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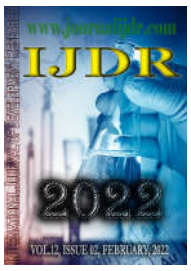

RESEARCH ARTICLE OPEN ACCESS

URBAN LAKE CONTAMINATION IN THE CITY OF CAMPINA GRANDE: CASE STUDY OF NEGATIVE EXTERNALITIES IN THE BODOCONGÓ RESERVOIR – PB

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ABSTRACT

With regard to water problems in the Brazilian Northeast, it is noteworthy that the impacts caused by human action are directly linked to the degradation of this finite natural resource. Thus, this article aims to assess the contamination of the urban lake, in the city of Campina Grande, through a case study on negative externalities, having as main interest the approach of well-being and orderly development in the urban-industrial context. and environmental. The methodology applied was the case study, with a qualitative emphasis. As results and discussions, it was noticed that the Bodocongó reservoir has high levels of environmental degradation

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INTRODUCTION

Access to safe water sources is crucial to improve the well-being of the population, as the water is used to grow food, both for subsistence and commercial purposes (Mehta *et al*., 2014). Water and sanitation are basic needs, allowing people to live in decent conditions and for humanity to develop. However, access to water is profoundly unequal across the world, for poor people access to water is a prerequisite for achieving a minimum standard of health and carrying out productive activities (Who, 2015).The scarcity of natural resources such as water is a growing concern around the world as it is one of the main causes of rural poverty. Water scarcity is mainly associated with overexploitation of aquifers, climate change and other ecosystem problems, and may be driven by the growing demand caused by an increasing population (Momblanch *et al*., 2019). Thus, water scarcity translates into economic problems and food insecurity (Fasel*et al*., 2016). A safe and reliable water supply is crucial for human survival and sustainable progress, as the energy and food sectors depend on water, and at the same time, energy production and consumption needs to be considered in relation to the energy sectors. water and food (Corsano *et al*., 2007; Martínez-Guido *et al*., 2019).

Municipal systems extract and distribute water for the direct use of the population and play an important role in the global hydrological cycle, representing 12 - 14% of the total water withdrawn globally for human purposes (Florke*et al*., 2013). Water also plays a key role in increasing agricultural and industrial productivity. Without adequate, safe and accessible water, The word pollution is defined as any form of alteration of natural properties, whether physical, chemical or biological, that may occur in the environment (Vianna, 2015). In this way, it is possible to distinguish pollution from contamination, as this represents a potential risk to nature, and is therefore more harmful to the environment and human health. Pollution of water sources, deforestation, siltation of rivers, inadequate use of irrigation and soil sealing, among many other actions of modern man, are responsible for the death and contamination of water (Dagnino, 2002; Gonçalves; Franco, 2016). Several forms of pollution are described in the literature as: arising from rural agro-industrial sectors, accidental leaks from industries, pipelines, ships, and resulting from the application of poisons in agriculture,Urban centers have always been the main sources of polluting and contaminating water resources. The growing increase in the demand for water resources, especially superficial ones (rivers, lakes and groundwater), caused their growing

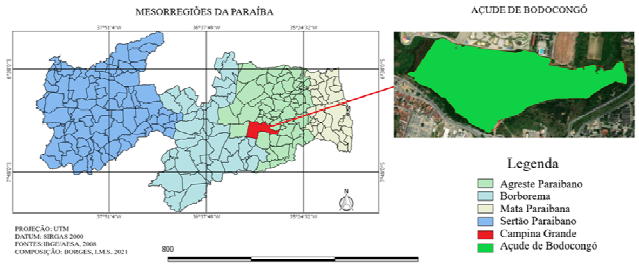
deterioration, as treatment in urban centers is inadequate or non-existent for wastewater. It is noticeable that the more water used, the greater the amount of wastewater returned to surface water sources, and consequently, the greater and faster its deterioration (Derisio, 2016).The liquid effluents derived from urban centers can be divided according to their genesis into two groups: I) domestic effluents that are characterized by contaminated wastewater, basically, by human and animal feces, food and soap and detergent residues, and II) industrial effluents that originate from the discharge of industrial effluents, both into water bodies and into the sewage network to be treated, without proper prior treatment, which causes serious sanitary and environmental problems (Archela*et al*., 2003; Felippe; Junior, 2012).Faced with warnings about the imminent water availability crisis, the National Congress approved the National Water Resources Law Project, which instituted the National Water Resources Policy (PNMA) and created the National Water Resources Management System regarding issues of availability and sustainable use of water (Machado, 2002; Ribeiro&Rolim, 2017). What came to be understood as the set of government guidelines and actions with the objective of controlling economic activity and the expectation of reversing the degradation of natural resources. It was seen that it is not just about establishing standards for pollutant emissions or monitoring compliance with technical standards and punishing those who pollute the environment.

