

## **The impact of disruption of the barrage in Mariana–MG on the health of the riverside population in the city of Colatina–ES.**

Impacto do rompimento da barragem em Mariana–MG na saúde da população ribeirinha da cidade de Colatina–ES.

El impacto de la interrupción de la barrera en Mariana–MG en la salud de la población ribereña en la ciudad de Colatina–ES.

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**ABSTRACT:** Water is a human right which should be provided in adequate quantity and quality favorable to consumption. The aim of this study is to measure the impacts on the riverside population of the city of Colatina–ES caused by the spread of iron mining debris and waste in the Rio Doce coming from a dam break located in the town of Mariana–MG. The methods used in this study used together theoretical research and fieldwork using a longitudinal aspect, quantitative and non-probabilistic. The approach in the epidemiological level showed significant increase in the incidence of prodromal signs and symptoms of diseases such as diarrhea, fever and skin and appendages

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disorders that obtained approximate increase of 172.7%, 133.3% and 35.3% respectively. Such parameters are associated with the consequences of environmental disaster resulting in impacts on the environment, interruption of water supply, the water contamination and others. It was noted the need to redefine the themes in education in coming health by governmental institutions and public agencies government to management of the water quality. Symptoms seen as fever, diarrhea and skin diseases have emerging rates associated with the adverse effects on biological boundaries, psychological, social and economic aspects.

Keywords: Water; Ore waste; Rio Doce; Riverine population; Public health.

**RESUMO:** A água é um direito do ser humano, que além de ser fornecida em quantidade adequada, deve ser qualitativamente favorável ao consumo. Objetivou-se neste estudo mensurar os impactos na população ribeirinha da cidade Colatina–ES provocados pelo desprendimento de rejeitos de mineração no Rio Doce, provenientes da cidade de Mariana–MG. Os métodos utilizados para o projeto foram embasados em uma pesquisa teórica seguida de um trabalho em campo de caráter longitudinal, quantitativo e não probabilístico. A abordagem, no âmbito epidemiológico, demonstrou aumento expressivo na incidência de sinais e sintomas prodrômicos de patologias, como a diarreia, febre e afecções de pele e fâneros que obtiveram evolução aproximada de 172,7%, 133,3% e 35,3%, respectivamente. Tais parâmetros estão intimamente associadas as consequências do desastre ambiental, pelas alterações do meio ambiente, interrupção do fornecimento de água, contaminação hídrica, dentre outras. Notou-se necessidade de redefinir temáticas de educação em saúde pelas instituições governamentais para o manejo de qualidade da água. Sintomas como febre, diarreia, e alterações de pele tiveram elevação das taxas associadas com efeitos adversos no âmbito biológico, psicológico, social e econômico.

Palavras-chave: Água; Rejeitos de minério; Rio Doce; População ribeirinha; Saúde Pública.

**RESUMEN:** El agua es un derecho humano, que además de ser proporcionado en cantidad adecuada, debe ser cualitativamente favorable para el consumo. El objetivo de este estudio para medir el impacto en la población local de la ciudad de Colatina-ES causada por el desprendimiento de residuos mineros en el Rio Doce, de la ciudad de Mariana, Minas Gerais. Los métodos utilizados para el proyecto se basa en un trabajo de investigación teórica seguida de un campo de carácter longitudinal, cuantitativa y no probabilístico. El enfoque, el nivel epidemiológico, mostró un aumento significativo en la incidencia de signos y síntomas de enfermedades como la diarrea, enfermedades de la fiebre y de la piel y faneros que obtuvieron incremento aproximado de 172,7%, 133,3% y 35,3% prodrómicos respectivamente. Estos parámetros están estrechamente relacionados con las consecuencias de un desastre ambiental, por los cambios en el medio ambiente, la interrupción del suministro de agua, la contaminación del agua, entre otros. Se señaló la necesidad de redefinir los temas de educación para la salud por las instituciones gubernamentales para la gestión de la calidad del agua. Los síntomas tales como fiebre, diarrea y cambios en la piel habían elevado las tasas asociadas con efectos adversos en contexto biológico, psicológico, social y económica.

Palabras clave: agua; Relaves de hierro; Rio Doce; Población local; Salud pública.

## INTRODUCTION

In Brazil, there are about 1,400 mining companies that mainly extract metals, including manganese, gold, asbestos, copper, iron and zinc. The mineralized waters of rocks contain high concentrations of strong metals used in the purification process. Which can cause contamination in areas with different levels of vulnerability enhanced by human actions<sup>1,2</sup>.

The rate of vulnerability of the geographical area or the affected community is one of the factors that enhance consequences. The range of events in the social, economic, environmental and health cause damage to health of the population<sup>3</sup>.

