The discovery of the decline of the manhole bath in the municipality of Açailândia/MA in an environmental education project

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ABSTRACT
This work aimed to show an initiative by students from the Civil Engineering Course in the municipality of Açailândia/MA to carry out an Environmental Education project aimed at raising awareness among the local population about the use of environmental septic tanks and grease traps, in an attempt to reduce the release of domestic sewage into streams close to the region, more specifically the Açailândia River. In addition to this environmental problem, this article sought to analyze the effects of water flow in the vicinity of the "banho da Bueira", which caused land to move downhill, consequently generating siltation in this resort that was so popular and used by the population of this municipality for fun, fishing, washing dishes and clothes. In this sense, this work brings a reflection on the effects of disorderly occupation in riverside regions that should be protected by the municipal government, and that when due attention is not given, an exorbitant increase in garbage and sewage, generally produced in peripheral regions and which are carried by rainwater without any type of treatment to the nearest river, reducing its quality until it becomes completely unsuitable for human contact.

Keywords: Civil Engineering, Sewage, Pollution, Waterf.

1 INTRODUCTION

In most underdeveloped countries, the urbanization process occurred in a disorganized way, impacting the so-called water infrastructure (sanitary sewage, rainwater and solid waste), with the

immediate consequence of pollution in the environment, due to the discharge of effluents directly into the rainwater sewage network that eventually reaches the urban rivers located in its vicinity (TUCCI, 2005).

The contamination of these freshwater sources, which are essential for human, animal and industrial supply, is usually obtained by pumping water from underground wells, a process widely used to supply small and medium-sized cities, impairing their quality and bringing diseases of all kinds to the local population.

However, this pollution was not always so intense. Some time ago, when cities were smaller, rivers were able to recover their quality with some ease, but nowadays, due to the large volume of sewage produced by cities, upstream of the hydrographic basins had as a serious consequence the decrease in the capacity of dilution of these pollutants, which generated great damage to the environment and especially to the residents of the cities. Because the downstream areas that receive all kinds of sewage and garbage have their margins supplied with this polluting material.

Making an analogy and using the street as an example instrument, because it receives rainwater, we know that the water drains through the gutters going towards the "mouths of wolves" that transport the water to flow into the streams in the region. The flow supported by any asphalt street drainage also has its limitation, and can be calculated by the rational method, obeying the following formula below:

$$Q = \frac{C.i.A}{3,6}$$

Being:

Q=flow rate in m3/s

C=runoff coefficient (dimensionless)

I=rainfall intensity in mm/h

A=drainage area(km2)

In order for the drainage system to be efficient, it is necessary that this flow produced by rainwater is equal to the maximum amount supported by the gutter system that passes through the "wolf's mouth" and then through the galleries until it reaches the streams. However, this absorption capacity by the micro drainage system is impaired by the obstruction caused by garbage and debris that are found on public roads, especially disposable materials such as pet bottles, in addition to plastic packaging of different types, causing a factor of efficient reduction of this flow in the channels and may even generate flooding in nearby locations in case of heavy rain in these regions (Reduction Factor, DAEE/CETESB, 1980).

In this sense, in order to calculate this flow of water that displaces by this means, it is also necessary to know the concentration time in which rainwater leaves the farthest point to its exultory, which can be the end of the watershed or an artificial means of drainage such as sewage, mainly to know the time of action that can be taken in risk areas in relation to their margins.

Obeying the following Kirpich's Equation:

$$t_c = 57.\left(\frac{L^3}{\Delta h}\right)^{0,385}$$

Where:

tc=concentration time in min

L=thalweg in km

Δh=elevation gain in m

However, this time it takes for rainwater to reach this drainage system will depend on the average intensity of the rain that falls in this location, which varies greatly the rainfall index from region to region, and it is necessary to set up an equation known as rainfall, obeying the following parameters:

$$I_m = \frac{(K.TR)^a}{(t+b)^c}$$

Where:

Im=mean maximum precipitation intensity, mmh-1

TR=payback period,years;

t=duration of precipitation,mim.

K,a,b and c=parameters adjusted based on local rainfall data.

In this sense, depending on the intensity of the rain that falls in this region, it can cause large floods of water carrying a large amount of diffuse pollution carried by the nearby rivers belonging to this basin. This fact is aggravated by the disorderly occupation of urban land in regions bordering these basins, such as irregular or clandestine allotments built in these vicinity, generating more garbage and domestic sewage. This causes a reduction in the quality of the water, requiring greater chemical treatment for its purification, which in extreme cases can lead to a qualitative shortage, which occurs when there is no possibility of recovery for human consumption.

The occupation of riverine areas, whether on a regular basis, authorized by public agencies or spontaneously through invasions of protected areas, also causes an increase in sediments released into

these rivers, mainly due to the deforestation of these coastal areas that generate erosion, resulting from the increase in the speed of surface runoff through urbanized areas of great earth movement.

However, the increase of this sedimentation in the basins leads to the silting of the sections of the drainage of the natural course of this river, with a reduction in the flow capacity of these conduits. In addition to the possibility of the emergence of vegetation on these sandbanks and organic materials that accumulate on their banks, obstructing the passage of water, which can generate flooding in these riverside regions.

This accumulation of sedimentary load is the result of the change in the basin system, due to the change in the natural geographic space caused by the urbanization process, ceasing to be a rural basin that had a greater vegetation interception, greater permeable areas (soil infiltration), less runoff on the soil surface and slower drainage to an urban basin that has impermeable surfaces. such as roofs, streets, and floors.

The results of these changes in the flow processes are: increase in maximum flow and surface runoff, reduction of peak time and decrease of base time. This means that much more garbage and water are transported to the rivers in a short time, leading to a reduction in the section of rivers, an increase in the frequency of flooding in places of greater sedimentation and an increase in the energy and speed of runoff, which can produce real canyons that reach 30 m deep and 50 m wide in fragile soils. that is, generating quite high declensions.

In this sense, some alternatives used by developed countries to reduce this increase in these problems and use more sustainable criteria such as respecting the natural flooding of the rivers, and their water flow should not be increased or expanded by those who occupy the basin, whether motivated by a simple allotment, or a simple urban landfill, to the construction of bridges and highways, and fundamentally to the waterproofing of the allotments, that is, the principle is that no urban user can increase the natural flooding of the watersheds.

In addition, the occupation of urban space and the drainage of rainwater must prioritize the natural mechanisms of runoff such as infiltration, which means: increasing recharge; reduce occupancy in areas with a low water table; preserve natural vegetation; reduce pollution transported to rivers; reduce maximum downstream flows and maintenance in artificial drainage system.

However, unlike developed countries, Brazilian governments prefer to solve this type of problem in a less effective way with significant losses to the population, based on the false principle that "the best drainage is the one that removes surplus rainwater as quickly as possible from its place of origin".

