CONCILIUM, Vol. 23, Nº 3, 2023
DOI: 10.53660/CLM-839-23B09
ISSN: 0010-5236

Water quality trough the use of bioindicators, climate change and enviromental education in the paraense Amazon

Qualidade da água através da utilização de bioindicadores, alterações climáticas e educação ambiental na Amazónia paraense

Received: 2023-01-11 | Accepted: 2023-02-12 | Published: 2023-03-02

Antônio Pereira Júnior
ORCID: https://orcid.org/0000-0001-6241-985X
Universidade do Estado do Pará, Brasil
E-mail: antonio.junior@uepa.br
Gundisalvo Piratoba Morales
ORCID: https://orcid.org/0000-0002-5930-7053
Universidade do Estado do Pará.
E-mail: gundymorales@gmail.com
Norma Ely Santos Beltrão
ORCID: https://orcid.org/0000-0003-1991-2977
Universidade do Estado do Pará.
E-mail:: normaelybeltrao@gmail.com
Ana Julia Soares Barbosa da Silva
ORCID:https://orcid.org/ 0000-0002-8701-9868
Universidade do Estado do Pará
E-mail: anajulia.barbosa@uepa.br
Lucy Anne Cardoso Lobão Gutiérrez
ORCID: https://orcid.org/0000-0002-4199-1977
Universidade do Estado do Pará, Brazil
E-mail: lucyannegutierrez@uepa.br
Edmir de los Santos Jesus
ORCID: https://orcid.org/0000-0002-4383-5353
Universidade do Estado do Pará, Brazil
E-mail: edmir.jesus@uepa.br

ABSTRACT

Water quality, currently determined through laboratory analysis, can also be determined by the presence or absence of bioindicators sensitive to climate change, and these relationships can be the subject of studies in Environmental Education. The objective of this integrative analysis was to identify the existing gaps in physical-chemical and microbiological analyses, the use of biomonitors, the insertion of climate change and the role of Environmental Education as a fundamental complement to these analyses in the Pará Amazon, especially in the municipality of Paragominas. The secondary data were obtained from academic literatures published between 1997 and 2022, the year in which the National Water Resources Policy turns 25 years old. The data obtained and analyzed indicated that the research on water quality in the Pará Amazon, uses physical-chemical parameters, and compares the laboratory data obtained with the values established in Resolution No. 357/2005. The use of these parameters associated with aquatic bioindicators in Paragominas already presents data directed, with greater frequency, to the Uraim River, igarapé 54 and seven, which leaves a gap as to the Paragominas/Prainha River, which is a receptor of urban effluents and a tributary of the right bank of the Uraim; there are other gaps such as: scarcity of research regarding water quality and climate change are scarce; Environmental Education, although the municipality already has a plan for this, is still only applied in formal education spaces in lower and upper elementary school, but is not applied to users of water resources, which leaves them at the margins of this process. Therefore, these gaps become difficulties in the correct and active application of the NWRP.

Keywords: Population growth; Urbanization; Surface water contamination; Water pollution.

RESUMO

A qualidade da água, atualmente determinada através de análises laboratoriais, também pode ser determinada pela presença ou ausência de bioindicadores sensíveis às alterações climáticas, e estas relações podem ser objeto de estudos em Educação Ambiental. O objetivo desta análise integradora foi identificar as lacunas existentes nas análises físico-químicas e microbiológicas, a utilização de biomonitores, a inserção das alterações climáticas e o papel da Educação Ambiental como complemento fundamental destas análises na Amazónia do Pará, especialmente no município de Paragominas. Os dados secundários foram obtidos nas literaturas acadêmicas publicadas entre 1997 e 2022, ano em que a Política Nacional de Recursos Hídricos completa 25 anos. Os dados obtidos e analisados indicaram que a investigação sobre a qualidade da água na Amazónia do Pará, utiliza parâmetros físico-químicos, e compara os dados laboratoriais obtidos com os valores estabelecidos na Resolução n.º 357/2005. A utilização destes parâmetros associados a bioindicadores aquáticos em Paragominas já apresenta dados dirigidos, com maior frequência, para o rio Uraim, igarapé 54 e sete, o que deixa uma lacuna quanto ao rio Paragominas/Prainha, que é um receptor de efluentes urbanos e afluente da margem direita do Uraim; há outras lacunas como: escassez de pesquisas quanto a qualidade da água e as alterações climáticas são escassos; a Educação Ambiental, embora o município já tenha um plano para tal, continua a ser aplicada apenas em espaços de educação formal nas escolas primárias inferior e superior, mas não é aplicada aos utilizadores dos recursos hídricos, o que os deixa à margem deste processo. Por conseguinte, estas lacunas tornam-se dificuldades na aplicação correta e ativa do PNRH.

Palavras-chave: Crescimento populacional; Urbanização; Contaminação das águas superficiais; Poluição da água.

INTRODUCTION

The water quality standard tends to change from the processes of industrialization (RODRÍGUEZ-GUERRA; MARTINEZ, 2020), urbanization (NASCIMENTO et al., 2020), population growth (ABDALA, 2019), and expansion of agricultural boundaries (NASCIMENTO et al., 2019) due to the generation of waste and effluents containing elements or chemical substances, lipophilic or hydrophilic. By acting on the physical-chemical parameters that determine this quality, they cause changes in their concentrations that can induce eutrophication, resulting from the elevation of pollutant loads (UNITED NATIONS, 2015). Another factor is the gap between the residual collection and sewage treatment that are either absent or deficient.

Conceptually, this standard is defined in the Resolution of the National Environment Council (NEC) of No. 357 (BRASIL, 2005, p. 4), in Chapter I, Article 2, item XXVIII, as "substances or other indicators representative of water quality." Besides the laboratory analysis of physical parameters: hydrogen potential-pH; water temperature; turbidity, and chemicals: dissolved oxygen (OD), Biochemical Oxygen Demand ($BOD_{5,20}$), total nitrogen, and total phosphorus (http://pnqa.ana.gov.br/Qualiagua.aspx#), it is stated in Article 7, paragraph 3, that "the quality of aquatic environments may be assessed by biological indicators, where appropriate, using organisms and aquatic communities (p.8)".

In resolution 430 (BRASIL, 2011), Article 3 states that "the effluents from any polluting source may only be discharged directly into the receiving bodies after proper treatment and provided that they comply with the conditions, standards, and requirements outlined in this resolution and other applicable standards. In contrast, 36 million people in Brazil have access to treated water, and 106 million whose homes have neither sewage nor solid waste collected (SILVA et al., 2020). All this occurs two years after the promulgation of the legal framework of Basic Sanitation, Law No. 14.026 (BRASIL 2020), which covers four actions: drinking water supply, sanitary sewerage, urban cleaning, and solid waste management, and urban rainwater drainage management (VASCO, 2022; NETO COSTA et al., 2020).

Despite the existence of legislation, basic sanitation in Brazilian industrial districts, such as in the state of São Paulo, municipality of Bauru, where the problem is associated with heavy metals in liquid effluents that are not treated and are released into the domestic sewage network and tend to flow into the river Bauru (NAKADAKARI, 2022). In the state of Macapá, the Matapi river basin, one of the tributaries of the Amazon River that flows through the cities of Santana and Mazagão, in this state, and is very close to the industrial district, which now needs research and studies to determine and mitigate the damage that the effluents generated in this district can cause to the receiving water body (PAIXÃO NETO, 2021).

In the context of the Northern region, the state of Pará, the quantitative concentration of freshwater is high (12%). Because it presents the most significant area extension in the Brazilian Amazon (DIAS et al., 2017), this extension of this state is occupied by 144 municipalities. The right to basic sanitation is present in only 31 of them which already have sanitation. In the others, such as Belém, it is absent or incipient. This has caused the accumulation of waste in precarious pipes and solid waste on public roads and inside water bodies (CARNEIRO et al., 2020).

