



## Evaluation of data on bathing indices of the main beaches in the metropolitan region of Belém, Pará, Brazil in the period July 2016/2021

*Evaluation of balneability index data of the main beaches of the metropolitan region of Belém, Pará, Brazil in the July 2016/2021 period*

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### Summary

Water is a natural resource with great importance and diverse purposes of use, however it is a limited resource. Beaches are dynamic environments, made up of sandy soils and sediment deposits caused by wave action, which is why this mobility provides protection to the coastline due to the influence of waves. The beaches located in the Metropolitan Region of Belém – RMB, are considered estuarine beaches, due to the inflows of Guajará Bay and Amazon rivers. Evaluate data on bathing indices for the main beaches in the Metropolitan Region of Belém, PARÁ, BRAZIL in the period July 2016/2021. This is a quantitative study of descriptive analysis of data obtained from the bodies responsible for analyzing and disseminating monitoring of bathing conditions on beaches in the Metropolitan Region of Belém – RMB. An Excel table was created (Microsoft Excel 2016). In 2016, three beaches showed non-compliance in the results, being classified as unsuitable for swimming, these being the beaches of Baía do Sol, Amor and Cruzeiro, located respectively in the Districts of Mosqueiro, Outeiro and Icoaraci. This was the only year in which the two beaches located in the districts of Mosqueiro and Outeiro were classified as unsuitable, in the period from 2016 to 2021, unlike Praia do Cruzeiro, in the District of Icoaraci, which presented problems in the years 2016, 2018, 2019 and 2020. Suggesting possible exacerbated human activity at the site, undue dumping of sewage or influx of other rivers. Urbanization, the large tourist influx in certain months of the year, improperly dumped sewage and rain can be major factors in the accumulation of organic matter and reservoirs of parasites, viruses and various enteric diseases. It is concluded that the main beaches in the Metropolitan Region of Belém – RMB analyzed in this study, based on the data obtained by SEMMA, were in compliance with legislation regarding monitoring, analysis, collection, environmental education and dissemination of data to the population. Except for Cruzeiro beach, in the District of Icoaraci, which was non-compliant in the months of July in four years between 2016 and 2021. **Key words:**Bathing. Beaches. Waterborne Diseases.

### Abstract

Water is a natural resource with great importance and diverse purposes of use; however, it is a limited resource. The beaches are dynamic environments, composed of sandy soils and sediment deposits caused by wave action, for this reason due to this mobility provides protection to the coast by the influence of waves. The beaches located in the Metropolitan Region of Belém - RMB, are considered estuarine beaches, due to the affluence of the Guajará Bay and rivers of the Amazon. To evaluate the data of the bathing indices of the main beaches of the Metropolitan Region of Belém, PARÁ, BRAZIL in the period July 2016/2021. This is a quantitative study of descriptive analysis of data obtained from the agencies responsible for the analysis and dissemination of monitoring of the bathing ability of the beaches of the Metropolitan Region of Belém -RMB. An Excel table (Microsoft Excel 2016) was composed. In 2016, three beaches showed inconsistency in the results, being classified as unsuitable for bathing, and these were the beaches of Baía do Sol, Amor and Cruzeiro, located respectively in the Districts of Mosqueiro, Outeiro and Icoaraci. This was the only year in which the two beaches located in the districts of Mosqueiro and Outeiro were classified as unsuitable, in the period from 2016 to 2021, unlike Praia do Cruzeiro, in the District of Icoaraci, which presented problems in the years 2016, 2018, 2019 and 2020. Suggesting possible exacerbated anthropogenic activity at the site, improper sewage dumping or inflow from other rivers. Urbanization, large tourist influx in certain months of the year, improperly dumped sewage, and rainfall may be preponderant factors in the accumulation of organic matter and reservoirs of parasites, viruses, and various enteric diseases. It can be concluded that the main beaches of the Metropolitan Region of Belém - RMB analyzed in this study, based on the data obtained by SEMMA, showed compliance with the legislation about monitoring, analysis, collection, environmental education, and dissemination of data to the population. Except for Cruzeiro Beach, in the District of Icoaraci, which showed non-compliance in the month of July in four years between 2016 and 2021.

**Keywords:**Bathing suitability. Beaches. Water-borne Diseases.

### 1. Introduction

Water is a natural resource with great importance and diverse purposes of use, however it is a limited resource. Beaches are dynamic environments, made up of sandy soils and sediment deposits caused by wave action, which is why this mobility provides protection to the coastline due to the influence of waves. The beaches located

in the Metropolitan Region of Belém (RMB), they are considered estuarine beaches, due to the inflows of Guajará Bay and Amazon rivers (BRASIL, 2010; VALENTE, 2019; MUEHE, 1994).

