Chapter 59

Municipal public management and the conservation of water resources: a case study of the microbiological quality of a pond located in the city of Caucaia

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ABSTRACT
Industrial and technological growth and development, with an intense urbanization process, cannot be carried out only by the economic aspect, exposing natural resources to contamination. The release of effluents, without proper treatment, impairs the quality of the water, and it is up to the public power to effectively comply with the inspection and awareness of civil society, aiming at the preservation of water resources. For the development of this article, applied, explanatory research was used, characterizing itself as a case study, selecting for this study a lake located in the municipality of Caucaia, state of Ceará. Thus, the general objective of this work was to study the microbiological quality of water in a pond, located in the municipality of Caucaia, state of Ceará, based on Resolution Nº 396, of the National Council for the Environment (CONAMA). The experimental study was carried out by studying the microbiological analysis of the water, detecting the presence of total coliform microorganisms, thermotolerant coliforms, and the presence of E.coli. It was observed that the tests were positive for the detection of total and thermotolerant coliforms and Escherichia Coli. One of the main reasons that may have influenced the positive results is the presence of solid and liquid waste, including sanitary sewage, capable of offering health risks or making the water degradable for recreation and fishing. Therefore, more effective action by the government is needed concerning the inspection of effluent treatment, as well as carrying out environmental education campaigns and sanitation and cleaning actions around this water body.

Keywords: Water body, Conservation, Total coliforms, Thermotolerant coliforms, E.coli.

1 INTRODUCTION

In the current world scenario, awareness has been increasing that the process of growth and technological and industrial development, associated with the intense process of urbanization, cannot be carried out solely from the economic point of view, exposing natural resources to contamination. Due to the change in society's habits, the increase in water consumption, and the increasing release of waste from human activities, it is necessary to search for sustainable development, where there is a balance between economic and social development, preservation of the environment, and quality of life.

The public and strategic management of water resources must be treated as a priority by Organs management bodies, as it is of fundamental importance for the conservation and good use of water. Because

it is unique, natural, and essentially good for human beings and the balance of ecosystems, showing clear signs of scarcity and pollution, the Public Power must emphasize the necessary attention and care for water resources.

The management of water resources must count on the participation of the Public Power, users, and the community. Water resources management is understood as a set of actions and measures aimed at regulating the use, management, and protection of water bodies.

One of the major problems faced by communities is the pollution of water bodies. Water pollution is the alteration of its characteristics by any actions or interferences, whether natural or anthropogenic. As a result of pollution, several diseases may be associated with water, such as cholera, hepatitis, amebiasis, and others, harming health.

All public policies related to health, the environment, social well-being, and urban and regional development must be concerned with universal access to drinking water. For adequate management of water resources, the Municipal Power can use strategic actions that make the population aware and encourage participation in the water preservation process, such as environmental education in schools, population awareness, and participation in environmental preservation actions. and water resources, through the organization of forums. Another strategy that can be carried out by the Government is the monitoring established in the National Water Resources Policy, intending to classify water bodies according to the predominant uses of water, using, as a criterion, their quality standards. Monitoring provides the necessary basis for water management, with a focus on maintaining and preserving water resources.

Thus, the general objective of this work was to study the microbiological quality of water in a pond, located in the municipality of Caucaia, state of Ceará, based on Resolution Nº 396, of the National Council for the Environment (CONAMA). The specific objective was to identify some measures that can be taken by the Government to improve water management.

The need for sustainable development exposes situations that force the Public Power to think about management forms, making it necessary to apply a model that can guarantee the perpetuation of natural resources and that ensures life in the urban environment, such as water resources. . Despite the various environmental legislations that address the use of water, conservation and preservation work is still carried out slowly, due to lack of financial resources to implement the necessary actions, lack of popular awareness and even governmental spheres, on the importance of conservation and recovery of water resources in urban development.

Given the argument above, studies such as the present work, addressing public management and conservation of water resources, become important, considering the relevance of the theme and the lack of effective measures for the preservation of water bodies at national, state, and local levels. municipal.