The Capim River Integration Region (RIRC) in South Eastern Pará has 16 municipalities (Abel Figueirêdo, Aurora do Pará, Bujarú, Capitão Poço, Concordia do Pará, Dom Eliseu, Garrafão do Norte, Ipixuna do Pará, Irituia, Mãe do Rio, Nova Esperança do Piriá, Ourém, Paragominas, Rondon do Pará, Tomé-Açú and Ulianópolis), which must have a Municipal Sanitation Plan – PMSB (PARÁ, 2001).

The PMSB is already prepared in five (31%) of them, that is, in 11 (69%). It is worth noting that the RIRC, at the Brazilian level, is a component of the hydrographic basin of the Gurupi river, which belongs to the North Atlantic hydrographic region. Suppose there still needs to be a deficiency at the household level in the productive sectors, especially the industrialization sector, which in Brazil is geographically decentralized. In that case, there are numerous examples, such as mining. In it, trace metals can disperse and sediment in freshwater or marine aquatic environments and influence changes in electrical conductivity (NASCIMENTO et al., 2015; ROUABHI, 2020).

Another industrial process, textiles, generate chemical compounds called recalcitrant (MANENTI et al., 2015). In the dairy industry, changes in physical-chemical parameters occur with the deposition of whey in water bodies. In livestock farming, multiple pollutants such as feces (rich in phosphorus - P) containing the pathogen Cryptosporidium and cattle urine (urea, rich in nitrogen - N), change the concentrations of these two chemical elements, which culminates in bioaccumulation (QUINELATO et al., 2021).

Currently, all these occurrences are identified using only physical-chemical water quality parameters. However, these changes can be identified using biological indicators or bioindicators. Their use can be made at the organism, population, or community level because they will always respond depending on the alterations of those components, either by the transient or cumulative presence of pollutants or contaminants (NASCIMENTO et al., 2019). The genesis of this association began between 1960 and 1990, with the study on the modifications that occurred and still occur on coral reefs due to the bleaching of these reefs (PRAZERES et al., 2020) and phytoplankton (YUSSUF, 2020).

In Pará, the first studies with aquatic insects occurred between 1990-1992 in a lentic system, receptor of bauxite mining effluents, located on the right bank of the Trombetas River in Oriximiná (BRASIL et al., 2022). Among the numerous components of the phytoplankton are the microalgae called diatoms, belonging to the group Bacillariophyta, which are sensitive to water pollution, variation in acidity, and eutrophication processes (SANTOS, 2021). Therefore, they make up the sensitive natural environmental system and also respond to the excessive presence of metals such as iron and aluminum - Al (AMARAL, 2022) or even microbiological, such as *Escherichia coli* **(**SANHUDO et al., 2021**)**

In international studies, aquatic vertebrates such as fish are being used as bioindicators of water quality from the pressures exerted by heavy metals such as iron (Fe) on these populations (LI et al., 2019; MAHAMOOD et al., 2021). In the national territory, as well as in the Brazilian Amazon and Pará, research on the association between water quality and bioindicators is already occurring (BERSCH, 2020; GOMES, 2021) and directed to this metal because there is a presence of pathogenic microorganism's absorbers of it, which also contributes to the loss of water quality (ROMERO, 2020; STORTO, 2021).

Regarding the causes of loss of water quality, besides the five already exposed, two more should be added: the occurrence of climatic extremes (MARINHO et al., 2020) and poor environmental sensitivity, which brings to seven the possible causes for this loss. Concerning climate extremes (Ex.: El Niño) in the Amazon region, they can be torrential rains or severe droughts, and cause physical changes in this quality, such as in the hydrogenic potential, since the acids contained in Amazonian soils, arising from the decomposition of organic matter (MO), enter the water bodies of this region (MARINHO, 2018).

To mitigate the shortage that this can cause to the industry in general, livestock and agriculture, the process of prevention and coexistence with climate extremes in Brazil, is legislated by the National Policy on Climate Change, Law No. 12.187 (BRASIL, 2009). In the context of Brazilian legislation, this activity aims to develop a critical state in the individual to make him able to the conservation of natural resources, as well as increase his environmental sensitivity, and that can be a multiplier agent of this criticality (RODRIGUES et al., 2020). Therefore, EE should be part of the training and training of employees of industries and commerce, as well as the neighborhood, especially with the use of information technology (e.g., mobile phones), since the channels of dissemination of information are numerous as Google, Yahoo among others, to spread the problem of water pollution and the need to conserve its quality (MORAES et al., 2020).

Consequently, between Environmental Education and water quality, the link occurs because the former improves the knowledge and practice of the user regarding the use and conservation of surface and groundwater and, thus, becomes a public policy that shows what the intention of its existence is and that there is a problem that requires the direct participation of the user to solve it which, in this case, is the conservation of water quality (PAIXÃO; SILVA, 2019). In the industrial sector, environmental education may increase the knowledge of chemical components and waste management, whether affluent or not, and thus contribute to mitigating the loss that now occurs due to inadequate destination and final disposal of waste and effluents, especially meatpacking plants where the generation of the latter originates from the blood of animals in evisceration and carcass washing (CONCEIÇÃO et al., 2020).

All these facts justified the study and increased the need for it in search of scientific evidence in the academic literature related to water resources in Paragominas that can inform: 1. What is state of the art about water quality? 2. About the use of bioindicators in water quality analysis? 3. What are the main obstacles preventing effective water quality maintenance since the promulgation of the National Water Resources Policy (PNRH). Low n. 9.433 (BRASIL, 1997)? 4. Are there reports of the consequences of these changes to human health and the aquatic environment? 5. What are the prospects for changes in water quality from Climate Change? 6. How does the National Policy for Environmental Education contribute to maintaining water quality? 7. What are the remaining gaps in maintaining water quality?

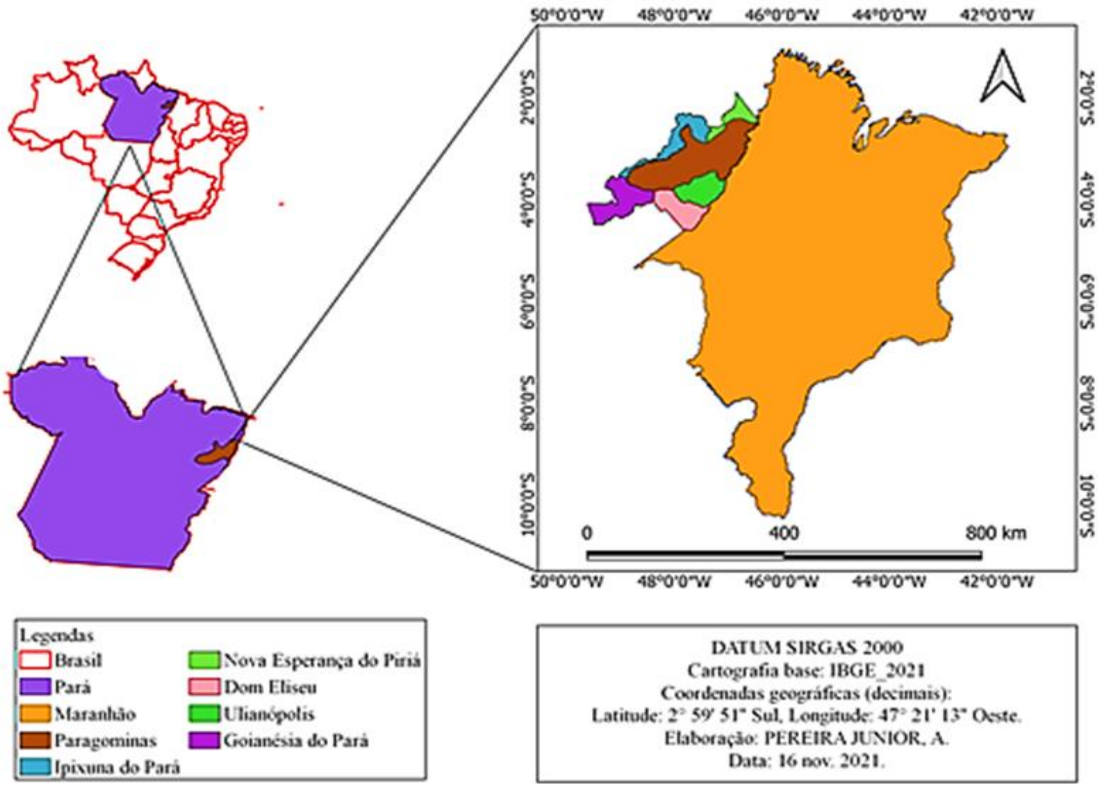
To better develop this integrative review, it was composed of four sections: (1) Introduction, where generalized information on water quality, bioindicators, climate change, and environmental education was allocated, (2) Methodology, which grounded the structuring of the secondary data search, and grounded the composition of (3) Results, where the quantitative selection process of the academic literature was demonstrated, which contains the argumentation of the cited authors and their point of view regarding the theme and, finally, (4) the Discussion, where the synthesis of the arguments contained in the articles that actively answered the seven guiding questions was made.

