

Intervention plan for the protection of APPs: case study of the Espinharas River in the city of Patos - PB

Emmanuel Marques da Silva

Master's student, UFPB, Brazil.
emmanuel_marquess7@hotmail.com

Sheila Rodrigues de Albuquerque

Master's student, UFPE, Brazil.
sheilaarq1@gmail.com

Gabriel Lincoln Lopes Carvalho

Master's student, UFPB, Brazil.
gabrielincolnlopes@live.com

Paulo Roberto de Oliveira Silva

Master's student, UFPB, Brazil.
pauloliveira.arq@outlookc.om

José Augusto Ribeiro da Silveira

Professor Doctor, UFPB, Brazil.
ct.laurbe@gmail.com

ABSTRACT

Due to the urbanization processes of recent years, a significant loss of the relationship between water resources and cities has been observed, where Areas of Permanent Preservation (APPs) have been gradually degraded and irregularly occupied. Given these scenarios, laws such as the Forest Code (Federal Law No. 12,651/2012) have been created in an attempt to mitigate and preserve the riparian zones of rivers, mangroves, lakes, ponds, and other water bodies, but due to problems in the applicability of the law itself. Thus, this study proposed to study the PPAs of the Espinharas River in the city of Patos/PB, to highlight interventions that can generate requalification of the river banks. The method of analysis chosen was exploratory research, with the support of techniques such as field visits, photographic surveys, data collection, mapping of PPAs, and finally the diagnosis of land use and watershed. The results of this study consisted of the proposal of a linear park plan applied in the areas of the PPAs of the Espinharas River, urban equipment that has the purpose of providing the requalification, restoration, and renaturalization of the areas degraded by the processes of irregular occupation and urbanization.

KEYWORDS: Permanent Preservation Areas. Intervention Plan. River-City.

1 INTRODUCTION

In Brazil, permanent conservation areas (APP)¹, according to the Forest Code (Federal Law No. 12.651/2012), are areas of environmental vulnerability that are part of riverbanks, mangroves, hilltops, and slopes, among others. It is in these areas that biotic and abiotic activities develop with greater proportion and relevance (BRASIL, 2012).

However, from the point of view of the historical context, this law has not been effectively considered and/or shows difficulties in its applicability, neither by the population nor by the city managers. The majority of people with low purchasing power have difficulties in accessing the formal housing market and therefore tend to adopt strategic housing measures, where APPs end up being the target of such measures, noting that the risks of occupation of APP areas are not considered, but only the need for housing, regardless of the situation (ALENCAR, 2016).

However, it is not only irregular occupations that are found in APPs but also real estate developments, secondary roads, and public buildings, among others, that contribute to the problems of sealing and degradation of APPs areas. Mello (2008) states that the concept of APP in the Brazilian scenario embodies what we call the principle of inviolability: the prohibition not only of the removal of vegetation but also of any form of use and occupation.

According to the aforementioned author, there is a paradox regarding APPs and the laws that govern them, i.e., on the one hand, we have the multiple urban, social, and economic functions that rivers provide to cities, in addition to their capacity to attract people; on the other hand, we have laws and legal causes that prohibit and prevent the formal occupation of these areas of the margins of Brazilian urban waters, in search of environmental conservation.

Based on the arguments presented, one notices that this principle of inviolability that governs the concepts of APPs in Brazil is real, being appropriate for debates and evaluations on the legislative form, as strategies have been built and applied in recent years. Given that the establishment of the legislation has not provided significant reflections, due to the identification in the areas of margins of rivers, lakes, and streams, among others, irregular dwellings, illegal businesses, projects of riverside parks, vertical condominiums, among other uses, thus verifying the non-compliance of the law (MELLO, 2012).

¹ “Permanent Preservation Area: protected area, covered or not by native vegetation, with the environmental function of preserving water resources, the landscape, geological stability and biodiversity, facilitating the gene flow of fauna and flora, protecting the soil and ensuring the well-being of human populations” (BRASIL, 2012).

Alencar (2016), on the Forest Code, points out that the issues related to the management of water bodies appear in the urban legislation, defining the form of use and occupation of the banks after a large part of them are occupied. Thus, it can be seen that the difficulty in understanding the Forest Code on the issues of APPs for urban areas lies in the lack of understanding of the need to protect the areas on the banks of water resources.

In the context of riverbanks and other tributaries, the APPs are designated according to the principle of the width of the riverbed, where these protective measures can vary between thirty and five hundred meters (Table 01). In addition, these needs for modification and amendment led to discussions within the National Environment Council (CONAMA) and the National Congress in 1999, but they are still on the agenda today.

Table 01 - Width of watercourses and corresponding APPs (in meters) according to changes in the Forestry Code over the years

1965		1986		1989		2012	
Watercourse	APP	Curso de água	APP	Watercourse	APP	Watercourse	APP
L < 10	5	L < 10	30	L < 10	30	L < 10	30
10 < L < 200	½ L	10 < L < 50	50	10 < L < 50	50	10 < L < 50	50
L > 200	100	50 < L < 100	100	50 < L < 200	100	50 < L < 200	100
-	-	100 < L < 200	150	200 < L < 600	200	200 < L < 600	200
-	-	L > 200	= L	L > 600	500	L > 600	500

Source: Cardoso, 2012

Given the above, it was seen that laws and conservation projects exist, but in practice, They present difficulties in their compliance because given situations concerning APPs are more vulnerable to degradation. In the Brazilian scenario, most of the APPs have a high level of degradation, soil sealing, water pollution, infertile soil, and threatened fauna, and flora, among other demands resulting from the growing urbanization process in the cities.