The environmental disaster affects the psychological behavior of communities changing the routine life, which triggers pathological disorders resulting from “post-disaster” such as Depression, Panic Disorder, Burnout, Hypertension blood, Diabetes, Hives, Gastritis, and Cerebrovascular Diseases. Inside this context it is possible demonstrate increasing of prodromal signs, linked to consumption and contact with contaminated water, such as diarrhea, fever and skin changes. This is because water is a central substrate for different metabolic reactions. This substance acts in physiological processes such as absorption, digestion, excretion, transport of nutrients and human gases into the circulatory system, maintaining the temperature and control the flow of other substances into the intracellular and extracellular environment. Any change in the composition of water ingested may cause diversion in body homeostasis<sup>4</sup>.

The Brazilian National Water Agency (Agência Nacional das Águas – ANA, 2015)<sup>5</sup> demand the use of physical and chemical indexes what instruct the population and direct planning for the use of water resources quality. The main quality parameters Federation Units use are: the Water Quality Index (IQA), Contamination Index by Toxics, bathing Index (IB), Trophic State Index (IET), Water Quality Index for protection of Aquatic Life (IVA) and Quality Score Raw Water for Public Establishment purposes (IAP).

Among the physical and chemical parameters, it evaluates the color, odor, flavor, quantity of mineral salts and oxygen concentration in the water. The amount of organic matter reflects in the oxygen concentration, the proliferation of living organisms, in the presence of hazardous chemical heavy metals may cause bio-accumulation processes<sup>6,7</sup>.

For human consumption, it is necessary some care management with water care. According to the Committee of Bacia do Rio Doce, CHB – DOCE (2015)<sup>8</sup>, the water stored in external areas require containers with covers without gap to avoid deposition *Aedes aegypti* mosquito eggs. For efficiency it is necessary the use of a screen between the container and the cover. Storage water tanks must be completely sealed to prevent animals entering and the spread of disease.

The use of water from draw-wells and subterranean mines is not recommended for human consumption because it is possible that is contaminated by microbiological agents and organic

matter coming from the sewers and other kinds of chemical pollutants<sup>8</sup>.

The water for human consumption, it must be drinkable and come from reliable sources<sup>9</sup>. In places where there is no access to clean water, it is recommended accomplish the treatment of water with homemade methods for consumption on the same day, to avoid contamination and diseases.

However intake of treated water, even if the same day, can cause symptoms of allergies, and in long-term, cancer, when presence of chemical heavy metals. The lead (Pb), has a potential carcinogenic factor, and can cause infections in the circulatory system, renal system, immune system, nervous system and reproductive system. The accumulation of mercury (Hg) in organism is concentrated in brain and kidney, could harm brain functions, that can cause Alzheimer. The cadmium (Cd) is a causative agent of pulmonary inflammation and liver diseases, with accumulation on renal proximal tubules causing urinary disturbances such as increased excretion of calcium. Copper (Cu) can cause increased oxidative metabolism. The zinc (Zn), at high concentrations, generates a toxic effect causing enzymatic alterations. Ultimately, chrome (Cr) is a carcinogen-causing propensity to lung tumors and skin irritations<sup>10</sup>.

The exposure to contaminated mud by hazardous chemical metals can cause allergic reactions as skin irritation, redness, swellings, small bubbles, burning sensation, discomfort, mainly in skin folds, articulations and genitals areas<sup>11</sup>. Therefore, it is necessary to research on the epidemiological context.

On November 5, 2015, occurred in Mariana (Minas Gerais, Brazil), the breaking of dam weir containing combings from iron extraction, reaching the entire watershed of the Rio Doce and nearby cities among them the city of Colatina, located in the northwestern region of the state of Espirito Santo, Brazil.

According to the Brazilian Institute of Environment and Renewable Resources (IBAMA, 2015)<sup>12</sup>, the breaking of the Fundão dam in Bento Rodrigues (Mariana District – MG) containing mining waste was cast as the biggest environmental disaster in Brazil's history and countless consequences for not only for the local population but to all populations in need of Rio Doce waters.

On December 6, 2015, the Water Autonomous Service (SAAE) based on Baixo Guandú–ES, confirmed the presence of arsenic (2.6394 mg/L), lead (1.03 mg/L), aluminum (1405.5 mg/L), iron (2,784 mg/L), manganese (61.222 mg/L) and barium (5,385 mg/L) among other chemical waste at levels above the recommended, which contaminates the entire length of the Rio Doce from the city of Mariana to the coast of Espirito Santo<sup>13</sup>. However, these datas were extracted from non-scientific source, so it is necessary better technical researches.