The problems caused by the lack of basic sanitation and adequate urban drainage are repeated throughout the country, and it is very necessary that the work investigates in depth where the sources of freshwater contamination in urban regions begin and what is the real size of the impact on society.

In addition, deforestation in floodplain regions should also be observed and whether the local population respects the minimum distance of the forest code, which is fifteen meters from the vicinity of streams (Law No. 12,651) from permanent preservation areas (APPs), even with an update in 2021 (Law No. 14,285), resulting in an increase in sediments in these springs, caused by the clearing of riparian forests that are important for soil protection in these riparian areas.

The trees found in these regions are fundamental for the evapotranspiration process that occurs in the foliage and in the soil (vegetation cover), producing rainfall that penetrates the soil supplying the springs, which will contribute to supply the flow of the main river. In addition, the reduction of infiltration, due to the replacement of the natural cover by impermeable areas, the aquifer tends to lower the level of the water table due to lack of food (especially when the urban area is very extensive), reducing underground runoff. (FELLENBERG, 2012)

Also in relation to the biological pollution of water for domestic purposes, the lack of a sanitary sewage system that makes it possible to collect and treat sewage before it is released into nature is a major problem not only throughout Brazil. A viable alternative is the use of septic tanks and grease traps in residents' homes, mitigating the discharge of sewage into these rivers. (FELLENBERG, 2012)

The main sources of water contamination are the bacteria of the coliform group, constituting the most used contamination indicator worldwide, being used as a basic bacteriological parameter in the definition of standards for monitoring the quality of water intended for human consumption, as well as for characterization and evaluation of water quality in general.

The coliform group includes the genera: Citrobacter, Enterobacter, Klebsiella, Escherichia, etc., and the bacteria of the genus Escherichia are exclusively of fecal origin and the other members of the coliform group can sometimes occur with relative abundance in the soil and even in plants.

Fresh, brackish and saline waters intended for bathing (primary contact recreation) will have their condition evaluated in the following categories:

> § 1 Waters considered suitable may be subdivided into the following categories: a) Excellent: when in 80% or more of a set of samples obtained in each of the previous five weeks, collected at the same site, there are at most 250 fecal coliforms (thermotolerant) or 200 Escherichia coli or 25 enterococci per l00 milliliters; b) Very Good: when in 80% or more of a set of samples obtained in each of the previous five weeks, collected in the same place, there are a maximum of 500 fecal coliforms (thermotolerant) or 400 Escherichia coli or 50 enterococci per 100 milliliters; c) Satisfactory: when in 80% or more of a set of samples obtained in each of the previous five weeks, collected in the same place, there are a maximum of 1,000 fecal coliforms (thermotolerant) or 800 Escherichia coli or 100 enterococci per 100 milliliters". (Art. 02 of CONAMA Resolution No. 274 (2000)

However, care must be taken when using this water when pollution is evident, as stated in § 4 of the same resolution: "*d) the presence of waste or discharges, solid or liquid, including sanitary sewage, oils, greases and other substances, capable of posing health risks or making recreation*

unpleasant;" In addition to dirt carried by rainwater that can cause the deterioration of the quality of beaches or resorts, being characterized as a result of the washing of public roads by rainwater.

In an attempt to raise a reflection on this problem, this work proposed to the residents of the observed areas to encourage the use of septic tanks and grease traps in the homes of the analyzed residents, the first with the objective of reserving an adequate place for the storage of waste from the toilets and the second with the function of retaining the waste from the kitchen sink. avoiding throwing organic and inorganic debris such as food leftovers, detergents and especially cooking oil down the drain.

In order to contribute to the improvement of this situation, this article shows the stages of preparation and performance of an environmental project carried out by the students of the sixth period of the Civil Engineering Course at UEMASUL-MA, as a research practice of the Hydrology Course, aiming at learning the content of this discipline in a more significant way, seeking real solutions to the problem in question.

In order to contribute to this cause, the project sought to raise awareness among the residents of Juazeiro Street (Vila Maranhão neighborhood), in the city of Açailândia-MA, about the polluting sources of sanitary sewage released into the streams of the regions, encouraging this local population to use environmental septic tanks (banana trees) because they are less polluting and the installation and handling of grease traps in homes.

This street (Juazeiro) was chosen among the others in the Vila Maranhão neighborhood because it is located on the banks of the Açailândia stream, the main hydrographic basin of the city, making it easier to identify the causes and reasons for the impacts of environmental problems in this locality. With this, we sought to make a preliminary analysis through observation of the reality and interview with the residents of this region, in an attempt to understand the changes and impacts suffered in the environment over time due to anthropogenic action.

To better clarify the current pollution, water was collected at this point of the Açailândia River and a comparison was made with two other points upstream, aspiring to know if it would be suitable for bathing (bathing test). In addition, other changes in the space caused by the action of water were analyzed, such as rainfall that causes great erosion and burial at the end of the street because it does not have an efficient micro drainage system to capture rainwater capable of damping the flow speed at the end of the downstream street.

2 MATERIAL AND METHODS

This proposal was inspired by the Tripod Law that encourages the university to promote research, teaching and extension during the realization of the disciplines (CF/88), in this sense to comply with methodologies such as presentation of seminars and development of projects that help

the applicability of the knowledge acquired during the course to its local reality, the stages of this project will be presented below.

2.1 PRESENTATION OF THE PROBLEM AND THE DEVELOPMENT OF PRIOR KNOWLEDGE

In order for the student to start a scientific research, it is necessary to have a predisposition for learning, for this the teacher must create a favorable environment that arouses the student's interest in discovering alternatives to solve the problem. In this sense, in the process of discovery, the student has to go through the "activation" phase, where the teacher creates a question with an optimal level of uncertainty (not too much or too little clarifying) that provokes the student's desire to explore the environment and find the correct answer (BRUNER, 2000).

This desire to learn also involves the observation of the applicability of this knowledge in real situations, that is, the single most important factor of learning in the teaching-learning process "is what the learner already knows" (SWELLER, 2001). The most important concept of this theory is "meaningful learning", in which he says that the more specific concepts are supported by other more general or relevant concepts, called "subsumers", developed through experiences witnessed during their daily lives (MOREIRA & MASSINI, 1982, p.7).

Based on these ideas, during the Hydrology Course, previous knowledge was developed so that the student would be able to improve the basic knowledge of the discipline to the most advanced. Among the information presented during the classes, it was shown that accelerated urbanization caused a concentration of people in small urban spaces, producing a direct effect on the water infrastructure: supply, sanitation, rainwater (urban drainage and riverside floods) and solid waste.

This disorderly migration to the cities, without urban planning, has caused the occupation of the poorest population in vulnerable areas of the periphery, where there is no adequate basic sanitation infrastructure, usually close to springs, forests and hills, increasing deforestation and pollution of all kinds of environment.

As the concept of watershed was presented, it allowed the professor to show some examples of local micro-basins or subsystems close to the campus of the Civil Engineering Course, such as the one on the Açailândia River, which is located in the Jacu neighborhood (figure 1), a region that favors the use of learning schemes located in its memory. acquired during their life experiences.