Based on the context discussed, the purpose of this study is guided by the search for measures of reconciliation of the city with the rivers, from the recovery of PPAs and their implementation in the existing urban network. This is not a simple task, because the strategies of reconciliation proposed for rivers and cities, involves confrontations of relations of certain parts, that is, on the one hand, there are the riparian zones that correspond to the areas of vegetation around the river, areas that perform environmental functions essential to water quality and create the dynamics of the watershed, in hydrological, geomorphic and ecological terms, and on the other hand, the relationship with the waters that addresses the social, economic, environmental and historical structuring of cities, motivated by "multiple urban functions linked to water" (MELLO, 2008).

2 OBJECTIVES

2.1 GENERAL OBJECTIVE

The general objective of this work is to present an intervention plan based on the diagnosis of the PPA areas of the Espinharas River, Patos/PB.

2.2 SPECIFIC OBJECTIVES

- Analyze the areas of APPs of the Espinharas River;

- Identify the factors of degradation of the APPs;
- Create mechanisms for the requalification of the areas of APPs.

3 METHODS AND MATERIALS OF ANALYSIS

The method used to achieve the objectives of this research has been characterized as exploratory, to deepen the issues of the problem and thus allow: a) the delimitation of the research topic; b) the precision of the objectives, and c) the formulation of the hypothesis. Furthermore, "in general, it involves bibliographic research; interviews with people who have practical experience with the problem under study; analysis of examples that stimulate understanding" (PRODANOV and FREITAS, 2013, p. 52). In addition, the research was divided into the following stages:

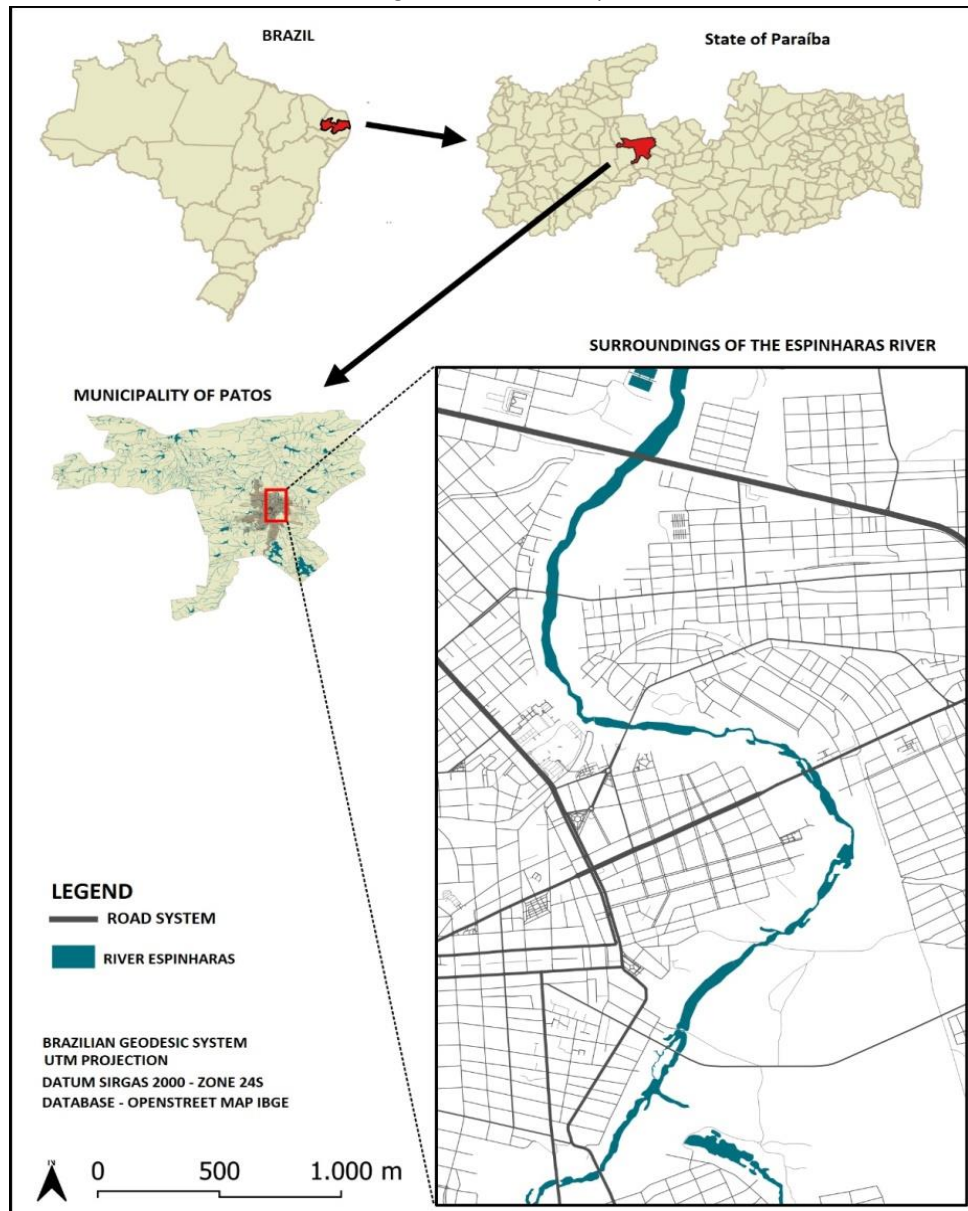
- **Stage 01:** In the first stage, a literature review was carried out from dissertations, articles, theses, journals, and digital materials.
- **Stage 02:** In the second stage, field visits were made to understand how the conservation areas are, using surveying, photographic, and geoprocessing equipment.
- **Stage 03:** In this stage, the data obtained were analyzed and presented in maps and informative graphics, using programs such as Qgis, AutoCAD, and PowerPoint.
- **Stage 04:** In the last step, the results were discussed and final considerations were made.