With the invasion of mud in the town and surrounding areas, it caused a strong social and psychological impact by affecting the river symbol of the city. Another repercussion to be highlighted is the water storage made by the people during the days of suspension of water supply,

with no adequate guidance on storage, promoting the development of vectors, resulting in health problems making it important check the impact on the welfare of the population to the management of water for consumption and to evaluate the possible damage to physical and mental integrity because of the difficulties imposed by the environmental disaster.

## **METHODS**

Students of the University Center of Espírito Santo–UNESC collected the data in this article. It was used a longitudinal study of quantitative and non-probabilistic character, through field research from systematic surveys in the riverside population of the city of Colatina–ES, in the period prior to the impact of dam break in Mariana–MG and after the arrival of the affected water. Aimed total applied three questionnaires: day 0 (day before the passage of waste), 60 and 120 days after the event. (See Appendices A and B).

The first questionnaire (day zero) was applied on November 9, 2015, a date that precedes the arrival of the ores waste and metals. In the second and third visit conducted guidelines on the management of water for consumption and guidance on disease prevention. The others questionnaires was applied in the third and fifth month after the disaster and the passage of waste mining. Therefore, it was realized three approaches, in distinct moments, keeping the same respondents of the first approach. So, it is possible to systemize a comparative, in this population, looking for the before and after of the mining waste arrival in Colatina – ES.

For the reconciliation of results were used chi-squared test, which according Vieira (2008)<sup>14</sup>, is to make an inference in which two contradictory assumptions made based in part on knowledge of the facts. The first hypothesis is called H0 (null hypothesis), which most often say that there are no differences between groups of data. The other hypothesis is called the H1 (alternative hypothesis) is that which contradicts the previous one. The test does not eliminate the possibility of mistakes but provides the p-value (probability value). By convention, if the p-value is less than 0.05 ( $p < 0.05$ ), it conclude that the null hypothesis should be rejected. If the p-value is greater than 0.05 ( $p > 0.05$ ), the researchers did not reject H0, because the results are considered statistically insignificant. In addition to this, it was used the adherence or G test of homogeneity, which according Callegari-Jacques (2008)<sup>15</sup>, is used to determine whether an observed distribution launders frequencies with an expected distribution (determined in theory).

The whole process of this research was approved by the Research Ethics Committee of the University Center of the Espírito Santo (CEP-UNESC), CAAE: 53467216.8.0000.5062.

## **RESULTS**

From an initial sample of 116 respondents, about the first field research approach, the study had a wide variety of people profiles. The overview of this population can be seen in Table 1.

Table 1- Profile of the respondents

Variables	Options	N=116	%
<b>Number of residents</b>	1	9	7,76
	2 a 4	77	66,38
	> 4	30	25,86
<b>Age (Years)</b>	12 a 25	16	13,79
	26 a 60	66	56,90
	> 60	33	28,45
	Not answered	1	0,86
<b>Children at residence</b>	Yes	42	36,21
	No	73	62,93
	Not answered	1	0,86
<b>Elderly at residence</b>	Yes	47	40,52
	No	69	59,48
<b>Education degree</b>	Not literate	18	15,52
	Elementary school	53	45,69
	High school	33	28,45
	Higher education	11	9,48
	Not answered	1	0,86
<b>Disabled persons</b>	Yes	17	14,66
	No	96	82,76
	Not answered	3	2,59
<b>Residence time</b>	< 1 year	14	12,07
	1 - 5 years	21	18,10
	> 5 years	75	64,66
	Not answered	6	5,17
<b>Type of construction</b>	Masonry construction	107	92,21
	Timber	2	1,72
	Loam	2	1,72
	Others	2	1,72
	Not answered	3	2,59
<b>Sanitary control</b>	Sewerage system	49	42,24
	Directly into river	57	49,14
	Septic tank	8	6,90
	Not answered	2	1,72

Table 2 – Specifics approaches modules

Variables	Questionnaire	Options	N	%
<b>Level of confidence of the population in relation to data about quality of water for consumption</b>	<b>Q2<sup>2</sup></b>	Trust	15	15,3
		Distrust	83	84,7
		Not answered	1	-
	<b>Q3<sup>3</sup></b>	Trust	11	11,22
		Distrust	87	88,78
		Not answered	1	-
<b>Level of difficulty encountered in the management of water by the population for the situation</b>	<b>Q2<sup>2</sup></b>	No changes	15	15,3
		Partially	23	23,5
		Lot	43	43,9
	<b>Q3<sup>3</sup></b>	Fully	17	17,3
		Not answered	1	-
		No changes	9	9,2
<b>The use of water collected directly from Rio Doce</b>	<b>Q1<sup>1</sup></b>	Partially	22	22,4
		Lot	44	44,9
		Fully	23	23,5
	<b>Q2<sup>2</sup></b>	Yes	16	14,16
		No	97	85,84
		Not answered	3	-
<b>Q3<sup>3</sup></b>	Yes	10	10,1	
	No	89	89,9	
	Not answered	14	14,29	
<b>Respondent's knowledge about the correct management of undrinkable water</b>	<b>Q1<sup>1</sup></b>	No	84	85,71
		Yes	30	26,32
		Not answered	2	-
	<b>Q2<sup>2</sup></b>	No	84	73,68
		Yes	55	57,29
		Not answered	41	42,71
<b>Q3<sup>3</sup></b>	No	3	-	
	Yes	45	45,92	
		No	53	54,08