For the development of this article, applied and explanatory research was used, characterized as a case study, to study effective public municipal actions for the preservation of water resources, select for this study a lake located in the municipality of Caucaia, state of Ceará. The experimental study was carried

out by studying the microbiological analysis of the water, detecting the presence of total coliform microorganisms, thermotolerant coliforms, and Escherichia Coli microorganisms.

This article is structured in Introduction, Development, Materials and Methods, Results, Conclusions, and References. The Introduction presents, to the reader, the theme, the research problem, the justification, and the objectives of the study.

Development is divided into Theoretical Foundation, Materials and Methods, and Analysis of Results. The Theoretical Foundation presents the theoretical framework of the work, contextualizing some basic concepts related to the theme, which will underpin the practical part of the study. The Materials and Methods bring the methodological procedures that guide the work. The results bring the case study, bringing information about the microbiological quality of the water in the analyzed lagoon and suggestions to improve the planning of the management of water resources in the municipality of Caucaia.

The conclusions about the work carried out bring recommendations for the effective management of water resources and are followed by references.

2 DEVELOPMENT

Theoretical foundation

Water is the basis of life on Planet Earth as it maintains biodiversity, and the survival of the human species supports the economy of regions, countries, and continents and is essential for food production. Therefore, understanding water as a substance, and understanding its ecological, economic, and social role on planet Earth is extremely relevant and of great current and future importance (TUNDISI; MATSUMURA-TUNDISI, 2020).

In modern society, whether on a global or local level, changes are common and extremely fast. The technical-scientific evolution of this time and the great urban growth must be organized sustainably, taking into account environmental issues: such as climate, vegetation, biodiversity, water resources, and atmosphere. The importance of water resources management systems, by governments, with the effective participation of civil society, becomes a subject of extreme relevance for populations in general (DA SILVA, 2003).

The extraordinary process of technological and industrial growth and development, associated with the intense urbanization process that took place from the second half of the 20th century onwards, has influenced profound changes in the living standards of modern society. This process was reflected in the increase in water consumption and the ever-increasing release of waste from these activities (REIS; QUEVEDO; NAIME, 2013).

As society has become more economically developed and more complex, the multiple uses of water have also become more diversified. Such diversification makes water management a specialized task and of high technical value, since it is necessary to use its multiple uses, to use water most efficiently and

economically possible, avoiding the pollution of water resources (TUNDISI; MATSUMURA -TUNDISI, 2020).

Water pollution is understood as the alteration of its characteristics by any actions or interferences, whether natural or anthropogenic. These alterations can produce aesthetic, physiological, or ecological impacts. The term contamination is used in situations where one or more substances are found in the environment, but do not cause any noticeable damage, while the term pollution is used for cases where harmful effects are evident (ORTIZ; AMÉRICO-PINHEIRO, 2016).

The management of water and the associated environment, notably soils, is strongly linked to the evolution and experience of public planning for the use and conservation of water resources. In recent decades, the environmental paradigm has significantly expanded the concept of water supply integrated with the effects of interventions and management actions in ecosystems associated with the defense of aspects of nature. In other words, the importance of preventing pollution has grown, with ecological quality currently being one of the parameters to be taken into account in public management planning concerning water use (FERREIRA; CUNHA, 2005).

For the implementation of efficient water management, the concomitant existence of an effective institutional system focused on the management of these resources is essential. It is also important to point out that there are no standardized models or rules for the implementation of water management since each hydrographic basin has its peculiarities relevant to environmental, economic, social, cultural, and geographic aspects (DA SILVA, 2003). Thus, enabling economic and educational political measures, in the local context, in the case of the Municipality of Caucaia, and regional or even global, is a matter of extreme relevance and the present study will contribute, providing information on this issue.

