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The river – city relationship: case study of the espinharas river in the city of Patos/PB

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ABSTRACT
Since the emergence of cities, their relationship with water resources has been evident, especially with rivers, which have been responsible for the growth and development of numerous cities throughout history. In this historical construction, the river-city relationship has faced ups and downs, and today it is a worrying and contradictory reality, where urban processes are characterized as one of the main causes of existing problems. Thus, the proposal of this research aims to understand the relationship between cities and the river, and for this, an object of study was selected - the Espinharas River, located in the city of Patos, in Paraíba. The method of analysis chosen was field research, aiming at loco visits, surveys, and the creation of conceptual maps, for the characterization of the riparian zones and understanding of their relationship with the city. As results and conclusions, it was verified that urban rivers face real problems due to urbanization processes, and that planning measures should be applied to obtain the re-establishment of the riveting that applies to the city of Patos and the Espinharas River, which are inserted in this context.

KEYWORDS: River City. Relationship. Urbanization.

1 INTRODUCTION

The emergence of the first cities and civilizations is linked to water bodies, where the presence of water was the determining factor for the emergence of the first urban centers (SPIRN, 1995). The convenience for the transportation of goods, energy supply, fauna and flora, agricultural development, and human circulation, among others, made water resources strategy for the new settlements since the river was the most important of these water resources for the creation and development of urban centers, "thus showing the spatial structuring function attributed to water bodies" (CUNHA, 2019).

Spirn (1995) states that the rivers, besides establishing the place of settlement of the dwellings and urban nuclei in general, also provided the logistics and the geographical location of the dwellings and their activities performed, being a structure of functions. Moreover, according to Cunha (2019), the dwellings and residences of noble use of the community were installed in places with higher topography, creating protection against invasions, floods, or any other type of adversity. And in the areas closest to the riverbanks were carried out commercial activities, transportation of goods and people, and construction of warehouses and the less favored classes of the population resided in these areas.

Riley (1998) emphasizes the importance of considering the river landscape not only the main bed of the river but trying to visualize its structuring totally, that is, understanding that rivers are formed by banks, floodplains, vegetation and the topography shaped by them, existing abiotic and biotic components that integrate, inhabit and interact in an interdependent way (MEYER ET AL., 2003 APUD CUNHA, 2019).

Rivers are formed from a water table or the melting of snow on mountain peaks, which creates an extensive capillary network that forms the watersheds, besides all the processes of evaporation and evapotranspiration of plants and other stages of the hydrological cycle by which rivers are formed. It should be noted that all these stages are part of the same system, and for this reason, it is considered an inseparable structure, with points of vulnerability (BARTALINI, 2006). If any one of these parts that make up this system is neglected or degraded, the whole system will be compromised, with a direct impact on the hydrological cycle of water (HOUGH, 1995).

According to Spirn (1995), urbanization has generated a new dynamic for the hydrologic cycle, due to the irregular occupation of its banks, the permeability of the soil, the changes in the fluvial and topographic design of the river, the deforestation of the vegetation

on the banks, and the process of disposal of waste produced by the city in urban waters. In this way, the rivers have been degraded and their vital mechanisms have been altered. However, the river-city relationship was seen as something contradictory, because what was necessary for the vitality and emergence of urban settlements came to be seen as an obstacle and barrier to urban development and a constant threat to the city (GORSKI, 2010).

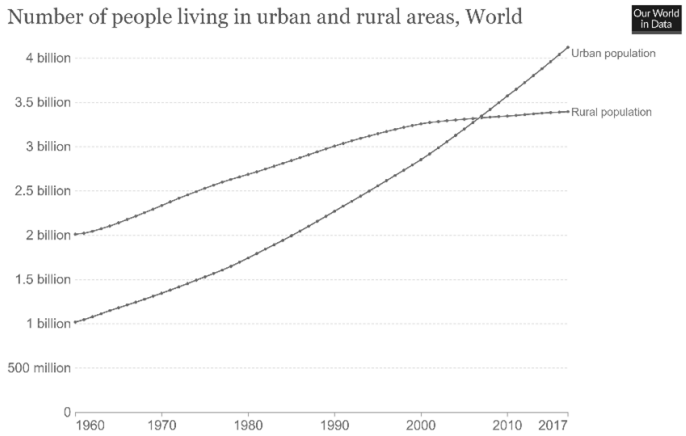
Therefore, historically, rivers and other water resources have been crucial in several situations for the development and urban dynamics of cities. This created a relationship between urban and natural factors that involved man and nature. However, over the years this harmonious relationship has turned into something contradictory and rivers are the most damaged in recent years by the whole process of urbanization applied by urban centers (ALENCAR, 2016).

