DOI: https://doi.org/10.36489/saudecoletiva.2020v10i59p4408-4419

Comparative analysis of physical-chemical and contaminant elements in the body of the water of Riacho Grilo in the state of Sergipe

Análisis comparativo de elementos fisicoquímicos y contaminantes en el cuerpo de agua del Riacho Grilo en el estado de Sergipe

Análise comparativa de elementos físico-químicos e contaminantes em corpo d'água do Riacho Grilo no estado de Sergipe

ABSTRACT
This study aimed to analyze and compare the physical-chemical and bacteriological parameters of Grilo Stream, located in Sergipe, with the analysis performed in 2009 by SEMARH. The methodology used the data collected in May 2015, to develop a comparative study with this analysis of 2009, plus the total copper in the water. The collection of samples was in loco, with the presence of riparian vegetation and absence of waste in the area. A subtle difference was noted between the models due to heavy rain on collection days. However, phosphorus, chloride and coliforms showed significant changes, with the first two indicating contamination chemicals, and reduced coliforms can be derived from the rain and values for total solids, which can lead to an accumulation of bacteria. As a result, the level of copper found makes the use of water inappropriate.
ESCRIPTORS: Water; Stream; Physicochemical analysis; Coliforms.

RESUMEN
Este estúdio tuvo como objetivo analizar y comparar parâmetros físico-químicos y bacteriológicos de Riacho Grilo, ubicado em Sergipe, com los resultados del analisis de 2009 de la SEMARH. La metodologia utilizó los datos recolectados em mayo de 2015, para desarrollar un estudio comparativo con esta analisis de 2009, más el cobre total en el agua. La recolección fue in loco, com presencia de bosque de ribera y ausencia de desechos em la zona. Se notó una sutil diferencia entre modelos debido a fuertes lluvias en los días de recolección. Sin embargo, fósforo, cloruro y coliformes disipados, los dos primeros indican contaminación por químicos y coliformes reducidos que pueden separarse de la lluvia y los valores para sólios totales que pueden conducir a la acumulación de bactérias. Como resultado, el nível de cobre encontrado hace que su médico utilice el agua.
DESCRIPTORES: Agua; Arroyo; Análisis Físico-Químico; Coliformes.

RESUMO
Este estudo objetivou analisar e comparar parâmetros físico-químicos e bacteriológicos do Riacho Grilo, localizado em Sergipe, com os resultados da análise de 2009 pela SEMARH. A metodologia utilizou-se dos dados coletados em maio de 2015, para desenvolver um estudo comparativo com tal análise de 2009, acrescida do cobre total na água. A coleta das amostras foi in loco, com presença de mata ciliar e ausência de lixos na área. Notou-se sutil diferença entre os modelos devido à forte chuva nos dias da coleta. No entanto, o fósforo, cloreto e coliformes apresentaram alterações significativas, sendo que, os dois primeiros indicam contaminação por produtos químicos, e os coliformes reduzidos podem ser derivados da chuva e dos valores para sólidos totais que podem levar a um acúmulo de bactérias. Como resultado, o nível de cobre encontrado torna o uso da água imprópria.
DESCRITORES: Água; Riacho; Análise Físico-Química; Coliformes.

RECEIVED ON: 10/27/2020 **APPROVED ON:** 10/30/2020

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INTRODUCTION

The State of Sergipe is bathed by 8 hydrographic basins [1] they are: São Francisco, Japaratuba, Sergipe, Vaza Barris, Piauí and Real Costeira [1] which covers the Caueira and Abaís villages; and Coastal [2], which includes Sapucaia. [2] Among them is that of the Piauí River, considered state since its source is mostly within the state. [3] The Piauí River watershed is located in the southern part of the state of Sergipe. It has a drainage area of 4,150 km², covering 15 municipalities, six municipalities being fully inserted: Salgado, Santa Luzia do Itanhy, Estância, Boquim, Pedrinhas and Arauá [4] with a length of 166.93 km, that is, equivalent to almost 19% of its length and meets the needs of 15 municipalities. In addition, it has a spring in the state of Bahia, in Serra dos Palmares, in the Sergipe municipalities of Riachão do Dantas and Simão Dias. [3]

The Piauí River cuts through the state of Sergipe in a west-east direction, having as main tributaries: Piauitinga, Fundo, Quebradas, Guararema and Arauá, being divided into two climatic regions: sub-humid and agreste regions. [5] Among the tributaries, the Piauitinga River stands out, which corresponds to the left bank of the Piauí River, where the Grilo Creek is located, in the sub-humid region, in which the eastern municipalities of the Riachão do Dantas are located, south of Boquim, north of Pedrinhas, Salgado, east of Arauá, Santa Luzia do Itanhy, Umbaúba and Itabaianinha. [6] The watershed is located between the geographical coordinates (SAD 69) 10º34'10 "and 10º45'12" S (latitude) and 37º22'20 "and 37º34'22" W (longitude), with a total area of 418.20 km², and drains parts of the territory of the Municipalities of Lagarto, Boquim, Itaporanga D'Ajuda, Salgado and Estância. [7]

