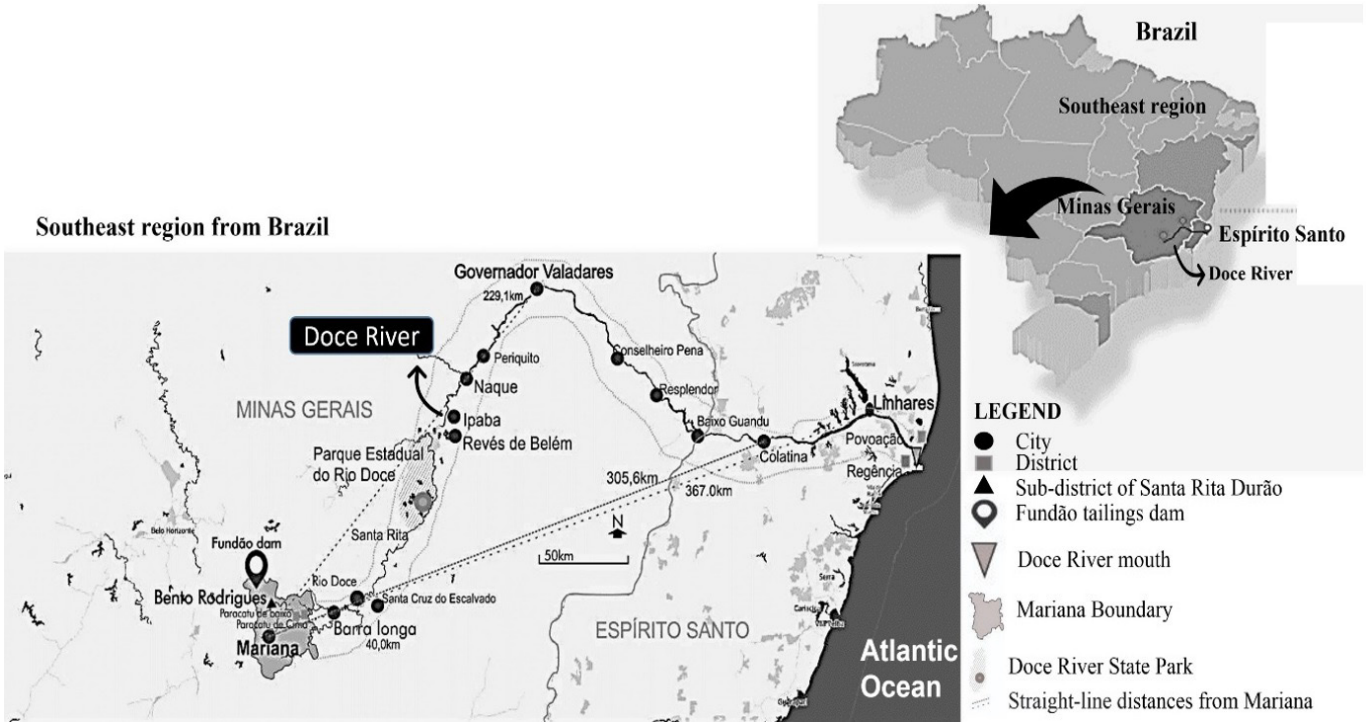

Figure 1. Main cities and towns affected by the Fundão tailings dam collapse, in Mariana, Minas Gerais, Brazil.