METODOLOGY

AREAS OF APPROACH

The geographic delimitation of this integrative review was the Rio Capim Integration region, southeast of the state of Pará, where the municipality of Paragominas is located, as well as four bordering municipalities: Dom Eliseu, Ipixuna do Pará, Nova Esperança do Piriá and Ulianópolis (Figure 1). All belong to the Capim River Integration Region (PARÁ, 2001).

Figure 1 - Map of the Capim River Integration Region, and the component municipalities.



Source: authors (2021).

The method employed was Integrative Literature Review (ILR), because, according to the statement of Guimarães et al. (2019), in it, it is allowed to understand what occurred in the past, in this case, the characterization of water quality associated or not with bioindicators, climate change and environmental education. Six steps described were employed in this review (Table 1).

Table 1 - The five steps used for literature selection.

Step	Actions	Checking on...
1	Identification of the theme.	Water quality associated with bioindicators, climate change and environmental education.
2	Research Questions.	Is water quality established in association with bioindicators? What about climate change? What about Environmental Education?
3	Inclusion and Exclusion	The inclusion/exclusion of the literature was performed from the careful establishment of the following selectors: 1. time scale (2013 to 2022); 2. publications from the North region 3. publications in the Pará Amazon; 4. publications on the Capim River Integration Region, especially on the municipality of Paragominas; 5. context of surface water.
4	Content Evaluation	The contents were assessed: 1. Did the water quality analysis involve only the physical-chemical parameters established in CONAMA Resolution #357/2005? 2. Did it associate bioindicators or not? Which ones? 3. Did it involve changes in water quality resulting from climate change? 4. Is there a narrative about Environmental Education as a tool for using and conserving water and maintaining its quality?

5	Levels of Evidence.	The levels of evidence described by Guimarães et al. (2019) were adapted from those described by the Agency for Healthcare Research and Quality: level 2 - individual studies with experimental design; level 3 - case reports/experiences; level 4 - descriptive studies or studies with a qualitative approach.
6	Interpretation of results.	Preparation of the summaries of the knowledge contained in the selected and analyzed literatures, only of the literatures published between 2018 to 2022, to verify data from the last five years.

Elaborated from data contained in Guimarães et al. (2019).

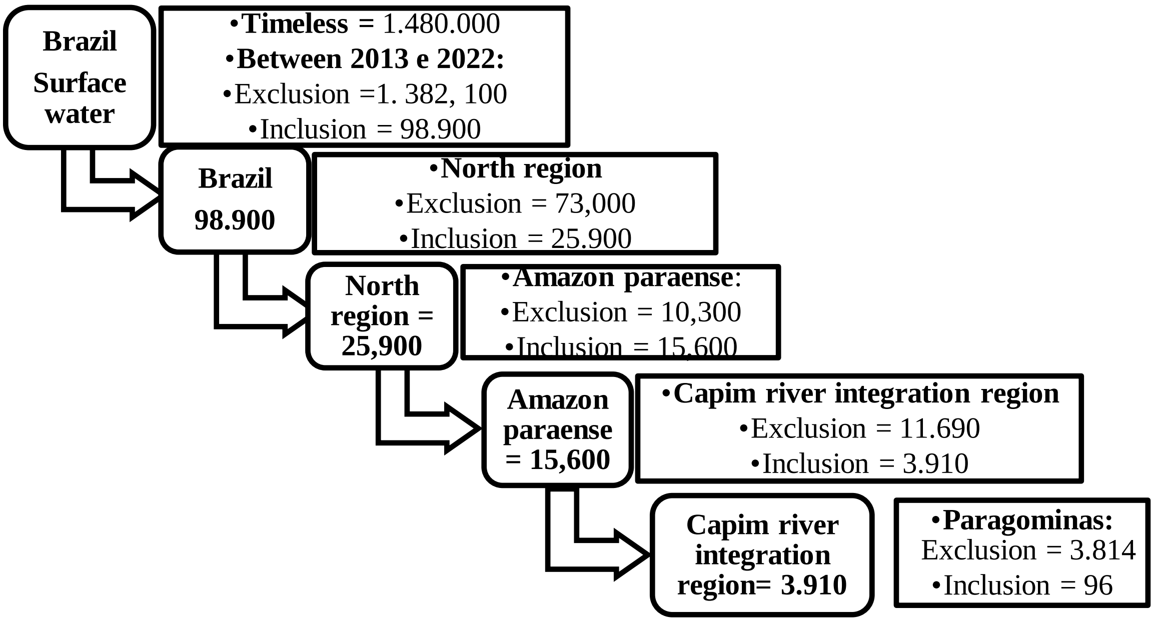
As for the establishment of the inclusion/exclusion process, we took as a basis what is described by Carlomagno and Rocha (2016), complemented by the arguments of Sousa and Santos (2020) on content analysis. These authors wrote that this type of analysis presents contributions to both the description and interpretation of texts selected for studies of this nature. The National electronic databases consulted were Google Scholar, Portal da Coordination for the Improvement of Higher Education Personnel (IHEP), National Water Agency (NWA), Higher Education Institutions (HIE), Brazilian Institute of Geography and Statistics(BIGS), Scopus Web Science, among others. The statistical analysis of the data was conducted with the help of Excel software, version 2013, using the spreadsheet contained in this digital tool. Descriptive statistics was used to calculate frequencies (relative absolute), mean, and standard deviation. The charts and tables were prepared according to the standards established by the Brazilian Institute of Geography and Statistics (IBGE, 1993).

RESULTS

SELECTION OF ACADEMIC LITERATURE

For this step, it was identified that in Brazil, regardless of the period, for surface waters, 118,000 publications were found. After applying pre-established filters and the process of exclusion and inclusion, the final selection was made (Figure 2).