Lagoa do Tabapuá – Municipality of Caucaia

The municipality of Caucaia is located in the Metropolitan Region of Fortaleza, in the Northeast portion of the state of Ceará, bordering the municipalities of Fortaleza, São Gonçalo do Amarante, Maracanaú, Maranguape, Pentecoste, in addition to the Atlantic Ocean. It comprises an irregular area of 1,293 km2. The municipality of Caucaia is fully inserted in the Metropolitan Hydrographic Basin and its main drainages are the Ceará, Cauhipe, and Anil rivers, in addition to the Juá creek (SECRETARIA DE MINAS E METALURGIA, 1998).

Parque Tabapuá is a neighborhood in the city of Caucaia - CE, built-in 1968 by the 4th Army Engineering Battalion to house federal public servants. It is on the banks of the BR-222 and covers the entire swamp in the municipality. The tabapuã lagoon is located in the Tabapuã neighborhood, Caucaia, Microregion of Fortaleza, Metropolitan Mesoregion of Fortaleza, Ceará, Northeast Region, Brazil.

Knowledge of the water quality of Lagoa do Tabapuá, for multiple uses, has been a constant concern of Caucasian society and municipal authorities. The causes that influence poor water quality are numerous. With the permanent degradation of the environment by man, the production of solid waste and chemical

products, often released into water courses, has increasingly aggravated this problem. As the solution to this problem requires the participation of several sectorial institutions, and as the joint and concomitant action of these institutions is still deficient, the issues are partially resolved and investments are carried out ineffectively (PLANO STRATEGICo DOS RECURSOS HÍDRICOS DO CEARÁ, 2009).

Water quality analyzes are necessary to know the situation of the water body about the anthropic activities that occur in them or their surroundings. Through this instrument, it is possible to plan the multiple uses of water bodies and to control the impact that these uses can generate (COSTA et al., 2012). The quality standards referred to in this research deal with bacteria from the total and thermotolerant coliform group, specifically the E. coli microorganism.

3 MATERIALS AND METHODS

3.1 STUDY AREA

The analysis was carried out at Lagoa do Tabapuá, located in Bairro Tabapuá, Municipality of Caucaia, Rua Santos Dumont. The waters of the lagoon present, nowadays, a dark tone, the presence of solid residues, vegetation on its margins, and, in its surroundings, there are residences.

3.1.1 Sampling

The collections made for the detection of total coliforms and thermotolerant coliforms were carried out on August 1, 2022. Water samples were collected manually and superficially, between 30 and 50 cm deep, in sterile glass bottles, kept under refrigeration at a temperature of 4º C, and sent to the Laboratory of Microbiological Analysis of the Federal Institute of Education, Science, and Technology of Ceará - Campus Caucaia, for analysis.

Table 01 – Reference Analytical Methods used in Water Analysis.

Organism	Methodology
Total coliforms	APHA et al.
Thermotolerant coliforms	APHA et al.
Escherichia Coli	APHA et al.

Source: Author (2022).

Initially, 1 mL of the sample was transferred to 2% Brilliant Green Bile Broth (BVB) and these were incubated in a water bath at 35º C for 24-48 hours, containing the inverted Durhan tube. Those tubes in which gas production and turbidity occurred were considered positive.

For each positive tube of 2% Brilliant Green Bile Broth, an aliquot was transferred to tubes containing Escherichia coli Broth (E.C) which were incubated in a water bath with circulating water at 45º C/24-48 hours, for detection of thermotolerant coliforms.

3.1.2 Microbiological Tests

Table 01 shows the reference analytical tests that are defined in the "Standard Methods for The Examination of Water, 2006 edition.

4 RESULTS ANALYSIS

Table 02 shows the result of the microbiological analysis of the water in Lagoa do Tabapuá, carried out in August, regarding the detection of the presence of Total Coliforms, Thermotolerant Coliforms, and Escherichia coli.

Table 02 – Results of microbiological tests of water collected in Lagoa do Tabapuá.

Organism	Presence of microorganisms
Total coliforms	+
Thermotolerant coliforms	+
Escherichia Coli	+

Source: Author (2022).