4 RESULTS AND DISCUSSIONS

4.1 GENERAL CHARACTERIZATION

The Espinharas River, formed by the confluence of the da Cruz and Farinha Rivers, is located in the city of Patos, in the state of Paraíba, and is the main water resource of the city's metropolitan area. According to data from the Brazilian Institute of Geography and Statistics (IBGE), Patos has a population of approximately 108,000 inhabitants and has shown strong urban growth and development in recent years (SILVA; LIMA; and MENDONÇA, 2013).

Figure 1 – Location Map.



Source: Author, 2022.

With the growth and development of urban issues, the APPs that make up the banks of the Espinharas River began to be degraded and irregularly occupied, in addition to other problems generated in the watershed such as soil sealing, siltation and soil erosion and other points pointed out in this study as water pollution, deforestation and irregular occupations on the banks.

For this purpose, three points were evaluated to understand the APPs:

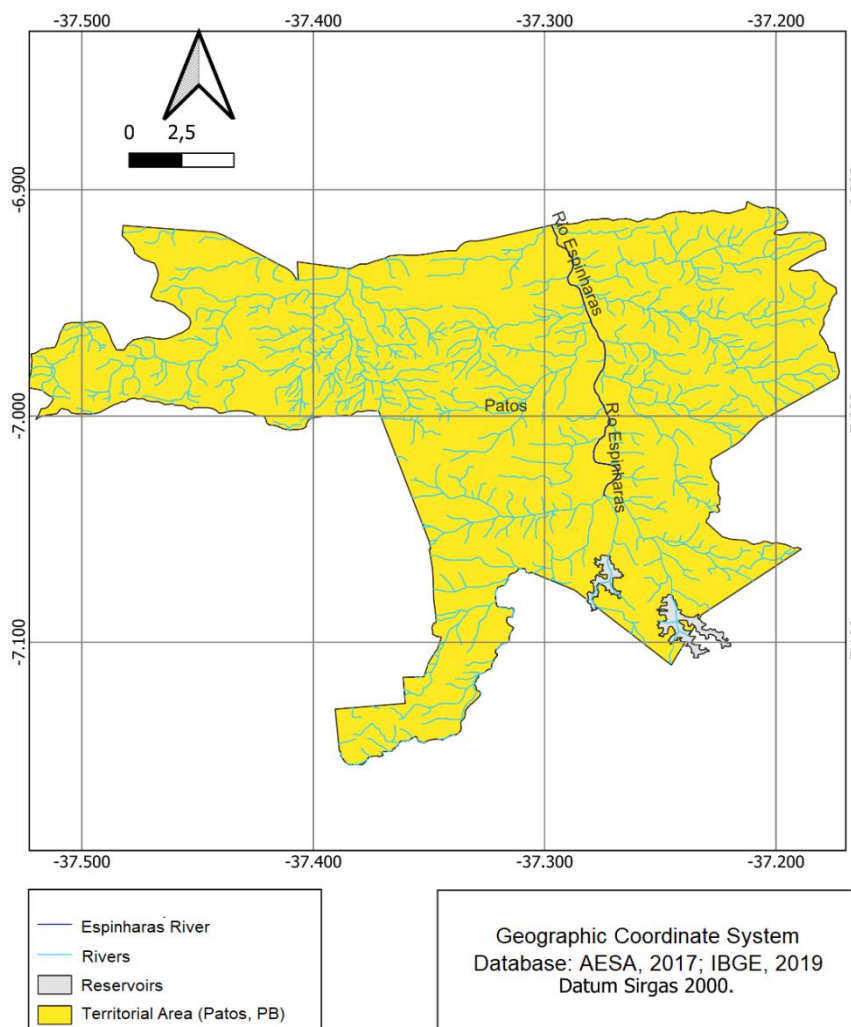
4.2 WATERSHED

According to Gosrki (2010, p. 43), the watershed corresponds to the area, and territory endowed with a slope, which allows the flow of waters that are directly or indirectly directed to a central water body.