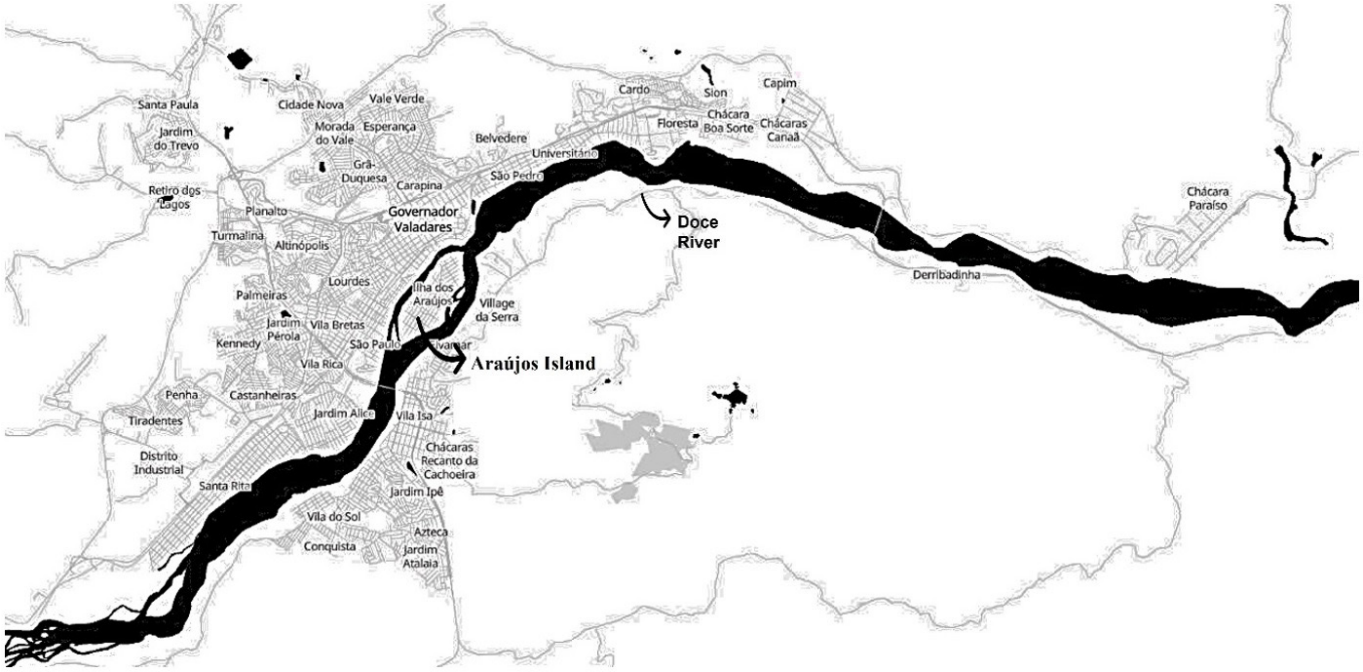

Figure 2. Araújos Island, one of the most affected neighborhoods in Governador Valadares, Minas Gerais, Brazil, by the Fundão tailings dam collapse.

fishing interdiction and also started to buy water (Leonardo et al., 2017). On the other hand, the population concern and negative perception might not reflect in behavioral changes. In Regência, approximately 70% of interviewed people mentioned to know someone in the community who continued to eat fish after the disaster (Leonardo et al., 2017). Moreover, habit changes may be more intense in a period close to environment disaster and loss strength over time.

Because the Fundão dam burst polluted watercourses and ecosystems with mining tailings and harmed mainly cities bathed by Doce River, these damages might change population lifestyle related to eating and water use. Therefore, this study aims to identify changes in dietary habits and water use in the Araújos Island neighborhood, Governador Valadares, as well as evaluating the citizens' perception regarding the impacts in food and water, after contamination of the Doce River with mining tailings. Information from this study may help to direct trade and government agencies strategies regarding the main concerns and demands of citizens related to the subject in Governador Valadares.

2 Material and methods

A descriptive research was performed in the Araújos Island neighborhood, Governador Valadares, Minas Gerais, Brazil, whose population was distributed in 3212 residences in 2016, according to information from town hall from Governador Valadares, and composed of 7659 habitants, according to 2010 census (Instituto Brasileiro de Geografia e Estatística, 2010). The neighborhood was chosen because is entirely bathed by the Doce River, which supplies water for the place after treated by municipal Autonomous Service of Water and Sewer (SAAE). Research was conducted after approval by Human Research Ethics Committee (CAAE 55803716.8.0000.5147) and followed its recommendations.

A hundred interviews, determined considering a confidence level of 95% (Malhotra, 2011), were randomly performed in residences with a resident family member (who answered the door, preferably), in April of 2017, using semi-structured questionnaires. The approach of the questionnaires included initially the sociodemographic profile of the respondents, followed by dietary and water use habits (before and after Doce River contamination with mining tailings) and lastly, the perception about food and water safety.

The record numbers of artesian wells and cisterns per year (November29th 2001 to May 20th 2021) in Governador Valadares, registered by Minas Gerais Water Management Institute (IGAM), were collected from the Integrated Environmental Information System (SIAM) of Minas Gerais, and provided by Minas Gerais Water Management Institute (IGAM). The chronology of the records of artesian wells and cisterns in the last twenty years was analyzed, using Excel, to verify the groundwater use trends in Governador Valadares after Fundão burst. The registration process of the groundwater use grant rights in IGAM is undertaken as self-declaration, by filling several forms provided by IGAM[1].

Statistical analyses were performed using software R (R Core Team, 2016). In order to verify the association between variables (dietary and water use habits and sociodemographic characteristics, for instance), the chi-square test and Fisher's exact test were used at a significance level of 5%.

3 Results and discussion

3.1 Impact of sociodemographic characteristics on behavioral changes

According to interviewees, the family structure of the Araújos Island neighborhood, in Governador Valadares, Minas Gerais, Brazil, consists of three or more members (72%), without children or youngsters up to eighteen years old (65%) and gross monthly family income ranging from one to six minimum salaries (62%) (Figure 3). These data are proximal to the sociodemographic profile published in last census, in 2010, which shown that Araújos Island was characterized by 23.0% of families with children and youngsters up to nineteen years old and gross monthly familiar income majoritarily up to five minimum salaries (53.8%) (Instituto Brasileiro de Geografia e Estatística, 2010). Gross monthly familiar income (p-valor of 0.6325), number of residents (p-valor of 0.2910) or absence/presence of children in families (p-valor of 0.6224) did not significantly (p-valor at 5%) affect changes in dietary and water use habits in Araújos Island.