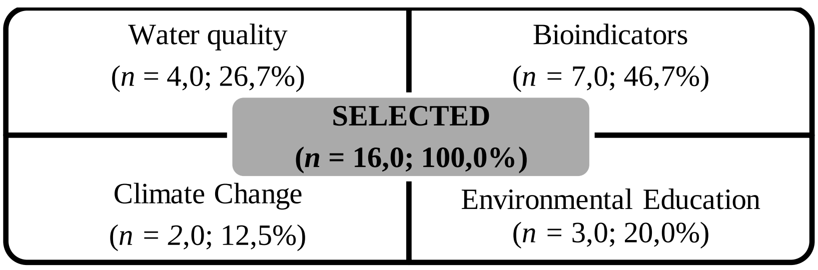
Figure 2 - Quantitative academic literatures in without the time scale and with the time scale to the Capim River Integration Region, southeastern mesoregion of Pará.



Prepared by the authors (2023).

For the municipality of Paragominas, there were 96 literatures read in their entirety, with special attention to the objective, results, and conclusion. v It was found that most of them (n = 80; 83.4%) did not associate water quality studies with biodiversity, climate change, and environmental education. With this, only 16 (16,6%) that addressed the four themes of this research (Figure 3).

Figure 3. Distribution of the 16 selected literatures on the four themes of this search. Paragominas. Pará.



Prepare by the authors (2023).

LEVEL OF EVIDENCES

The application of the level of evidence (L.E.) indicated that of the 16 academic literatures selected for the period between 2019 and 2022. L.E. 2 was the most frequent, which demonstrates a concern with water quality and the use of environmental identifiers that allow a more effective analysis to establish this quality (Table 1).

Table 1 - Level of evidences (absolute = *fi*, and relative = *fr* (%), identified after contents analysis of the 17 selected articles. Paragominas – Pará.

Levels of evidences	*fi*	*fr %)*
2	9	56,3
3	2	12,5
4	5	31,3
$\sum$	16	100
$\bar{x} \pm \sigma$	5,3±3,5	--

Prepared by the authors (2023).

WATER QUALITY

It is observed that in the four articles (Chart 1), the application of the CONAMA Resolution 375/2005, is still the driving vehicle for water quality. Another factor that draws attention is the concern of researchers with the Uraim River, although there is a right-bank tributary that currently plays the role of a receiver of domestic effluents, especially in the urban area: the Prainha or Paragominas River, which is a right-bank tributary of the Uraim River, who plays the role of a source for the municipality of Paragominas.

Chart 1. Literature on water quality selected for the municipalities of the Rio Capim Integration Region, Paragominas - Pará.

Author/Year	L. E	Objectives and results	Conclusion and Recommendations
2019, Silva et. al.	**2**	- Analyze the water quality in an urban stretch of the Uraim River. - Of the five points analyzed two of them showed high values for DO, BOD and COD.	In this stretch, the water quality has been compromised by urbanization.
2019, Pratti.	**2**	- Analysis of water quality for pesticide application - Hardness x pH, EC x pH, and SDT x pH; SDT x EC. With negative degrees of correlation acid pH.	- The water in the Capim River region is suitable for the application of pesticides. - Promote testing whenever you use water from the irrigation site.
2020, Nascimento et al.	**2**	- To previously evaluate the quality of the raw water of the Uraim River and compare the results with those required by the CONAMA 357/2005 resolution. - With the exception of pH, turbidity, temperature, DO, they are within the normative standards in resolution 357/2005.	- The water quality parameters of the Uraim River are within the Class 2 requirements. - Long-term monitoring is recommended in view of the peculiarity of this river and the cycling of nutrients.
2021, Neves et al.	**4**	- Evaluate quantitative and qualitative data during and after the deactivation of	- The deactivation of the dam did not influence the

		a dam at the Parariquara Igarapé, Paragominas-PA. - During and after the activation only the flow rate changed.	water quality; the flow was restored.

Legend: L. E = level of evidence. Prepared by the authors (2023).

BIOINDICATORS

As for the use of bioindicators, the eight articles analyzed (Chart 2) already reveal a more pronounced concern with the association between them and water quality, from the analysis of physical-chemical parameters, as well as the classification of the aquatic environment (GOULART; CALLISTO, 2003). There has also been the inclusion of climate change, as well as a study conducted on the Prainha or Paragominas River (SILVA et al., 2020).

Chart 2. Eight literatures whose content links the use of bioindicators to water quality. Paragominas - Pará.

Author/Year	L.E	Objectives and results	Conclusion and Recommendations
2018, Braga et al.	**2**	- Identification of the macroinvertebrates of the Uraim River. - Identification of 211 species, with prevalence of the so-called tolerant ones.	- The Uraim River is classified as "disturbed" in terms of water quality. - The data may guide further studies.
2019, Sá et al.	**3**	- Introduce the importance of biological indicators and climate change in water quality assessment.	- The use of biological indicators is important to identify contamination in aquatic ecosystems in terms of water quality. - Use the biological indicators as a complement to the physical-chemical analysis of the water.
2020, Silva et al.	**2**	- Quantitative analysis from the presence/absence of diatoms as indicators of water quality in Prainha and Uraim rivers. - The parameters phosphorus and pH presented changes in the values allowed by the water legislation.	- The waters of both lotic environments tend to lose quality in the dry season. - Presence of representative individuals in the Prainha River in the dry season. In the rainy season in rivers Prainha and Uraim, the frequency of individuals decreases. - Continued research for better monitoring of water quality,
2021, Silva.	**2**	- Assess the importance of semi-aquatic insect species in a mineral extraction area. - In 16 streams/riffles of Paragominas with greater vegetation cover, there was a greater distribution of species	- The presence/absence/absence of forests directly influences the concentrations of the species - Riparian vegetation contributes directly to this distribution.

2022, Brasil et al.	**2**	- To analyze the history of the use of some groups of aquatic insects as bioindicators of environmental change in the state of Pará. - Ephemeroptera, Plecoptera, Trichoptera and Odonata, current as aquatic and terrestrial indicators at some stages of their life cycle.	- Aquatic insects of the orders Ephemeroptera, Heteroptera, Odonata, Plecoptera, and Trichoptera are efficient bioindicators.
2022, Moy et al.	**2**	- Study the effects of changes in physical structure and physicochemical parameters in 45 lotic environments. - Changes in EC, causes little change in the Heteroptera community (6%).	- Changes in land use, cause changes in water EC and modify Gerromorpha communities.
2022. Santos et al.	**2**	- Assessing anthropogenic impacts as a function of EPT's sensitivity - In the 32 sampling sites, the different land uses caused different responses to these pressures as occurred in species richness.	- The richness indices are much more responsive than the others to anthropogenic actions - They suggest that future applications of the BMWP[1] Index should always be adapted to Amazonian water conditions.

Legend: L. E = level of evidence; EPT's' = Ephemeroptera, Plecoptera and Trichoptera; EC = Eletric Conductivity; BMWP = Biological Monitoring Working Party . Prepared by the authors (2023).

CLIMATE CHANGE

The one articles that were read and analyzed for this theme (Chart 3), bring an association between these changes, and the use of biondicators to demonstrate the alterations caused in the strata of the aquatic ecosystems that occurred both in the physicochemical and in the rainfall rates in this municipality, and that can interfere in both biotic and abiotic factors. The consequence of these actions is the alteration of the water quality.

Chart 3. Studies of climate change and water quality in the two rivers: Prainha and Uraim. Paragominas - Pará.

Author/Year	L.E	Objectives and results	Conclusion and Recommendations
2019, Giuliatti et al.	**4**	- Quantitatively analyze the rainfall distribution in Paragominas from the El Niño and La Niña phenomena. - There is both monthly and annual variability in rainfall ranging from 1096 mm to 2716 mm.	- The Amazonian winter can suffer changes, both in the wettest and the least rainy period as occurred in 1992 and 2009. - The study can contribute to better urban and rural planning in the municipality of Paragominas
2020, Conceição et al.	**4**	- Identify the influence of the rainfall regime and the changes in the physicochemical parameters of the water quality of the Uraim River.	- The application of Fuzzy Logic better exposes the interference of rainfall in relation to physicochemical parameters such as pH.