(<sup>1</sup>) Q1: First questionnaire application (November/2015), N=116. (<sup>2</sup>) Q2: Second questionnaire application (January/2016), N=99; (<sup>3</sup>) Q3: Third questionnaire application (March/2016), N=98;

The profile of schooling of the population studied states that 45,69% of the 115 respondents, who answered this specific quest, reached elementary school, 28,45% reached high school and only 9,48% have completed higher education. Register also that 15,52% were not literate. It this demonstrates the correlation between the low level of education and high fraction of participants who did not know the theme of water potability at the beginning of the work that shows a deficit learning on the complexity of the topic discussed.

One of the objects in this study is health education, by which it sought to analyze the prior knowledge of the population about methods to make contaminated water into drinkable water as well as enlighten the proper handling. In the first survey it was found that 73.68% of respondents (n = 114) had a negative performance on the level of knowledge of the subject matter. In the second questionnaire there was an increase in the informational level of respondents to the level of 57.29% (n = 96) which was nominated to the guidance provided by the researchers to the population. Finally, the third and final questionnaire was noted that n 54.08% of the 98 respondents not had knowledge of the water potability methods. (See Table 2).

The study exposes relevant significant regarding the reliability of citizens in the information provided by agencies, institutions and companies responsible for quality control of water. The

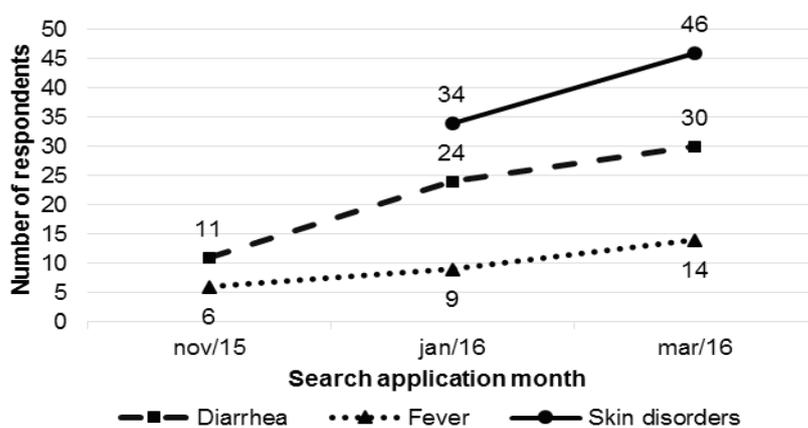
evolution of this category showed that in the second (Q2) and third (Q3) search approaches: Q2, 83 of 98 respondents distrust about water quality control attested by government organs; Q3, the number rises to 87 people.

In the first survey on the use of water collected directly from Rio Doce, 14,16% of respondents answered “Yes” and 85,84% “No”. In the second questionnaire, 10,10% answered positive and 89,90% negative. In the third questionnaire, 14,29% answered positive and 85,71% negative. The total values of consulted in the questionnaires 1, 2 and 3 were respectively, 115, 99 and 98.

O grau de dificuldade encontrado pela população para lidar com os desafios e adaptações consequentes da qualidade da água disponível (atividades diárias domésticas, lazer, alimentação, etc.), correlacionando períodos dos meses de janeiro e março de 2016. Assim, podemos afirmar que das 98 pessoas que responderam à pergunta, no mês de janeiro, 15,3% disseram “Nada”, 23,5% “Pouco”, 43,9% “Muito” e 17,3% “Totalmente”. Já no mês de março, observam-se alterações expressivas referentes às respostas “Totalmente”: 23,5% e “Nada” 9,2%, “Muito” e “Pouco” somaram 63,7%.

