Revista GEOSABERES

www.geosaberes.ufc.br
ISSN: 2178-0463

MAPPING OF IRREGULAR OCCUPATIONS IN PERMANENT PRESERVATION AREAS ALONG URBAN STRETCH OF MUMBUCA STREAM IN MONTE CARMELO, MINAS GERAIS

MAPEAMENTO DAS OCUPAÇÕES IRREGULARES EM ÁREAS DE PRESERVAÇÃO PERMANENTE AO LONGO DO TRECHO URBANO DO CÓRREGO MUMBUCA EM MONTE CARMELO, MINAS GERAIS

MAPEO DE OCUPACIONES IRREGULARES EN ÁREAS DE PRESERVACIÓN PERMANENTE A LO LARGO DEL TRAMO URBANO DEL NÚCLEO MUMBUCA EN MONTE CARMELO, MINAS GERAIS

https://doi.org/10.26895/geosaberes.v15i0.1295

ANA CRISTINA RAMOS ALVES [1]
ISMARLEY LAGE HORTA MORAIS [2*]

[1] Cartography and Surveying Engineer , Federal University of Uberlândia (UFU).
Rodovia LMG 746, Km 1, Monte Carmelo (MG), Brazil, ramos.alvesac@gmail.com, http://orcid.org/0000-0002-6235-4889

[2] Professor, Postgraduate Program in Civil Engineering at the Federal University of Uberlândia (UFU).
Av. João Naves de Ávila, 2121, Block 1Y, ZIP: 38400-902, Uberlândia (MG), Brazil, ismarley@ufu.br,
http://orcid.org/0000-0003-0042-5466
* Corresponding author

Article History:
Received on 22 from November of 2023.
Accepted on 25 of March of 2024.
Published in of 03 of April of 2024.

ABSTRACT

This work aimed to map the Permanent Preservation Area (PPA) along the Mumbuca stream located in Monte Carmelo - MG. The determination of irregular occupation areas, as well as the mapping of land use and occupation, were obtained from the classification supervised through the SAS Planet computer program. In the Mumbuca stream PPA area, 64.43% were occupied by vegetation, 22.17% of urban use, and 13.39% by water. The initial section of the PPA that passes through the city center, was responsible for most of the irregular occupations in the area of permanent preservation, being that 21,02% of the 22,17% of the urban use, was located in this region. The rest of the PPA, which corresponded to about two-third of the total area, had only the remaining 1.15% of irregular occupations in the permanent preservation area.
Keywords: Geoprocessing. Permanent Preservation Area. Irregular occupation.

RESUMO

Este trabalho teve como objetivo mapear a Área de Preservação Permanente (APP) ao longo do córrego Mumbuca localizado em Monte Carmelo - MG. A determinação das áreas de ocupação irregular, bem como o mapeamento de uso e ocupação da terra, foram obtidos da classificação supervisionada por meio do programa SAS Planet Computer. Na APP do córrego Mumbuca, 64,43% da área é composta por vegetação, 22,17% corresponde ao uso urbano e 13,39% pela água. A seção inicial do APP que passa pelo centro da cidade, foi responsável pela maioria das ocupações irregulares na Área de Preservação Permanente, sendo que 21,02% dos 22,17% do uso urbano, estava localizado nesta região . O resto do APP, que correspondeu a cerca de dois terços da área total, tinha apenas 1,15% das ocupações irregulares na área de preservação permanente.
Palavras-chave: Geoprocessamento. Área de Preservação Permanente. Ocupação irregular.

RESUMEN

Este trabajo tuvo como objetivo mapear el Área de Preservación Permanente (APP) a lo largo del arroyo Mumbuca ubicado en Monte Carmelo - MG. La determinación de las áreas de ocupación irregular, así como la cartografía de uso y ocupación del suelo, se obtuvieron a partir de la clasificación supervisada a través del programa informático SAS Planet. En el área de APP de la quebrada Mumbuca, el 64,43% estaba ocupado por vegetación, el 22,17% por uso urbano y el 13,39% por agua. El

tramo inicial de la APP que pasa por el centro de la ciudad, fue responsable de la mayor parte de las ocupaciones irregulares en el área de conservación permanente, siendo que el 21,02% del 22,17% del uso urbano, se ubicó en esta región . El resto de la APP, que correspondía a cerca de dos tercios del área total, tenía sólo el 1,15% restante de ocupaciones irregulares en el área de preservación permanente.
Palabras clave: Geoprocesamiento. Área de Preservación Permanente. Ocupación irregular.