The sub-basin of the Espinharas River has a surface area of about 3,330 km², with its boundaries surrounded by the sub-basin of the Taperoá River to the southeast, the Pajeú River to the southwest, the tributaries of the São Francisco River, the Piancó and Médio Piranhas sub-basins to the west, and the Seridó River sub-basin to the east (AESAs, 2010).

Regarding the micro-basin of the Espinharas River, we observe unfavorable changes in the water dynamics and consequently causing problems such as erosion and infiltration of water, which is one of the main impacts on watersheds caused by the urbanization processes of the city of Patos/PB.

Figure 2 - Espinharas River Basin



Source: Research Archives (2022)

Studies conducted in recent years show that watersheds near urban areas suffer from the influence of factors that contribute to the acceleration of river siltation compared to watersheds in areas that maintain their natural areas. Among the many problems caused by erosion is the exposure of the soil due to the removal of vegetation. Such a situation is present in the Espinharas River, which has undergone upheavals due to the urbanization processes of its watershed, thus receiving the effects of soil erosion and loss of vegetation.

Figure 3- Soil with erosive processes on the banks of the Espinharas River



Source: Research Archives (2022)

Another need identified in the Espinharas River basin is the sealing of the soil, which implies a decrease in water infiltration and promotes an increase in direct runoff, which overloads the natural drainage networks of the city, causing flooding. According to Montgomeru (1992), the higher the level of soil sealing, the more frequent, severe, and long-lasting the floods.

Figure 4 - Largest flood event in the city of Patos/PB - year 2009



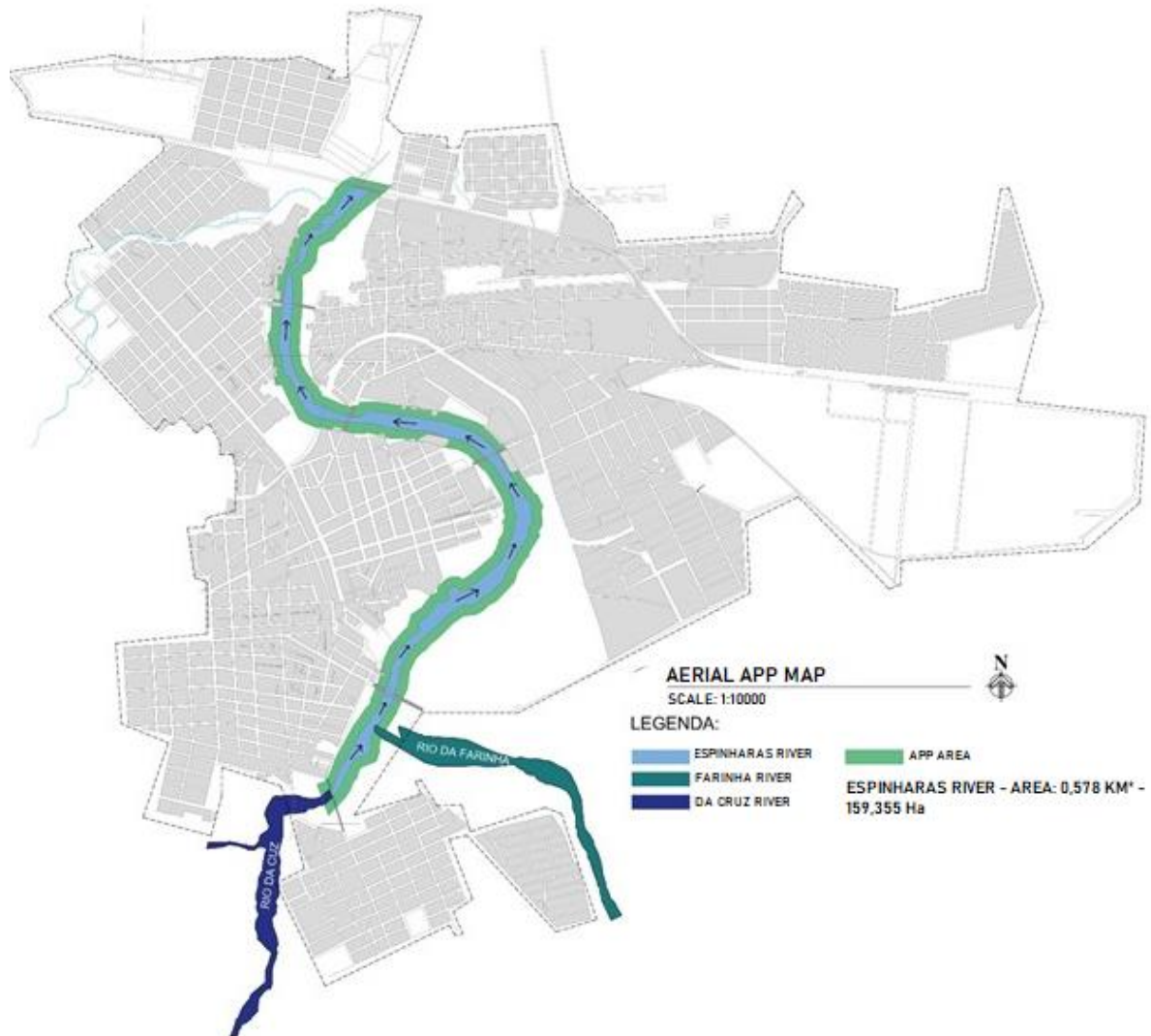
Source: Figueiredo (2012)

4.3 Areas of Permanent Conservation - APP

Concerning the diagnosis of the APPs, which are areas protected by Law No. 4771/65, together with the modifications introduced by Law No. 7.803/89, which, according to the Ministry of the Environment (CONAMA), in its Resolution No. 004 of 1985, specifies what are conservation areas and their dimension concerning water courses, the map of the demarcation

of the APPs of the Espinharas River is also highlighted, to understand how these areas are affected by the urbanization processes of the city on the banks of the river.