		- pH, turbidity, color BOD, change during the rainy season, with high decomposition of organic matter.	

Legend: L. E = level of evidence. DO, Dissolved Oxygen; Biological/Biochemical Dissolved Oxygen; COD. Chemical Dissolved Oxygen. Elaboration; pH, Hydrogen potential. Prepared by the authors (2023).

ENVIRONMENTAL EDUCATION

The literature selected for this theme, in the municipality of Paragominas, indicated that in this municipality, a municipal public policy is already in place for the application of this educational line. However, the integral practice of it is not yet evident in the selected studies (Chart 4).

Chart 4. Three literatures selected to environmental education. Paragominas – Pará.

Author/Year	L.E	Objectives and results	Conclusion and Recommendations
2019, Paixão e Silva.	**4**	- To analyze Environmental Education as a public policy implemented by the municipality of Paragominas in the management of natural resources. - Proposal for solving the environmental crisis that has occurred since 2008.	- The actions of EE provoked strong impact in the community regarding the "awareness" for the care, preservation, and appreciation of the urban environment, with "cleaner schools and more sustainable practices".
2021, Azevedo et al.	**3**	- To get to know the Environmental Education Policies developed in Paragominas. - Teachers have an area of training that is not focused on the application of EE, although most of them do not know that it has already been implemented.	- The Environmental Education Policies are still poorly applied, even with the seriousness of the environmental problems, among them "water shortage, basic sanitation, among others.
2021, Lopes et al.	**4**	- Applying Environmental Education in the context of watersheds - The descriptors already developed are punctual, fragmented, with a nature conservation character.	- It needs to provide initial and continuing training for teachers working in Environmental Education with a transversal and interdisciplinary character. -Society must exercise more effective social control over public policies.

Legend: L. E = level of evidence. Elaboration: Authors (2023).

DISCUSSION

Water quality

The Water Quality index values for most (n = 15; 57.7%) of the 26 Brazilian states, and the Federal District, allow for a classification of water quality (Table 1).

Table 1. Values for water quality assessment

	Faixas I	Faixas II
States / Water Quality Rating.	AL, MG, MT, PR, RJ, RN, RS	BA, CE, ES, GO, MS, PB, PE, SP
Great	91-100	80-100
Good	71-90	52-79
Reasonable	51-70	37-51
Bad	26-50	20-36
Terrible	0-25	0-19

Prepared from data contained in the Water Quality Portal (ana.gov.br)

Table 1 does not indicate the presence of established values for the state of Pará. The possibility that the pedogenesis, vegetation, the presence of a single climatic season, and the large concentration of sediments, decomposing organic matter that can change the value of pH, DO and, consequently, the BOD, is raised. However, in the literatures that were the object of this review, it was noticed the application of the classification according to this table.

In the Uraim River, Silva et al. (2019), Nascimento et al. (2020) and Nascimento et al. (2021), analyzed five physical-chemical parameters (pH, Turbidity, Temperature and DO) of water quality at points with higher and lower population agglomeration, and the data obtained were compared with standards already stipulated in Resolution 357 (BRASIL, 2005).

In the same year, Pratti (2019), analyzed five STD, Color and turbidity, EC, pH, hardness), in waters available for pesticide application, and compare the values found with the descriptors in the Water Treatment Gate that obeys the standards established by the Normative COPAM/CERH-MH, No. 01 (MINAS GERAIS, 2008). There was no relationship between the Temperature variations that directly influence the Electrical Conductivity, and since irrigation uses ionic substances, they may not adhere to the water molecules in the face of these variations.

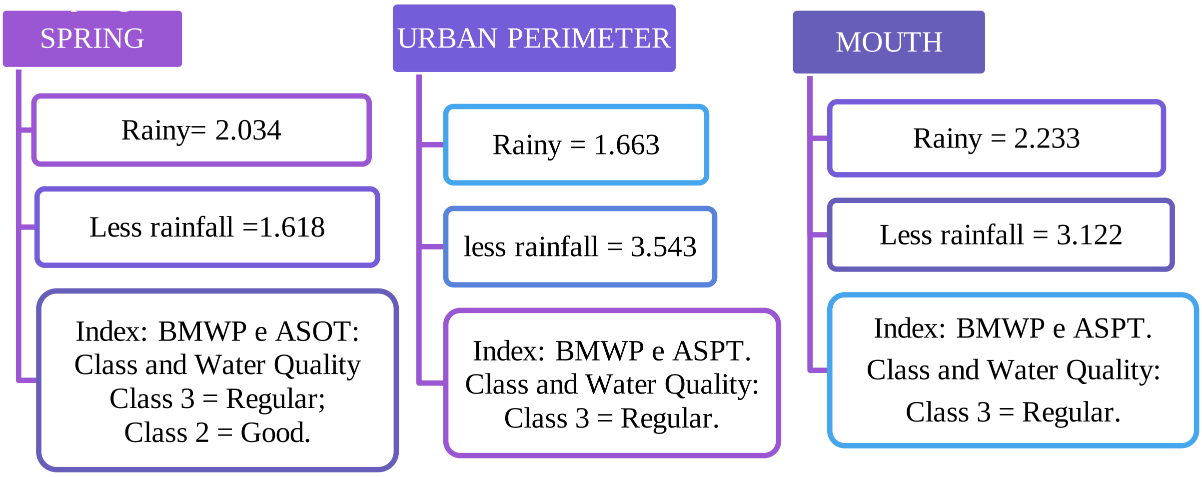
The most evident gap is the lack of concern with the association of these surveys with the use and occupation of the soil, loss of APP, and the association of the data obtained with the parameters analyzed, in addition to the geomorphology of the soil, via ionic dissolved solids coming from it from the surface runoff that rises or the absence of marginal vegetation. Changes in DO can be derived not only from the reception of domestic and/or industrial effluents. The input of organic matter (OM) from bare soil causes a decrease in the bioavailability of DO.

BIOINDICATORS

Most Studies (BRAGA et al., 2018; SÁ et al., 2019; SILVA et al., 2020; MOY et al., 2022; SANTOS et al., 2022) selected for analysis the physicochemical parameters that identify the water quality of bioindicators. The core of the question in these researches, was directed to the quantitative of the species classified as tolerant, sensitive, or intolerant and, there is also a direction to the impact factor as mining (SILVA, 2021).

In the research conducted v by these authors, at Ouricuri River, municipality of Capanema-PA, the authors classified the macroinvertebrates in three groups: Sensitive (Ephemeroptera, Plecoptera and Trichoptera); Tolerant (Odonata, Megaloptera, Coleoptera and Heteroptera) and resistant (Diptera, Mollusca and Anellida). Regarding water quality, four parameters were measured: pH, T°, DO, EC. They applied bioindicators in two strands: BMWP/ASPT and EOT, where they associated Ephemeroptera, Odonata and Trichopetera (EOT), i.e., sensitive, and tolerant specimens in the three surveyed points (Figure 3)

Figure 3. application of bioindicators and classification of water quality. Paragominas – Pará.



Prepared by the authors (2023).