INTRODUCTION

Historically, it is possible to observe the influence of water on population distribution. People have used these resources for centuries as a source of water, food, transportation, etc (MEDEIROS; ROMERO et al., 2018). Areas that must be natural resources preservation, started to be taken over by irregular occupations and activities that infringe the land use determined by the urban legislation (SOUZA et al., 2019). The lack of protection and preservation of water resources has led to environmental problems such as soil erosion, silting of watercourses, the proliferation of vectors, and compromised water quality due to disposal of polluting residues (SOUZA et al., 2019).

The Permanent Preservation Areas (PPA) was created by Brazilian Federal Law No 4771, of 1965, to avoid the degradation of ecosystems. Law no 4.771 determined protection strips around the waterways, taking into account the rivers' and streams' width, or the radius of lakes and springs (BRASIL, 1965). In 2012, the law was repealed by Law 12,651, known as the New Forest Code, but maintained the role of ensuring the maintenance of Permanent Preservation Areas and as a very important instrument to guarantee the preservation of ecosystems (fauna and flora), to maintaining the landscape and the quality of life of the population (BRASIL, 2012). For watercourses less than 10 meters wide, as is the case with many of the watercourses present in Brazilian urban areas, the Permanent Preservation Area is considered the marginal strips with a minimum width of 30 (thirty) meters from the regular river channel.

The preservation of PPAs plays an important ecological role, as well as helping to provide the infiltration and rain drainage necessary for the balance of the ecosystem, contributing to the preservation of aquifers, as well as, controlling soil erosion and consequently silting and pollution watercourses, avoiding floods in addition to ensuring the well-being of biodiversity and the human species (CAMPAGNOLO et al., 2017; COELHO; BUFFON; GUERRA, 2011).

Irregular occupation of PPAs occur on the banks of rivers, ponds, and springs, such as residential or commercial houses, settlements, and precarious housing (slums or land invasion), and disrespect the distance that must be preserved according to the width of the watercourse (BRASIL, 2012; VARGAS, 2008).

The objective of this manuscript is to determine the types of land use and occupation in the PPA of Córrego Mumbuca in the city of Monte Carmelo, in the state of Minas Gerais.

MATERIAL AND METHODS

PHYSICAL ASPECTS OF THE STUDY AREA

The municipality of Monte Carmelo is located in the mesoregion of Triângulo Mineiro and Alto Paranaíba, State of Minas Gerais. According to the Brazilian Institute of Geography and Statistics, the municipality has 45,772 inhabitants, distributed over a territorial area of 1,343,035 km^2, and a population density of 34.08 inhab./km^2 (IBGE, 2010). The main economic activity is the manufacture of tiles and bricks and the cultivation of coffee.