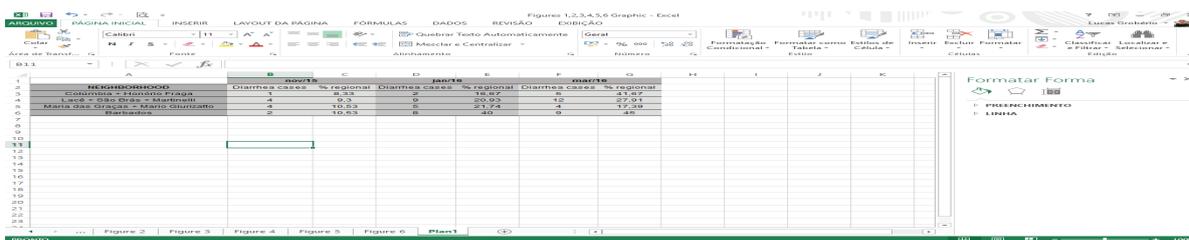
The degree of difficulty encountered by the population to deal with the resulting challenges and adaptations water quality available (domestic daily activities, leisure, food, etc.), correlating periods of January and March 2016. Infers from these data that of the 98 people who answered the question, in January, 15.3% said “no changes”, 23.5% “partially”, 43.9% “lot” and 17.3% said “fully”. In March, it was observed significant changes related to answers “fully”: 23.5% and “no changes” with 9.2% of the respondents.

For health assessment were listed three categories prodromal as fever, diarrhea and skin diseases and epidermal attachments. The incidences of these items during the research were laid out in Figure 1, which shows an increase in the number of people with such symptoms, and cases of fever grew by 133.33% over the months of November 2015 to March 2016, and the diarrhea that amounted to 172.72% in the same period. Skin and epidermal attachments of disorders grew by 35.3% compared to the months of January and March 2016.



It is important to note, that even with the reduction of the population of research over the questionnaires, the evaluated parameters remain in numerical ascendancy.

Following strand of symptoms, it was found that the diarrhea had higher incidence in some districts, thus making an effect of correlation concerning a certain region. However on implementation of the chi-square and G tests was not set as the default population survey the results, since the p-value corresponding to a value greater than 5% (0.05) in all research applications, and  $p = 0.96$  in the month of Nov/15,  $p = 0.36$  in Jan/16 and  $p = 0.193$  in Mar/16. Thus, not establishing statistical standard, the neighborhood highest number of cases reported in percentage by region was Barbados (see Table 3).

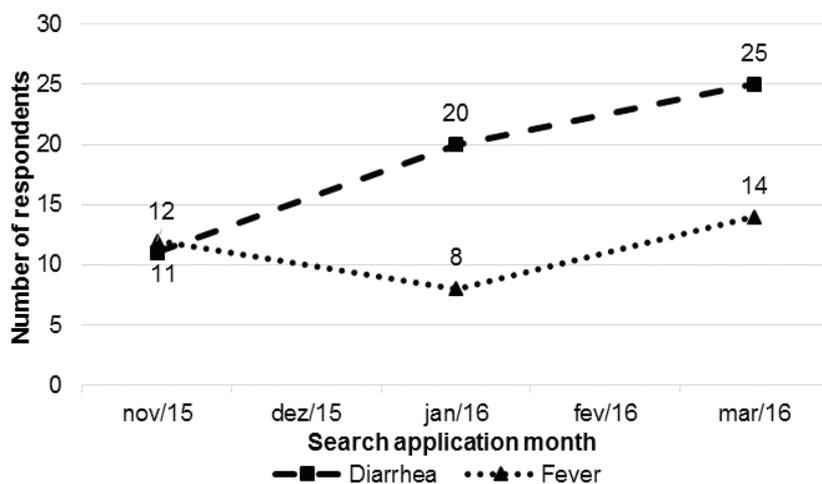


REGIÃO/REGIÃO	NOV/15		JAN/16		MAR/16	
	Diarrhea	% regional	Diarrhea	% regional	Diarrhea	% regional
Barbados	4	16.00	0	0.00	12	37.04
Leão	4	16.00	0	0.00	12	37.04
Marã	4	16.00	0	0.00	12	37.04
Paraná	2	8.00	8	25.24	9	27.99

Regarding the presentation of prodromal symptoms, in other residents of the same household, found in the questionnaire 1 that 11.58% of respondents reported the presence of symptoms in other resident and 88.42% answered “No”. As for fever, 12.5% said they had another resident to the table, and 86.46%, denied the incident.

In the questionnaire 2, 20.83% of respondents said they had another resident in his home with diarrhea and 79.17% denied. Regarding fever, 8.33% confirmed and 91.67% said “No”. During the third interview, 26.04% of respondents claimed to have diarrhea in some other resident of the same household, and 73.96% did not. Concerning the fever, 14.58% of respondents ensured that another resident of the same household presented the framework and 85.42% do not (see. Figure 2).