As a result of the expansion of urban centers in recent years, environmental degradation processes have occurred on a global scale, and the natural environment has been compromised by the advance and growth of urban centers. Among the natural resources that have been compromised are the rivers, which have been devastated and degraded on a large scale in recent years. Baptista and Nascimento (2001) state that this process of degradation began around the Middle Ages and reached its peak at the end of the 18th century, with the industrial revolution, when the quality of the water deteriorates and the large and important urban rivers are transformed into industrial deposits and receptors of polluted water and human waste (BAPTISTA and NASCIMENTO, 2001).

In the same period of the 18th century, countries such as Italy, France, Germany, and England realized that the waters that were part of the marshy areas were responsible for the transmission of diseases and sometimes the death of people and animals, thus starting a process of extinction of these hydric areas. In addition, this period saw the emergence of the first hygienist ideas of the time, which aimed at the disposal of urban waters, regardless of their origin, thus allowing a radical change in the parameters of the relationship between cities and rivers (SILVEIRA, 2002).

All the processes and activities of the hygienists allowed in the twentieth century, on a global scale, the population growth, and among this population that arose, a relevant part was in urban areas, where the urban centers became more agglomerated, being made the use of housing in flood areas, on the banks of rivers, contributing to the conflicts of the relationship rivers-cities (BAPTISTA, 2013).

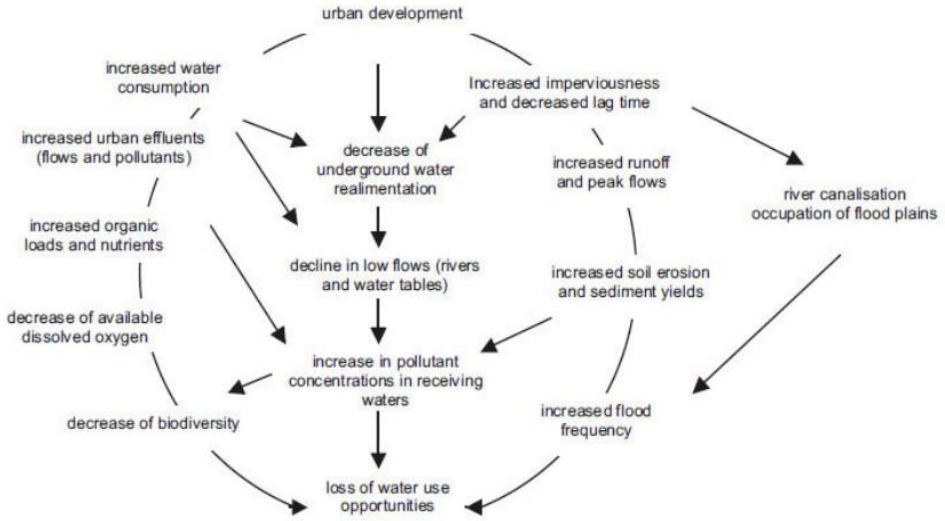
Figure 1- Evolution of the world population (left) and in urban areas (right)



Source: UNFPA (2011), IAURIF (1997).

In this way, it can be seen that the impacts generated by the evolutionary processes of the cities and the impacts of urbanization in relation to the natural environment, in general, on the rivers, have allowed a progressive loss of the potential of the river banks and the quality of their waters, something that was perceived directly and with multiple aspects for the water resources, where the impacts of urbanization on the waters (Figure 02) decharacterized the landscape and provided the first points of degradation.

Figure 2- Impacts of urbanization on water



Source: adapted from CHOCAT(1997) apud CASTRO (2007)

The hygienist ideas and thoughts prevailed until the twentieth century, however, in the mid-1960s there began to be a decline, especially in developed countries, where environmental awareness and consideration of water needs and their relationship with the city began to emerge. To this end, the quality and quantity of water resources, such as rivers, began to be the subject of debate and reflection among urban users. And so, in the 1980s, activists emerged with principles based on what they called "smart growth", aiming at the recovery and renaturalization of urban rivers and their transformation, providing measures of reconciliation between rivers and cities (SILVEIRA, 2002; MALLEA, 2009).

Thus, the development and expansion of cities in the context of urbanization processes following the demands of users, have become the main cause of problems and conflicts faced by the urban and environmental environment. Furthermore, Beck (1986) in his studies, discusses the theory of "risk society", which is a result of the classical industrial development, in which society is characterized by constant risks of catastrophes and environmental crisis, the author defines such processes as "civilizational self-threat" (BECK, 1986).

2 OBJECTIVES

2.1 GENERAL OBJECTIVE

The research aims to analyze the relationship between the Espinharas River and the city of Patos, in Paraíba.

2.2 SPECIFIC OBJECTIVES

- Analyze the riverbank areas;
- Identify the environmental and urban aspects that affect the river-city relationship;
- Understand the degradation processes present in the riverbanks.