Riacho Grilo is located in the south-central region of the state of Sergipe, supplying its headquarters, the municipality of Salgado, with a population of 19.365 inhabitants by the last sense of 2010, with a current estimate of 20.025 inhabitants with an area of 247.579 km² and distance up to 54 km from the capital. It also supplies the municipality of Boquim with 8 population of 25.533 inhabitants by the 2010 census and current estimate of 26.899 inhabitants, with an area of 205.643 km² and a distance of 82 km from the capital. [9]

According to Santos [10], Riacho Grilo "is of great importance in this region because it is responsible for the water supply to 16.329 inhabitants of the headquarters and 3 villages in the municipality of Boquim". After its water is treated by the distribution network of the regions, it is used for personal hygiene, domestic use, for consumption by agriculture, in irrigation in plantations, in the sustainability of native vegetation and in industry. [10] In general, all rivers have cultural characteristics of the society in which they are inserted.

Chemical pollution of an organic or inorganic nature is what causes one of the most serious problems affecting the environment [11], due to the introduction of fertilizers, pesticides, chemicals in general, the presence of drained water in the agricultural area, sewage spills or even the presence of industries that use heavy metals, which can pollute water and persist in water bodies. [12] Problems like these can affect the population who use water supply as a source of food and leisure, and can bring health problems associated with their intake. The use of fertilizers and pesticides in crops can promote soil contamination, since some fertilizers contain heavy metals in their composition, such a characteristic can contribute to the maximization of the soil's toxic content. [13] Heavy metals, from rainwater, can be transported by the force of gravity, infiltrating the empty spaces of the soil, contaminating the various water reservoirs, as well as the different forms of life that inhabit this environment. [14]

In view of this, it is pertinent to investigate the water situation of Riacho Grilo in the state of Sergipe, since it is questioned about its consumption being able to the population according to the current resolution. Thus, this article aimed to analyze the physical-chemical and bacteriological parameters of Riacho Grilo, to compare the results with the analysis made in 2009 by the State Secretariat for the Environment and Water Resources (SEMARH) for the configuration of the National Program for the Development of Water Resources PROÁGUA National which was carried out based on the ordinance No. 357/2005 for Class 2 of waters of the Resolution of the National Environment Council - CONAMA.

METHODS

It consisted of documentary research at the Secretary of Water Resources of the State of Sergipe located in the municipality of Aracaju, which made it possible to obtain data constructed by that institution for the year 2009.

In addition to a bibliographic study, a simple on-site study was carried out in order to evaluate water samples from Riacho Grilo in Grilo village, municipality of Salgado/SE. The collection was carried out on May 22nd, 2015 in the morning at 9:58 am and wide mouth sterile plastic containers were used to collect 1000 mL of water for evaluation. It is important to highlight that the climatic situation was in a rainy state. During the same, two gloves were used to protect against bacteriological agents and this was done against the current on the surface of the water body. All recommendations required by the laboratory were followed. The analyzes were carried out at the Laboratory for Environmental Studies (Laboratório de Estudos Ambientais - LEA) of the Institute of Technology and Research (Instituto de Tecnologia e Pesquisa - ITP). The standards were split and identified according to the regulation used by the ITP. For the determination of the most probable number (NMP/g) of coliforms and thermotolerants, the analyzes were carried out in the Environmental Studies laboratory at ITP. All analyzes were performed on May 22nd, 2015.

In the microbiological analysis of Total and Thermotolerant Coliforms, 25 ± 0,2 mL aliquots were used in 0,1% peptone saline until a 10-1 and 10-3 solution was obtained. In addition, the presumptive test was performed in a series of 5 tubes containing lauryl sulfate tryptose broth, incubated at 35-37ºC for 24-48 h. [15]

Tubes with turbidity and gas formation in Duran tubes were considered positive. Then, confirmatory tests were carried out for Total Coliforms and Thermotolerants where, for Total Coliforms, the broth present in the positive tubes was seeded in tubes containing Brilliant Green Bile Broth (VBBL) and incubated in an oven at 35-37ºC for 48 hours and, for 48 hours. Thermotolerant coliforms, sown in E. coli broth (EC), incubated at 45,5ºC for 24 hours. The NMP/g values were calculated according to Silva et al. [16]