Figure 5 - Areas of Permanent Preservation of the Espinharas River, Patos/PB



Source: Personal Collection, 2022

With the elaboration of the APP map and with the technical visits, it was identified that the peripheral areas of some neighborhoods in the city are in disagreement with the current laws on APP and their constraints since it was seen as an expressive value of the dwellings present in the APP of the Espinharas River.

Today, the Espinharas River is formed by a riverbed that has an average width of 50 meters, where, according to the law, both the Forest Code and CONAMA, the areas of APPs for rivers with a channel of these dimensions must have a conservation area of 100 meters in length on each bank. However, this situation does not exist in the Espinharas River, since a significant densification was found in the riparian area, which in turn is formed by irregular constructions of residential, commercial, or institutional use.

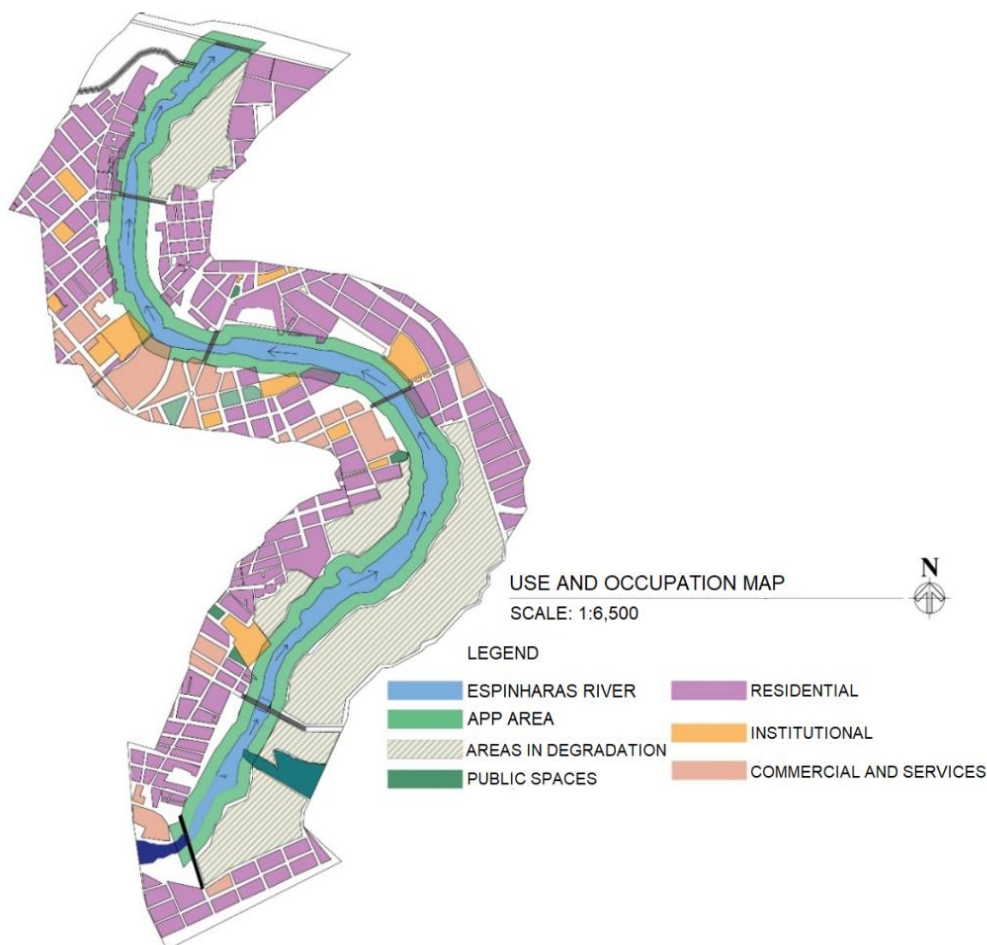
4.3 USE AND OCCUPATION OF THE SOIL

As mentioned before, the areas of implementation of the city of Patos were established on the banks of the Espinharas River, generating irregular occupations according to the laws of protection of the areas of water resources banks.

Along the course of the waters of the Espinharas River, there are irregular dwellings, located in areas of risk and vulnerability, and according to the Brazilian Forest Code are not allowed areas for any kind of occupation.

Hence, for a better understanding of these occupations on the river banks, the map of land use and occupation was developed, considering a distance of 300 meters from the river banks and highlighting the types of buildings in residential, institutional, and commercial.