3 METHODOLOGY / METHOD OF ANALYSIS

As a method of analysis, we used field research, which is applied to obtain information related to a problem to which we are looking for an answer or a hypothesis that we want to prove. It also consists of the observation of facts and phenomena relevant to the research. Thus, "the field study tends to use much more techniques of observation than of questioning". (GIL, 2008, p. 57).

Based on the established methodology, the research was divided into four distinct stages:

- Stage 01: the first stage, a literature review was carried out in search of theoretical contributions about the historical, geographical, and social processes in the context of the river-city relationship;
- Stage 02: In the second stage, data collection was carried out through in loco visits, which provided environmental and urban data on the relationship of the riverbanks with the city. In this stage, photographic records, marking of nodal points, and dialogues with residents, among other forms of diagnosis were carried out.
- Stage 03: In the penultimate stage, the data collected in the previous stage were presented in maps, through the use of programs such as Georeferenced Information System (Qgis), AutoCAD, and PowerPoint.
- Stage 04: In the last stage, a discussion of the results was carried out on the aspects of the banks of the Espinharas River and its relationship with the city.

4 RESULTS

4.1 GENERAL CHARACTERIZATION

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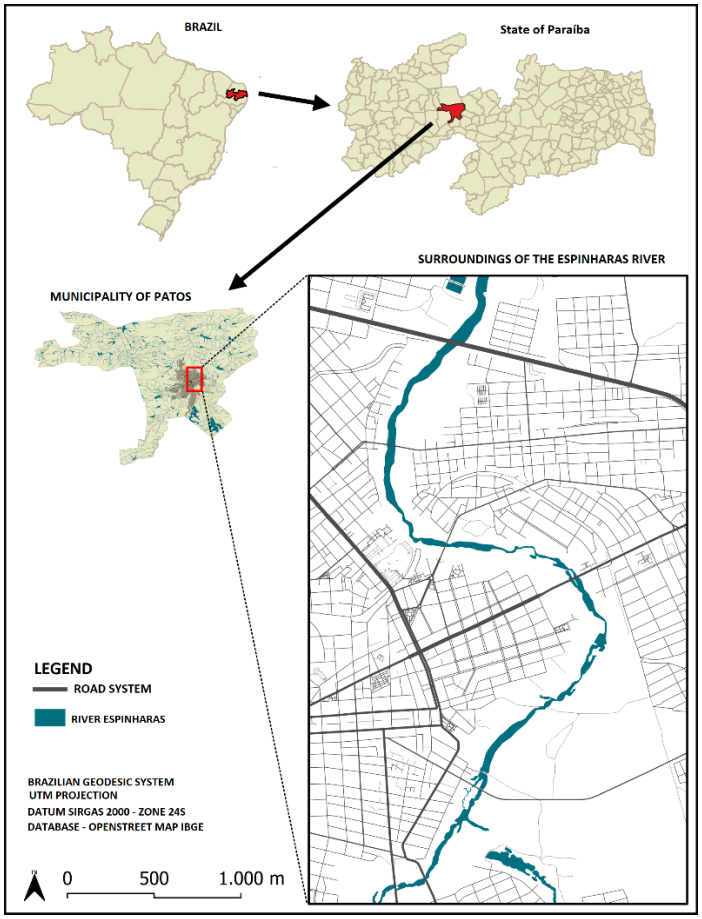
Figure 3 – Location Map.



Source: Elaborated by the authors, 2022.

Located in the city of Patos, in the Sertão of Paraíba, the Espinharas River is characterized as the most important water body in the metropolitan region of the city of Patos, and in recent years has shown clear signs of degradation and neglect by managers and the local population.

The city of Patos, according to data from IBGE, presents a population with an estimated 108,000 inhabitants by the year 2021, its urban formation originated on the banks of the Espinharas River and around ponds, which over time were deprived of the natural landscape.

According to Silva, Lima, and Mendonça (2013), the Espinharas River is formed by the confluence of the Rio da Cruz, where its source begins in the municipality of Imaculada, located near Patos, along with the Rio da Farinha, in the municipality of Salgadinho, and thus present in an urban area of the municipality of Patos (Figure 4).