Figure 1 – Prainha do Jacu

Source: The author(2023)

In this sense, the impact of the disorderly occupation of the needy population in the vicinity of the Açailândia River was discussed, causing serious erosion and silting due to the felling of the native forest on the banks, in addition to the increase in domestic depletion released into its waters due to this population increase.

However, in order for the student to feel safe in his research, it was necessary to present initial concepts of the basin such as: drainage area, form factor, average extension, precipitated volume, sinuosity, elevation, concentration time and slope. Subsequently, the parameters that govern the rainfall equation were presented, as well as a rational method for calculating flow and introduction to the elements that make up the micro drainage (COLISCHONN; DORNELLES, 2013)

2.2 THE DIVISION OF THE GROUPS AND THE ACCOMPANIMENT IN THE SEMINARS

The methodology of this work was applied in a Civil Engineering class of the Hydrology discipline of UEMASUL (State University of Maranhão do Sul) in 2023, divided into four groups of 5 components (totaling 20 students enrolled in the 2021 class), belonging to the sixth period of graduation. These groups received study topics that were initially responsible for researching and deepening these subjects in scientific works (articles, dissertations, theses, magazines and books), developing a previous knowledge or learning scheme so that they would later be able to apply their ideas within their local reality. The groups were divided with their respective themes below:

a) Water group: responsible for knowing the forms of water treatment, parasitic diseases related to the consumption of unsafe water by humans due to the discharge of domestic sewage and the understanding of water analysis practices.
b) Grease trap group: responsible for disseminating and making the population aware of the benefits of installing grease traps in homes, avoiding throwing grease and organic debris into domestic sewers, teaching the process of installing and cleaning it periodically. In addition to encouraging complementary practices such as reusing cooking oil to produce

organic soaps and the practice of composting food leftovers that often end up down the drain.

c) Banana Tree Environmental Cesspool Group: this group sought to research the benefits of these types of cesspools in terms of improving rainwater contamination so that later they could create a more accessible model of their own and disseminate to the neediest population in the study area the stages of its construction, also explaining the functionality of the cesspools in the environment, discouraging the practice of using black cesspools, harming the water table.

d) Erosion group: this group sought to carry out a survey of erosion and siltation in the vicinity of Juazeiro Street, identifying its causes, and possible solutions, making the population aware of the harmful effects of the practice of throwing garbage and debris in these holes, encouraging the practice of preserving riparian forests.

The preparation for the field research involved the presentation of seminars of the fruits of his research, thinking about this methodology considering that self-explanation is a great way to develop a relevant load in the student's long-term memory (SWELLER, 1990), identifying his gaps in understanding during his presentation, giving the opportunity through discussion with teachers and colleagues to improve his work.

2.3 THE DEVELOPMENT OF BROCHURES AND THE PROCESS OF ENVIRONMENTAL AWARENESS

The process of creation and application of the environmental education project by the study groups followed the stages of knowledge of theoretical references similar to their object of study, later the development of methodologies for the investigation of the field research, so that the students are able to synthesize their ideas in informative folders aimed at the environmental awareness of the population of the study area (figure 2). This work is part of a Hydrology project, and its central point is focused on valuing water, a vital element for human beings, so the themes were guided to the issue of preserving its quality, focusing on the rivers and groundwater in the neighborhoods visited that serve to supply the community.

Figure 2: Interview with residents of Juazeiro Street

Source: The author(2023)

2.4 THE COLLECTION AND ANALYSIS OF WATER FROM THE AÇAILÂNDIA RIVER

During the realization of this work, a partnership was achieved with IFMA (Federal Institute of Maranhão) of the Açailândia campus, which was responsible for analyzing the quality of the water in terms of bathing (water suitable for bathing). Then, there was a collection at three points of the Açailândia River, one near Juazeiro Street (figure 3), where an environmental awareness project took place, and the other two further upstream, Prainha do Jacu, in the Jacu neighborhood and the Yasmim resort in the Colina Park neighborhood. The objective would be to understand the flow of pollution that moves through the waters of the river and observe the local nature and its possible pollutions.

Figure 3: Water collection in the Açailândia River

Source: The author(2023)

2.5 THE DELIVERY OF THE ARTICLES BY THE GROUPS

At the end of this project, the students were asked by the teacher to provide a technical report in the form of a scientific article showing their conclusions after the field research and the conclusions reached in relation to the topics discussed by the groups. It was also used as a source of information the interview with the local residents during the environmental awareness, enabling the understanding of the change of the geographical space over time in that region, due to the alteration caused by human

occupation that had disastrous consequences in the nature of that place, especially in that part that make up the Açailândia River that is in the vicinity of Juazeiro Street.

2.6 DEEPENING THE SOURCES OF POLLUTION AND SILTATION IN THE MANHOLE BATH

After the conclusion of the course of the discipline of Hydrology together with the completion of the Environmental Education project, the professor and some students decided to investigate more deeply some sources of water pollution in the region of the first collection (sample 1 and 2), known as the bueira bath (see figure 4), a bathhouse that was once very popular in the region by the population of the municipality. in the period of the 90s, which in recent years has been suffering the impacts of pollution, silting and abandonment by the municipal government. In this sense, a second questionnaire was made with questions passed to residents near the locality on August 15, 2023, in an attempt to investigate new sources of pollution in this region and perhaps propose solutions.

Figure 4: Culvert bathhouse

Source: The author(2023)

3 RESULTS AND DISCUSSION

During the field research, carried out on June 15 of this year, the students' research groups conducted interviews with the residents about their respective objects of study and took photos that showed the main environmental problems in this location. The water group asked the residents the following questions:

1- In your opinion, what is the importance of water for the population?
2- In your opinion, what is the main cause of water pollution?
3- Do you know the possible effects of consuming contaminated water?
4- What to do to avoid water pollution?
5- Do you think it contributes to the non-pollution of rivers?

Among the questions asked to five residents of this group, all agreed that water is a very important resource for the maintenance of life (100% in question 1), identifying that the main cause of pollution of the Açailândia River is the discharge of domestic sewage (80% in question 2) and throwing garbage (20% in question 4). However, they do not know how to avoid this type of pollution released into the environment or the negative effects of contact with contaminated water (60% do not know how to answer questions 3 and 4).