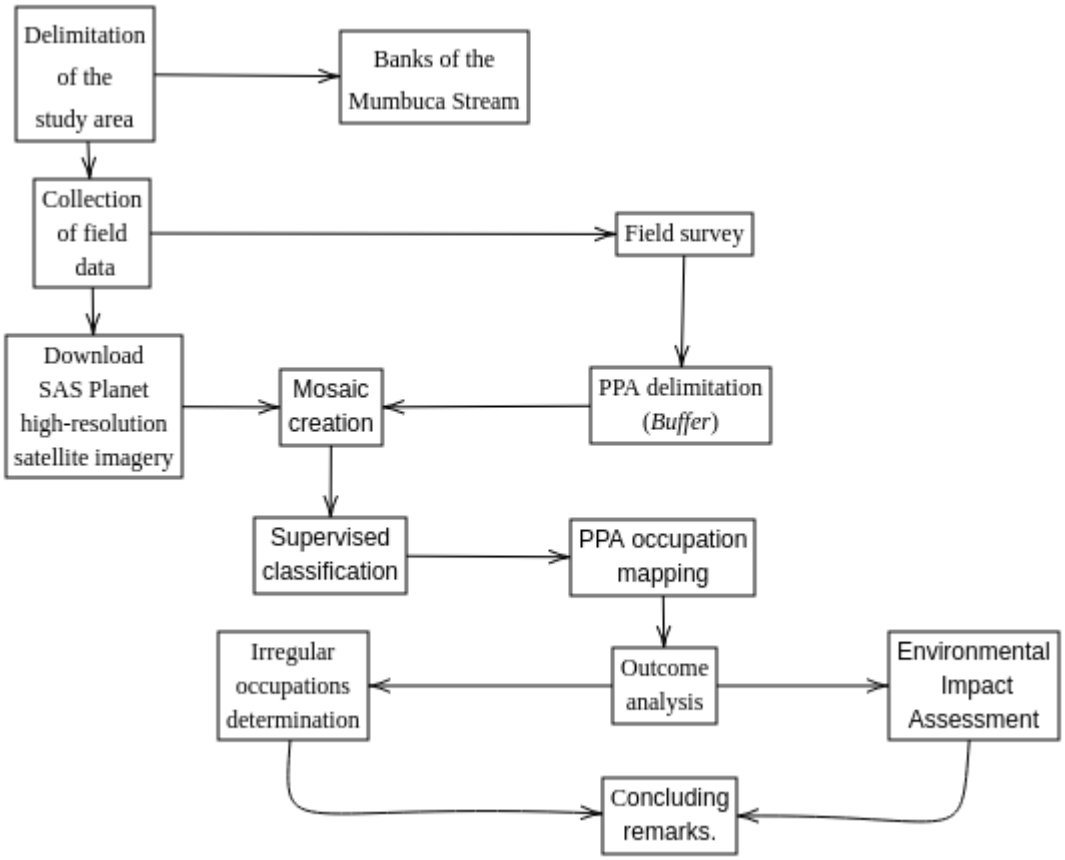
The urban area of Monte Carmelo is drained by the Mumbuca stream, which covers the Southeast, East, and Northeast sectors of the city, and by the Olaria stream, located in the Southwest and Northeast sectors. The object of study of this work will be the urban stretch of

the Mumbuca stream. The Mumbuca Stream is approximately 6,400 km long, and it is the waterbody with the most impact from the lack of urban planning and environmental conservation, as it receives sewage and garbage disposal.

WORK STEPS FLOWCHART

The work started with the delimitation of the study area, collection of field data, and generation of maps, as shown in Figure 1.

Figure 1 – Flowchart of the steps performed



Source: The authors (2024).

GEOREFERENCING OF STREAM MARGINS

Initially, fieldwork was carried out to visually recognize the area to be surveyed and collect the geographic coordinates of the banks of the Mumbuca Stream. This step was necessary to allow the definition of the width of the PPAs. Two Topcon Hiper V GNSS receivers and RTK (Real Time Kinematic) positioning method were used. The geographic coordinates used as the basis for the survey were processed using the static method, and the Brazilian Network for Continuous Monitoring of GNSS Systems (RBMC (MGMT - Monte Carmelo)) was adopted as the geodetic control point. The points (geographic coordinates) sought in the survey were linked by generating a line that comprises the margins of the Mumbuca Stream using Computer-Aided Design (CAD). Using the QGIS software, this file was converted to the shapefile format, which was used as a control point for the georeferencing of satellite images (QGIS DEVELOPMENT TEAM, 2021). Subsequently, a polygon-type file

of the perimeter of the banks was created with the CAD software, and the file was converted to a shapefile format using QGIS software.

MOSAIC CREATION OF THE URBAN PERIMETER

For mosaic creation of the urban perimeter of the city of Monte Carmelo, were downloaded several high-resolution images of the year 2020 with SAS Planet software (SAS.PLANET, 2020). PlanetScope satellite images were obtained, captured with a spatial resolution of 0.57m / pixel and RGB composition.