According to Leme (2010), the complexity of environmental policies exceeds the need for coordination and cooperation between environmental agencies, where they must be designed in order to dialogue, directly and clearly, with sectorial policies in order to add environmental criteria to the conception of all public policies, especially those for development. Environmental planning such as the Water Resources Plan (PRH) which is an instrument of the National Water Resources Policy (PNRH) regulated by Law 9.433/1997, to be implemented necessarily in the hydrographic basins and the Ecological-Economic Zoning (ZEE), which is an instrument of the National Environmental Policy (PNMA) regulated by Federal Decree 4.297/2002, can be the solution for understanding the socioeconomic and environmental dynamics (Carvalho, 2014). With regard to environmental zoning, it was foreseen as one of the instruments of the PNMA, in which the objective was "the preservation, improvement and recovery of the environmental quality conducive to life, aiming to ensure, in the country, conditions for socio-economic development, interests of national security and the protection of the dignity of human life". Meanwhile, industrial zoning was instituted at the national level by the II National Development Plan (II PND), approved by Law 6151, of December 4, 1974. Law 6803/1980 discusses the basic guidelines for industrial zoning in critical areas pollution and the organization of industrial activities with environmental protection.Its implementations guarantee control by municipal managers over economic, social, tourist and leisure activities, which are directly linked to the development of regions and the reduction of social and economic inequalities (Dorneles, 2010). In this sense, the objective of the research was to evaluate the contamination of an urban lake in the city of Campina Grande through a case study of negative externalities in the Bodocongó reservoir, with the main interest in improving the quality of life and the orderly development of cities. , including in the environmental and urban-industrial scope.

RESEARCH ELABORATIONS

Case Study Methodology (CEM): The methodology applied is the case study (MEC) which is done in a way that incorporates the point of view of the "actors" in the case under study, making it ideal for exploring negative externalities in water resources, which depend so much on the person how much of the context. Although it is considered a qualitative research, MEC uses qualitative and quantitative research methods (Freeman *et al*., 2012). As in all qualitative research methodologies, the MEC has been adopted as a very desirable strategy, with systematic and rigorous procedures, and producing unbiased results (Yin, 2009). Therefore, Yin (2015) sees it as a challenging research approach with a rigorous methodological path. MEC's main strength is its reliance on multiple data collection techniques and sources. There are some challenges to the use of case study methodology such as multiple definitions and inconsistent use of the term case study in scientific and professional literature. In this sense, the MEC was used to describe a teaching tool and/or a way of keeping records and mitigating the environmental problems found (Yin, 2015). Some consider this a methodology, others a choice of what should be studied (Anthony& Jack 2007; Crewell, 2017).The MEC provides a detailed description of a particular case (or cases) in the context, the methodology allows the study of individuals, groups and organizational, social and political, economic and environmental experiences (Yin, 2009). For the purposes of this integrative review, MEC will be defined as a qualitative approach in which the investigator explores a case or cases through in-depth data collection using various information data sources and reports the case description, themes and/or findings. (Creswell, 2007; Mattar& Ramos, 2021).

Geographical and historical characterization of the study environment: The study area included the surroundings of the Bodocongó Reservoir located in the geographic coordinates (7º 13' 11" S and 35º 52' 31" W), located in the middle course of the Paraíba river. It has an altitude of 548 meters and the dam belongs to the municipality of Campina Grande-PB, located in the mesoregion of AgresteParaibano (Figure 1). It has a hydraulic basin area of 371,897 m2, maximum capacity of approximately 1,020,000 m3, maximum of 8.5 m (Andrade *et al*., 2018).



Source: Author's own, 2021.