The water resources monitoring process in Brazil started late compared to countries like China, which began the water quality monitoring process at the beginning of the 20th century (MARTINS, 2012). According to Sousa and collaborators (2018), RMB presents precariousness in its sewage treatment services. In this way, assuming the lack and insufficiency of its basic sanitation services, which directly compromise the environment, causing changes in the quality of water consumed by the population.

Bathability verification is carried out by microbiological and physical-chemical analyzes on Brazilian beaches evaluated in accordance with CONAMA resolutions 274 of November 29, 2000 and 357 of March 17, 2005. In this study, the data analyzed were based only on CONAMA resolution 274/00 and in the manual of the laboratory responsible for water analyzes (BRASIL, 2000; BRASIL, 2005).

Bathing analyzes are carried out in accordance with CONAMA resolution 274/00, which defines bathing criteria for fresh, brackish and saline waters. Among the analyses, microbiological research is included, which aims to verify total and thermotolerant fecal coliforms, being the *Escherichia coli* the bacteria with the greatest pathogenic potential for humans. Other parameters, such as salinity, enterococci, isobath, flowering, will also be checked based on the law that provides for bathing (BRASIL, 2000).

CONAMA Resolution 357/05 is responsible for providing for the classification and standard framework of bodies of water. The main physical-chemical parameters provided by it involve salinity analysis, determination of lentic or lotic environments, polluting load, cyanobacteria, quality class, water classification, thermotolerant coliforms (enterococci), toxicological tests, *Escherichia coli*, Biochemical Oxygen Demand (BOD), dissolved oxygen, turbidity, true color and Hydrogen Potential (pH), alpha chlorophyll, cyanobacteria density, total dissolved solids, dissolved aluminum, arsenic and phosphorus. (BRAZIL, 2005).

The analyzes of RMB beaches are carried out by the Municipal Secretariat for the Environment (SEMMA) in conjunction with other bodies, such as the Belém City Hall – PMB and the Central Laboratory of the State of Pará – LACEN. Collections are generally carried out by SEMMA and LACEN, in the period of June, aiming at the high demand for bathers in the parias in the month of July (PMB, 2022). In this sense, the chosen period was the month of July to carry out analyzes of data published from journalistic vehicles in the state of Pará and municipalities in Pará.

The parameters follow the protocols of the Manual of Guidelines for Collection of Water, Environmental Samples and Products Subject to Health Surveillance of the Central Laboratory of the State of Pará (LACEN) and CONAMA resolution 274/00, which provides for bathing criteria. Water can be classified as suitable or unsuitable for bathing following the values provided for by current legislation, being classified as unsuitable when it reaches the value of 2,000 *Escherichia coli* for every 100 milliliters of water analyzed (PMB, 2022).

In this way, based on the analysis of the parameters, in accordance with current legislation for each type of water body, these waters can be classified as suitable or unsuitable for use by the general population (BRASIL, 2000; BRASIL, 2005).

## 2 Study area

The research was carried out in frequently sought after resorts close to the RMB, located on the island of Mosqueiro and districts of Outeiro and Icoaraci. The district of Distrito Administrativo de Mosqueiro (DAMOS) is located approximately north of the capital of Pará between 01°03' and 01° 05' South latitude and between 48°29' and 48°18' West longitude (W) of Greenwich. It has an area of approximately 212 km<sup>2</sup>, with 17 km of beaches formed by the Pará River, highlighting Praia do Farol, Praia do Bispo, Praia Paraíso, Praia Grande, Praia Chapéu Virado and Praia Maraú, considered the most frequented (BITENCOURT, 2016).

The Administrative District of Outeiro (DAOUT) is located approximately 35 km from the center of Belém, being the closest island district to the RMB, widely frequented by tourists and local residents seeking the main beaches, such as Praia do Amor, Praia Grande and Praia da Brasília, while the Administrative District of Icoaraci (DAICO) is located 20km from the capital of Pará. The place is surrounded by Praia do Cruzeiro, which attracts the attention of tourists and nearby residents. However, the beach was several times unsuitable for swimming (BITENCOURT, 2016).

## 3 Methodology

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This is a quantitative study of descriptive analysis with data obtained from the bodies responsible for analyzing and disseminating the monitoring of bathing on the main beaches of the Metropolitan Region of Belém – RMB, these being the Municipal Secretariat for the Environment – SEMMA, Prefeitura Municipal de Belém – PMB and Central Laboratory of the State of Pará – LACEN. The data were analyzed and organized in an Excel spreadsheet (*Microsoft Excel 2016*).