It was evident that the application of bioindicators for a water quality analysis is more effective and makes the classification more secure, especially when these analyses are directed to water potability, as well as reinforces the index of Minimum Parameters for the Preservation of Aquatic Life (MPPAL), as well as allows a better analysis of the trophic state of aquatic ecosystems (TSAE), since both make up the Index of Water Quality for the Protection of Aquatic Life (IWQ), whose quality ranges from "optimal = IWQ ≤ 2.5", to "poor = IWQ > 6.8" (https://www.pna.ana.gov.br/indicares-protecao-vida.aspx)

CLIMATE CHANGES

This area of research still lacks studies on the association between water quality and climate change, although the municipality of Paragominas has an economic vein based on commodity: sojiculture, which has a very pronounced need for water, since the hydrological cycle is associated with climate. One of its components, precipitation, was the object of study by Giuliatti et al. (2019), v in this locality, and they alerted to the fact that local agriculture can indeed be affected by variations in the precipitation rate, as in 2011, where there was a 4º C increase in temperature, and even floods, such as the one that occurred in 2018, in view of the increase in rainfall volume that was between 581 and 561 mm, when the local average ranges from 285 to 365 mm.

Therefore, the ways to measure these precipitations altered due to climate change, and that influence the physical-chemical parameters and consequently the water quality. On this subject, Conceição et al. (2020), analyzed parameters such as pH, turbidity, color, and BOD of the waters of the Uraim River, with the application of fuzzy logic, and proved that the application of this logic can improve the analysis of the parameters measured and establish the most effective levels for water quality.

It is noted that in these two studies, there was no application of aquatic environmental bioindicators, although they can contribute to the formation of a database on changes in water quality in the municipality of Paragominas, not only for the agricultural sector but also for human supply, since the Uraim River is the source of this locality, and only with the use of parameters already specified, but that do not involve other aspects such as coverage of basic sanitation in urban and rural areas.

ENVIRONMENTAL EDUCATION

In the municipality of Paragominas, since 2016, a Municipal Environmental Education Plan was constituted. But Azevedo et al. (2021) and Paixão and Silva (2019), analyzed the applicability of EE in this locality from this document, and concluded that the implementation was not disseminated in the local community, i.e., did not go beyond the classroom, then, it does not cover the municipality as a whole, and is restricted to the pedagogical process in this formal space of education.

It is worth mentioning that the public policy inherent to EE, in the context of water resources conservation, at the Brazilian level, has shown advances in attention to the legislative provisions contained in Law n. 9433 (BRASIL, 1997), as described by Lopes et al. (2021). However, in the municipality under study, it was not yet evident that the concern with water conservation, because the local community has no knowledge about the municipal plan for this action, since there is a limitation on its application in formal environments of knowledge acquisition.

CONCLUSION

In the municipality of Paragominas, the state of the art about water quality is still scarce, because the concentration of studies and research is still based on the Uraim River, due to the role of source that this body of water plays. Another factor is the application of bioindicators as an associative tool for classifying the quality of the water, which is in a stage of development and growing occurrences, and phytoplanktonic or non-phytoplanktonic invertebrates have already been identified, although there has not yet been an expansion to the other tributaries of this body of water, among them the Prainha/Paragominas River.

Regarding the reports of diseases transmitted by ingestion of contaminated water in the municipality, there is a scarcity of literature, which may cause a feeling that "everything is in accordance with the water legislation". However, this may only be a more optimistic view in a municipality of 54 years of existence, where three institutions of higher education and vocational education coexist.

Therefore, it is necessary to expand the theoretical and practical application of Environmental Education to the community in general, from the generation of workshops and training that increase sensitivity to the conservation of water and other natural resources. In addition, it verifies the application of the guidelines offered by the National Water Agency associated with climate change, whose scarcity of research and studies in this area are evident in Paragominas.

The obstacles to environmental enforcement reported here can be overcome, and one of them already has a defined public policy. The others depend on the knowledge that the Paragominas community has about it, and what is the real engagement of each member of it in the conservation of water quality. The research on these associations must be continued in order to evaluate the real situation of the Paragominas water network and the evolution that it presents in future studies.

REFERENCES

ABDALA, S. A. **Evolution of the Tietê River water quality and the factors that influence it.** 2019. Dissertation (Master in Public Health) - University of São Paulo, School of Public Health, São Paulo, 2019.

AMARAL, M. W. W. **Epilithic diatoms from subtropical streams with high concentrations of aluminum and iron, southern Brazi**l. 2022. Dissertation (Master in Conservation and Management of Natural Resources) - Universidade Estadual do Oeste do Paraná, Cascavel, 2022.

ANA. National Water Agency. **Climate change and water resources**. Brasília: ANA. 2016.

AZEVEDO, M. A. M.; SOUZA, F. M.; REIS, A. C. M.; PONTES,. A. N. Environmental education policies developed in municipalities of the southeastern region of Pará. **Brazilian Journal of Environmental Education**, v. 16, n.° 5, p. 482-493,2021.

BERSCH, K. T. J. **Benthic macroinvertebrates as water quality bioindicators for monitoring water environmental services in the Epaminondas Stream basin, Pelotas (RS).** 2020. Thesis (Doctorate in Sciences) - Federal University of Pelotas, Rio Grande do Sul, Brazil, 2020.

BRAGA, C. E. S., GUTJHAR, A. L. N. v Inventory and analysis of aquatic macroinvertebrates bioindicators of water quality in the Uraim River, Paragominas, Pará, Brazil. **Biosphere Encyclopedia**, v. 15, n.º 28, p. 1068-1076, 2018.

BRAZIL. **Law n° 9.433**, of January 8, 1997. Establishes the National Water Resources Policy, creates the National System for Water Resources Management, regulates item XIX of art. 21 of the Federal Constitution, and alters art. 1 of Law No. 8.001, of March 13, 1990, which modified Law No. 7.990, of December 28, 1989. Available at: L9433 (lanalto.gov.br). Accessed on 30 abr. 2022.

BRAZIL. **Resolution n.° 357**, of march 17, 2005. Provides on the classification of bodies of water and environmental guidelines for its framing, as well as establishes the conditions and standards for effluent discharge, and makes other provisions. Available at: conama.mma.gov.br/?option=com_sisconama&task=arquivo.download&id=450. Accessed on: apr. 30, 2022.

BRAZIL**. Resolution n° 410**, of May 04, 2009. Collection of legislation: federal edition, Brasília, Brazil. Access on: apr. 30, 2022. Available at:

Resolução CONAMA nº 410 de 04/05/2009 (normasbrasil.com.br). Acesso em 30 abr. 2022.

BRAZIL. **Resolution nº. 430,** of may 13, 2011. Collection of legislation: federal edition, Brasília, Brazil. Available at: conama.mma.gov.br/?option=com_sisconama&task=arquivo.download&id=627. Accessed on: apr. 30, 2022.

BRAZIL. **Low n.° 14.026,** on the 15 july 2020. It updates the legal framework of basic sanitation and alters Law no. 9.984, of July 17, 2000, to attribute to the National Agency of Waters and Basic Sanitation (ANA) the competence to edit reference rules about the sanitation service, Law no. 10. 768, of November 19, 2003, to alter the name and attributions of the position of Specialist in Hydric Resources, Law no. 11.107, of April 6, 2005, to prohibit the rendering by program contract of the public services dealt with in art. 175 of the Federal Constitution, Law no. 11. 445, of January 5, 2007, to improve the structural conditions of basic sanitation in the country, Law No. 12.305, of August 2, 2010, to deal with deadlines for the environmentally adequate final disposal of waste, Law No. 13.089, of January 12, 2015 (Metropolis Statute), to extend its scope to micro-regions, and Law No. 13.529, of December 4, 2017, to authorize the Union to participate in a fund with the exclusive purpose of financing specialized technical services. Available at: https://www.planalto.gov.br/ccivil_03/_ato2019-2022/2020/lei/l14026.htm#:~:text="Dispõe%20sobre%20a%20criação%20da,para%20a%20regulação%20dos%20serviços. Accessed on fev, 01, 2023.