Figure 6 – Soil use and occupation map of the Espinharas River, Patos/PB



Source: Elaborated by the Authors (2022)

It has been observed that there are a considerable number of buildings on the river banks, from large companies to educational institutions, which are located in areas that should be preserved. In this way, it can be seen that the public administration has been flexible in allowing companies to construct buildings in these conservation areas, without taking into account the requirements of the Forestry Code and without any kind of conservation strategy for the occupied areas, which directly affect the river's ecosystem.

Figure 7 - Shopping Mall on the banks of the Espinharas River



Source: Personal Collection (2022)

Another factor identified concerning the buildings that are located on the banks of the river is that all the buildings do not have their front facades facing the river, i.e. the APPs, which shows that there is a disregard for the course of the water that surrounds the city of Patos. It is also possible to see that these buildings are arranged in a way that makes it impossible to see the natural landscape of the river (Figure 8).

Figure 8 - Buildings along the Espinharas River



Source: Research Archives (2022)

With the study carried out on the banks of the Espinharas River, it became evident that the areas of protection and preservation (APPS) face problems due to the irregular occupations that are implanted in its territory, making it necessary to intervene in the requalification of these areas.

4.4 INTERVENTION PROPOSAL

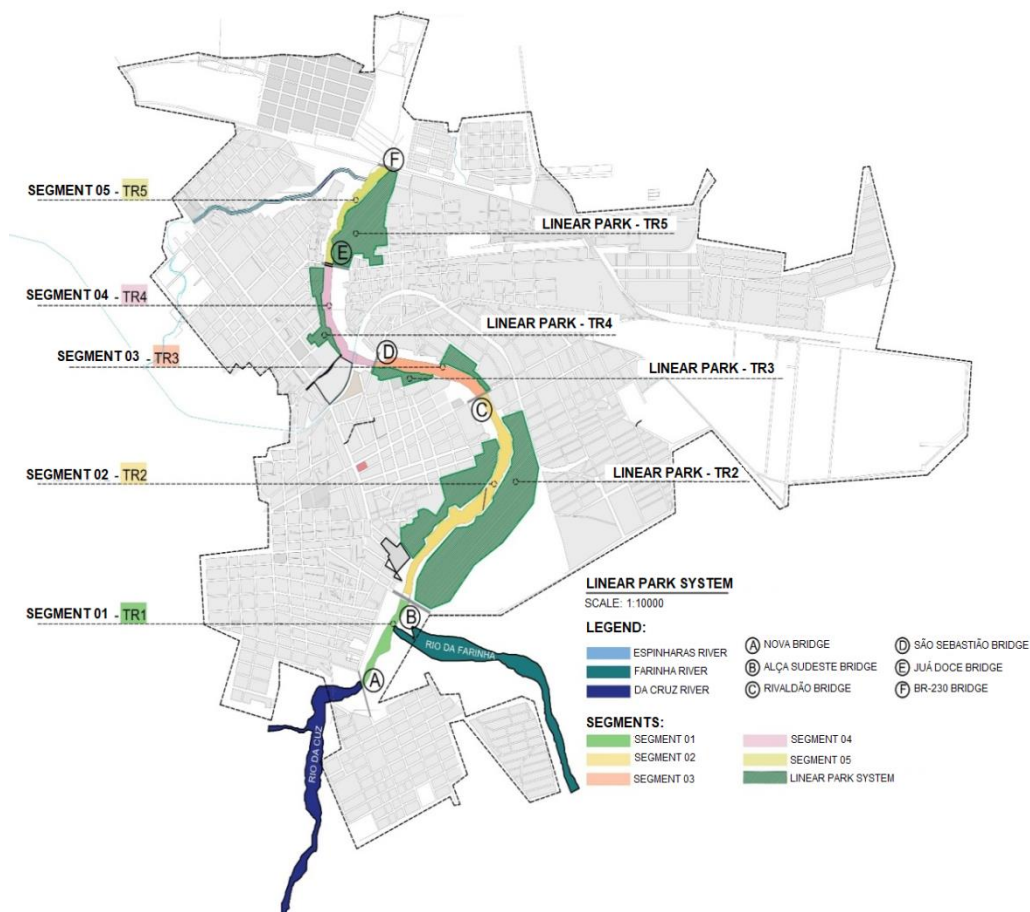
Based on the diagnosis of the watershed, the areas of PPAs, and the soil use and occupation, the next step of this study was based on an intervention proposal for the river

banks, to promote efficient strategies for the establishment of connections between the city and the river banks, as well as the recovery of the PPAs and their potential for the city.

Thus, for the intervention plan of the river, a plan of linear parks established based on urbanistic parameters and applied on the banks of the watercourses was thought, besides the importance of being connected to the paths of the rivers to the water network. Linear parks, which are usually longer than they are wide, create links between green areas, protect and restore the local ecosystem, allow for flood control, and also provide areas for recreation and other activities.

Considering all these positive factors that the implementation of green parks in the Espinharas River causes, a network of linear parks has been designed, which are distributed along its course, seeking to create environments that favor the local ecosystem (fauna and flora) and the sustainable development of the city. The proposal aims to select the areas most affected by the expansion of the urban network on the riverbanks, and consequently to establish parameters that contribute to the control of unregulated growth, generating measures that provide efficient relationships between the riverbanks and the city, transforming the APPs into a series of linear parks (Figure 9).