**Figure 2 – Diarrhea and fever incidence in another resident in the same residence of respondents**



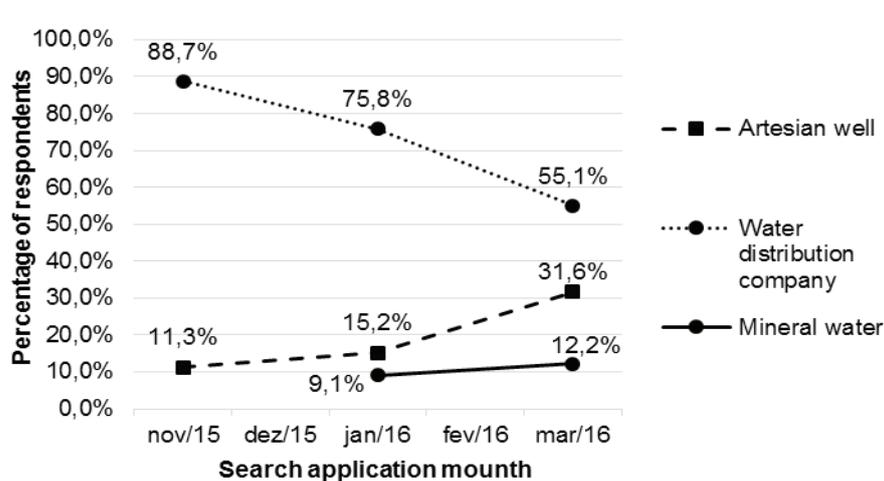
A statistical correlation was found, using the chi-square test ( $p = 0.040$ ), in the presence of diarrhea associated with the type of storage stated in the questionnaires. Surveys show that there was a higher incidence of intestinal disorders in the population that stored water in water tanks (in absolute numbers 7 of 13 people). In the other options, percentage rates of “non-occurrence of diarrhea” were higher.

Analysing the relationship between the origin of drinking water and the incidence of blemishes, rashes, itching and other skin disorders in the six months following the arrival of ore detritus, it was not possible to determine a statistical relationship between the parameters evaluated, according the application of the G test ( $p\text{-value} = 0.082$ ).

Between the questionnaire 2 and questionnaire 3 was observed an increase in the reporting of skin diseases (34.7% in Q2 to 47.4% in Q3), but this phenomenon has no statistical value by chi-square test.

In relation to the origin of drinking water, it was found variations among the collections of the questionnaires such as increased water consumption from wells, reduced user percentage of distributor and increase in consumption of mineral water as shown in Figure 3 below.

**Figure 3 – Data from the origin of drinking water versus time**



These data on the variation of origin of water consumption show that 33.6% of the population stopped using the water distributed by local supply companies with a reduction in the consumption of water coming from the Rio Doce. In contrast there were increases in the use of another water sources like draw-wells (with total growth of 20.3% between the months of November-2015 to March-2016), and increased consumption of bottled mineral water. However, as for the previous data were not applied probabilistic tests which would conclusively prove the statistical significance of the datas.

## DISCUSSION

With the questionnaires, it was observed that most of the people interviewed did not trust in the water data presented by the public agencies and governmental institutions responsible for quality control (86.73% of respondents).

Even before the application of research in the field already expected some suspicion by the population in relation to such information due to the large impact of the environmental disaster occurred in the dam mediations still in Minas Gerais, and possible damage to health that such a situation could cause for the populations of the cities hit by the mud and debris from the extraction of ore, like Colatina, where testing and analysis were performed. Colatina is the second city bathed by the Rio Doce, in Espírito Santo. The fear of damage to health from water consumption taken from the sources makes much of the population do not drink and do not cook with the product that reaches their taps, causing increase in consumption water from mineral sources causing hardship for the local population as increased spending on household expenses.

The results of the questionnaires show that part of respondents (14,16%) used the water directly from the Rio Doce before the passage of ore waste. After the arrival of water contaminated by environmental accident, there was fear among the population to consume the resource (10,10%). However after the application of the questionnaire 3, realize that this fear has declined and that there was return of water use by up to higher rates (14.29%) than the first questionnaire identified in Figure 3 that after the elucidation made by researchers about necessary care for the daily routine after the passage of mud.

It was evaluated the incidence of diarrhea in the riverside population of Colatina in view of the large epidemiological and social importance of prodromal symptoms and its consequences, such that dehydration and hospitalization, especially children and the elderly, resulting in health spending and loss of work by the economically active population.

It was observed increasing in occurrence of diarrhea from the first questionnaire on November 9, 2015, applied before the ore tailings arrive in Colatina, until the last in March, 2016. Indicating the possibility between this environmental disaster and clinical found. It is also worth noting that due to lack of water or afraid to use unfeasible water for consumption, the population realized the water storage buckets and water tanks, for example possibly, by inadequate water management contributed to this frame.

Table 3 shows the location of Barbados with the highest number of cases of diarrhea recorded in percentage by region, this indicating discussion of possible that variables cause these values.

This locality is geographically subject to greater accumulation of sediments in the riverbed.