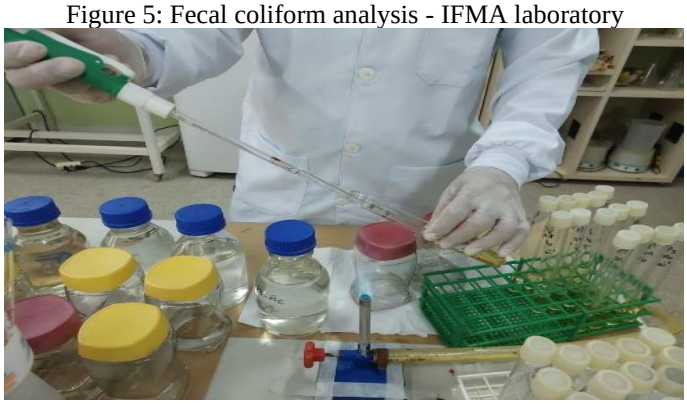
These results coincide with those of the grease trap group that interviewed ten residents in total, showing that 80% admitted not knowing what a grease trap is and its relevance to sustainability, with some residents (30%) showing interest in installing a grease trap, however, many of them mentioned the lack of resources as an obstacle to the implementation of this device.

The cesspool group found that residents know what a common septic tank is and that they contribute to sewage treatment (75%), but do not know about banana cesspools (100%).

In the field investigation by the erosion group, a large crater was noticed at the end of the street, in addition to the fact that it did not have a basic rainwater sanitation system. Another problem was the debris thrown into the crater by the population is the total lack of knowledge of the understanding of gullies, the importance of the riparian forest for the preservation of the river during the interviews (100% of the interviewees), but identifying that the landscape of the old resort of the region was decreasing in depth.

This local bathhouse (sample 1 and 2) was one of the first water collection points, in addition to Prainha do Jacu (sample 3 and 4) and Yasmin bathhouse (sample 5 and 6) in the vicinity of the same river, totaling six samples, two from each location. These samples were analyzed by the IFMA-Açailândia laboratory (see figure 4), the test was for thermotolerant fecal coliforms, which gives the result if the waters are suitable for bathing or not.

Figure 5: Fecal coliform analysis - IFMA laboratory

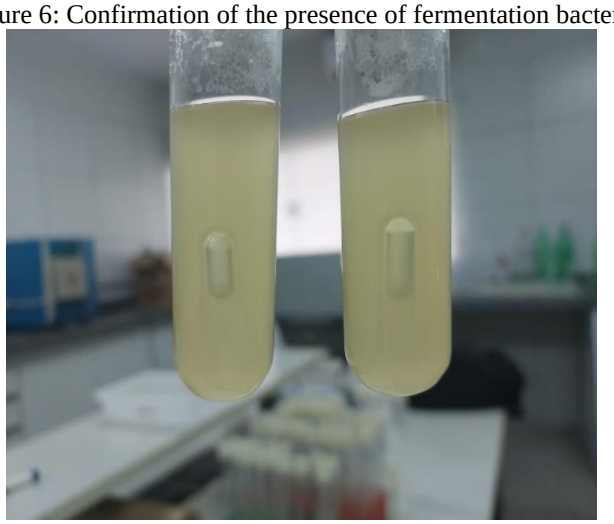


Source: The author(2023)

This technique consists of identifying the coliform bacteria that constitute the most used contamination indicator worldwide, being used as a basic bacteriological parameter in the definition

of standards for monitoring the quality of water intended for human consumption, as well as for characterization and evaluation of water quality in general. The objective of the thermotolerant test is to observe whether the water presents gram-negative, aerobic or facultative anaerobic, non-spore-forming bacilli that ferment lactose with acid and gas production in 48 hours at 35ºC, as shown in the figure below.

Figure 6: Confirmation of the presence of fermentation bacteria



Source: The author(2023)

According to article 2 of CONAMA Resolution No. 274 (2000), the water of the three points analyzed has quantities of less than 250 coliform particles in one hundred millimeters of water, being classified as of excellent quality for bathing (see table 1).

Table 1: Fecal coliform results

	Thermotolerant test (NMP/100ml)
Title	**Column 1**
Sample 1	80
Sample 2	3
Sample 3	3
Sample 4	3
Sample 5	3
Sample 6	3

Source: Source: The author(2023)

Although the collected water samples had low coliform values, sample 1 presented a maximum value of 80 NPM, being the result totally according to its location, since it is more downstream in

relation to the other collection points, where many foci of plastic and organic garbage carried by the river current to this point were found. (See Figure 7)

Figure 7: Plastic waste carried by the current

Source: The author(2023)

Regarding the results found in the manhole bath, obtained after the environmental education period that took place on August 11, new questions were asked to local residents (14 interviewees in total), in an attempt to deepen the environmental problems initially found at the site.

1) How many years have you lived in this residence?
2) How far is your house from the swamp?
3) Do you preserve the native vegetable in your yard?
4) Have you ever planted trees in your backyard?
5) Do you know the importance of riparian forests (vegetation) near rivers?
6) Do you know that it is a water hole and how important it is for the river?
7) Do you consider that in recent years the water holes in this region have increased or decreased? What was the reason for this increase or decrease?
8) In recent years, has there been an increase or decrease in the depth of the river in the vicinity of your home? If so, what do you think caused the decrease in this depth?
9) Have you ever bathed in Bueira? If so, in what period did you take your last shower?
10) Do you currently consider the manhole water to be of good quality for bathing and consumption?
11) Was manhole bathing ever popular with people in the area? If so, in what period?
12) Do you think the manhole bath could be a great tourist spot?
13) Does your home have a septic tank? If not, where does the sewage produced from the toilet go?
14) Where does the sewage produced in the sink go?

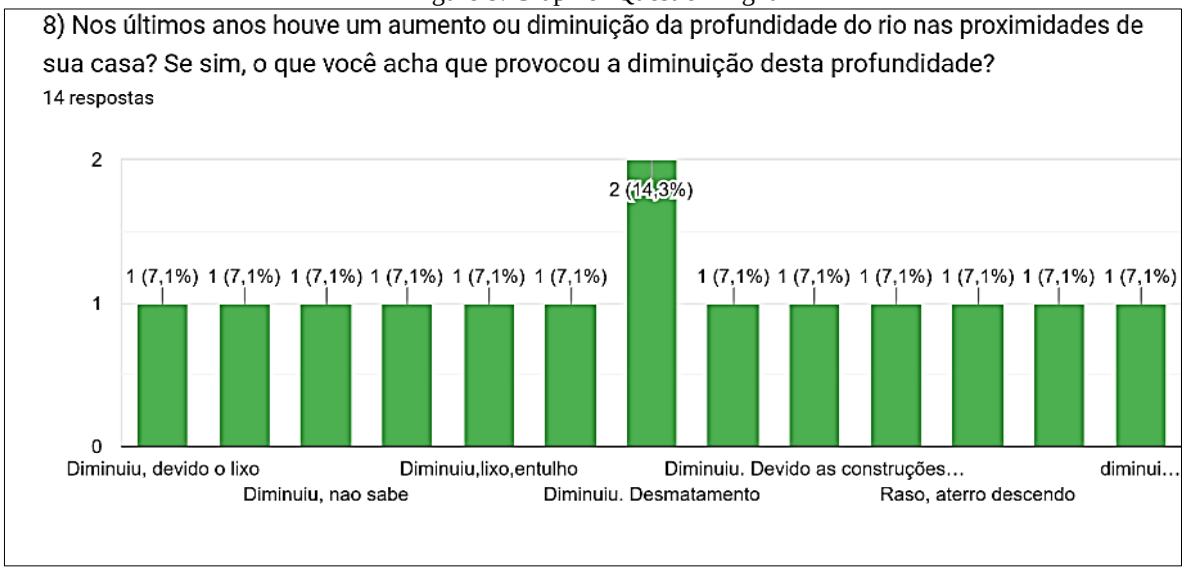
15) Is there any kind of erosion or gully on your street? If so, what do you consider to be its cause?