Figure 9: Intervention areas - Linear Parks



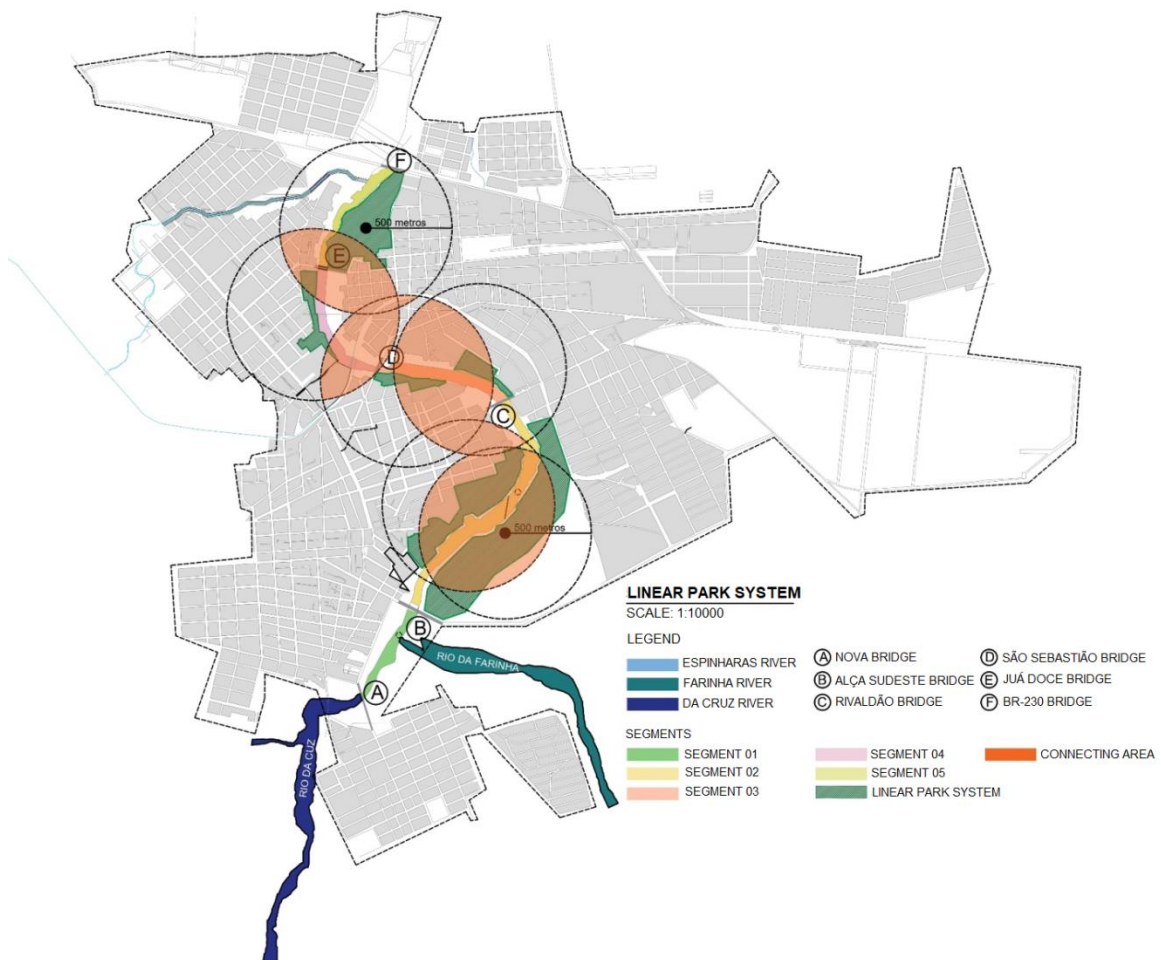
Source: Elaborated by the authors (2022)

With the implementation of linear parks, the city gains several benefits for its inhabitants, such as the availability of shaded areas, improvement of air humidity, reduction of

heat islands, improvement of soil permeability, and faster passage of rainwater, among others. In general, the city of Patos/PB is beginning to express greater vitality and well-being for its entire population.

To better understand how the connection between the parks and their indicated areas works, a system of radii has been developed between the central areas of each place selected for the insertion of each of the parks, thus obtaining a better visualization of the permeability created between them, which provides positive experiences of walkability along the entire path. For this reason, radii of 500 meters were introduced in the linear parks, creating wide and strategic visualizations between the connecting areas and their spaces (Figure 10).

Figure 10: Boundary Radii - Linear Parks



Source: Elaborated by the authors (2022)

In summary, the proposal for linear parks aims to confirm a harmonization between the urban and natural environment. All this through the integration of green spaces, sports, and leisure areas, walking circuit systems, spatial contemplation, interconnected environments between the river and the city, and reinsertion measures between the river and the city, i.e. the establishment of efficient strategies based on the potentialities of the banks of the Espinharas River and its APPs.

5 CONCLUSION

It was concluded before the investigations carried out on the correlation of the margins of rivers and the APPs, distinct justifications that can be applied in favor of the valorization and preservation of the riparian zones of the hydric resources and specifically of the urban rivers, which for this study was directed to the Espinharas River, in the city of Patos/PB.