Overall**,** respondents were female (55%), single (41%) or married (36%), with (55%) or without children (45%), aged between 21 and 40 years (51%) and with low level of education (66%) (Table 1). A representative part of respondents (60%) was composed of students, housewives, retired people, or autonomous workers. The higher percentage of single younger respondents (59% aged from 18 to 40 years old) with lower level of education (40% with Middle Education) might be justified because interviews were conducted during work schedule. At the moment of the interview, the family member who supposedly

Figure 3. Frequency distribution of the sociodemographic characteristics from families from Araújos Island neighborhood, Governador Valadares, Minas Gerais, Brazil, from data collected in April of 2017.

1 The forms used for registration of the groundwater use grant rights in Minas Gerais state are available on the Minas Gerais Water Management Institute (IGAM) website http://www.igam.mg.gov.br/outorga/formularios.

Table 1. Changes in dietary and water use habits in Araújos Island, Governador Valadares, Minas Gerais, Brazil, after contamination of the Doce River, according to the sociodemographic characteristics of the interviewees, from data collected in April of 2017.

Sociodemographic characteristic	Categories	Changes in water use habits			Change in dietary habits		
		Yes	No	p-valor	Yes	No	p-valor
Gender	Male	33	12	1.00	25	20	0.9357
	Female	40	15		29	26	
Age group	18 to 20 years	12	5	0.6896	8	9	0.815
	21 to 30 years	23	7		18	12	
	31 to 40 years	14	7		10	11	
	41 to 50 years	9	5		7	7	
	Over 50 years	15	3		11	7	
Marital status	Single	29	12	0.8374	23	18	0.9219
	Stable union/married	28	8		20	16	
	Widower	6	3		4	5	
	Divorced	10	4		7	7	
Children (up to eighteen years old)	Yes	34	11	0.6224	23	22	0.7621
	No	39	16		31	24	
Number of children (up to eighteen years old)	None	34	11	0.6849	23	22	0.7331
	One	20	11		16	15	
	Two	11	3		8	6	
	Three or more	8	2		7	3	
Education level	Fundamental Education	6	2	0.3118	2	6	0.05962
	Middle Education	40	18		30	28	
	Higher Education/Graduation	25	5		21	9	
	Other	2	2		1	3	
Profession	Student	21	7	0.5158	17	11	0.2023
	Employee of public company	7	1		4	4	
	Employee of private company	23	9		18	14	
	Autonomous	8	4		7	5	
	Housewife	3	3		1	5	
	Retired	6	0		5	1	
	Other	5	3		2	6	
Frequency of physical activity	Everyday	13	2	0.1289	9	6	0.3147
	Three to six times a week	18	8		14	12	
	Once or twice a week	25	5		19	11	
	Do not practice	17	12		12	17	
Practice of physical activity	Yes	55	14	0.0053	40	29	0.0065
	No	17	12		12	17	
Have regular appointments with a nutritionist or go on a diet or have dietary restrictions	Yes (at the moment of interview)	34	5	0.0026	29	10	0.0005
	Not at the present or never	37	24		23	38	

had a higher education level and provided financial support to the family was at work (outside home).

Sociodemographic characteristics of interviewees did not significantly influence changes in dietary and water use habits in Araújos Island, Governador Valadares. As shown in Table 1, these behavioral changes were significantly independent of gender, age group, marital status, number of children, education level or profession of the respondents (p-value > 0.05).

A health-promoting lifestyle seems to be a characteristic of interviewed group because a representative part of the residents was doing physical activity weekly (71%), or was receiving nutritional attendance, was going on a diet or had dietary restrictions (39%) (Table 1). These patterns of behavior (Table 1) have significantly (p-value < 0.05) influenced the changes in water and food consumption habits in Araújos Island after Fundão tailings dam.

Several studies have been demonstrated a positive correlation between regular physical exercise and healthy eating patterns because both are associated with positive health outcomes and prevention of chronic diseases and premature death (Warburton et al., 2006; World Health Organization, 2002). Hence, people who have these behaviour patterns usually seek for healthy lifestyle and tend to choose practices that contribute to their health.

3.2 Changes in patterns of water use after disaster

More than one year after Fundão tailings dam (17 months), 73% of the residents from Araújos Island have changed their habits of water use. The majority changed the source of water for cooking (53%), drinking (38%) and washing food (37%), while minor changes were observed for watering the animals (25%), brushing teeth (20%), gardening (17%), washing clothes (8%) and bathing (8%) purposes.

Public supply water (PSW) supplied by Autonomous Service of Water and Sewer (SAAE) from Governador Valadares has been the main source of water used by the residents for all domestic purposes (Figure 4). However, after disaster, it was observed a reduction in PSW use, for all domestic purposes, mainly for cooking (50%), drinking (36%), washing food (35%), watering the animals (25%) and brushing teeth (20%) (Figures 4 and 5). These changes were significantly (p-value < 0.05) associated to health risk concerns.