## 4 Results and Discussion

Table 1 refers to data from the main beaches of the three RMB districts in which the rates of

bathing ability in the period from 2016 to 2021. In this way, a table was created to better understand the data collected by the bodies responsible for analyzing and publishing bathing indices on these beaches. The construction of the table was based on the degree of importance of information to be highlighted in this study, namely: The location of beaches by district; the beaches analyzed in each district; the years of analysis and classification of beaches as suitable or unsuitable. This way, there is a clearer identification of the classification of each beach, associated with its district and the year of analysis.

The Municipal Environment Secretariat (SEMMA) is the body responsible for planning, coordinating, supervising, executing and controlling activities aimed at conserving, protecting, preserving, recovering and restoring the quality of the environment and public green areas. It is responsible for deliberating water analyzes in the RMB and island districts, mainly in testing the bathability of water on beaches (SEMMA, 2022).

Since 2006, the beaches in Pará located in the districts of Outeiro, Mosqueiro and Icoaraci have been undergoing bathing and environmental education analyzes carried out by the City of Belém, through the Municipal Secretariat for the Environment (SEMMA) (PMB, 2014). According to Table 1, it is possible to view the beaches and their respective bathing conditions.

Local	Beach	Year	Classification
DAICO	cruise	2016, 2018 and 2020	Improper
		2017, 2019 and 2021	Own
WE GIVE	Bay of Sun	2016	Improper
	Areião	2016 and 2021	Own
	Ariramba		
	Hat Flipped		
	Lighthouse		
	Marahú		
	Murubira		
	Paradise		
	Beach Big		
	s TheO Francisco		
Bay of Sun	2017 and 2021		
DAOUT	Love	2016	Improper
	Brasilia	2016 and 2021	Own
	Beach Big		
	Love	2017 and 2021	

In Mosqueiro, in July 2016, the study carried out together with LACEN following the requirements of CONAMA resolution 274/00, found that the beaches of Farol, Marahú, Ariramba, São Francisco, Murubira, Areião, Chapéu Virado, Paraíso and Praia Grande were also suitable for recreational use. Praia Grande and Brasília beach, in Outeiro, were considered satisfactory.

Furthermore, according to data released by SEMMA in 2016, the beaches Baía do Sol, in Mosqueiro, do Cruzeiro, in Icoaraci and Praia do Amor, in Outeiro, were considered unsuitable for swimming (SEMMA, 2016).

In July 2017, thirteen spas passed the bathing test and were considered suitable for recreational use. These being Praia do Amor and Praia Grande, in Outeiro; Cruzeiro beach, in Icoaraci and on the beaches of Baía do Sol, Paraíso, Marahú, São Francisco, Murubira, Chapéu Virado and Farol, in Mosqueiro (PMB, 2017).

In 2018, the beaches of Amor and Praia Grande, in Outeiro; Baía do Sol, Paraíso, Marahú, São Francisco, Murubira, Chapéu Virado and Farol, in Mosqueiro were also considered suitable for swimming. However, Cruzeiro beach, in Icoaraci, was considered unsuitable during this period (PMB, 2018).

In 2019, eighteen RMB beaches passed the bathing test, these being the beaches of Amor, Praia Grande and Brasília, in Outeiro; Areião, Chapéu Virado, Farol, Murubira, Ariramba, São Francisco, Marahu, Paraíso, Baía do Sol and Praia Grande, in Mosqueiro. And on that occasion, Cruzeiro beach, in Icoaraci, was considered suitable for swimming (PMB, 2019).

In 2020, around eighteen beaches in the RMB were analyzed for bathability tests, these being the beaches of Amor and Praia Grande, in Outeiro; Baía do Sol, Paraíso, Marahú, São Francisco, Murubira, Chapéu Virado and Farol, in Mosqueiro. Cruzeiro beach, located in the District of Icoaraci, was once again considered unsuitable for swimming (PORTAL AMAZÔNIA, 2020).

SEMMA is the competent body for carrying out and supervising bathability analyzes in the RMB. The institution's objective is to guarantee safety, inspection and environmental education in resorts in the region in order to guarantee the best benefits for bathers, tourists and the population living close to the resorts. It is noteworthy that water-borne diseases are the biggest problem on contaminated beaches, with amoebiasis, giardiasis, gastroenteritis and cholera being some of the diseases that can affect the population that risks visiting contaminated resorts (PORTAL AMAZÔNIA, 2020).

