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Evaluation of heavy metals and environmental pollutants in Rio do Sal (Nossa Senhora do Socorro - SE) and its impact on human health

Evaluación de metales pesados y contaminantes ambientales en el Rio do Sal (Nossa Senhora do Socorro - SE) y su impacto en la salud humana

Avaliação de metais pesados e poluentes ambientais no Rio do Sal (Nossa Senhora do Socorro - SE) e seu impacto na saúde humana

ABSTRACT
The purpose of this article was to analyze the concentration levels of heavy metals and pollutants into the Rio do Sal as, given that residents of its banks have used it as food, water and leisure sources. One of the most common environmental problems is the chemical pollution resulting from residential and industrial effluents. Considering the period that heavy metals persist in water bodies, it is essential to evaluate their levels of incidence in the environment. The method applied was a data collection conducted in June 2011 in the banks of the studied river located in Nossa Senhora do Socorro/SE. For the analysis, atomic absorption spectroscopy was applied. The result demonstrated high concentration of heavy metals that exceed the maximum level allowed by CONAMA. The conclusion revealed, therefore, that Rio do Sal is unsuitable for human consumption due to elevated amounts of copper.
DESCRIPTORS: Toxicology; Environmental Analysis; Heavy Metals.

RESUMEN
El objetivo del artículo fue analizar metales pesados y contaminantes del Río de Sal y su impacto en la salud humana, considerando que residentes de sus márgenes lo utiliza como fuente de alimento, agua y entretenimiento. Actualmente uno problema ambiental común es la contaminación química derivada de los vertidos residenciales e industriales. En vista del tiempo que los metales pesados persisten en cuerpos hídricos, resulta fundamental investigar sus niveles en el medio ambiente. El método aplicado fue una colecta de datos realizada en junio de 2011 a orillas del Río de Sal ubicado en Nossa Senhora do Socorro/SE. El análisis empleado fue mediante una Espectroscopia de Absorción Atómica. El resultado mostró la presencia de metales pesados que superan el límite máximo permitido por el CONAMA. La conclusión reveló, entonces, que el Río de Sal no es considerado apto para el consumo humano debido a las elevadas cantidades de cobre.
DESCRIPTORES: Toxicología; Análisis Ambiental; Metales Pesados.

RESUMO
O objetivo deste artigo foi analisar metais pesados e poluentes no Rio do Sal e o seu impacto na saúde humana, considerando que moradores de suas margens o utiliza como fonte de alimento, água e lazer. Atualmente um dos problemas ambientais mais comuns é a poluição química decorrente dos despejos residenciais e industriais. Tendo em vista ao tempo que os metais pesados persistem em corpos hídricos, torna-se fundamental uma pesquisa acerca de seus níveis no meio ambiente. O método aplicado foi uma coleta de dados realizada em junho de 2011 as margens do Rio do Sal localizado em Nossa Senhora do Socorro/SE. A análise empregada foi através de Espectroscopia de Absorção Atômica. O resultado demonstrou a presença de metais pesados que ultrapassam o limite máximo permito pelo CONAMA. A conclusão revelou, portanto, que o Rio do Sal é considerado impróprio para consumo humano devido a quantidades elevadas de cobre.
DESCRITORES: Toxicologia; Análise Ambiental; Metais Pesados.

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INTRODUCTION

One of the most serious problems affecting the environment is chemical pollution of an organic or inorganic nature, which occurs due to residential and industrial dumping. Pollution is defined as any physical, chemical or biological change that causes a change in the normal biological cycle, interfering with the fauna and flora of the environment. Water pollution, one of the most serious, causes changes in the physical, chemical and biological characteristics of the waters, which are decisive for their quality, and may make their use for human consumption impossible.[1]