According to Figure 4, residents have already been concerned about the safety of PSW before disaster because mineral water was used for drinking by 44% of residents at that time. However, the consumption of mineral water in Araújos Island increased after Fundão collapse, mainly for drinking (26%) and cooking (38%) (Figures 4 and 5). Hence, abovementioned data suggest residents' concerns about health risks to humans and animals associated with contamination of water with Fundão's mining tailings.

Overall, several factors have been directing choice of drinking water source including concerns about health risks, perceptions about water treatment efficacy, water safety and sensory qualities

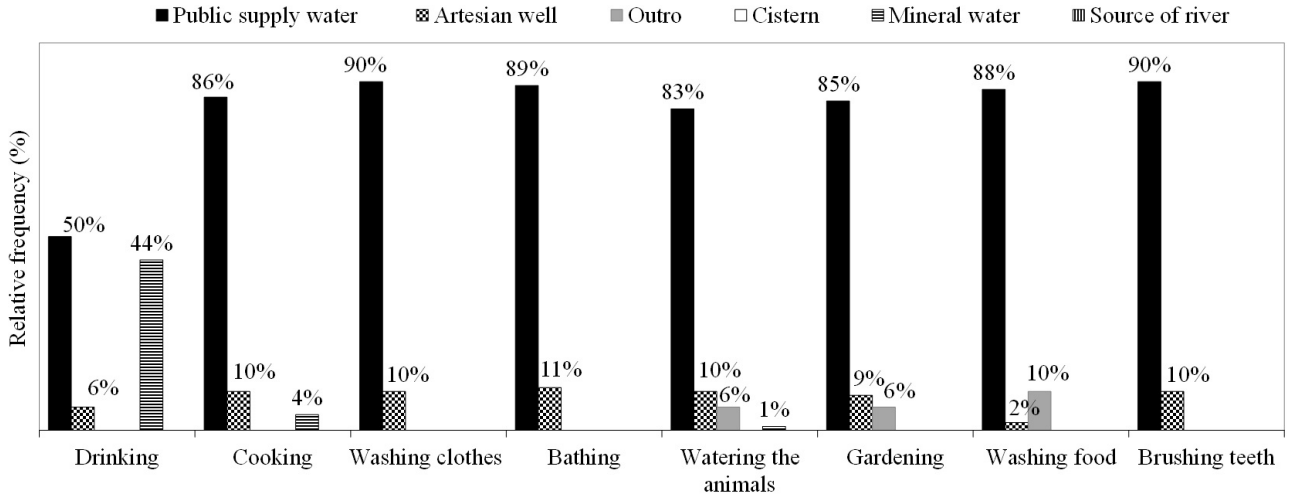

Figure 4. Domestic water uses in the Araújos Island, Governador Valadares, Minas Gerais, Brazil, before contamination of the Doce River with mining tailings, from data collected in April of 2017.

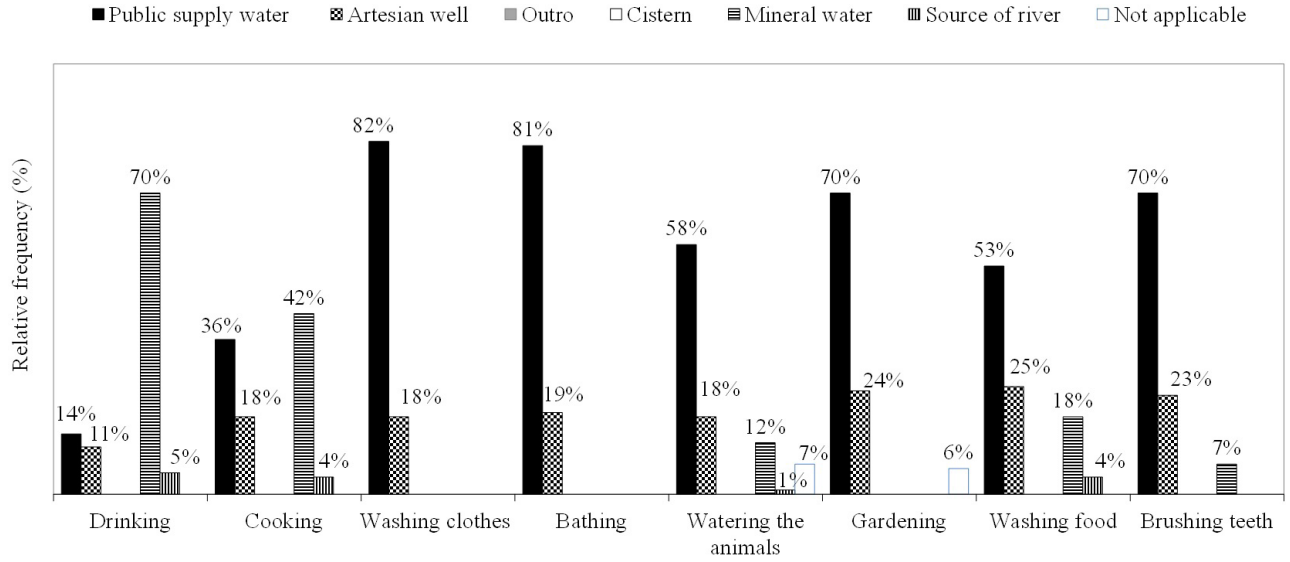

Figure 5. Domestic water uses in the Araújos Island, Governador Valadares, Minas Gerais, Brazil, after contamination of the Doce River with mining tailings, from data collected in April of 2017.

