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Disorderly occupation and contamination of the Baixo Jaguaribe sub-basin, CE

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Abstract: Ceará has about 90% of its territory inserted in the semi-arid region of Brazil, characterized by the occurrence of irregular rains in time and space, high temperatures, strong insolation and high rates of evaporation. These characteristics, together with the lack of environmental preservation, accelerate the deterioration of water quality, due to the concentration of salts and pollutants. Population growth and the consequent increase in industrial activities contributed to aggravate environmental problems, especially those related to the preservation of groundwater and surface water. Given this situation, the surveys carried out in this review point to the most critical environmental impact points, which can be analyzed as a factor for the development of actions that seek to reduce these potential impacts.

Keywords: Jaguaribe River, Contamination, Water quality.

I. INTRODUCTION

The State of Ceará has about 90% of its territory inserted in the semi-arid region of Brazil, characterized by the occurrence of irregular rains in time and space, high temperatures, strong insolation and high rates of evaporation. These characteristics, together with the lack of environmental preservation, accelerate the deterioration of water quality, due to the concentration of salts and pollutants (COGERH, 2009).

Despite all the progress provided by the water policy implemented in recent years in Ceará, several municipalities suffer from the problem of water scarcity in the state, being, in times of drought, dependent on water supply by water trucks, or directly from water sources in the which do not have data on water quality.

According to Roseno (2016), at the end of 2016, Ceará is in the process of a complete water collapse. No less than 70% of the municipalities declared an emergency situation. The total volume of the reservoir system is 7%, and 54% of the monitored dams are below 5%.

In recent decades, population growth and the consequent increase in industrial activities have contributed to aggravate environmental problems, especially those related to the preservation of groundwater and surface water. Contamination of water resources is a consequence of anthropogenic action and has become a major problem in densely urbanized areas.

The Jaguaribe River watershed suffers from a lack of government planning, the sewage system does not reach 10%, the rest of the effluents are discharged along its course, leading to contamination and eutrophication of water (COGERH, 2009) .

In this context, open sewers and lack of treatment are causing water, soil and air contamination. Effluents contaminated with Oil and Grease Content (TOG) and pesticides are already found in the Lower Jaguaribe Sub-basin (FERNANDES, 2017).

Taking into account the economic difficulties and the fragility of public policies for the management of water resources in Ceará, it is not enough to have water in quantity. It is necessary to look at its quality, as it needs to be suitable for human and animal consumption.

Given this situation, the identification and assessment of environmental hazards and health risks become important tools to contribute to the control and prevention of the population's exposure to these polluting residues.

II. OBJECTIVES

GENERAL OBJECTIVE

Assess the disorderly occupation and contamination of the BaixoJaguaribe sub-basin, CE

SPECIFIC OBJECTIVE

- Assess anthropogenic contamination in the Sub-basin.

- Analyze the impacts caused by agriculture and agribusiness

III. MATERIAL AND METHODS

Study Area

The Jaguaribe River watershed covers an approximate path of 633 km, from its sources in Serra da Joaninha, in the Municipality of Tauá, to its mouth in the Atlantic Ocean. It drains an area corresponding to 48% of the State of Ceará, benefiting 81 municipalities, totaling 74,621 km^2, and is subdivided into five sub-basins: Salgado, Alto Jaguaribe, MédioJaguaribe, BaixoJaguaribe and Banabuiú (COGERH, 2009) .

The Lower Jaguaribe Hydrographic Region drains an area of 5,452 Km^2, covering about 137 km, which extends from the Ponte de Peixe Gordo on the BR-116 to its mouth, located in the city of Fortim. The Jaguaribe river, in this region, has as its main tributary the Palhano river, in which the only reservoir managed by COGERH of this sub-basin is located, the Santo Antônio de Russas weir, with a capacity to accumulate 24,000,000 m^3. This region includes the municipalities of Tabuleiro do Norte, Limoeiro do Norte, Quixeré, Russas, Jaguaruana, Palhano, Itaiçaba, Aracati and Fortim (COGERH, 2009).

Disposal of TOG-contaminated Effluent

With the huge fleet of vehicles running in Brazil and around the world, there is also a large amount of used automotive lubricating oil that is discarded in various parts of the city at the same time. According to the National Petroleum Agency - ANP (2021), 1,408,931,436 liters of lubricating oil were sold in 2020.

According to data from DETRAN-CE (2021), the vehicle fleet in the municipality of Tabuleiro do Norte-CE is 15,801 vehicles, of which 884 are large vehicles, such as trucks and trailers, that is, 5.6% of the total fleet of the municipality. The estimated monthly consumption of lubricating oil for the large vehicle fleet in the municipality is 12,376 liters.