Figure 1. Location of the Bodocongó Reservoir in the Mesoregion of AgresteParaibano

As it belongs to the mesoregion of the Agreste region of Paraíba, it is located in the transition strip between the Zona da Mata (northeastern coast) and the Sertão. As it is a transition strip, the vegetation of both the Atlantic Forest and the Caatinga can be found in the Agreste region of Paraíba. The most predominant climate is the semiarid with high temperatures, and low rainfall, with irregular and scarce rainfall, where shrubby vegetation predominates (small trees). Although the soil is quite fertile in some isolated regions, however it is not as productive due to the lack of rain,being a region less humid than the Zona da Mata and less dry than the Sertão (Zanella, 2014). As it is located on the Borborema Plateau, the altitudes in the Agreste range can vary between 500m and 800m, being the highest in the northeast of Brazil.From the beginning, the weir was created to alleviate the water scarcity problem in the region, since the Açude Novo and the Açude Velho were not meeting the needs of the population. The population of the metropolitan region of the city had been growing a lot as a result of the high urbanization process. Furthermore, the Bodocongó Reservoir is very far from the Novo and Velho Reservoirs, and in this sense it can be useful in supplying the local population of the Bodocongó neighborhood and surrounding areas. The construction of the dam began in 1915 and in 2017 it was completed and handed over to the population. However, it has never been widely used by the population of the city due to its high level of salinity, which has made the water unfit for consumption since its construction (Cavalho*et al*., 2009). The creation of the weir was a decisive factor for the emergence of new neighborhoods and the industrial complex around it, followed by the industrial poles. In the mid-1930s, a tannery and a textile factory in Bodocongó were built on the banks. In its surroundings there is a university center composed of

the State University of Paraíba and the Federal University of Campina Grande.

RESULTS OR FINDING

Legal foundations associated with the externalities produced in the Bodocongó reservoir: The United Nations Environment Program (UNEP) played an important role in disseminating environmentally conscious practice, especially among non-developed countries. According to a document prepared by UNEP, "The EIA is a formal study process used to predict the consequences produced in the environment by a development project." In this sense, the document issued by the World Bank is called the Brown Agenda, whose notes unfold. in the five biggest environmental problems currently faced in our country, namely: absence or inefficiency in basic sanitation, degradation of the air in metropolitan areas, water degradation in urban regions, poor management of solid waste and serious pollution. In the Bodocongó reservoir, this problem is the result of the human activities of people who live there or not. It is noteworthy that the population increase makes basic sanitation an even more outdated indicator, this is due to the various irregular urban occupations, as well as the lack of government assistance that bring this right to all inhabitants.As can be seen, the problem of sanitation has been discussed on a daily basis, having acquired global features in recent centuries, considering the potentialization of the accumulation of waste together with the absence and inefficiency of its proper management, as is the case with what has been happening on the banks of the dam (Figure 2), where one can observe a real neglect of the population that frequents this environment, promoting an accumulation of waste in the Bodocongó reservoir in the region, this waste can be carried by rain to the banks of the reservoir, by wind or even dragged directly by the population.

Source: Authors, 2021.

Figure 2. Solid urban waste found on the banks of the Bodocongó weir

Law nº 6.938/81, on the other hand, lists the EIA as one of the instruments of the PNMA (art. 9, III) and establishes the competence of the National Council for the Environment (CONAMA) to create norms and criteria for the licensing of effective or potentially polluting activities (Article 8, I). Furthermore, the Federal Constitution of 1988, which dedicates a specific chapter to the environment (Title VIII, of the Social Order; Chapter VI, of the Environment), establishes that "everyone has the right to an ecologically balanced environment, good for common use of the people and essential to a healthy life, imposing on the Public Power the duty to defend and preserve it for present and future generations". It is understood that the right to adequate solid waste management is, in essence, the unfolding of the right to an ecologically healthy environment.As a constitutional instrument of the National Environmental Policy - PNMA, the EIA has as its main purpose, as a source of technical information, the full and total achievement of the objectives set by the National Environmental Policy, as set out in Law n. 6.938/81 (Cunha, 2013).It consists of the right to an ecologically balanced environment, which also includes the right to a healthy quality of life. Therefore, environmental laws seek to promote the well-being of society and the relationships between different species and of these with the environment, achieving the health of organisms and ecosystems present in the Bodocongó reservoir. This problem often does not have an efficient solution due to several factors that encompass the activity carried out in the dam, among them family fishing, bathing, washing cars, motorcycles and trucks, family and subsistence agriculture stand out. Thus, it is necessary to establish, in accordance with CONAMA Resolution No. 357/2005 (Brazil, 2005), the guidelines and basic criteria for the use and implementation of the EIA, in accordance with the PNMA and with Law No. 6.938/81.Article 1 - For the purposes of this Resolution, an environmental impact is considered to be any change in the physical, chemical and biological properties of the environment, caused by any form of matter or energy resulting from human activities that directly or indirectly affect: I - health , the safety and well-being of the population; II - social and economic activities; III - the biota; IV - the aesthetic and sanitary conditions of the environment; V - the quality of environmental resources.