The mosaic was generated in the QGIS software uniting all high-resolution images obtained by SAS Planet and georeferenced using the shapefile file of Mumbuca stream as a spatial reference.

PERMANENT PRESERVATION AREA DELIMITATION

The buffer tool in the QGIS software was used to define the PPA of the Mumbuca stream, according to the range of permanent preservation required by the Brazilian Forest Code - Law 12,651 / 2012 (BRASIL, 2012).

As the Mumbuca stream has a width fewer than 10.00 m along its entire length, was made a buffer of 30.00 m in the polygon file of the perimeter of the Mumbuca stream margins to determine its PPA (according to the recommendation of the New Forest Code).

SUPERVISED CLASSIFICATION AND PPA OCCUPATION MAPPING

To PPAs irregular occupations mapping, a high-resolution satellite image obtained through the mosaicking process was used, superimposed on the 30.00 m buffer generated for the delimitation of the PPA. Then, the image was cropped, extracting only the area comprising the preservation strip.

The visual interpretation technique and the SCP plugin were used to perform supervised classification of the cropped image. The areas have been classified into Vegetation, Urban Use, or Water. The Vegetation class comprised all arboreal vegetation and grasses. The Urban Use class comprised the areas and buildings of urban use, such as buildings and paving. The Water class comprised the Mumbuca stream.

After processing these data, the layout of the PPA Delimitation Maps and the Land Use and Occupation Map were created, to assess the occupations in disagreement with the environmental legislation and to point out the main impacts resulting from these occupations.