(taste or odor), knowledge about health hazards associated with drinking unsafe water, cost and environmental damage, among others (Francis et al., 2015; Irianti et al., 2016; Li et al., 2019; Queiroz et al., 2013). Health concerns have been one of the main motivations for water consumption patterns in locals with environmental pollution and risks (Huang et al., 2015).

Changes in water use have also occurred in communities affected by Fundão burst. In Regência and Povoação, districts located in Linhares city, Espírito Santo state, Brazil, familiar expenses with water purchase increased 73.9% after the disaster (Leonardo et al., 2017). According to Rodrigues et al. (2016), the main motivations are related to insecurity and negative perceptions about health risks associated with unsafe water, lack of reliability in information about water potability, discredit in public power, among others (Rodrigues et al., 2016).

After Fundão disaster, the use of water from artesian wells have increased in Araújos Island, for all domestic purposes, mainly for washing food (23%) (Figures 4 and 5). Likewise, water from cisterns started to be used by minor part of residences (Figures 4 and 5). According to data collected from the Integrated Environmental Information System (SIAM) of Minas Gerais, the number of artesian wells and cisterns recorded by Minas Gerais Water Management Institute (IGAM) after Fundão burst (from November11th 2015 to May 20th 2021) was 623, which corresponded to 55.7% of the total amount registered in the last twenty years, since November 29th 2001 (Figure 6). Therefore, there was a significant increase in these annual records after the Doce River contamination with mining tailings, mainly regarding cisterns registrations (Instituto Mineiro de Gestão de Águas, 2018). It is believed that these amounts may be underestimated because artesian and cisterns wells may not have been registered yet by IGAM, once registration process is undertaken as self-declaration. It is important to highlight that the water obtained from clandestine artesian wells may not meet the potability standards and, if not adequately treated, may represent additional heath risk. Bacteria of fecal origin and other harmful substances including toxic metals, which are able to reach the groundwater, may be found (Al-Paruany et al., 2018; Boelee et al., 2019; Daneluz & Tessaro, 2015). Despite of this, some people may choose these water sources because seem to believe they provide safer water than PSW one.

3.3 Dietary habit changes after Fundão collapse

Seventeen months after disaster, approximately half (54%) of interviewees has changed its habits of consumption of food (*in natura* or industrialized). The main changes mentioned were the reduction or interruption of consumption of specific food products and food made out of home as well as replacement of food product brands or of the manufacturer. These changes were detailed, for specific groups of food, in Figure 7.

After disaster, most of habitants from Araújos Island stopped (40%) or reduced (10%) the freshwater fish consumption or even replaced the manufacturer or the product brand (14%) (Figure 7). Similar changes in fish consumption habits were observed in communities from cities affected by Fundão burst. Residents in Bento Rodrigues, a sub-district of Santa Rita Durão (district from Mariana) as well as those from Paracatu de Baixo and Paracatu de Cima, both districts from Mariana, Minas Gerais state, stopped to eat freshwater fish caught in rivers contaminated with Fundão mining tailings (Silva, 2019).

Likewise, Regência and Povoação communities, Linhares, Espírito Santo state, considerably changed their fish-eating habits after fishing interdiction. These changes caused an increase of 79.7% in familiar expenses because most of the consumed fish was fished by a family member (81.9%) or was provided by neighbors or relatives (29.5%). Before the disaster, most of the habitants (98.0%) from these communities used to eat fish or shellfish in