BRASIL, L. S.; OLIVEIRA JÚNIOR, J. M. B.; SHIMANO, Y.; DIAS, SILVA, K.; JUEN, L. Aquatic Insect bioindicating land use change in Pará, Brazil: Evidence and perspectives. **Oecologia Australis,** v. 26, no. 3, p. 424-444, 2022.

CARLOMAGNO, M. C.; ROCHA, L. C. v How to create and classify categories to do content analysis: a methodological question. **Electronic Journal of Political Science**, v. 7, n.° 1, p.173-188, 2016.

CARNEIRO, C. R. O.; RIBEIRO, H. ,. C.; BATISTA, V. A.; SILVA, D. F.; LIMA, A. Z. S.; BOTELHO, M. G. L.; FURTADO. L. G.; PONTES, A. N. Basic sanitation conjuncture and municipality sanitation plan in Belém do Pará in the Eastern Amazon. **Research Society and Development,** v. 9, n° 8, 2020.

CONCEIÇÃO, M. M. M.; SOUZA, R. R. N.; SILVA, A. C. S.; MACHADO, N. I. G.; CARNEIRO, C. C. A.; GUEDES, F. L.; SILVA, N. S.; SILVA, M. O.; LIMA, A. C. S.; TAVARES, L. S.; SOUZA, G. B.; MARTINS, I. V. M.; RIBIERO, T. S.; SILVA, M. P.; SILVA, A. S. F. The Fuzzy logic in the study of water quality in the Uriam Paragominas - PA river. **Brazilian Journal of Development,** v. 67, n.° 6, p. 38575-38588, 2020.

DIAS, N. M.; MORALES, G. P.; BELTRÃO. N. E. S. V Water resources policy in Pará: the evolution of the instrument of granting the right to use water resources. **Contribuciones a las Ciências Sociales**, 2017.

GUILIATTI, N. M.; RODRIGUES, A. B. M.; JESUS, E.; S.; PEREIRA JÚNOR, A. Variability of monthly and annual precipitation in the municipality of Paragominas-PA. v **Biosphere Encyclopedia**, v. 16, n.° 29, p. 17161730, 2019.

GOMES, M. V. T., GARCIA, C. A. B. SATO, Y., MENDES, E. A., MIRANDA, M. O. T., COSTA, S. S. P. Determination, and evaluation of Mercury Concentration in fish in the Sao Francisco River Watershed, Brazil. **Environment & Water**, v.16, n.º 2, 2021.

GOMES, R. C. **Revegetation of areas degraded by mining in the Jamari National Forest and its relationship with surface water quality.** 2021. Thesis (Doctorate in Environmental Diagnosis, Treatment and Recovery) - Paulista State University "Júlio de Mesquita", Sorocaba, 2021.

GOULART, M.; CALLISTO, M. v Bioindicators of water quality as a tool in environmental impact studies. **FAPAM Journal**, v.1, n.° 1, p. 1-9, 2003.

GUIMARÃES, H. C Q.C.P.; PENA, S. B.; LOPES, J. L.; GUANDALINI, L. S.; GAMBA, M. A.; BARROS, A. L. B. L. Scientific Evidence on leg ulcers as sequelae of leprosy. **Acta Paulista Nursing**, v. 32, no. 5, p. 564-5701, 2019.

IBGE. **Tabular presentation guidelines**. Brasília: IBGE, 1993.

LI, Y., WANG, M., CHEN, X., CUI, S., HOFSTRA, N, KROEZE, G., MA, L., XU, W., ZHANG, Q., ZHANG, F., STROKABLE, M. Multi-pollutant assessment of river pollution from livestock. **Water Research**, n.º 209, 2022.

LOPES, A. P.; CAMPOS, M. A. T.; NOGUEIRA, V. v Environmental education in watershed contexts: an integrative review of national and international research. Electronic **Journal of the master's in environmental education**, v. 38, n° 1, p. 336-361, 2021.

MAHAMOOD, M.; JAVED, M.; ALHEWAIRINI, S. H.; ZAHIR, F.; SAH, A. K.; AHMAD, I. *Labeo rohita*, a bioindicators for water quality and associated biomarkers of heavy metal toxicity. **Clean Water**, n.° 17, 2021.

MANENTI, D. R., SOARES, P. A., SILVA, T. E. C. V., MÓDENES, A. N., ESPINOZA-QUIÑONES, F. R. E., BERGAMASCO, R., BOAVENTURA, R. A. R., VILAR, V. J. P. Performance evaluation of different solar advanced oxidation processes to the treatment of a real textile dyeing wastewater. **Environmental Science Pollution Research**, v. 22, n.º 2, p. 833-845, 2015.

MARINHO, E. R.; VITORINO, M. I.; MOURA, M. N.; BARBOSA, I. C. C.; COSTA, L. G.; SILVA, E. R. M. Climatic events associated with the water quality of the Guamá river, São Miguel do Guamá. **Ibero-American Journal of Environmental Sciences**, v. 11, n. 6, p. 262-273, 2020.

MARINHO, E. R. **Analysis of the water quality of the Guamá river and its climatic and socioenvironmental interfaces in São Miguel do Guamá, northeast Pará**. 2018. Dissertation (Master's in environmental sciences) - Federal University of Pará, Belém, 2018.

MINAS GERAIS. Joint deliberation **CPAM/CERH n.° 01**, de 16 de march de 2010. v Provides on the creation of the Working Group to establish criteria and procedures for the institution of the restriction and control area of groundwater and makes other provisions. Available at: http://www.siam.mg.gov.br/sla/download.pdf?idNorma=12913. v Accessed on 10 jan. 2023.

MORAIS, L. H. T.; LUNA FILHO, R. L. C.; SANTOS JÚNIOR, J. A.; SIQUEIR, W. N.; PEREIRA, D. R.; LIMA, M. V.; SILVA, H. A. M. F.; FRANÇA, E. J.; AMARAL, R. S.; MELO, A. M. M. A. Use of *Biomphalaria glabrata* as a bioindicador of groundwater quality under the influence of NORM. **Journal, of Environmental Radioactivity,** n° 242. 2022.

MOY, K. M.;BRASIL, L. S.; OLIVEIRA JÚNIOR, J. M. B.; JUEN, L.; VIEIRA, T. B.; DILVA, K. D. Effects on environmental changes on Gerromorpha (Heteroptera: Hemiptera) communities from Amazonian streams. **Hydrobiology**, n° 1, 2022.

NAKADAKARI, L. H. V **Proposal of a monitoring plan of industrial effluents with heavy metals for the city of Bauru-SP**. 2022. Course Completion Paper (Bachelor in Biological Sciences) - Paulista State University - Faculty of Science, Bauru, 2022.

NASCIMENTO, B. L. M., GOMES, D. R. C. S., COSTA, G. P., ARAÚJO, S. S., SANTOS, L. C. A., OLIVEIRA, J. D. Behavior, and evaluation of potentially toxic metals (Cu(II), Cr (III), Pb (II) and Fe (III) in surface waters of Capivara and Bacuri creeks Imperatriz-MA, Brazil. **Sanitary and Environmental Engineering,** v.20, no.30, p.369-378, 2015.

NASCIMENTO, J. M. H.; FARIAS, T. L.; SILVA. M. S.; ,IRANDA, L. A. S.; MOURÃO, F. V.; CORRÊA, G. M. v Preliminary analysis of the water quality of a water body in Paragominas - PA. **Brazilian Journal of Animal and Environmental Research**, v. 3, n.° 3, p. 2272-2281, 2020.

NASCIMENTO, L. C.; NAVAL, L. P. Toxicity determined by the use of pesticides on water quality indicator organisms. **Brazilian Journal of Environmental Sciences**, no. 53, p. 69-80, 2019.