From the analysis of the questionnaires and Figure 2, there has been a considerable and steady increase in the number of residents who cohabit with respondents who had diarrhea symptoms during the passage of waste mud the city. Although properly informed about the risks, some affected residents continued to consume water from the contaminated river, which may be closely related to the rising incidence of diarrhea, along with improper storage of drinking water in homes, as pathogenic organisms benefit and proliferate in reservoirs under these conditions.

Regarding fever there was a decrease of cases (four cases) of cohabiting after passing the contaminated water and the interval between the first and second questionnaires. Between the second and the third application, realize an increase (six cases).

Among the analyzes carried out with statistical significance, the relationship between the form of storage and the occurrence of diarrhea frames shows a possible error storage or contamination of water supply routes came from Rio Doce, with consequences for health. The larger diarrhea associated fees to the storage in water storage tanks, half the volume of water accumulated is provides an environment for microorganisms.

Regardless of education actions employed, intestinal complaints grew change in the comparison of questionnaires 1, 2 and 3, which shows the need for differentiated approaches to education and awareness of proper care and water management.

Through non-scientific articles were identified tailings coming from mud and ore waste came from Mariana – MG contained strong metals and other toxic substances. It was researched in this study for skin disorders such as irritation, stains, hair loss, itching and irritability, and metals as mercury, chrome, silver and aluminum can cause skin irritation, which are identified by Ferreira and Wermelinger<sup>10</sup> (2013). Analyzing the questionnaires carried out in 2016 was detected that a considerable portion of the population interviewed had some skin disorders (34.69%).

Complaints were observed by the respondents, as the nuisance that changes in the skin caused them, beyond the constraints reported by one of the respondents, according to which other people who visited showed patches and itching on the skin.

The importance of the results that show high incidence of prodromal symptoms which suggest the need for intervention for greater control of water quality, as avoid, not only the discomfort of people, also a public economy in relation to medical expenses.

In this research, it was observed that most of the people interviewed do not foresee a possible improvement of the current condition of the Rio Doce (69.73%), and that the vast majority (44.39%) also reported that this occurrence difficult much your life regarding daily activities, leisure, among others. Distrust of residents are still frequent and adds to a meager or no prospect of improvement. This is evidenced by the data, in Figure 3, demonstrating that the local population uses wells as an alternative source in water consumption.

From the perspective gained from the results of the research done, it was noted the need to redefine the themes in education in coming health by governmental institutions and public agencies government. In the face of lack of better approach techniques and more effective information and regular in the daily lives of the communities affected by the environmental disaster becomes essential more policies of public health and collective. The high data of symptoms seen as fever, diarrhea and skin diseases have adverse effects on biological boundaries, psychological, social and economic of the population. Concluding rationally about the consequences of the environmental disasters caused by mankind, note is extremely negative effects mainly in the riverside population in these cities.

Some problems cannot be identified in the short term, requiring continued studies for a longer period, aiming to better analysis of water quality and other harm to human health. Besides that, it is important the inclusion of non-local population in future research as the distribution of water from the Rio Doce covering all around the city of Colatina.

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## APPENDIX A – QUESTIONNAIRE 1

### **1- Identification: Name:**

Map: n°

Serach group:

Neighborhood:

Address:

Contact with Health Basic Unit:

### **2- About habitation:**

2.1 Number of residents: ( ) 1 ( ) 2-4 ( ) more than 4

2.2 Age ( ) 12-25 years ( ) 26-60 years ( ) more than 60 years

2.3 Are there children at residence? ( ) Yes ( ) No

2.4 Are there elderly at residence? ( ) Yes ( ) No

2.5 Education degree: ( ) Not literate ( ) Elementary School ( ) High school ( ) Higher education

2.6 Are there disabled persons at residence: ( ) Yes ( ) No

2.7 If so, which condition? ( ) Locomotion ( ) Visual ( ) Hearing ( ) Others

2.8 How long time in this residence: ( ) <1 year ( ) 1 - 5 years ( ) more than 5 years

2.9 Type of construction: ( ) Masonry construction ( ) Timber ( ) Loam ( ) Others

2.10 Sanitary control: ( ) Sewerage system ( ) Directly into rivers ( ) Septic tank

### **3- About the water**

3.1 Actual provenance of water consumption? ( ) Artesian well ( ) Water distribution company ( ) Into river ( ) Other

3.2 Will you store water to consume? ( ) Yes ( ) No

3.3 If so, which option: ( ) Water tank ( ) Buckets ( ) Others

3.4 Is this water drinkable? ( ) Yes ( ) No

3.5 Did you know how to make the undrinkable water ideal for consumption? ( ) Yes ( ) No

3.6 The water stored is the only source for your consumption? ( ) Yes ( ) No

3.7 Uses water collected directly from Rio Doce for any activity? ( ) Yes ( ) No

3.8 If so which option? ( ) To drink/preparing meal ( ) Bath ( ) Irrigation ( ) fishery ( ) use in animal herd

#### **4- General guidelines**

3.1 You received guidance from any source? Civil defense/Fire department ( ) Residents Association ( )

Medical students of UNESC ( ) Newspaper / TV / Radio / Internet ( ) Received no guidance ( )