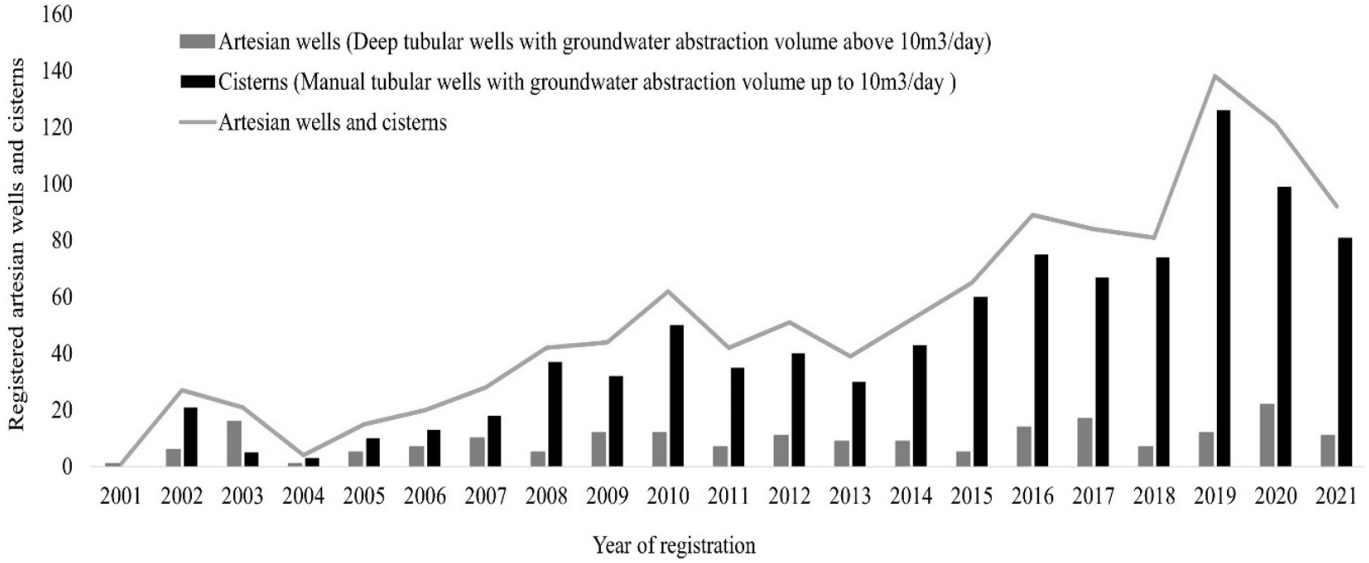

Figure 6. Number of legal artesian wells and cisterns registered annually in Governador Valadares. Source: data collected from the Integrated Environmental Information System (SIAM) of Minas Gerais, provided by Minas Gerais Water Management Institute (IGAM), between November29th 2001 and May 20th 2021, and compiled by authors.

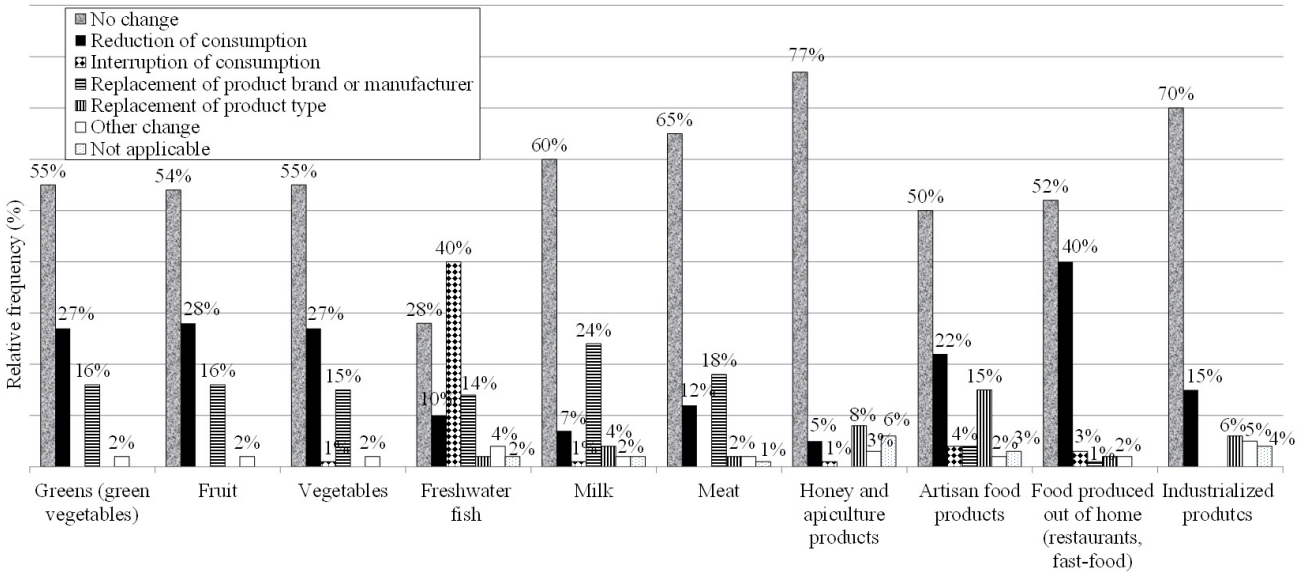

Figure 7. Changes in dietary habits in Araújos Island, Governador Valadares, Minas Gerais, Brazil, after contamination of the Doce River with mining tailings, in 2015, from data collected in April of 2017.

frequency varying from three (53.4%) to seven (20.9%) times a week (Leonardo et al., 2017). Hence, this environmental disaster result in severe social, economic, phycologist and cultural impacts for many people, mainly those that depends on the Doce River and Atlantic Ocean to their subsistence and recreation.

These behavior changes may have been motivated by health concerns related to contamination of fishes with toxic metals and other pollutants that come from toxic mining tailings, as suggested by studies published in the literature. It has been stated that some metals are involved in the biogeochemical cycle and they movement thought water, plants and animals, resulting in the partial accumulation of these elements in cells (Chary et al., 2008; Draszawka-Bolzan & Cyraniak, 2014). Using assays for predicting acute toxicity, Sartori and collaborators (Sartori et al., 2016) found bioaccumulation of Al and Fe in fishes exposed during 96h to water collected from Doce River in Regência (ES) region. Hence, this evidence may stimulate concerns about this problem in the flood affected population.