It was observed that the tests were positive for the detection of total and thermotolerant coliforms and, specifically, for Escherichia Coli. One of the main reasons that may have influenced the positive results is the presence of solid and liquid waste, including sanitary sewage, capable of offering health risks or making the water degradable for recreation. In general, the presence of total coliforms is linked to the discharge of domestic effluents that have a high concentration of these microorganisms. However, while total coliforms may be present in the water, due to the organic load, E.coli comes exclusively from the fecal origin and indicates recent fecal contamination.

Photo 01 shows the growth of total coliforms in 2% brilliant green bile broth.

Photo 01- Growth of total coliforms in brilliant green bile broth.

Source: Author (2022).

Bacteria from the coliform group normally inhabit the intestinal tract of warm-blooded animals, as indicators of contamination of a water sample by feces, in addition to naturally occurring in soil and vegetation. Most water-associated diseases – called water transmission or transmission – are transmitted by the fecal route, that is, the pathogenic microorganisms, eliminated through the feces, reach the aquatic environment. In this way, contamination of people who supply themselves, or, in a broader context, who have contact with this water, may occur (DA SILVA, 2019).

Photo 02 shows the gas formation and growth of the E.coli microorganism in the E.coli broth.

Photo 02- Growth of the E.coli microorganism in the E. coli broth.

Source: Author (2022).

E.coli is a bacterium belonging to the Enterobacteriaceae family, being the most important species, it is inserted in the group of fecal coliforms, which indicate fecal contamination of food or water, which can cause an unwanted reaction, being pathogenic to man and others. animals (BRINQUES, 2015). The presence of total coliforms and E.coli in the water of the Tabapuá lagoon points to a risk to the environment and public health, with the possibility of an increase in waterborne diseases and a decrease in the quality of the water body, such as the occurrence of eutrophication and release of foul gases.

Regis (2022) studied the microbiological quality of a pond located in the city of Russas, similarly to the present work, identified the presence of total coliforms, thermotolerant coliforms, and E.coli. Da Silva et al., (2019) studied the microbiological quality of a well located in Sítio Alegre in the municipality of Lagoa Seca-PB and verified the existence of total coliforms and thermotolerant coliforms, however, contrary to the result observed in the present work, the authors did not verify the presence of E.coli. This contamination also harms the economic activity of fishing, as there may be contamination of the population due to the consumption of contaminated fish from this lagoon.

According to Resolution No. 396, of the National Council for the Environment (CONAMA), water for human consumption and animal drinking needs to be free of E. coli and thermotolerant coliforms. It was found that the contamination of the lagoon remains effective, requiring awareness of the surrounding population, in addition to the application of efficient cleaning measures, which must be carried out by Organs competent bodies.

The set of normative legislation to monitor water quality is very vast and needs to be considered by the public authorities. Municipal, state, and federal authorities must work together with civil society to ensure compliance with established rules, preserve environmental quality, and protect the health of the population, guaranteeing the right to quality water.

5 CONCLUSION

The Tabapuá lagoon is of great importance for the leisure of the population of Caucaia, and it is common to practice physical exercises on its banks, as it is located in the urban area of the municipality of Caucaia. Another important role is the development of economic activities, such as fishing. The Tabapuá lagoon is of fundamental importance in improving the microclimate in the municipality of Caucaia, in addition to serving as a recipient of urban drainage.

Microbiological analyzes indicated that there is a fecal contamination process in Lagoa do Tabapuá, as the presence of total and thermotolerant coliforms and, specifically, of E. coli was detected. Due to the presence of these microorganisms, the waters of the Tabapuá lagoon do not have adequate microbiological quality for the development of fishing, and it is not safe to consume fish from the lagoon or to use the water body for recreation, due to the risk of contracting diseases, because of the indications of contamination by discharges of domestic effluents.

In this sense, it is recommended the adoption of some measures, through the municipal public power, such as regular cleaning of the areas around the lagoon, environmental education actions with the population, frequent collection of garbage, greater effectiveness in the inspection against illegal canalization of effluents and compliance with established rules, to preserve environmental quality and protect the health of the population, guaranteeing the right to quality water.

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