RESULTS AND DISCUSSION

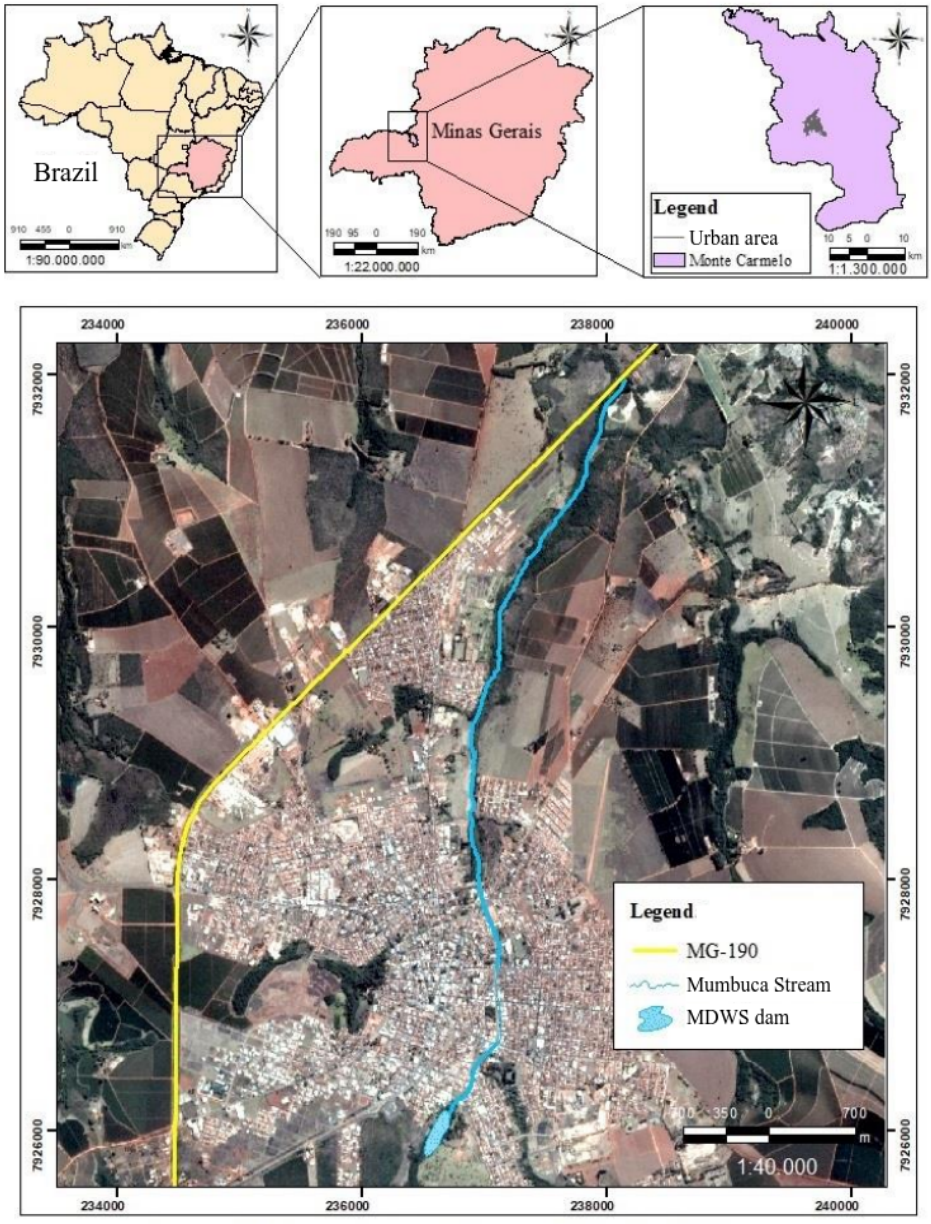
PPA DELIMITATION

The urban stretch of the Mumbuca stream starts at the water catchment dam of the Municipal Department of Water and Sewage (MDWS) and continues to the MG-190 highway (Figure 2). The PPA area is 0.434 km^2, corresponding to 1.54% of the total urban area of the municipality of Monte Carmelo (28.20 km^2).

The visual analysis of the PPA indicated that in some stretches of the Mumbuca stream the width of the preservation strip should be greater than 30 m to cover the humid area. The humid area is related to the water table depth, which varies in the dry and rainy seasons of the year, but which should not be occupied to avoid soil and water contamination. This area is part of the stream bed area and must be under permanent protection. It is periodically flooded by the

lateral overflow of rivers or lakes, by direct precipitation, or by the water table outcrop, and has biota with specific characteristics (COMITÊ BRASIL, 2012). However, conceptually and technically, there is no clarity in the legislation in terms of its delimitation (CUNHA; PIEDADE; JUNK, 2015). In general, these areas are found in the plains, where the watercourses have reduced surface runoff speed, lower infiltration speed and the soils are more clayey, forming brown-purple stains in visual identification. They can also be aquifer recharge areas, reaffirming the importance of being under protection (CUNHA; PIEDADE; JUNK, 2015). However, unfortunately, these areas are frequently used for agricultural and agricultural activities, as they usually present fertile soils (ARANA; JARDIM; ARANA, 2017).

Figure 2 – Location of the urban stretch of the Mumbuca stream in the municipality of Monte Carmelo/MG



Datum: SIRGAS 2000 - UTM
Produced by: ALVES, A. C. R. (2000)
Source: IBGE - Instituto Brasileiro de Geografia e Estatística (2015)
Planet (2019) - RGB composites (3,2,1)

Source: The authors (2024).