Additionally, it was observed an expressive reduction in consumption of fruit (28%) and vegetables (27%), food produced out of home (40%) and artisan food products (22%) in Araújos Island (Figure 7). The reduction in consumption of food produced out of home and artisan food products may be related to uncertainty of consumers about the quality of water used for food production. Likewise, the reduction of consumption of unprocessed food (fruit, vegetables, eggs, meat and milk) produced in Mariana have occurred in Bento Rodrigues, Paracatu de Baixo, Paracatu de Cima, resulting in an increase of demand for industrialized products (Silva, 2019).

3.4 Damages and risk perceptions after Fundão burst

Although eating and water use patterns have multifactorial drivers (individual, social, economic, cultural and environmental factors) (Cardoso et al., 2016; Irianti et al., 2016; Li et al., 2019) and health and wellness has been identified as one of the major motivations of Brazilian food choice (Instituto de Tecnologia de Alimentos, 2010), studies have shown that communities affected by environmental damages have been specific motivations for eating habits, mainly related to health concerns (Silva, 2019; Huang et al., 2015; Leonardo et al., 2017).

Therefore, results from this study corroborate previous findings because most of residents from Araújos Island (96%) perceived an addition risk to food production after Fundão dam burst, mainly related to chemical (83%), biological (29%) and physical (9%) origins. In Regência and Povoação, changes in eating habits were motivated by negative perception about health risks caused by environmental disaster. In these locations, most of the interviewed people (90.0%) classified the quality of Doce River water as bad and affirmed to be worried about health risks related to sea bath, fish eating or water consumption at that time (Leonardo et al., 2017). Similarly, concerns about environmental threats related to the contamination of water and food with mining tailings have motivated changes on dietary habits in Bento Rodrigues, Paracatu de Baixo, Paracatu de Cima (Silva, 2019).

In addition, the majority (84%) of residents from Araújos Island pointed out some kind of damage to the family after the disaster, including financial (69%), psychological (55%), health risks (39%), waste of time (14%), physical risks (12%) and loss of recreation (swimming).

Similar complaints have been done by habitants from Regência and Povoação, Espírito Santo. The majority (99%) pointed out changes in several aspects of the routine that may affect eating habits. One of them was the increase in social conflicts among relatives, friends and neighbors because neighbors use to exchange and share food. Furthermore, most of them cited the increase of expenses with food (79.7%) and water (73.9%) as well as economic loss related to the reduction of commercial activities

(46.8%), fall in tourism (37%) and agricultural activities (39.0%). Impacts on physical and emotional health were mentioned by 24.0% and 46.3% of respondents in Regência and Povoação, respectively (Leonardo et al., 2017).

Adverse health effects associated to the Fundão disaster were found in several populations affected by the flood. In Colatina, other city from the same Brazilian state, it was observed an evolution of pathologies in riverside population including diarrhea, fever and skin and appendages disorders with an approximate increase of 172.7%, 133.3% and 35.3% respectively, considering the period between one day before the arrival from water contaminated with mining rejects in Colatina and 120 days after this event (Rocha et al., 2016). In an exploratory, transversal and descriptive study performed in Barra Longa, Minas Gerais, 37% of the 507 interviewed people complained about health hams after the Fundão tailings dam collapse including breathing (40% for adults and 60% for children up to thirteen years old) and skin (15,8%) problems as well as mental and behavior disorders (11,0%). Among the respondents with complaints (396), 56% changed routine activities and 77.9% mentioned physical harms. Headache and anxiety were the most frequently damages mentioned beyond cough, leg pain, skin allergy, rhinitis, fever, shortness of breath, cramps, lack of appetite, diarrhea, exhaustment and weight loss. According to the habitants, 72.3% of these symptoms started after two or six months after disaster. Emotional harm (sleeplessness, tension, mood swings) affected 83.4% of them, while mental or neurologic disorders (anxiety, depression and stress) occurred in 23% of the respondents (Instituto de Saúde e Sustentabilidade, 2017). Similar health effects (allergies, breathing disorders and nausea) were mentioned by more than 80% of residents from Marina, Minas Gerais, which participated from a qualitative and exploratory study (Ramos et al., 2017).

Besides, in Mariana, M.G., many farms lost their livelihood source because of interruption of agricultural and livestock activities due to health concerns about water and food safety. This change cause negative impacts in trade and social interactions in this city. Despite worries, some farms continued planting fruit and vegetables in areas contaminated with mining tailings, beyond distributing, changing and selling the production on food fairs which might cause adverse public health impacts over time (Silva, 2019).

In Araújos Island, most of the respondents evaluated the quality of PSW as very bad (8%), bad (22%) or reasonable (52%), while only 13% considered good to excellent. Most of them (77%) said to believe that PSW may cause a negative impact in foods, including reduction of quality (53%) and contamination (20%) of food made with PSW, or may result in some kind of alteration with bad implications to health (25%). Similar consequences were mentioned for food produced using water from Doce River.