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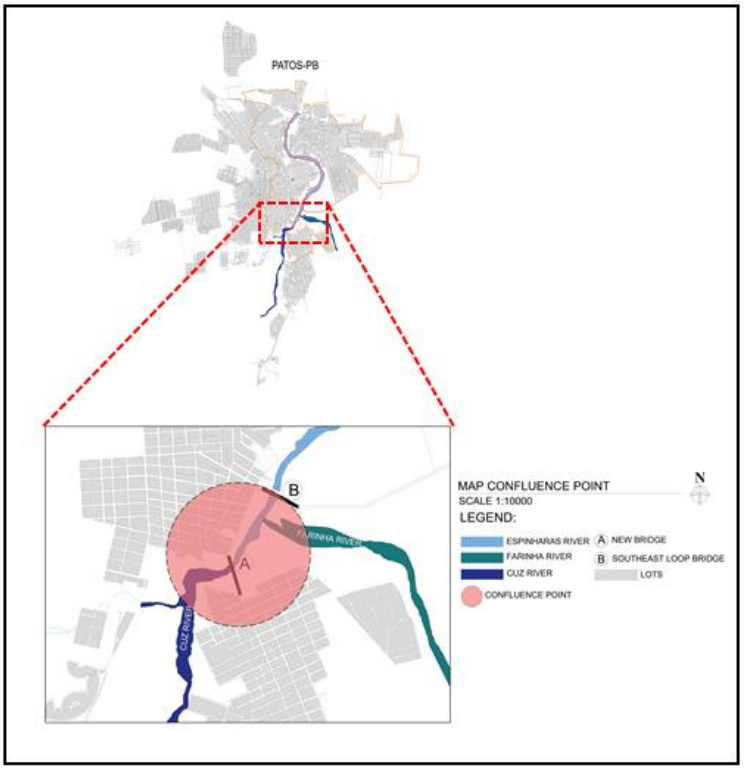
Figure 4- Confluence point between rivers



Source: elaborated by the authors, 2022.

In the current scenario, the Espinharas River has been facing problems resulting from the advance of the city along its banks, which has caused the decharacterization of the natural landscape, loss of water quality, changes in the channel due to silting processes, changes in the natural fluvial design of the river, among other problems generated by the conflicting relationship between the river and the city.

4.2 ENVIRONMENTAL AND URBAN CHARACTERIZATION

According to Mello (2012), the construction of a city undoubtedly alters the natural environment. Therefore, it is essential to identify the impacts resulting from the changes caused by urbanization. This is not an easy or simple activity, but something complex, because the impacts resulting from human occupation have several reasons.

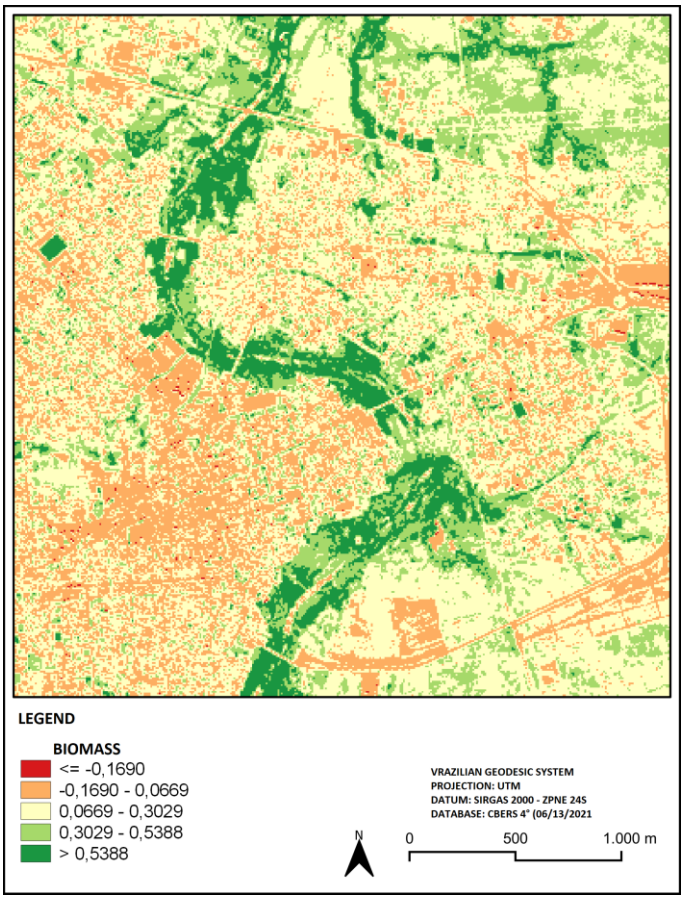
Thus, with the realization of in-loco visits and with the support of maps of characterization of the study areas, this work, in this stage, sought to elaborate the environmental characterization of the Espinharas River, considering the following aspects I. vegetation and soil and II. water quality, which is discussed in the following topic.

4.2.1 Vegetation and Soil

According to Mello (2012, p. 76), "the contributions of vegetation to the environmental balance are diverse, and some have not yet been fully elucidated." With this in mind, this study sought to understand the plant biomass that makes up the banks and

surroundings of the Espinharas River to understand the influence of greenery and its contributions to environmental stability.