It is extremely important to identify and measure impacts arising in a systematic way and based on pre-fixed normative criteria, in order to ensure and guarantee the identification of all possible impacts (positive and negative, direct and indirect, immediate and mediate , permanent and temporary, reversible and irreversible), so that proposals and corrective measures and/or impact reduction can be taken; communication between the different actors, bodies and entities involved and the possibility of subsequent control. In this context, the public power is extremely important when it comes to investigating and solving the problem of the dam and region that is facing serious problems of environmental management.It can be deduced that in order for there to be an adequate public management of effluent transport in the vicinity of the Bodocongó Reservoir, there must be effective communication between the multiple subjects involved, including between the population and the government, represented by the Municipality of Campina Grande. All the local population or those who use the dam, so that the processes of participation and inspection can take place in a harmonious and democratic way, always focusing on the realization of the common good and social ends.It just so happens that there were no answers that were clear enough to solve or alleviate the environmental problems found. The legal power, in line with environmental laws, must be applied in this environment, through the inspection and corroboration of the current municipal power in the search to solve environmental impacts that are recurring in the dam, as well as to seek mitigating measures to be applied directly in the environment in study.

Scenic beauties and the degradation of the Bodocongó reservoir: In the Bodocongó Reservoir it is possible to observe the various processes that enable environmental degradation in its surroundings, some of these processes can be listed, such as the felling and/or removal of riparian forest on the banks of the reservoir, enabling the creation of a eroded area that is later released to the water body bed through the silting process and consequently causing a decrease in the reservoir's water capacity. In addition, other activities such as the inadequate use of water, irregular plantations on its banks, the dumping of solid waste, the entry of effluents from domestic and industrial sources, as well as irregular constructions on its banks and vegetable plantations for commercial use through manual irrigation with water from the weir (Figure 3).Figure 3 shows the construction and irregular use of water in Bodocongó, this fact is mainly due to the lack of conditions of the population that uses this area for economic purposes, whether through fishing, agriculture or even car washing.

Source: authors' own, 2021.

Figure 3. Irregular constructions and plantations on the banks of the Bodocongó Reservoir

The practice of these activities enables not only the process of environmental degradation, but also the visibility of the landscape, that is, the "scenic beauties" of this area. It is known that the landscape is the set of everything that we can visualize at that moment, which, in turn, can bring an unpleasant or pleasant sensation. Therefore, scenic beauty can be defined as the harmonic visual and audible result formed by the set of natural or humanized factors of a place or landscape, or even "the result of the scenic representation of Nature".In addition to the environmental problems caused by the destruction of the scenic beauty of the Bodocongó dam, some social problems also arise, such as the population's lack of interest in living close to the dam, resulting in the devaluation of the houses and areas located around it. To try to alleviate this devaluation problem, the Bodocongó Park was created, with the aim of developing the landscape heritage of that place, in addition to providing youth and teenagers with recreation and leisure. However, when it comes to the promotion and revitalization of the landscape, the park does not achieve its objective due to its lack of connection with the dam, thus becoming a leisure and recreation area. The scenic beauty is one of the determining factors for valuing and using it mainly by the tourist industry, Irregularities in the environmental sphere caused by man's action, in the dam, have a precarious and outdated landscape condition that in a way conditions the environment not to be attractive to visitors or even to boost the growth and valuation of the neighborhood. Even though the neighborhood has the two main educational centers in the city of Campina Grande, it still depends on the scenic beauty of the landscape, as it is extremely important to expand local activities, such as tourism.