The city does not even have 25% of its urban area with basic sanitation, where sewage runs in the open, following the water course until reaching the saline lagoon, close to the Jaguaribe River, which contaminates the soil until the river and arrives overflow to the river bed. Among the sewage debris, there are lubricating oils improperly disposed of, coming from jet washes and automotive maintenance workshops (FERNANDES, 2017).

Survey of pesticides applied in irrigated agriculture in BaixoJaguaribe

According to data from the National Department of Works Against Droughts (DNOCS), there are currently 231 small producers and 20 companies dedicated to irrigated fruit growing in the Jaguaribe-Apodi irrigated perimeter, occupying a total area of 2,834.00 ha. The irrigated perimeter currently produces: corn, beans, soybeans, cotton, bananas, corn, guava, papaya, grapes, soursop, mango and ata. The irrigation systems used in the perimeter are: central pivot (87.04% of the area); drip (6.48%); microsprinkler (6.48%) (MILHOME et al., 2009).

Information on pesticides used by farmers was obtained from the Federation of Producers of the Jaguaribe-Apodi Irrigated Project (Fapija), responsible for the administration, organization, operation and maintenance of the perimeter irrigation infrastructure, in addition to data collected at the main points of sale of pesticides in the region (MILHOME et al., 2009). Data on the characteristics and physicochemical properties of the pesticides studied were obtained from Anvisa (2021) and from the Purchasing the database (PPDB).

IV. RESULTS AND DISCUSSION

The data related to the study, the potential of contamination of the Lower Jaguaribe Sub-basin was evaluated from scientific publications and data from the Water Resources Management Bodies. The surveys carried out point to the sources of contamination, after the city of Tabuleirodo Norte by TOG and in the mediations of the Irrigated Jaguaribe-Apodi perimeter by pesticides.

The surveys carried out in this review point out the most critical environmental impact points, which can be analyzed as a factor for the development of actions that seek to reduce these potential impacts.

Effluent Release

Brazil has specific federal legislation for the discharge of effluents. The main rule that regulates this matter is the one established by the National Council for the Environment (CONAMA), through resolution No. 430 of May 13, 2011, which "provides for the conditions and standards for the release of effluents, complementing and amending resolution No. 357 of March 17, 2005". This resolution determines the maximum values allowed for the release of domestic effluents and for effluents from any polluting source.

According to art. 16, the main conditions and standards provided for in the aforementioned resolution are presented.

The main conditions for the release of effluents according to CONAMA resolution 430/2011 are:

i) pH between 5 and 9;
ii) Temperature less than 40°C, and that its variation does not exceed 3°C in the limit of the effluent mixing zone as a receiving body;
iii) Sedimentable materials up to 1mL.L^{-1} in a 1 hour test in an Inmhoff cone;
iv) Oils and greases;
    A. The. Mineral oils: up to 20 mg.L^{-1}
    B. Vegetable oils and animal fats: up to 50mg.L^{-1}
v) Absence of floating materials;
vi) Biochemical Oxygen Demand (5 days at 20°C): minimum removal of 60%.

The results obtained for the characterization of water collected in the lower Jaguaribe sub-basin are presented in Table 1. The results indicated high concentrations for all analyzed parameters.

Table 1 - Comparison of the results obtained in the characterization with the release patterns.

Variable	**Average (**mg.L^{-1})	**Conama Resolution 430/2011**
COD	1.323,33	-
BOD	545,7700	-
Total oils and greases	300,6667	Até 20 mg.L^{-1}
Solids	5.020,5000	-

List of pesticides used in the irrigated perimeter of BaixoJaguaribe

Several pesticides have been applied in the irrigated perimeter of BaixoJaguaribe. The active principle of the main products used, data obtained from the survey in the region itself and some information on the properties of the compounds are presented in Table 2.