Figure 5 – Biomass Map

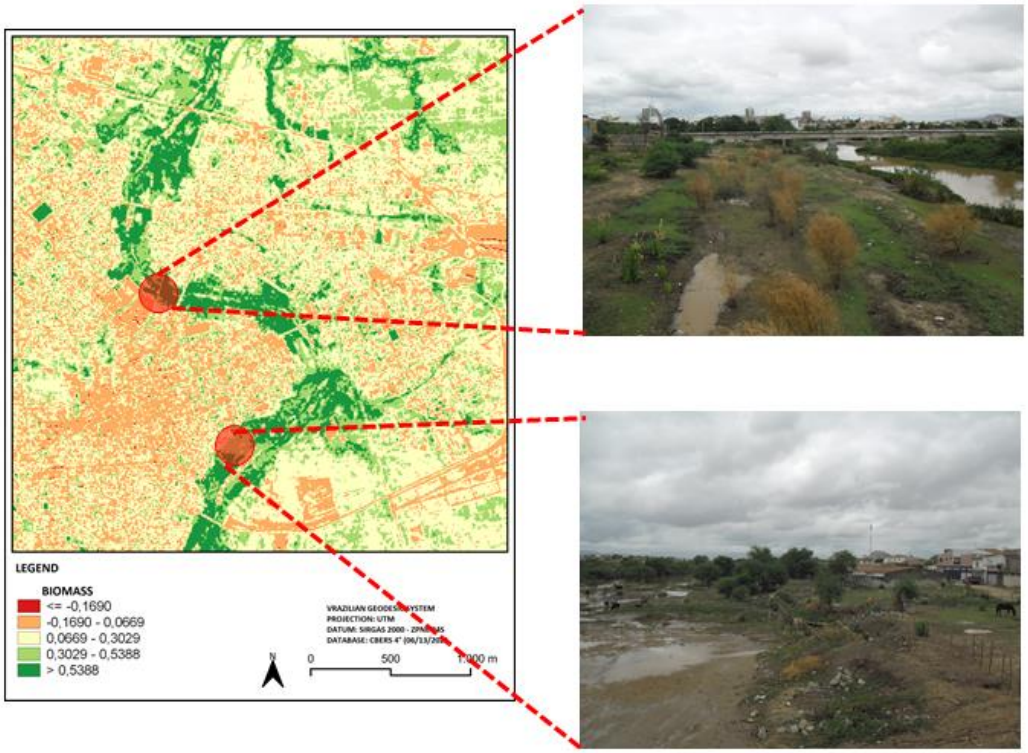


Source: Elaborated by the Author (2022)

Looking at the map presented in Figure 5, it can be seen that the vegetation indices registered are low and mostly concentrated along the river banks, represented in the legend by the color dark green. However, it is important to note that a considerable part of this vegetation is non-native and another part is plantations of a type of vegetation intended for animal feed. The light green color represents the undergrowth or low vegetation, and the other colors represent the lack of green cover.

In parallel, through the technical visits to the Espinharas River, it was possible to identify the problems inherent to the river, and about this, the factors of greater evidence found relate to the absence and decharacterization of the riparian forest that makes up the banks of the Espinharas River. Moreover, in several points, it is possible to identify the absence of native vegetation, grass plantations, and the proliferation of exotic trees, among other factors that reconfigure the natural landscape of the river banks (Figure 6).

Figure 6 - Degraded banks of the Espinharas River.



Source: Elaborated by the authors (2022).

According to studies by Mello (2008), riparian zones are responsible for providing the first habitats for wildlife. These areas are also called floodplains, where they are subject to periodic flooding, ecological cycles, maintenance, reproduction, and functioning of the local fauna. In the case of the Espinharas River, a process of degradation of the vegetation cover in the riparian areas and its replacement by non-native vegetation has been identified, as well as the cultivation of other vegetation used for livestock, causing the deterioration of the soil and its sediments.

Figure 7- Irregular plantings on the bank areas

Source: Research archives, 2022.

For Silva, Lima, and Mendonça (2014, p. 202), "the preservation of the vegetation cover is a fundamental condition for the conservation of water resources, since vegetation plays an important role in the protection and maintenance of springs and watercourses".

However, Silva (2011) points out that the soil along the banks of the Espinharas River is characterized by crystalline rocks and, in a small part, by sedimentary areas. Most of the soils are shallow, stony, of crystalline origin, and prone to erosion. For more, Santos et al. (2013) explain that the predominance of soils of these banks is defined as chromic luvissolo and neo solo.

Figure 8- Erosive Soil - Espinharas Riverbank

Source: Research archives, 2022.

4.2.2 Water quality

However, "the deterioration of water quality is one of the main factors for the removal of water bodies from urban life" (MELLO, 2008). Currently, the deterioration of water quality can be influenced by several factors, and measures for water treatment and requalification are always necessary.