NASCIMENTO, M. N.; BUSH, M.; BICUDO, D. C. Water quality and spatial dynamics in the largest water supply reservoir in Brazil and implications for diatoms assemblage. **Act Limnologica Brasiliensia**, v. 33, 2021.

NETO COSTA, T. G.; LOBO, C. F.; SOARES, W. V Conditions, and projections of access to basic sanitation in medium-sized Brazilian cities. **Terr@Plural,** v. 14, p. 1-22, 2020.

NEVES, M. N. B.; CUNHA, B. J. C.; TEIXEIRA, T. D. P.; PANTOJA, A. S.; AGRIPINO, L. M.; ISHIHARA, J. H. Quali-quantitative temporal analysis of the water in relation to the deactivation process of water dam in the micro-basin of Igarapé Parariquara, in the municipality of Paragominas-PA. In: Congresso Brasileiro de Geologia de Engenharia e Ambiental. 17. 2021.. Minas Gerais. **Electronic Proceedings.** Available in : CBGE - Anais (schenautomacao.com.br). Accessed in 30 dez. 2022.

PAIXÃO, F. J. M.; SILVA, M. L. Environmental education as a public policy for integrated natural resource management: a case study of the municipality of Paragominas, Pará State. **New Issues NAEA**, v. 22, n° 2, p. 93-115, 2019.

PAIXÃO NETO, M. J. V **Pollution policy, management, and reuse of water: a study on the application of the legislation in the industrial district of Amapá**. 2021. Monograph (Specialization in Irrigation and Management ide Water Resources) - Federal Rural University of Amazonia, Capanema, 2021.

PARÁ. **Law n. 6.381**, of july 25, 2001. Establishes the State Policy for Hydric Resources and creates the State System of Hydric Resources Management. Available at:

https://www2.mppa.mp.br/sistemas/gcsubsites/upload/41/POLITICA_DE_RECURSOS_HIDRICOS_DO_ESTADO_DO_PARA.pdf, Accessed in 10 jan. 2023.

PRATTI, R. M. **Water quality used for the application of agricultural pesticides in the Capim Region, Southeastern Pará**. 2019. Course Completion Paper (Bachelor in Agronomy) - Federal Rural University of the Amazon, 2019, Belém, Pará.

PRAZERES, M.; MARTINÉZ-COLON, M.; HALLOCK, P. Foraminífera as bioindicators of water quality: The foRAM Index revisited. **Environmental Pollution**, n.° 257. 2020.

QUINELATO, R. V.; OKUMURA, A. T. R.; BIFANO, R. B. A.; FARIAS, E. S.; BRITO, J. M. S.; FERREIRA, C. S. V. A.; SILVA, J. B. L.; BERNARDES, M. E. C.; SILVA, A. G. v Determination of surface water quality and its compatibility with Multiples uses: a case study of the Caraíva River. **Revista Brasileira de Geografia Física**, v. 14, n.° 01, p. 037-057, 2021.

RODRIGUES, N. F. S.; MIRANDA, S. B. A.; ANDRADE, J. C. The effectiveness of Environmental Education in Pará: a case study of the municipality of Concordia do Pará. **Contribuciones a las Ciencias Sociales**, 2020. Available at:

https://dialnet.unirioja.es/servlet/articulo?codigo=7760494. Accessed on 10 Jan 2023.

RODRÍGUEZ-GUERRA, A.; MARTÍNEZ, F. S. Social responsibility and environmental water management, a solution in Ecuador's dairy industry. **ALFA, v**, 4, n.° 12, p. 211-230, 2020.

ROMERO, J. M. D. **Effect of chemical speciation on iron uptake in Symbiodiniaceae.** 2020. Dissertation (Master of Science - Chemistry Program) - University of São Paulo - Institute of Chemistry, São Paulo, 2020.

ROUABHI, Y. A. **Comparative study of the biology and bioaccumulation of trace metuax in two Mytilidae: Mitylus galloprovinciallis (Lamarck, 19819) and Perna (Linnaeus, 1758) from the Algerian west coast.** 2020. Thesis (Doctorate in Science). Faculte des Sciences de Université de Mons, p. 13-29, 2020.

SÁ. R. J. S.; SOUZA, A. G. S.; JESUS, E. S.; PEREIRA JÚNIOR, A. Biological indicators of water quality and climate change. **Multidisciplinary Reviews**, n. 2, 2019. SANTOS, B, M., SANTOS, S. M., SOUZA, C. A., SANTOS, C. R. A., BORTOLINO, J. C. A. Environmental variability influences phytoplankton biomass composition in a Neotropical reservoir**. Oecologia Australis**, v. 25, n.º 1, p.90-102, 2021.

SANTOS, J. V. A. S.; LIMA, M.; MONTELES, J. S.; CARRERA, D. L. R.; FARIA, A. P. J.; BRASIL, L. S.; JUEN. L. Assessing physical habitat structure and biologia condition in Eastern Amazônia stream sites. **Water Biology and Security**, 2022. Available at: https://www.sciencedirect.com/science/article/pii/S277273512200172X

SANHUDO, D. G. F.; DALPIAZ, R. L. V.; SCAGLIONI, T. P.; SALOMONI, E.; FERMINO, F. S; SPOCHIATO, M. “Green Tides" in the bag of Tapés/RS. In: Integrated Teaching, Research and Extension Salon of UERGS. 10. 2-021. Porto Alegre. **Electronic annals.** Available at: http://pev-proex.uergs.edu.br/index.php/xsiepex/index

SILVA, A. C. S.; FARIAS, N. S. N.; PEREIRA JÚNIOR, A. v Diatoms as indicators of water quality in urban rivers**. Brazilian Journal of Development,** v. 6,n.° 6, p. 34616-34643, 2020

SILVA, B. L. **Influence of interspecific interactions and the environment on the organization of semiaquatic insect species in the Eastern Amazon**. 2021. Course Completion Paper (bachelor’s in biology) - Universidade Federal do Pará, Belém, 2021.

SILVA, D. F.; COSTA, G. G. G.; GOMES, L. F.; LOPES, D. F.; LOPES, M. S. B. Transparency and universalization of Water and Sewerage rates in the State of Pará, Brazil. **Research, Society and Development**, v. 9, n. 8, 2020.

SILVA, I. S.; GOMES. L. E. N.; CASTRO, M. P. B.; SILVA, M. P.; PENICHE, R. R.;LIMA, W. P.; RIBEIRO, R. R. Analysis of the water quality index and the influence of anthropic actions on the Uraim River. In: PEREIRA JÚNIOR, A.; JESUS, E. S.; RIBIERO, J. FM. F. (Org.) **The multiple visions of the environment and environmental impacts**, v. 2, Curitiba: Simplíssimo, 2019, p. 179-185.

SOUSA, J. R.; SANTOS, S. C. M. Content analysis in qualitative research: ways of thinking and doing. **Research and Debate in Education**, , v. 10, n. 2, p. 1396-1416, 2020.

STORTO, D. **Seasonal dynamics of microbial contamination of the water of the Tietê Ecological Park.** 2021. Dissertation (master's in environmental sciences) - Universidade Brasil, Itaquera, 2021.

UNITED NATIONS. **International decade for actions "water for life" – 2005-2015**. 2014. Retrieved from: https://www.un.org/waterforlifedecade/quality.shtml

VASCO, P. S. **Study shows that lack of sanitation harms more than 130 million Brazilians**. Federal Senate. 2022. Available at: Study shows that lack of sanitation harms more than 130 million Brazilians - Senate News. Accessed on: 02 Jan. 2023.

YUSSUF, Z. H. Phytoplankton as bioindicators os water quality in Nasarawa reservoir, Katsina State Nigeria. **Acta Limnologica Brasiliensia,** v. 32, 2020