Table 2 – main pesticides used in the irrigated perimeter of BaixoJaguaribe

Active principle	**ChemicalGroup**	**Toxicity**
Abamectin	Avermectinas	extremely toxic
Acefato	Organofosforado	moderately toxic
Acetamiprido	Neonicotinoide	moderately toxic
Atrazina	Triazina	moderately toxic
Azoxistrobina	Estrobilurina	moderately toxic
Carbosulfano	Metilcarbamato de benzofuranila	highly toxic
Cartap	Tiocarbamato	moderately toxic
Cipermetrina	Piretroide	highly toxic
Cletodim	Oximaciclohexanodiona	highly toxic
Clorotalonil	Isoftalonitrila	moderately toxic
Clorpirifós	Organofosforado	highly toxic
2,4 D	Ácidoariloxialcanoico	extremely toxic
Difenoconazol	Triazol	extremely toxic
Endossulfan	Organoclorado	extremely toxic
Esfenvarelato	Piretroide	highly toxic
Espinosade	Espinosinas	moderately toxic
Fenitrotion	Organofosforado	highly toxic
Fenpropatrina	Piretroide	highly toxic
Glifosato	Glicinasubstituída	Low toxic
Imidacloprido	Neonicotinoide	moderately toxic
Lambda cialotrina	Piretroide	moderately toxic
Lufenurom	Benzoilureia	moderately toxic
Mancozeb	Ditiocarbamato	moderately toxic
Mesotriona	Tricetona	extremely toxic

Metamidofós	Organofosforado	extremely toxic
Metolacloro	Cloroacetanilida	moderately toxic
Metomil	Carbamato	extremely toxic
Nicosulfuron	Sulfonilureia	moderately toxic
Paraquat	Bipiridílio	extremely toxic
Parationmetil	Organofosforado	extremely toxic co
Piraclostrobina	Estrobilurina	highly toxic
Piriproxifem	Éterpiridiloxipropílico	Low toxic
Propiconazole	Triazol	highly toxic
Teflubenzuron	Benzoilureia	Low toxic
Tiametoxam	Neonicotinoide	moderately toxic
Triazofós	Organofosforado	highly toxic
Trifloxistrobina	Estrobilurina	highly toxic

Source: Milhome et al. (2009)

As shown in table 2, there is a wide variety of chemical groups applied, with organophosphates being relatively more applied, followed by pyrethroids and carbamates. However, about 62% of the applied components belong to other less usual or recently registered classes. Products from the neonicotinoids and spinosyns class were introduced in Europe and Japan in the 1990s, and pesticides such as Tiamethoxan and Acetamiprid were only registered in 2002 and, therefore, information on these components is more limited (WARE; WHITACRE, 2004).

Regarding toxicity, 54% of the active principles analyzed belong to the Extremely Toxic and Highly Toxic classes. Among these are organophosphates, which are the most widely applied pesticides in the region, in addition to somecarbamates and pyrethroids.

According to Milhome et al. (2009), assessment of the potential for contamination of surface waters by classifying compounds into two groups: those that can be transported dissolved in water and those that are transported associated with suspended sediment. Table 3 presents the pesticides with the potential contaminant.

Table 3 - Contaminant in surface water

Active principle	**Contaminant in surface water**
Abamectin	Non-contaminating
Acefato	Non-contaminating
Acetamiprido	Potential Contamination Intermediary
Atrazina	Potential Contaminant
Azoxistrobina	Potential Contaminant
Carbosulfano	Non-contaminating
Cartap	Inconclusive
Cipermetrina	Non-contaminating
Cletodim	Potential Contamination Intermediary
Clorotalonil	Non-contaminating
Clorpirifós	Non-contaminating
2,4 D	Potential Contaminant
Difenoconazol	Potential Contamination Intermediary
Endossulfan	Non-contaminating
Esfenvarelato	Non-contaminating
Espinosade	Non-contaminating
Fenitrotion	Non-contaminating
Fenpropatrina	Non-contaminating
Glifosato	Potential Contamination Intermediary
Imidacloprido	Potential Contaminant
Lambda cialotrina	Non-contaminating
Lufenurom	Non-contaminating
Mancozeb	Non-contaminating
Mesotriona	Potential Contamination Intermediary
Metamidofós	Potential Contaminant
Metolacloro	Potential Contaminant
Metomil	Potential Contamination Intermediary

Nicosulfuron	Potential Contaminant
Paraquat	Potential Contamination Intermediary
Parationmetil	Potential Contamination Intermediary
Piraclostrobina	Non-contaminating
Piriproxifem	Non-contaminating
Propiconazole	Potential Contaminant
Teflubenzuron	Non-contaminating
Tiametoxam	Potential Contaminant
Triazofós	Potential Contaminant
Trifloxistrobina	Non-contaminating

V. CONCLUSION

The Jaguaribe River has become a catcher of organic pollutants, emerging chemicals and toxic metals in its course, arising from domestic, industrial and agro-industry actions, causing an anthropic impact on the environment, compromising the environmental quality of its Hydrographic Basin. The quantification of pesticides found in the BaixoJaguaribe sub-basin stretch indicates a high contamination as a result of intensive agriculture and agribusiness.

The surveys carried out in this work serve as a warning for the environmental degradation of the Jaguaribe River and show the need for studies in the area that seek mitigating actions for these potential impacts

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