Given the above, the Espinharas River currently presents a high level of water pollution; throughout its urban course, the degradation of water quality and the impacts caused by the urbanization process of the city are remarkable.

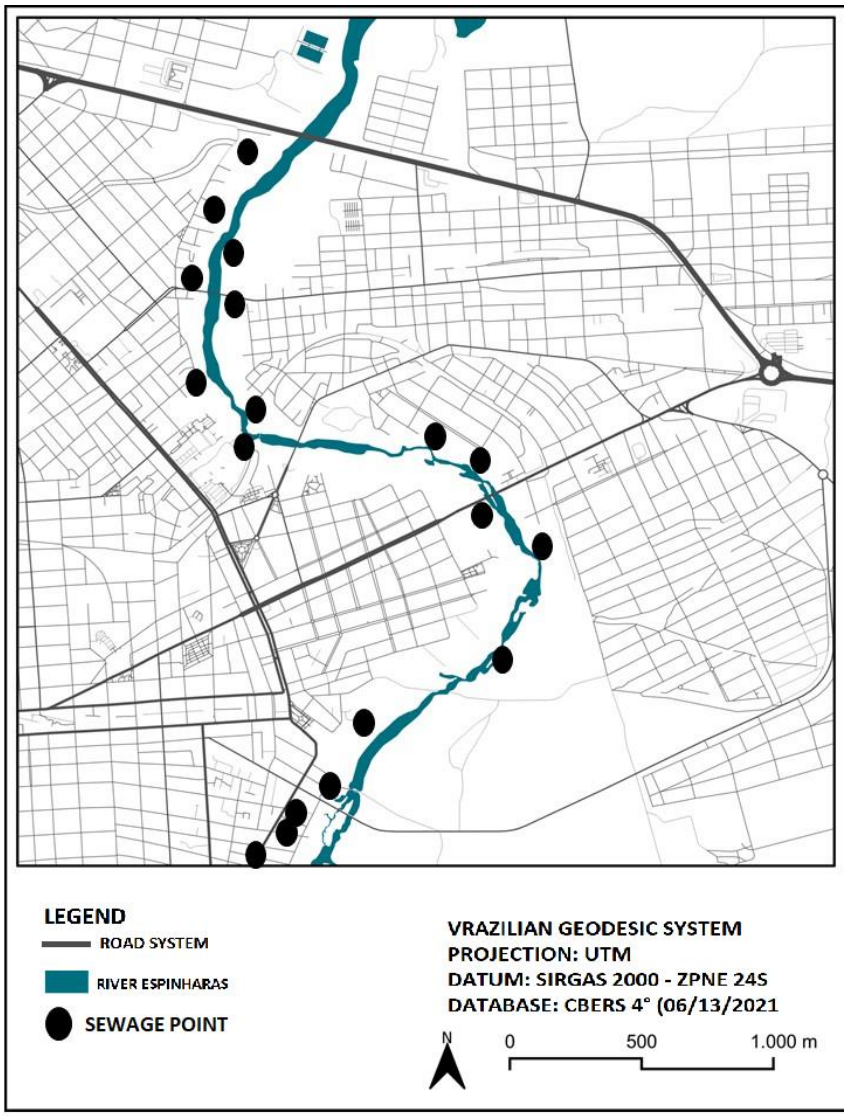
Figure 9- Sewage released into the Espinharas River

Source: Research archives, 2022.

Today, one of the main problems of the waters of the river Espinharas is the points of sewage of the city that are dumped in its waters. Thus, more than 20 points of sewage were found, all of which are dumped into the waters of the river, a situation of urgent nature to be solved, since this problem of water pollution derived from effluents has generated other problems for the river and the city, such as bad odor in central areas of the city, the

disappearance of aquatic species, economic loss of water, alteration of the hydrological system, the spread of acute and chronic diseases, eutrophication, among others.

Figure 10 - Sewage Points - Espinharas River



Source: Research archives, 2022.

The effluents discharged into the Espinharas River range from the hospital, industrial to domestic, and without any kind of proper treatment, since the city does not have any sewage treatment plants (STPs), and the only one that existed has been inactive since 2011. It is noteworthy that this situation is constantly worsening due to the gradual population growth, which leads to an increase in the production of waste and the discharge of wastewater into water bodies, making it more difficult to rehabilitate and restore the quality of the river water.

With environmental pollution at alarming levels, some problems become very noticeable, such as bad odors emitted by the river. Although the river is intermittent and its flow is only for short periods of the year, because of the annual discharge of sewage from the entire city, a bed of polluted and permanent water has been created in the river, causing unpleasant odors to the residents who live along the banks of the river.