The other parameters analyzed were those contained in the data for the year 2009: sample temperature (field), turbidity, pH (field), chlorides, total solids, total dissolved solids, ammonia, nitrogen – nitrite and total phosphorus. The only addition was total copper. For the analysis of inorganic parameters, the elements were quantified using the technique of Optical Emission Spectrometry with Inductively Coupled Plasma Source - ICP-OES (Optima 8000 PerkinElmer) using the American Water Works Association 3111B Determination Method. [17] This technique allows the quantification of the chemical elements present in the sample based on the property of excited atoms or ions to emit electromagnetic radiation in the regions of the visible electromagnetic spectrum. Plasma acts enabling the quantification of a wide range of analytes, since it has enough energy to generate the excitation of chemical elements. In addition, the samples underwent an acid digestion procedure in order to remove the organic compounds present, thus facilitating the reading of the desired inorganic compounds. [17] The evaluation of turbidity, ammonia, nitrogen-nitrite and phosphorus was performed using the Spectrophotometer DR 6000 UV--VIS (Hach) through radio frequency identification (RFID). Additionally, the evaluation for total solids and total dissolved solids was performed using a conductivity meter (DM-32 Digimed). The results obtained were tabulated using Microsoft Excel software for later comparison and discussion with data previously published by DESO (Department of Sanitation of Sergipe) in 2009.

In addition to data collection and analysis of parameters, a visit was made to the region in order to observe environmental impacts, natural phenomena, without the presence of waste in improper places (in the analysis area) and the presence of riparian forest.

RESULTS

The results of the bacteriological and

physical-chemical analyzes for 2015 are shown in Table 1 below:

The data collected through documentary research referring to Riacho Grilo are shown below in table 2. These allow the comparison, analysis and presentation of possible explanations and/or solutions.

Among the information collected, a negligible difference was observed between the parameters of the 2015 and 2009 tables due to heavy rain in the previous days and during the sample collection, in addition to the margin of error of the analysis, they are: temperature, pH, ammonia, nitrogen/nitrate and turbidity. Phosphorus is zero in the second table, while in the first it has a concen-

Table 1. Bacteriological and physical-chemical analyzes of Riacho Grilo in 2015.

Ensaio	Volume (mL)	Resultado	LQ	Método
Temperatura da Amostra (campo)	100	26,0 °C	--	Sonda multiparâmetros
Turbidez	25	129 uT	0,5	RFID
pH (campo)	100	6,73	--	Sonda multiparâmetros
Cloretos	100	36,3 mg/L	3,0	Bureta Digital
Sólidos Totais	50	<5,0 g/mL	5,0	Condutividade
Sólidos Totais Dissolvidos	100	95,59 mg/L	5,0	Condutividade
Amônia	10	1,09 mg NH3-N/L	0,2	RFID
Nitrogênio-Nitrito	10	0,03 mgNO2-N/L	0,01	RFID
Fósforo Total	50	0,262 mg/L P	0,009	RFID
Coliformes Totais	100	2,2X102 NMP/100mL	--	Semeio em Placa
Coliformes Termotolerantes	100	1,7X102 NMP/100mL	--	Semeio em Placa
Cobre Total	100	0,027 mg/L	0,004	ICP-OES

Source: Own Authorship (2020).
Legend: LQ: Quantification Limit; RFID: Radio Frequency Identification; ICP-OES: Optical Emission Spectrometry with Plasma Source inductively coupled.

Table 2. DESO data for the year 2009 from several springs in the State of Sergipe, highlighting the Riacho Grilo in question in the study.

Manancial	Riacho Brejo	Rio Paripe + Poços	Rio Itamirim	Riacho Grilo	Riacho Areias
Local de Coleta	ETA Cristinápolis	ETA Indiaroba	ETA Itabaianinha	ETA Boquim	ETA Pedrinhas
Data de coleta	08/06/2009	08/06/2009	08/06/2009	29/05/2009	11/05/2009
Hora	13:20	10:00	14:45	15:10	10:00
Temperatura (°C) da amostra	25	25	25	25	25
Turbidez (UNT)	21,4	44,6	28,3	168	34,2
Ph	6,84	7,31	6,95	6,72	6,77
Cloreto (mg/L)	29,58	21,94	26,05	24,64	46,62
Sólidos totais (mg/L)	114	186	140	266	202
Sólidos totais dissolvidos (mg/L)	77,01	72,42	54,57	55,59	113,22
Amônia (mg/L)	1,69	2.43	0,99	1,1	1,16
Nitrato (mg/L)	0,36	0,08	1,10	0,82	0,32
Nitrito (mg/L)	0	0	0	0,02	0
Fósforo Total (mg/L)	0,03	0,06	0,03	0	0
Coliformes totais A86	1000	2000	1500	4500	800
Coliformes termotolerantes (UFC/100mL)	100	100	200	600	100

Source: DESO (2009).
Legend: ETA: Water Treatment Plant; UNT: Nephelometric Turbidity Units; UFC: Colony Forming Unit

tration of 0,262 mg/L. In addition, there was an increase in Chloride in the 2015 table compared to 2009. There was also an increase in solids in general in the first table, compared to the second, with a reduction in Coliforms in the 2015 table. It is important to note that the Total solid parameters in the first table are in the unit g/mL and in the second in mg/L.