However, in Brazil, the definition of what are the marginal strips of protection, is still a complex issue, given the numerous variables that are possible. Given the width of the riverbed is the only component that defines the margins of protection, thus contributing to the floodplain areas, water dynamics, and flood control. Conversely, this attribute should not be the only component in defining the margins of preservation, because other elements should also be considered such as depth, slope, topography, speed, and water absorption capacity, among other factors.

On the other hand, the Forest Code and its principles of intangibility have been shown to collaborate with the process of devaluation of the riverbank areas and consequently the APPs, and thus being ineffective in the operation of this law, especially when it comes to the climatic diversity and biomes of the various regions of Brazil.

Given this scenario, the research understood that the factors of preservation of riverbank areas and their importance for the requalification of APPs, where linear parks stand out as relevant strategies of intervention for the banks of the Espinharas River.

Accordingly, from particular planning, which was subsidized by the understanding and identification of important features for the enhancement of the margins of water resources, especially rivers, it was understood that cities together with managers can reverse deterioration scenarios, and thus promote positive and timely realities for improving the quality of life of the urban space and its inhabitants.

REFERENCES

- ALENCAR, Anna Karina Borges de. **URBANISMO SENSÍVEL ÀS ÁGUAS: O paradigma da sustentabilidade na concepção de projetos para recuperação de rios urbanos**. 2016. 295 f. Tese (Doutorado) - Curso de Arquitetura e Urbanismo, Universidade Federal de Pernambuco, Recife, 2016.
- BRASIL. Lei no 12.651, de 25 de maio de 2012. Dispõe sobre a proteção da vegetação nativa; altera as Leis nos 6.938, de 31 de agosto de 1981, 9.393, de 19 de dezembro de 1996, e 11.428, de 22 de dezembro de 2006; revoga as Leis nos 4.771, de 15 de setembro de 1965, e 7.754, de 14 de abril de 1989, e a Medida Provisória no 2.166-67, de 24 de agosto de 2001; e dá outras providências. 2012.
- BECK, U. (1986). **Sociedade de risco: Rumo a uma outra modernidade**. 2ª ed. São Paulo: Editora 34, 2011. 384 p.
- GIL, Antônio Carlos. **COMO ELABORAR PROJETOS DE PESQUISA**. 4. ed. São Paulo: Atlas, 2008. 176 p.
- GORSKI, Maria Cecília Bar. **RIOS E CIDADES: RUPTURA E RECONCILIAÇÃO**. 2008. 245 f. Tese (Doutorado) - Curso de Arquitetura e Urbanismo, Universidade Presbiteriana Mackenzie, São Paulo, 2008.
- HOUGH, M. (1995). **Cities and Natural Process**. New York: Routledge, 2002.
- MALLEA, Amahia. **Rivertown: rethinking urban rivers**. *Technology and culture*, v. 50, n.1, p. 217 -218, 2009
- MELLO, Sandra Soares. (2005); "As funções ambientais e as funções de urbanidade em margens de cursos d'água". *Oculum Ensaio Revista de Arquitetura e Urbanismo*, Campinas, v.4, p.49-61. Disponível em: [Erro! A referência de hiperlink não é válida.](#) ISSN: 1519-7727.

_____. (2008); **"Na beira do rio tem uma cidade: Urbanidade e valorização dos corpos d'água"**. 348f. Tese (Doutorado) – Brasília: Faculdade de Arquitetura e Urbanismo, Programa de Pesquisa e Pós-graduação, Universidade de Brasília.

_____. (2012); **"Espaços urbanos em beira d'água"**. In: **Seminário de áreas de preservação permanente em meio urbano**, 2., 2012, Natal. Anais... Brasília: ANPUR, p.1-20.

PRODANOV, Cleber Cristiano. FREITAS, Ernani César. **Métodos e Técnicas da Pesquisa e do Trabalho Acadêmico**. 2. ed. Rio Grande do Sul: Editora Feevale, 2013.

SILVA, R. M.P. **Alteração da cobertura vegetal na sub-bacia do Rio Espinharas no período 2000-2010: o geoprocessamento como ferramenta para o gerenciamento ambiental**. 2011. Dissertação (Mestrado). Programa de Pós-Graduação em Ciências Florestais. CSTR/PPGF, Patos-PB, 143p.: il. 2011.

SILVA, R. M.P.; LIMA, J. R; MENDONÇA, I. F. C. **Alteração da cobertura vegetal na Sub - Bacia do Rio Espinharas de 2000 a 2010**. Revista Brasileira de Engenharia Agrícola e Ambiental, v. 18, n.2, p. 202-209, 2014. Disponível em: <<http://www.scielo.br/pdf/rbeaa/v18n2/a11v18n2.pdf>>. Acesso em: 10 outubro 2022.

SILVA, Rosangela M. P.; LIMA, Joedla R.; MENDONÇA, Izaque F. C. de. **Alteração da cobertura vegetal na Sub-Bacia do Rio Espinharas de 2000 a 2010**. 2013. Disponível em: <<http://www.scielo.br/pdf/rbeaa/v18n2/a11v18n2.pdf>>. Acesso em: 10 outubro 2022.

SPIRN, Anne Whiston. **O jardim de Granito: A natureza no Desenho da Cidade**. São Paulo: Universidade de São Paulo, 1995.