16) If your street is eroded, would you use to throw garbage to plug potholes?

17) Does your street have basic sanitation, do you have wolf mouths? If so, how many wolf mouths are there on your street?

In this perspective it was possible to conclude what was already noticed initially in the first visit, the presence of sand ravines, vegetation and garbage, visually reducing the depth of the river and impairing its natural circulation, being confirmed by the testimonies of local residents who unanimously stated that in the last this region of the river became shallow due to the release of debris, garbage, landfill on its banks being carried by rainwater to the bathhouse and filling it (see Figure 8).

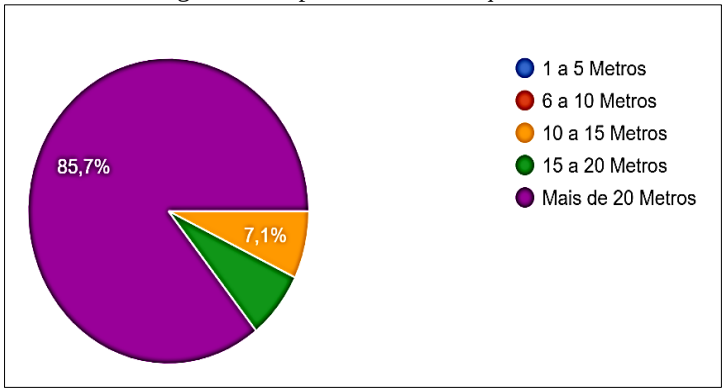
Figure 8: Graph of Question Eight



Source: The authorproduced by Google form (2023)

When asked the distance from the back of their house, most said it is more than twenty meters, respecting the minimum required by environmental legislation, which is 15 meters.

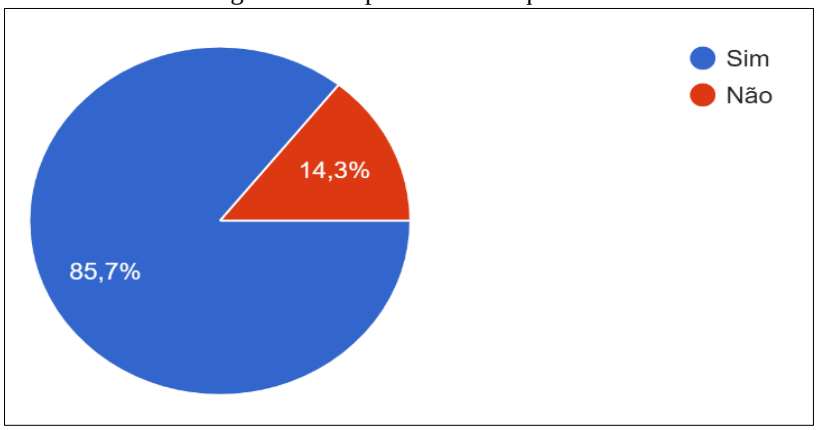
Figure 9: Graph of the second question



Source: The Author produced by google form (2023)

Most of the interviewees also stated that they preserve the native trees of their backyard, from this time of the beginning of their occupation and that they also contributed by planting some fruit trees (57.1%), stating that they know the importance of preserving the floodplain forest.

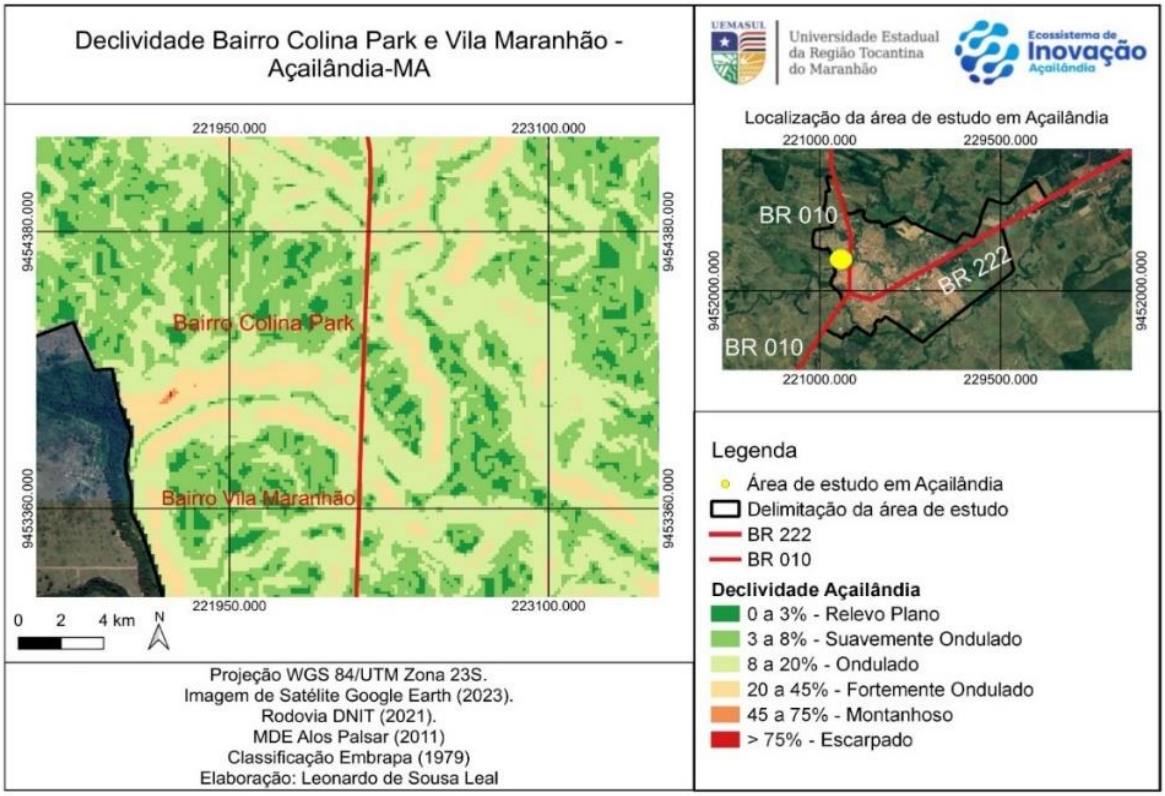
Figure 10: Graph of the fifth question



Source: The Author produced by google form (2023)

However, even some residents take the initiative to preserve the environment, some of the interviewees stated that deforestation in these regions has increased in recent years, contributes to the silting process, mainly because this region is highly undulating with an average slope of 20 to 45%, receives a large amount of sediments from other locations further upstream of the river. drastically reducing the natural flow of the movement of these waters when they reach the part where two large culverts that cross the BR 010 are located, in an alteration in the natural environment created by man in an attempt not to harm the path and speed of the river's current.