The growing increase in the disposal of heavy metals in the environment, or even their misuse in agriculture, through industrial and mining activities, among others, cause a significant environmental problem with risks that are often unknown.[2] Chemically, heavy metals are defined as a group of elements located between Copper and Lead in the periodic table having atomic weights between 63,546 and 200,590 and density greater than 4,0 g/cm^3. [3] However, toxicity will occur when its concentrations exceed the tolerance limit of the organisms, that is, within certain parameters they will not cause problems to living beings.[3]

Some of these heavy metals are among the most harmful pollutants. They are known as toxic metals, the main ones being lead, cadmium and mercury. The most relevant mechanism of toxicity is certainly the inactivation of enzymes.[4] This occurs with bivalent transition metal reacting with the amino and sulfhydryl groups of the proteins. Some of them can compete with essential elements and replace them in enzymatic metabolism, such as zinc, copper, mercury, iron, among others, for example. Some metals can also damage cells, by acting as anti-metabolic or by forming precipitates or chelates with essential metabolic agents.[5,6]

Rio do Sal is a sub-basin of the Sergipe River and is the main hydrographic supplier in the municipality of Nossa Senhora do Socorro, in addition to also supplying water to Aracaju.[7] It is a river that has a length of 20,5 km draining an area of approximately 62 km^2. However,

nowadays, this affluent has been undergoing strong ecological degradation due to the action of man. Deforestation for the construction of buildings, construction of stilts in the region, discharge of industrial and domestic effluents are just some of the main anthropic actions that have been attacking the local environment.[8] Located in the north of the state, Rio do Sal contributes to the water supply of the less prevalent areas of Aracaju and Nossa Senhora do Socorro, such as Lamarão, Bugio, Soledade and Porto Dantas.[9]

Rio do Sal bears this name due to the large exploitation of salt flats that occurred in the 1980s, however, this exploitation today does not have as much profit as in the past. Despite this, this tributary is still widely used by the local population for the development of the region's economic activity through its high functionality, such as fishing, use of clay, domestic supply and irrigation. However, the lack of environmental sustainability practice has considerably affected the ecological environment, directly affecting the population that makes Rio do Sal its own benefit.[10]

In view of the high persistence time of heavy metals in water bodies, it is essential that the assessment of their contamination levels can transcend diagnoses based solely on comparison with legal indices, and incorporate a dynamic analysis of monitored concentrations, through studies that allow to understand the behavior in the aqueous environment and provide more solid bases for the evaluation of the risk associated with them. [5] Therefore, this study aimed to analyze heavy metals in Rio do Sal, as well as the presence of pollutants that may interfere with water quality considering that residents of its banks use it as a source of food, water and leisure, which may be consuming water contaminated by heavy metals and various pollutants that can cause future health problems.

METHODS

It consisted of a bibliographic and on-site study in order to analyze the water samples from Rio do Sal. The data collection was carried out on June 12th, 2011 on the banks of the Rio do Sal located in the Conjunto Governador João Alves Filho - Nossa Senhora do Socorro/SE. The collection was carried out in the morning at 9:00 am and sterile plastic containers with wide mouths were used to collect 500 mL of water for evaluation. The environmental conditions were favorable and it had not rained in the past seven days. With the aid of a camera with a resolution of 2.0 megapixels, several images of the collection site were recorded. The collections and storage of the samples for water quality analysis were carried out following the appropriate procedures to guarantee the integrity of the samples and the reliability of the results. The collected sample was sent for analysis at the Environmental Studies Laboratory (Laboratório de Estudos Ambientais - LEA) at the Technology and Research Institute (Instituto de Tecnologia e Pesquisa - ITP) located at the Farolândia Campus of the Tiradentes University, Aracaju/SE.