Another problem caused by water pollution, one of the most visible in the current scenario, is eutrophication. The process of eutrophication brings great losses to the quality of river waters, such as a) taste; b) odor; c) turbidity; d) watercolor; e) reduction of oxygen in the water, among others. In the Espinharas River, it is caused by the high level of nutrients present in the water due to the discharge of wastewater into the river without any type of sanitation, for this reason, one notices the excessive presence of algae and aquatic plants in the superficial part of the water.

Figure 11- Water eutrophication - Espinharas River

Source: Research archives, 2022.

4.2.3 Soil Domain

To understand the soil domain, the river map of inflows and outflows was elaborated to understand the level of urbanization in the areas along the banks of the Espinharas River. From this map, it was possible to identify how densely populated these areas are by the population living in these spaces and thus understand what measures should be assigned to reverse this picture of existing degradation by the city to the river.

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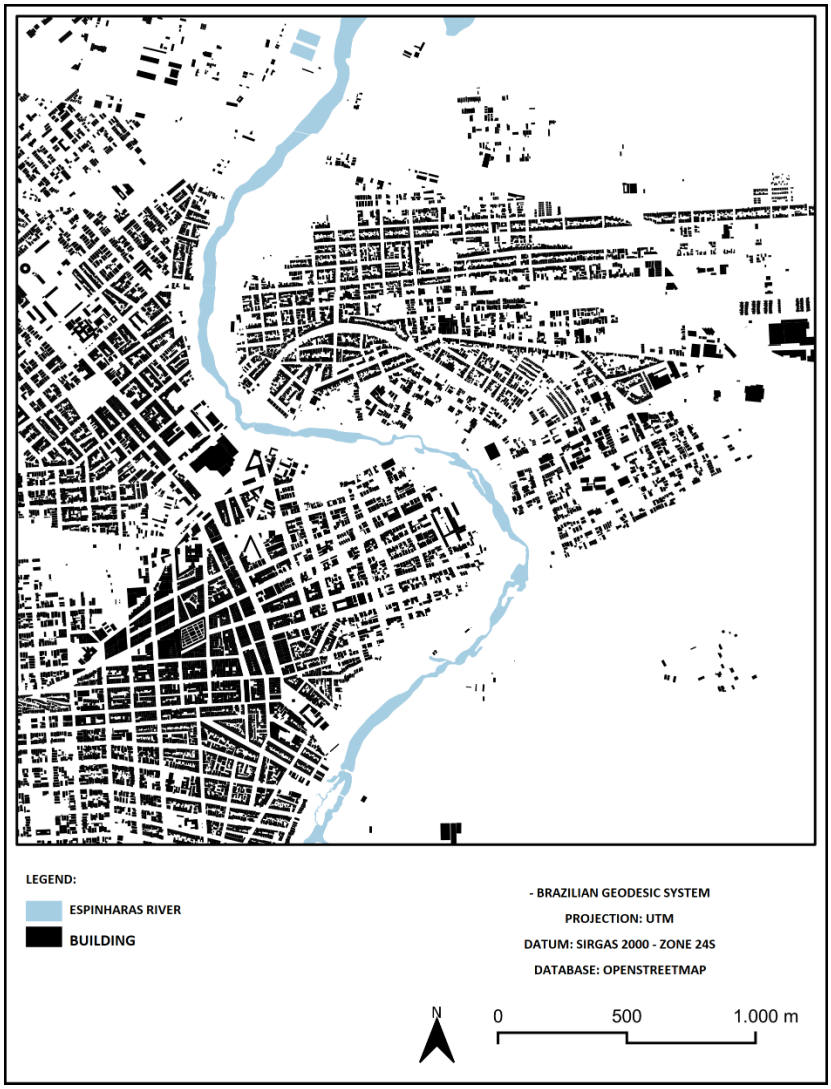
Figure 12 - Map of inflows and outflows - Espinharas River



Source: Elaborated by the author, 2022

Through the river map of inflows and outflows, it can be seen that the city has penetrated the banks of the river and that this penetration of urbanized areas into the natural environment has generated consequences for the city of Patos itself. However, the population density map of this study area was developed to reflect the real situation of the degradation of the river and the conflicts generated by the urbanization process on its banks.