Therefore, natural landscape sites with great scenic beauty are extremely important, as they represent an enormous economic tourism potential and an unparalleled national heritage within the reach of all, in addition to relevant components of conservation of a healthy and well-balanced environment (Ruschmann, 2016). Therefore, the Bodocongó Reservoir must be treated with care by the Government and the community (population/community), transforming it into protected areas by state or municipal government assistance or other forms of protection, allowing us to preserve it for the future, thus leaving an immeasurable legacy to the environment.
The preservation of natural scenic beauty combines with environmental preservation, as the two are inseparable. Because to preserve scenic beauty it is necessary to maintain natural resources in excellent condition, providing a setting of visual beauty to a given environment. In the case of the Bodocongó reservoir, it is noticeable that the two conditions are out of step, both the scenic beauty of the place and the lack of environmental preservation. Thus, the opposite occurs, such as environmental degradation and consequent degradation of scenic and scenic beauty.

Endemic pollutions associated with human activities: endemic diseases: Endemic pollution is most often associated with unplanned human activities. This pollution can be represented in several areas of a region, for example, but it can also be a unique and particular factor of a particular damaged area. an endemic. Endemics can occur through some conditions such as: Climate change, pollution, destruction of habitats, invasive exotic species, excessive exploitation of the natural environment, species extinction, threat to humans, proliferation of pests and endemic diseases (Roque, 2016).It is noteworthy that in the current situation of the Bodocongó reservoir, several social and environmental problems are linked to it. However, it is not overlooked that endemic pollutions are often directly associated with the economic and social deficit in a given area. The loss of biodiversity brings with it numerous consequences that not only affect the environment, but also affect human beings, whether in the economic or health spheres. As an example, we can mention the non-correct use of the water from the Bodocongó Reservoir for authorized and safe economic purposes, since it presents high levels of physicochemical substances, as well as the presence of microorganisms making its water unsuitable for consumption and human activities (Diniz*et al*., 2021).The pollution of the Bodocongó reservoir can generate a series of health problems in the local population related to the use of water or its inadequate consumption. These problems can characterize a series of endemics in the local or surrounding population, as well as in those who make use of this resource. In Bodocongó a series of irregular activities are carried out through the use of its water, such as fishing, growing vegetables, bathing and even household consumption. These activities can trigger skin and intestinal diseases such as ringworm, hepatitis, leptospirosis, cholera, typhoid, giardiasis, among many others, thus generating an outbreak in the local population.

A very recurrent problem is that the Bodocongó dam is located near the General Hospital of Campina Grande (FAP) and also the health clinics of the State University of Paraíba (UEPB) and the Federal University of Campina Grande (UFCG). Therefore, this proximity of the Bodocongó Reservoir with these medical centers can be worrying when it comes to endemic health and the proliferation of diseases, even though there are no studies that prove the proliferation of diseases in the mediation of these medical centers, it is important to highlight that the The influence of the dam is strong in the life of the local population, and it may have a direct or indirect correlation with cases of disease in the area.It is necessary to be aware of the different negative externalities that can be generated as a result of the pollution of this source for the population, as well as for the environment. These problems can harm not only human life, but also local biodiversity. Thus, it becomes necessary to propose measures for the recovery of this area, aiming at the well-being of the environment and the population.

CONCLUSION

It is concluded that, it was possible to observe the environmental damage caused by the irregular use of water from the dam for economic purposes, in addition to this, the population's lack of commitment to this water body is also evident. The urban spatial evolution, made possible even more in the interference and dumping of solid residues in the dam and on its banks, factors that directly interfere in the relationship of integration of the water body with the city. The interpretation of the behavior of each analysis criterion applied in this study helped to understand the patterns of lots located in the surroundings of Bodocongó and how these can influence the gradual increase of degradation in relation to water bodies.As for physical and visual accessibility characteristics, the Bodocongó Reservoir is clearly lacking. Through the results obtained, it becomes evident how the process of occupation of urban spaces present on the banks of the Bodocongó directs the way in which the city's relationship with them will take place. In addition, the needy

population seeks ways to support their families through the practice of illegal activities, such as the use of water without any treatment in the production of food that is later sold. The municipal government and the legislature, responsible for consolidating and enforcing environmental laws, must seek quick and safe measures to revitalize the same, without failing to incorporate the situation of dependence of people who use these waters directly or indirectly.

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