The choice of the evaluated metals was based on the presence of several factories in the region with great potential for releasing these components into the environment, including metallurgical and smelting factories. Therefore, the analysis of Lead, Cadmium and Copper were considered relevant. The metals were analyzed using the Atomic Absorption Spectroscopy (AAS) technique following the American Water Works Association Method of Determination 3111A. [11] This technique allows the quantitative determination of the chemical elements present in the sample based on the absorption of radiation by free atoms in the gaseous state. This is only possible due to the presence of a flame that converts the sample aerosol into atomic vapor, facilitating the absorption of light from a primary source.[12] The quantification of the evaluated metals was performed using the Aanalyst 300 (Perkin Elmer) equipment with AA WinLab data acquisition and analysis software, version 4.1. The results obtained were tabulated using Microsoft Excel software for later comparison and discussion with the data previously published by CONAMA Resolution No. 357.

The interpretation of the results was based on the maximum values for each evaluated component established by the CONAMA Resolution 11 no. 357, of March 17th, 2005 published in the Federal Official Gazette - DOU No. 053 pages. 58-63 that "Provides for the classification of bodies of water and environmental guidelines for their classification, as well as establishing the conditions and standards for effluent discharge, and other measures.[13]

RESULTS

The results of the toxicological analyzes for the year 2011 can be seen in table 1. The data presented show that lead and cadmium have concentrations which respect the maximum environmental values established by the environmental supervisory body. On the other hand, copper presented high levels in relation to that recommended by the same organ, which is already a factor that puts at risk the health of the riverside population that uses

Table 1. Analysis of heavy metals in Rio do Sal in 2011.

Analito	Resultados	Referência CONAMA
Chumbo (Pb)	0,01 mg/l	0,033 mg/l Pb
Cádmio (Cd)	0,005 mg/l	0,01 mg/l Cu
Cobre (Cu)	0,05 mg/l	0,013 mg/l Cu

CONAMA: National Environment Council (Conselho Nacional do Meio Ambiente). Source: Own authorship (2020).

the waters of the Rio do Sal.

In addition to the changes observed by heavy metals, environmental contamination due to the presence of various pollutants at the site was also analyzed. On the day of the collection, images were recorded to show the situation in which Rio do Sal was in that period. Figures 1 and 2 demonstrate the presence of various pollutants, such as pet bottles, tires, plastic bags, glass and residential waste, where they were found on the water and on the banks of the river. These findings contribute to the increased risk to the riverside population, in addition to strengthening the need for sanitary measures aimed at the treatment of Rio do Sal effluents, as well as their environmental preservation.

Figure 1. Shore of Rio do Sal.

Source: Own authorship (2020).

Figure 2. Presence of contaminants in Rio do Sal.

Source: Own authorship (2020).

DISCUSSION

Analyzing the data generated and relating them to the maximum levels established by the CONAMA Resolution, it can be inferred that Lead and Cadmium are within the permitted limit. This result is a great advantage, since high concentrations of these metals are quite toxic to the human body, in addition to causing cancer, neurological damage and causing abortion in pregnant women.[14,15] Unlike Cadmium, it is observed that the value presented for Copper is considerably high when compared to the normal values established by CONAMA. Changes like these can be directly linked to concentrations of these elements in the human body from exogenous exposures.

Copper analyzes show concentrations approximately four times higher than the maximum allowed content. This high content may be related to the presence of existing industries around the urban perimeter, such as the textile and soap industries. According to Alloway and Ayres [16], the main source of contamination by this metal is mainly due to industrial processes and agricultural activities. Copper is part of several biochemical processes in humans, but it can cause serious complications when at high rates in the body. One of the main consequences of contamination by this element is Wilson's disease: genetic dys-

function where pregnant women have high concentrations of this metal accumulated in the baby, affecting mainly the liver and the brain, in addition to causing neurological disorders.[17]

In addition to copper, the Rio do Sal basin was also characterized by the presence of cadmium, although it does not present values beyond what is permitted. However, it is necessary to pay attention and continue to monitor this hydrographic basin in an attempt to prevent its concentration along the river. Cadmium is known to be a very toxic chemical element, especially when in its ionic form, which is the most common form in freshwater or low salinity environments. Like copper, it has great chances of contamination of the population living on the banks of the Rio do Sal and are dependent on this hydrographic medium for survival, in addition to being responsible for the contamination of the region's fauna and flora.[18]