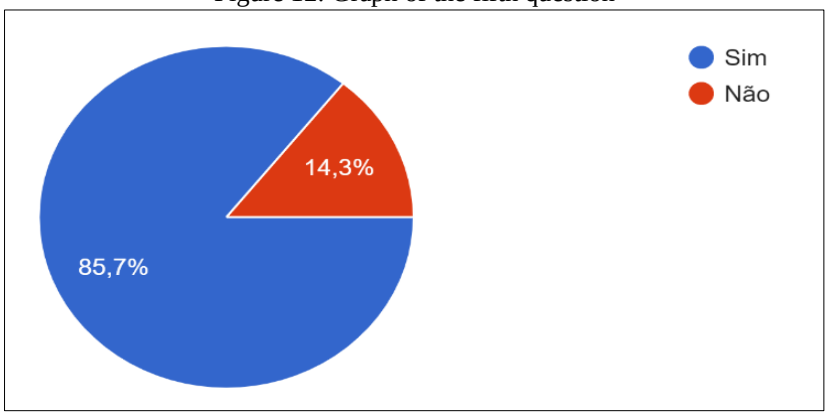
Figure 11: Slope of the Colinas Park and Vila Maranhão neighborhoods



Source: The author produced by the QGIS application (2023)

As mentioned, the anthropogenic action of the environment can accelerate the silting process, as deforestation increases in the floodplain region, consequently burying the river's water holes (natural sources), harming the natural process of evapotranspiration and infiltration of rainwater into the water table, through the soil sealing process.

Figure 12: Graph of the fifth question

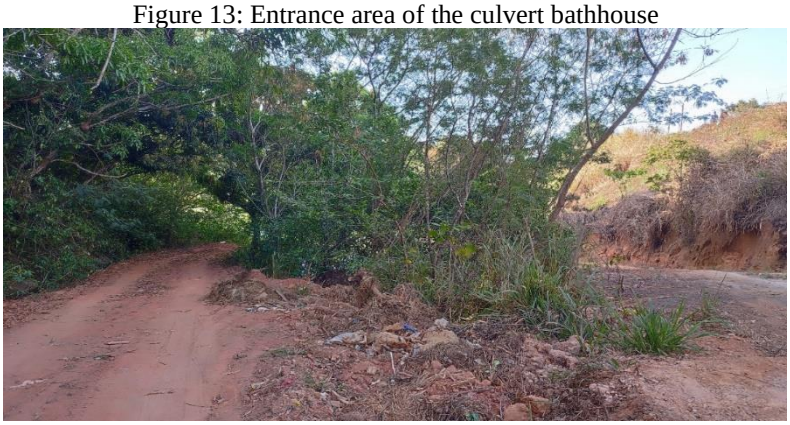


Source: The Author produced by google form (2023)

This replacement of natural protection zones around the resort can contribute to the increase of rainwater that may usually carry sewage, debris and landfills by rainwater, as we can see in the image

below, at the entrance of the resort where the local municipality deforested and landfilled a permanent protection area (APP), for the permission of entry of water trucks.

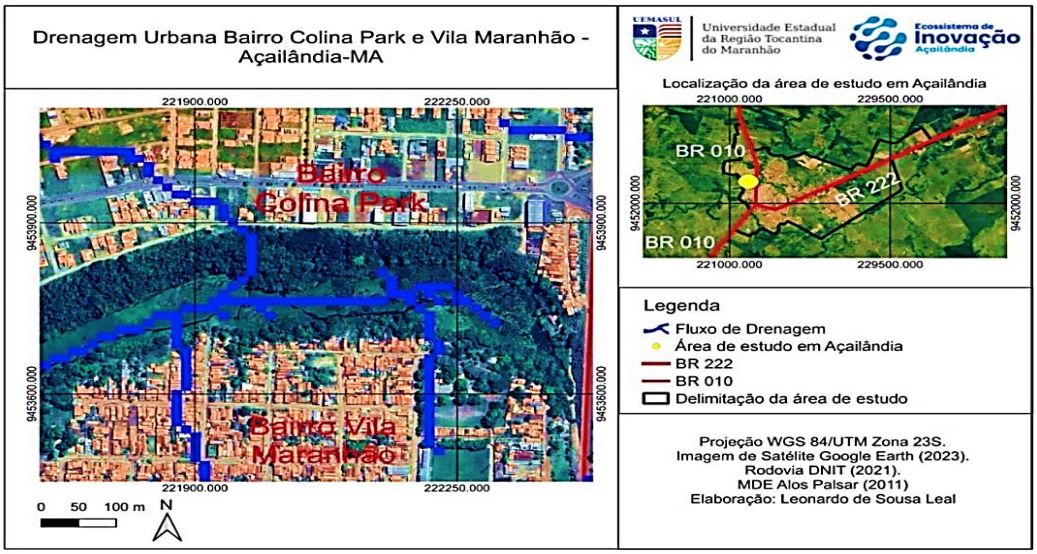
Figure 13: Entrance area of the culvert bathhouse



Source: The author (2023)

A major complaint gathered in the interviews in the vicinity of the culvert resort is that the construction of the Colinas Park Complex contributed to an increase in sediments released into the river and a decrease in the abundance of water (60%), in addition to flooding in lower regions in places where the construction of the subdivision did not previously occur. This brings evidence that the construction of the condominium of 1.34km2 on the left bank of the resort, impaired the infiltration process, replacing the natural soil with asphalt and concrete, increasing the flow of rainwater from this set towards the culvert.

Figure 14: Drainage flow map in study area



Source: The author produced by the QGIS application (2023)

According to the image above, a large amount of water descends through the riparian forest coming from the set, with an average slope of 24%, reaching a maximum slope of 176 meters of fall,

presenting a great hydraulic energy, capable of causing erosion in the upper part of the set, being taken down the hill to the resort, as shown in the figure below. especially if the drainage system is inefficient.