Therefore, the perception of health risk, low safety and poor quality of PSW, Doce River water and food may have stimulated changes in food habits and water use. Similar motivations have been published in other studies, as previously discussed (Instituto de Saúde e Sustentabilidade, 2017, Leonardo et al., 2017, Rodrigues et al., 2016).

3.5 Residents' perception about disclosed information

After disaster, 25% of the respondents have started to look for information about the impacts of contamination of Doce River in foods, while 27% had interest in looking for information regarding foods marketed in Governador Valadares.

Besides, 32% of the respondents started to look for information in food labels. Residents started to look for other types of information in food labels that could affect the choice of product. Some of them (38%) mentioned that they would like to find information about the quality and source of water used for production of fruit and vegetables. This behavior change suggests people are worried about the impacts of Doce River contamination on food safety, mainly related to water quality, and, consequently, on human health, corroborating previous findings from studies performed in cities affected by Fundão tailing dam (Instituto de Saúde e Sustentabilidade, 2017; Leonardo et al., 2017; Rodrigues et al., 2016).

In order to reduce or avoid possible risks associated with food contamination, 32% of the respondents said to have some criterion to differentiate food at the moment of purchase, most often for *in natura* foods. Part of them (31%), even believing that it is important to make this distinction, did not know how to do it. On the other hand, 23% did not have this attitude because they have believed there is no trustworthy and effective criterion for reaching the objective. Only 10% does not mind with this question. Therefore, these data reveal the importance of the information provided on food labels to help consumers in food choice after natural disasters. Indeed, food label systems have presented relevant importance on driving food choices and healthier eating behaviors or environmental attitudes and may be a valuable tool for consumers' choice (Cecchini & Warin, 2016; Toma et al., 2020).

The means of dissemination used by respondents who are concerned about the impacts of contamination of Doce River in foods were the point of purchase (68%), consultation with people of social coexistence (36%) or television programs (4%). Government organizations, non-government organizations, scientific literature, non-scientific publications, expertises and radio programs were not mentioned.

Additionally, most of them (59%) did not believe in information regarding portability of PSW and this negative perception was significantly associated with water and food consumption patterns.

Approximately half of the respondents (57%) have evaluated the disclosed information as little sustained and in-depth questioning, while 10% said there is no information available. On the other hand, a minor part classified the information as enough (8%) or as very detailed (1%), while 24% did not have formed opinion.

According Lowrey et al. (2007), despite the importance of media in disseminating information regarding natural disasters, journalists are unprepared to cover them, in part because of the lack of sufficient scientific knowledge and training. Indeed, conclusions from a study that evaluated the mediatic speech about Fundão dam outburst shown that media reports had a sensationalist and fatalistic focus in environmental issues without clarifying the problem in greater depth or presenting an educational approach. Besides, different predominant discourses about the disaster were

identified, sometimes guided by specific interests (Carrato et al., 2018; Fontes & Lopes, 2017). Therefore, the posture of media at natural disasters by disseminating of incorrect, insufficient, opportunistic and outdated information has been contributing to increase the skepticism and loss of confidence in disclosed information about quality of water and food.

4 Conclusions

Seventeen months after Fundão tailings dam burst, more than 70% of the residents from Araújos Island, in Governador Valadares, Minas Gerais, Brazil, have changed their water use habits. Most of them changed the source of water, mainly for cooking, drinking and washing food, and also reduced the consumption of public supply water (PSW), for all domestic purposes. Along with these changes, there was an increase on groundwater use abstracted from artesian wells and cisterns in Governador Valadares after the collapse.

In addition, after the environmental disaster, approximately half of residents has changed its dietary habits. In general, the consumption of specific food products was reduced (mainly fruit, vegetables and food prepared outside home) or interrupted (mainly freshwater fish) along with the replacement of brands or manufacturers of food products.

These changes were significantly associated to the residents' perception of health risks associated to Doce River contamination with mining tailings as well as lack of credibility in disclosed information about PSW potability. Furthermore, residents believe that PSW has poor quality and that Doce River water and PSW may cause a negative impact in food quality and safety. They perceived an addition risk to food production after Fundão dam burst, mainly from chemical, biological and physical origins and mentioned that the disaster caused some kind of damage to the family, including financial, psychological, health risks, waste of time, physical risks and loss of recreation (swimming). These concerns drove demand for information about the impacts of contamination of Doce River on food, mainly those marketed in Governador Valadares.

These behavioral changes are also related to their health-promoting lifestyle (regular physical activity or healthy diet) as well as health risk concerns about safety and quality of water and food after collapse. Therefore, the negative perceptions of residents related to health risk associated to consumption of contaminated food and water have stimulated changes in food habits and water use in Araújos Island, Governador Valadares.

This study highlights the importance of clarifying and making the population aware of the ways in which water and food are contaminated, in addition to providing more detailed information and guidance on their proper use and on issues involving water potability and food safety.

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