Cadmium is easily absorbed by nature, mainly by the aquatic environment, compromising the entire ecosystem. Fish and aquatic plants also suffer contamination by this metal, which may be one of the reasons for the extinction of several species.[19] According to Cardoso and Chasin[18], the main origin of cadmium is related to the mining and metals industry. These being the main emitters of this element in the environment. Such contamination occurs through the drainage of mines and, also, by rains from mining regions in addition to corrosion of the pipes. Contact with cadmium can lead to serious health problems in humans, such as respiratory, cardiovascular, renal, skeletal and liver diseases. In addition to these, he is responsible for immunological changes, chronic diseases and cancer due to occupational activity.[18]

In addition to these problems, Rio do Sal presents several other factors that have directly affected the quality of life of the riverside population. Currently, the river suffers from several serious problems that are related to the lack of basic sanitation, adequate sewage treatment, disorderly occupation of its banks, deforestation, various contaminants and open dumps are the main reasons that make Rio do Sal inappropriate for use.[10]

A study by Souza[20] and analyzed by Quinatto et al. [21] evaluated the quality of the waters of the Rio do Sal through the analysis of several parameters, creating an empirical model for the monitoring of water resources. The parameters evaluated were Turbidity, Dissolved Oxygen, pH, Faecal Coliforms, Total Residual and Biological Oxygen Demand. Evaluating the results obtained, Souza concluded that Rio do Sal presents a high degree of pollution, resulting from the launching of domestic and industrial waste, as well as urban waste. Observing the results obtained and relating them to this research, it is observed that the Rio do Sal had no effective treatment of decontamination of its waters since 2003 until the completion of the present work in 2011, which shows that it still remains contaminated. Thus, it is necessary to have a management plan to control its waters in order to make them viable for human consumption and supply to the population dependent on this resource. [21]

Cadmium is known to be a very toxic chemical element, especially when in its ionic form, which is the most common form in freshwater or low salinity environments.

Lessa and Silva[22] performed the analysis of the same parameters observed by Souza.[18] However, they assessed the water quality of the Sergipe River in the municipality of Laranjeiras, located in the west of the state, that is, in the initial portion of the Sergipe basin. As a result, it was observed that such parameters are within normal limits, except for faecal coliforms, which showed a value above normal. Observing that the Rio do Sal is located in the terminal portion of the Sergipe River basin, its contamination by fecal coliforms may come from the path that the river takes from its source until it flows into the Atlantic Ocean, bringing all this waste from the other tributaries, which can accumulate on the banks of the river. Human activity in the Rio do Sal region has also contributed to changing this parameter, since domestic waste is directly discharged into the river's waters and the lack of basic sanitation is precarious. [16]

The ecological imbalance caused by the presence of heavy metals in the environment contributes to environmental degradation, affecting the quality of life of those who live there.[13] Thus, it was observed how much human action can influence socio-environmental problems in addition to being the main responsible for the disorders of man in nature.

CONCLUSION

The results about the levels of concentration of heavy metals in the waters of Rio do Sal provided a favorable diagnosis regarding the presence of lead and cadmium. Regarding the presence of copper, the results showed values above the maximum limit established by CONAMA. Therefore, other tests are necessary to better understand this pollution on the

spot. These tests will serve as a way of controlling and monitoring the levels of these components in Rio do Sal, serving as a way of evaluating such elements over the years.

The contaminants observed show that a cleaning request must be made to the competent agency of the City Hall. In addition, it is necessary to place garbage collectors in specific locations and carry out action research involving inhabitants of its banks in order to raise awareness and enable experiences of attitudes that will contribute to the survival of this river and these individual's quality of life. For this, an effective environmental management that focuses on education and ecological preservation is recommended, so that it favors greater interaction between public agencies and society. ■

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