Figure 15: (a) maintenance-free duct system; (b) presence of erosion in the Colinas Park complex

Source: The author(2023)

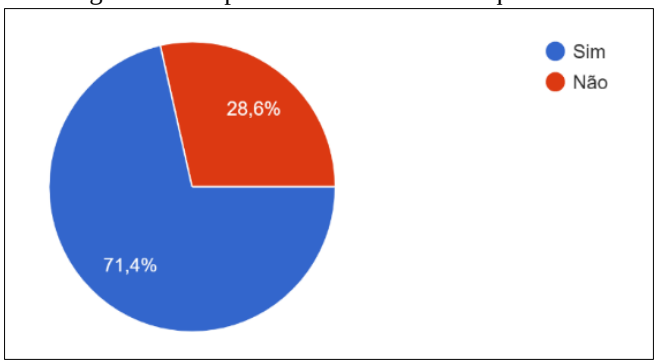
Another observed point of accentuated movement of rainwater is Dom Pedro II Street, which also receives a large amount of rainwater from the street above (Dom Pedro I Street) and from its own extension, meeting at the end with Juazeiro Street, which as already seen in this work, favors a large movement of earth that in turn flows into the stream below.

Figure 16: Intersection of water flow from Dom Pedro Street and Juazeiro Street at the intersection point where the erosion is located

Source: Google Earth (2023)

According to the research, it was confirmed that a large amount of earth, rubble and garbage was thrown by the population in an attempt to control the erosion found at the end of Juazeiro Street.

Figure 17: Graph of the tenth and sixth questions



Source: The author produced by google form

The disorderly movement favors the presence of sediments in this place, being pushed by the large amount of water that moves through the gutter in addition to the three streets, ending up in the manhole bath, being confirmed by the local population who consider that rainwater is responsible for the erosion at the end of the street (100%).

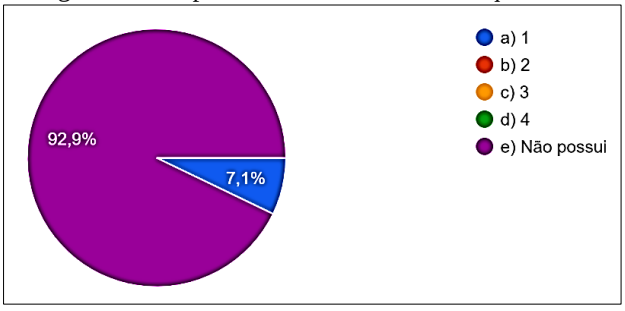
Table 2: Flow and velocity results found by the rational method

STREET	INCLINATION	flow	speed
JUAZEIRO	1,098%	70 l/s	4.14km/h
DOM PEDRO I (STADIUM)	1,79%	260 l/s	6.8km/h
DOM PEDRO II	7%	66 l/s	8.1km/h

Source: The author(2023)

This process could be mitigated if it had an efficient basic sanitation system that dampened the forces of the waters, not presenting any or only wolf's mouth that could contribute to this process.

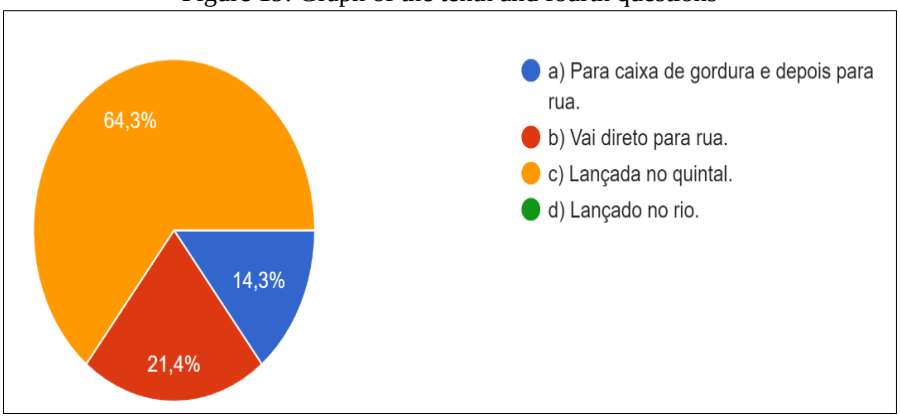
Figure 18: Graph of the tenth and seventh questions



Source: The author produced by google form

The lack of proper sewage with a single collector that receives rainwater and domestic sewage from the sink that flows through the alleys, contaminates the environment and people who walk on the street (21.4%) or when most of the time they put the pipes at the bottom of the yard running this material down the river (64.3%).

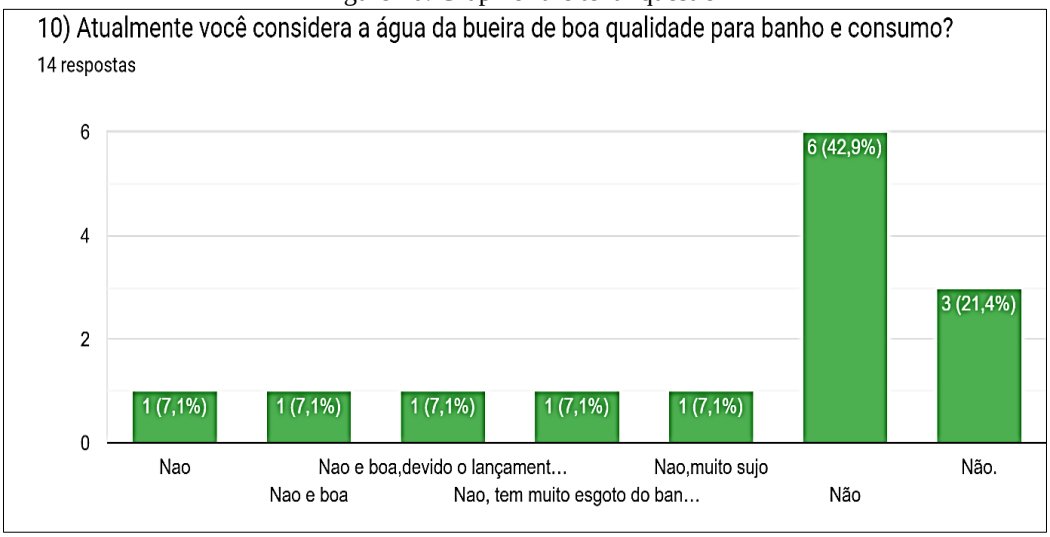
Figure 19: Graph of the tenth and fourth questions



Source: The author produced by google form

The same happens with the sewage produced in the bathroom, which is usually found in the backyard (64.3%), often poorly installed, leaking into the soil, in addition to black tanks that directly pollute the water table and the population's water supply sources (35.7%). In this sense, the fact that most of the houses discharged their sewage directly into the river made the local population suspicious of the quality of the water, having it for bathing and drinking (100%) and not bathing in the bathhouse of the culvert, for an average of 10 to 15 years.