In the analysis carried out, due to the high scientific use in copper metal industries, the test for this heavy metal was added, which in low doses is essential for the ecosystem. Thus, the dissolved copper value in the 2015 sample was 0,027 mg/L, considered a high concentration. Furthermore, in the visit to the region, in order to observe the environmental impacts and natural phenomena of the place, the presence of garbage in undue places in the analysis area was not found and this presented a great presence of riparian forest.

DISCUSSION

In view of the analyzes carried out, the obtaining of zero phosphorus in the second table, while in the results of the analyzes it has a concentration of 0,262 mg/L, is due to the presence of fertilizers, pesticides, chemicals in general or the presence of water drained in the agricultural area 12 which can cause excess phosphorus in water resources. To be null, either there was a decrease in these factors or it was the result of the rains that caused dilution, masking this data.

The increase in Chloride may have occurred due to the intrusion of the saline wedge, and also, due to some spillage of sanitary sewage in its tributary (Rio Piauitinga) and may have followed the route to its sub-tributary (Riacho Grilo). Although the fecal coliform test is more specific, the assessment of chloride serves as an indicator of contamination by sanitary sewage, and may associate its elevation in a river with spillage of sewage. In addition, it has an important factor in aquatic ecosystems since microorganisms are influenced by changes in their cell osmotic pressure. [18] In addition, it was possible to notice an increase in solids in general in the first table. This increase in total solids makes it possible to retain bacteria at the bottom of rivers and, as a consequence, may justify the reduction of Coliforms in the results obtained.

Low-dose copper is essential for the ecosystem, so it is important to obtain up to the maximum value of dissolved copper for Class 2 of water in 0,009 mg/L.

Low-dose copper is essential for the ecosystem, so it is important to obtain up to the maximum value of dissolved copper for Class 2 of water in 0,009 mg/L (CONAMA nº 357/2005). [19] Thus, the allowed value disagrees with the value found in the 2015 sample result. If found in a high concentration, continued intake of this metal above the animals' dietary levels can lead to an accumulation of the element in various tissues, especially in the liver, leading to eventual intoxication. [18] In addition, the accumulation of heavy metals in aquatic organisms compromises the entire food chain since the metal is accumulated by a process known as bioaccumulation. In this way, top chain organisms tend to have higher concentrations of the metal than those based on chain. [20] Clinical signs can be seen as nausea, apathy, vomiting, hemorrhagic diarrhea, kidney and liver problems. [21] Therefore, according to the current CONAMA resolution, the results make the water unsuitable for the characteristic use of its class.

The results of this work are in accordance with the ordinance of the Resolution of the National Environment Council - CONAMA No. 357/2005 for Class 2 of waters, with few changes between the parameters. [19] Knowing that the presence of certain substances in the composition of the waters is necessary for the maintenance of the life of aquatic organisms, the presence of substances foreign to its composition due to the inadequate actions of man to the environment, have impaired its use and its dynamic balance. [22] Thus, this result confirmed the importance of meeting this ordinance, considering that the well-being and health of the human being, as well as the protection of aquatic communities and the aquatic ecological balance are dependent on the quality of the waters. Furthermore, the fact that garbage is not found in undue places in the analysis area, makes it possible to understand that the region is at least preserved against human action. However, it is necessary to pay more attention to the presence of certain substances, alerting citizens to the need to adopt attitudes and measures that can guarantee the chemical and microbiological characteristics, in order to develop adequate sanitary conditions for drinking water. [23]

CONCLUSION

In addition to other uses, the waters of Riacho Grilo supply two municipalities in Sergipe, Salgado and Boquim. It remains well preserved in all its aspects: preserved riparian forest, continuous flow and little contact with animals in that region. Therefore, it is concluded that its drainage for supply during the

analyzed period from 2009 to 2015 does not indicate that it has caused environmental impacts for the stream.

Among the results of the bacteriological and physical-chemical analyzes, the data referring to phosphorus and chloride are indicative of the introduction of chemical products in Riacho Grilo. The decrease in the presence of coliforms may be due to rain and values for total solids that can lead to bacteria retention. According to the current CONAMA resolution, the high amount of copper in the sample makes Riacho Grilo unsuitable for the use of water in its class, requiring further analysis for further investigation.

The purpose of the studies allowed to present a debate about the current situation of the sub-affluent road, besides creating a reflection on the sustainability that would guarantee a control of the environment in research. It is necessary to highlight the insufficient quantity of recent articles about the territorial and hydrographic area of the state of Sergipe. It is hoped that the present work will serve as a discussion for future studies. ■

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