“SEMMA is committed to carrying out this bathing test due to the use of these beaches by the population, guaranteeing safety for recreation, bathing and leisure, with the certainty that the population will not fall ill, because there are diseases of water transmission (amoebiasis, giardiasis, gastroenteritis, cholera, etc.), that is, when that water is inappropriate, it can be a factor in the contamination of these diseases”, explained Juliany Frazão, head of the SEMMA Monitoring and Inspection Department (PORTAL AMAZÔNIA, 2020).

It is clear that Cruzeiro beach has been facing bathing problems on many occasions, however, in 2017 it was considered suitable for swimming (PORTAL AMAZÔNIA, 2020). Urbanization, a large tourist influx in certain months of the year, improperly dumped sewage and periods of rain can be major factors in the accumulation of organic matter and reservoirs of parasites, viruses and various enteric diseases (PORTAL

AMAZÔNIA, 2020).

In 2021, SEMMA found that all eighteen beaches analyzed in the districts of Mosqueiro, Outeiro and Icoaraci were found to be suitable for swimming. Cruzeiro beach, which for five years was considered unsuitable, was found to be suitable for swimming (PMB, 2021).

The other beaches analyzed, such as Praia do Amor, Praia Grande and Brasília, in Outeiro; Areião, Chapéu Virado, Farol, Murubira, Ariramba, São Francisco, Marahu, Paraíso, Baía do Sol and Praia, in Mosqueiro, also underwent bathing tests and were classified as suitable for bathing (PMB, 2021).

In July 2018, Cruzeiro beach was found to be unsuitable for swimming. In December of the same year, after evaluating the bathing tests, it was found that the resort was considered suitable for swimming. In this sense, as this study is only analyzing data from July, in table 1, it can be inferred that the year 2018 shown in the table refers to the July indices. The month of December is described as being relevant, given the different classifications in the same year (PMB, 2019).

Alves (2016) highlighted in his research that on the beaches of the municipality of Goiana, Pernambuco, there was an annual pattern, with the exception of 2001, which can be observed. It was found that Ponta de Pedras beach was considered unsuitable in most rainy seasons than dry seasons. Therefore, what happened in 2018 in the months of July and December, on Cruzeiro beach, is an event possibly associated with temporal trends.

In 2016, a study carried out by Rodrigues and collaborators in 2016 verified the bathing potential in the district of Mosqueiro, on the following beaches: Carananduba, São Francisco, Ariramba and Farol, where all beaches were classified as suitable. In the same year, these same beaches were analyzed by SEMMA and presented the same result, demonstrating consistency between both analyses. However, Baía do Sol beach, belonging to the Mosqueiro district, was considered unsuitable by SEMMA, but was not analyzed in the 2016 study, and therefore it was not possible to equate both analyses.

In 2016, the study by Ribeiro and collaborators carried out bathing analyzes on several beaches in the state of Pará, one of them being Praia do Amor, located in the district of Outeiro, which obtained excellent results for bathing checks. However, in the study carried out by SEMMA, in 2016, Praia do Amor and Praia do Cruzeiro were considered unsuitable. The research in question found that Praia do Amor obtained excellent results for bathing during the month with the greatest tourist influx and holidays in the middle and end of the year. Therefore, both analyzes were carried out in July of the same year, but presented divergent results.

## 5 Final considerations

It is concluded that the main beaches in the RMB analyzed in this study, based on the data obtained by SEMMA, were in compliance with legislation regarding monitoring, analysis, collection, environmental education and dissemination of data to the population. It is inferred that it is important that in addition to a good water analysis, environmental education and the dissemination of results are made available to the population through journalistic means. Environmental education is also relevant, as residents play a fundamental role in preserving beaches, especially in urban environments.

In 2016, three beaches showed non-compliance in the results, being classified as unsuitable for swimming, these being the beaches of Baía do Sol, Amor and Cruzeiro, located respectively in the Districts of Mosqueiro, Outeiro and Icoaraci. This was the only year in which the two beaches located in the districts of Mosqueiro and Outeiro were classified as unsuitable, in the period from 2016 to 2021, unlike Praia do Cruzeiro, in the District of Icoaraci, which presented problems in the years 2016, 2018, 2019 and 2020. Suggesting possible exacerbated human activity at the site, undue dumping of sewage or influx of other rivers.

For this reason, bathing analyzes are important to highlight possible environmental problems that are negatively influencing the beaches, especially in estuarine beaches such as nearby urban areas, and thus it is possible to prevent these waters from becoming a reservoir for water-borne diseases of importance for the public health.

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