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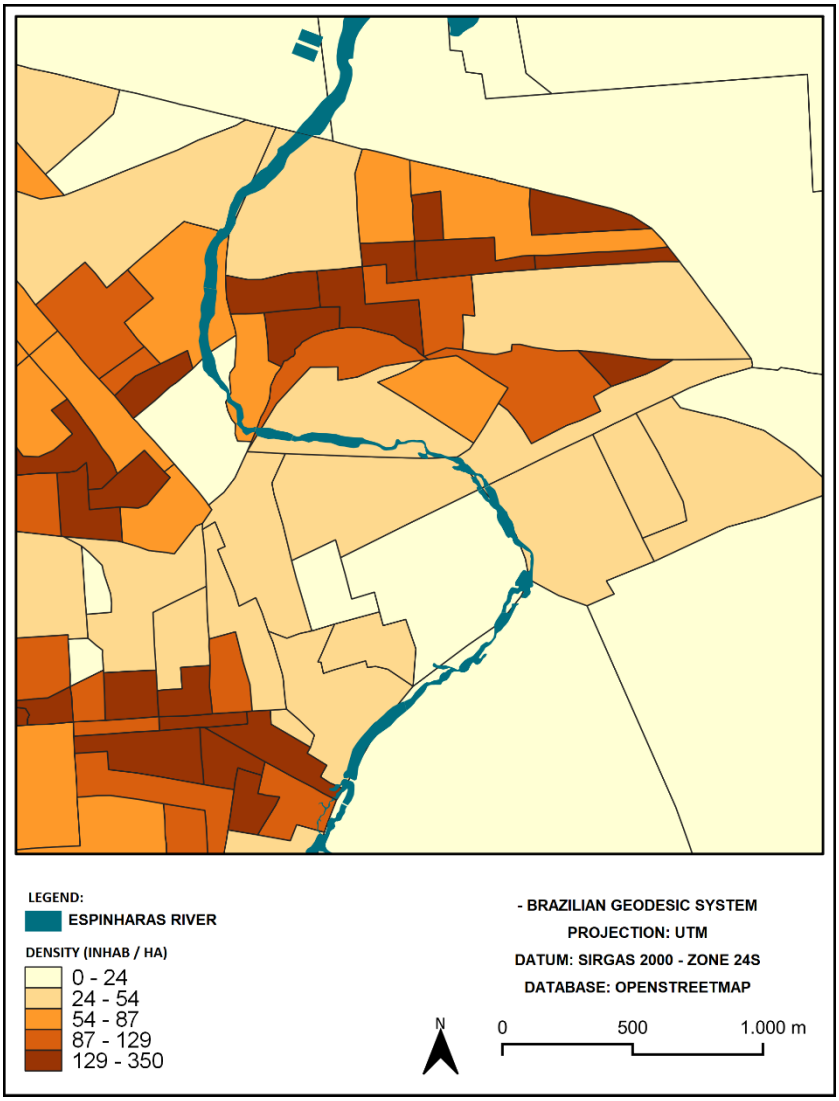
Figure 13 - Population Density Map – Espinharas River



Source: Elaborated by the authors, 2022

From the map of population density, it can be seen that the neighborhoods adjacent to the banks of the river have a high level of density, and because of this, the lives of these people have been affected, since a large part of this population is inserted in areas at risk due to flooding, in addition to the constant contact with contaminated water and bad smells emitted by the river.

By analyzing the vegetation/soil and water quality maps, it is possible to see that the situation of the river is worrying and needs attention. The banks are compromised by erosion processes, the water quality is precarious, and the vegetation areas have been deforested, contributing to the lack of relationship between the river and the city.

5. CONCLUSION

We have tried to present the characterization of the study area which is the Espinhara River and its spatial relations with the city, understanding in an objective way the relationship between the city of Patos and the Espinharas River. This case study is a typical example of the

situation experienced by many cases of urban rivers in several Brazilian cities, where water resources are not considered an element of urban planning, becoming only an urban byproduct.

The Espinhara River shows visible signs of degradation and neglect, both on the part of managers and the population. The urban and environmental analyses show the total neglect of the river, creating difficulties in the relationship between the city and the river.

Because of the results presented on the processes of degradation of the vegetation in the riparian areas of the Espinharas River, it was realized that it can no longer develop its environmental functions, such as improvement of air quality, interaction with aquatic systems, enrichment of the soil and water quantity in the watershed. Furthermore, the problems of vegetation, as well as the aspects related to the soil, because with the removal of the vegetation cover, the soil of the banks is unprotected, causing problems such as erosion, pollution, and fragility of mineral resources.

Therefore, there is an urgent need to apply planning measures and urban strategies to reverse this scenario of degradation and abandonment. These urban measures must take into account the factors and indicators that allow the relationship between the natural environment, which in this case is the Espinharas River, and the urban environment, which in this situation is the city of Patos.

As a result, it can be concluded that the Espinharas River has numerous potentials that can be used to improve the quality of life of the inhabitants of the city of Patos. Its banks, if connected coherently with the existing urban network, can provide the city with more urban attractions such as parks, squares, walking/hiking areas, bicycle paths, connecting spaces, open spaces, green areas, etc., besides improving the relationship between the river and the city. But for all this to happen, planning measures must be applied to improve water quality, prevent land occupation in riparian zones, promote local fauna and flora, and reduce visual and physical barriers, among other important measures that can be inserted in this context.

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