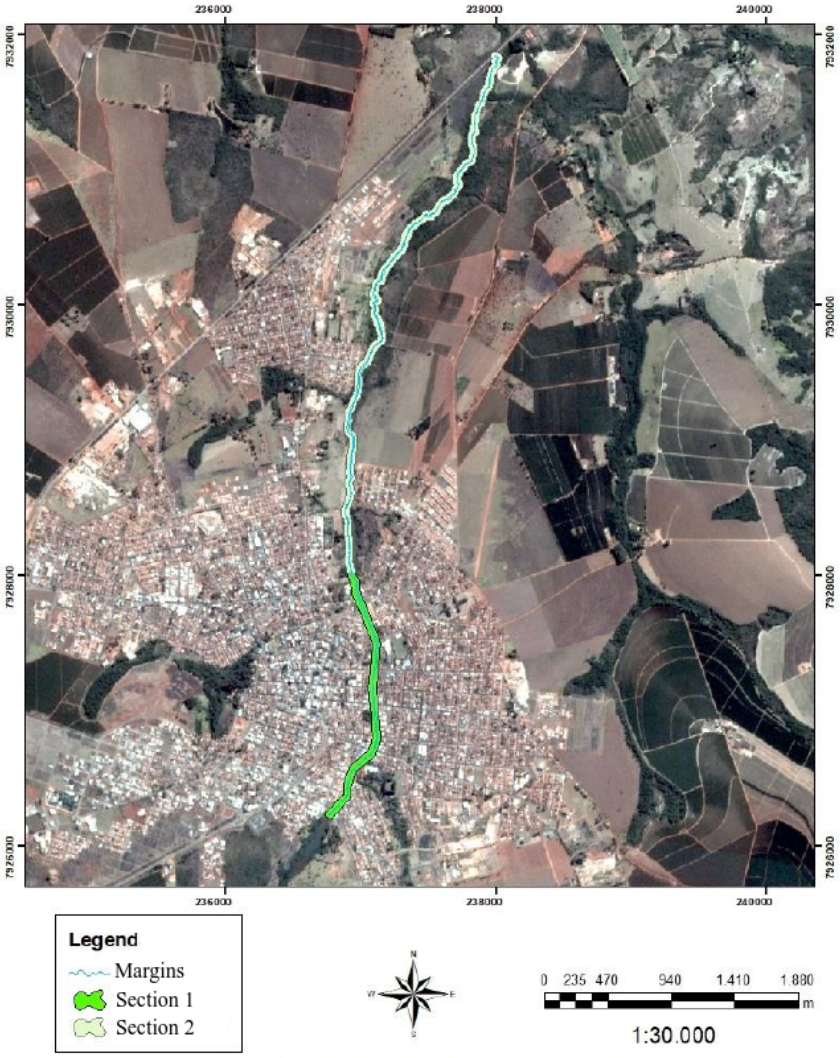
DETERMINATION OF PPA SECTIONS

After delimiting the PPA, there was a difference in land use and occupation along the watershed of the Mumbuca stream. Thus, for a better assessment of the PPA occupation and the resulting impacts, it was decided to divide the PPA into two sections (Figure 3).

The PPA Section 1 has a length of 2,028 km, an area of 0.138 km^2 and comprises the stretch of the Mumbuca Stream that includes the city center. It starts right below the Water Collection Reservoir of the Department of Water and Sewage, passing through the central region of the city of Monte Carmelo and ending close to the coordinate point (Latitude: 18º44'20.41"S; Longitude: 47º29'48.25"W), where the vegetation around the banks of the Mumbuca Stream becomes quite dense and difficult to access.

The PPA Section 2 has a length of 4.432 km, an area of 0.297 km^2, starts at the coordinates (Latitude: 18º43'21.83"S; Longitude: 47º29'41.16"W) and ends at the coordinates (Latitude: 18º41'17.06"S; 47º29'3.87"W) located across the MG-190 Highway.

Figure 3 – Delimitation of PPA sections



Datum: SIRGAS 2000 - UTM
Produced by: ALVES, A. C. R. (2000)
Source: IBGE - Instituto Brasileiro de Geografia e Estatística (2015)
Planet (2019) - RGB composites (3,2,1)

Source: The authors (2024).

Section 1 of the PPA is characterized by intense urbanization on both sides of the Mumbuca stream. Since its beginning, there is anthropic intervention in the area and no presence of native vegetation. There are also areas of exposed soil and just a few trees are seen in the landscape along the canal. The access roads across the stream come from engineering works (bridges or rainwater) and there are few humid areas (Figure 4).

A problem of great importance, caused by intensive land use, is the soil-sealing, which reduces stormwater infiltration, and may cause flooding, especially in periods of intense rainfall.

Another serious problem is the lack of adequate urban planning and sanitation, which may result in the disposal of solid waste or sewage without any treatment. This can cause siltation of the bed of water bodies, spread disease vectors, bad odors, as well as compromise water quality.