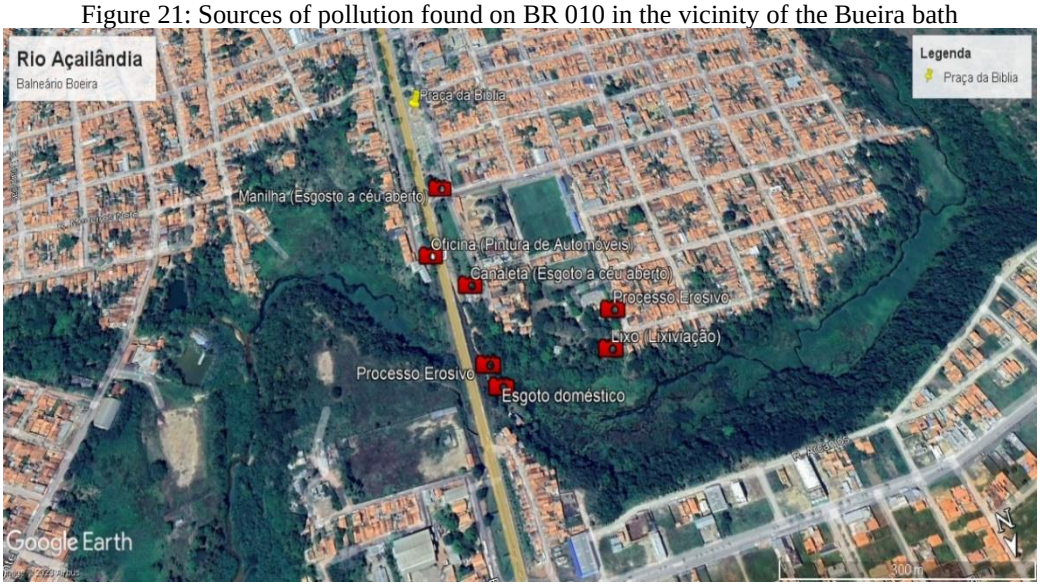
Figure 20: Graph of the tenth question



Source: The author produced by google form (2023)

In addition to these sources of environmental pollution, produced by local residents, at other points along the BR 010 highway, there are other sources of contamination that could contribute to an increase in the level of fecal coliforms and other polluting substances.

Figure 21: Sources of pollution found on BR 010 in the vicinity of the Bueira bath



Source: Google Earth

One of these foci is the domestic sewage from homes and businesses located near the Bible Square dumped directly into the street, with this, all liquid effluent travels to lower areas of the neighborhood that reach the river. In the photos it is possible to identify that from this point on the sewage travels through uncovered channels containing sludge, strong odor and dark color (figure 22).

Figure 22: Domestic sewage source in the direction of the sewage resort

Source: The author(2023)

The vicinity of the river still has pig manure, located at the entrance of the resort, generating substances harmful to the water such as sulfuric gas, ammonia and organic substances, contributing to

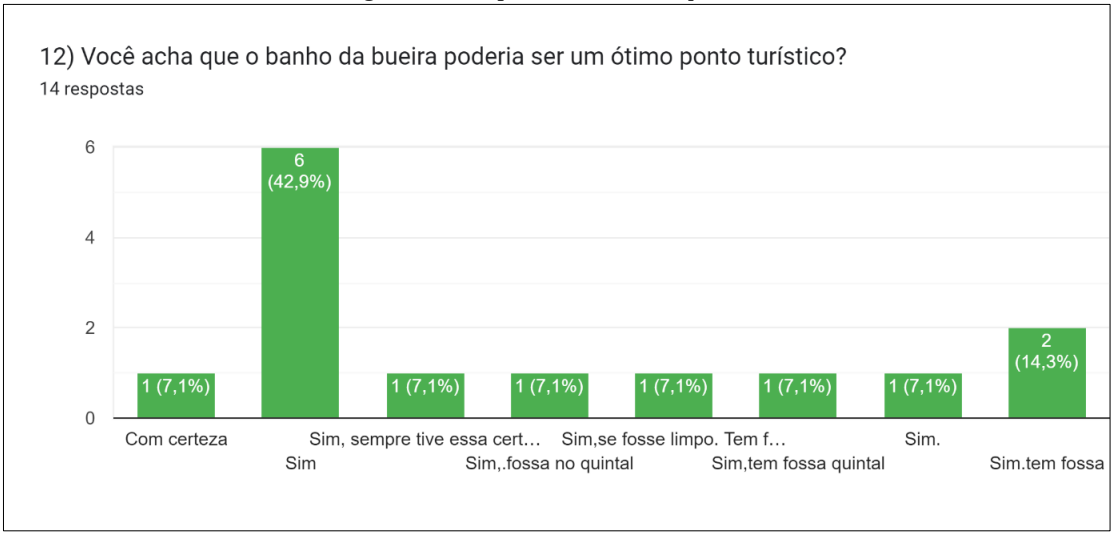
the process of eutrophication and new erosion on the banks of the BR 010, due to the deficiency of rainwater drainage that drains directly through old and unmaintained channels towards the river.

Figure 23: (a) pig farming near the river; (b) erosions found on the banks of the BR010 highway

Source: The author(2023)

In an average of 22 years in which they have lived in the same residence, the interviewees remember with nostalgia the good times of bathing in the manhole when the local population used its waters to wash clothes, taking the family to spend the day, cooling off from the heat in its cold and crystal clear waters, bringing a lot of joy to the children who lived there having fun in its waters. When asked if the culvert resort could be a great tourist spot for the city, most said yes, if it solved the problem of domestic sewage discharged into its waters, it could also be used to attract tourists to the city, since it is located close to the city center, serving as a source of income that could contribute to the generation of jobs for local families. as in the past.

Figure 24: Graph of the twelfth question



Source: The author produced by google form

However, in the period from 2005 to 2009, as reported by the residents, this bath that was so popular began to be less and less frequented, coincidentally it was the period of many changes in the local geographic space when the construction of condominiums and disorderly occupation occurred on its banks, causing the intensification of deforestation.

4 CONCLUSION

This work sought to encourage the practice of projects aimed at environmental education within Public Universities, as these methodologies have the ability to direct engineering students to observe the real problems found in society, seeking in some way to contribute to alleviate them, as they contribute to finding practical, accessible solutions, in addition to helping to raise awareness among the population to exercise day-to-day practices aimed at the reduction of environmental contamination, such as the use of grease traps and septic tanks in homes near rivers, thus avoiding the spillage of domestic sewage discharged into the sewers that flow into urban rivers.

The questionnaires used to interview the residents of Juazeiro Street showed a total lack of understanding about this subject, but at the same time it served to illustrate that many residents, despite few financial conditions, had the desire to contribute in some way to the better preservation of the local environment, mainly due to the fact that they observed the drastic changes in recent years in the landscape in which they live. impairing their quality of life.

The results of samples of the waters of the Açailândia River, carried out in the laboratory of the Federal Institute of Maranhão/IFMA, showed that despite all the polluting force, the river presents a certain quality, giving hope to all interested parties who believe that one day the current reality can be reversed, because according to many of the interviewees, an effort by the municipal government to create more environmental education projects and especially to improve the environmental education system would be enough. basic sanitation in the streets near the springs, creating an efficient micro drainage system that can reduce the impact of the discharge of domestic sewage and rainwater into the Açailândia River.

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