3.2 What guidance do you get? ( ) Consumption or water rationing ( ) Health Risk identification ( ) Vacate the affected areas

#### **5- About your health: in the last 30 days**

5.1 Been to a doctor's appointment? ( ) Yes ( ) No

5.2 What kind of medical consultation? ( ) routine visit ( ) parasitic diseases ( ) Infectious diseases ( ) Other types of medical consultations

5.3 Was you diagnosed with symptoms of diarrhea? ( ) Yes ( ) No  
If so, specify the duration of symptoms

5.4 About the time of occurrence: one day ( ) for one to three days ( ) beyond three days ( )

5.5 Someone else in the residence had symptoms of diarrhea in the last 60 days? ( ) Yes ( ) No

5.6 Was you diagnosed with symptoms of fever? ( ) Yes ( ) No

If so, specify the duration of symptoms

5.7 About the time of occurrence: one day ( ) for one to three days ( ) beyond three days ( )

5.8 Someone else in the residence had fever of the last 3 days? ( ) Yes ( ) No

5.9 Currently there is someone in the residence has any infectious condition? Yes ( ) No ( )

## APPENDIX B - QUESTIONNAIRES 2 and 3

### **1- Identification: Name:**

Map: n°

Serach group:

Neighborhood:

Address:

Contact with Health Basic Unit:

### **2- About the water**

2.1 Do you have stored water for consumption? ( ) Yes ( ) No

2.2 If you stored water as the water is stored? ( ) Waters reservoirs ( ) Bucket ( ) Artesian well  
( ) Others

2.3 Provenance of water consumption in the last 60 days: ( ) Artesian well ( ) Water storage  
methods ( ) Into rivers ( ) Previously stored water

2.4 Is these water drinkable? ( ) Yes ( ) No

2.5 Did You know how to make the undrinkable water ideal for consumption? ( ) Yes ( ) No

2.6 The water stored is the only source for your consumption? ( ) Yes ( ) No

2.7 Uses water collected directly from Rio Doce for any activity? ( ) Yes ( ) No

2.8 if so which option? ( ) To drink/preparing meal ( ) Bath ( ) Irrigation ( ) fishery ( ) use in  
animal herd

### **3- General guidelines on: the last 60 days**

3.1 You received guidance from any source? Civil defense/Fire department ( ) Residents  
Association( )

Medical students of UNESC ( ) Newspaper / TV / Radio / Internet ( ) Received no guidance ( )

3.2 What guidance do you get? ( ) Consumption or water rationing ( ) Health Risk identification  
( ) Vacate the affected areas

### **4 About Health in the last 60 days**

4.1 Been to a doctor's appointment? ( ) Yes ( ) No

4.2 What kind of medical consultation? ( ) routine visit ( ) parasitic diseases ( ) Infectious diseases  
( ) Other types of medical consultations

4.3 Was you diagnosed with symptoms of diarrhea? ( ) Yes ( ) No

If so, specify the duration of symptoms

4.4 About the time of occurrence: one day ( ) for one to three days( ) beyond three days( )

4.5 Someone else in the residence had symptoms of diarrhea in the last 60 days? ( )Yes ( )No

4.6 Was you diagnosed with symptoms of fever? ( ) Yes ( ) No

If so, specify the duration of symptoms

4.7 About the time of occurrence: one day( ) for one to three days ( ) beyond three days( )

4.8 Someone else in the residence had fever of the last 60 days? ( ) Yes ( ) No

4.9 Currently there is someone in the residence has any infectious condition? Yes ( ) No ( )

4.10 There are pregnant women in the residence ( )Yes ( )No

If so, specify...

4.11 Gestation period: first quarter ( ) second quarter ( ) Third quarter ( )

4.12 In relation to pregnancy occurs any of these manifestations: fever, muscle or joint pain, headache, nausea, vomiting ( )Yes ( )No

4.13 Developed symptoms of skin disease (itching, infection, hair loss or other? Yes ( ) No( )

5-Do you see any prospect of improvement of the current condition of the Rio Doce? ( )Yes ( ) No

6-How this occurrence difficult your life (daily activities, leisure, etc.)?No ( ) Partially ( ) Lot ( ) Fully ( )

7-Do you trust the water data reported by government organs and public institutions responsible for water quality control? Yes ( ) No ( )

8-What is the assessment of the measures adopted by the UNESCO medical students to reduce the consequences and difficulties of the situation? Excellent ( ) Good ( ) Regular ( ) Terrible ( )