Figure 4 – Land use in section 1

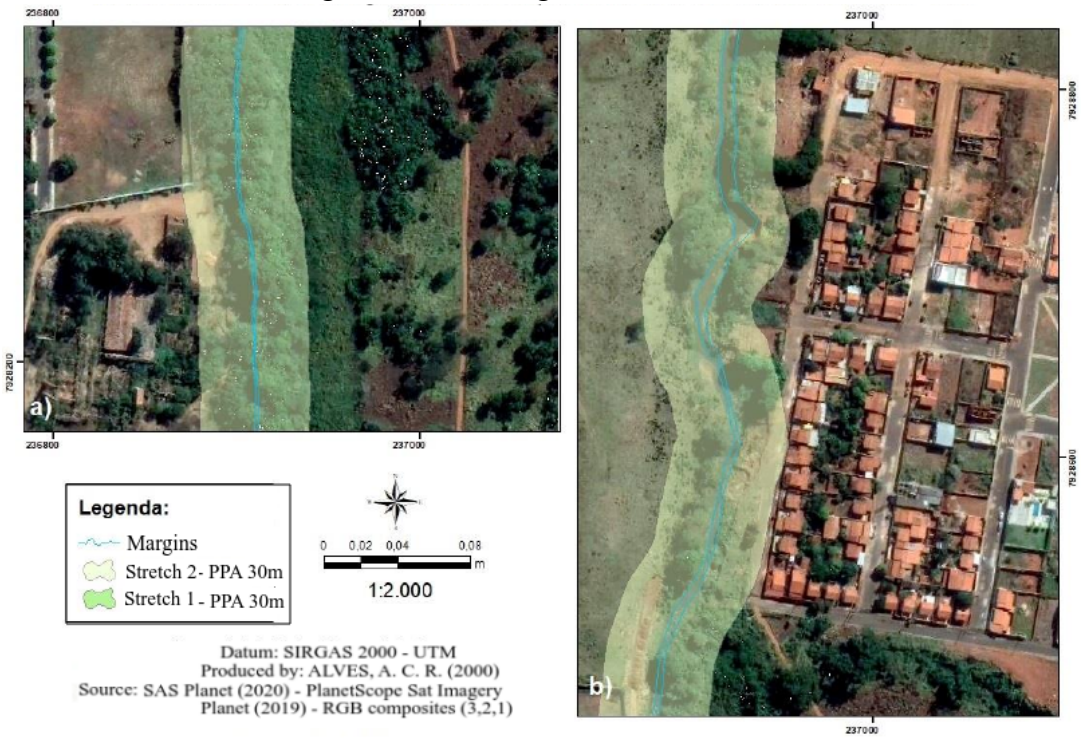
Source: The authors (2024).

The measures to recover the edges of the stream are related to the need to invest in public planning policies (Environmental Zoning, Environmental Impact Assessment (EIA), Modeling, Environmental Education), application and inspection of pertinent legislation, improving the quality of water and the environment.

In Section 2, the urban mesh is less dense and generally farther away from the edges of the stream. There is undergrowth or medium-sized vegetation in some points and the humid areas present fewer alterations (Figure 5). Although some blocks are bordering the PPA, this stretch is in a more favorable situation for preservation than Section 1. However, it is possible to observe the presence of pastures in the permanent preservation areas, where it is being non-compliance with environmental legislation. Although the vegetation present allows greater infiltration of water into the soil, greater preservation and afforestation of the PPA are necessary.

Permanent preservation areas are considered fragile and sensitive to environmental impacts and therefore merits special attention (ARANA; JARDIM; ARANA, 2017).

Figure 5 – Soil usage in the stretch 2



Source: The authors (2024).

CHARACTERIZATION OF THE PPA'S USE AND OCCUPATION OF THE SOIL

The supervised classification of the Permanent Preservation Areas was performed and defined the classes: vegetation, urban use, and water. The vegetation class comprises arboreal, creepy, and grassing vegetables. The urban use class comprises urban areas with buildings (home real estate, commercial real estate, sheds, squares, leisure areas constructed, etc.). Finally, the water class includes the region occupied by the stream bed.

The land use and occupation map make it possible to monitor the environmental impacts, especially in environmental preservation areas. The knowledge of the use of the soil allows preservation and maintenance measures of the PPA, in addition to ensuring better environmental management.

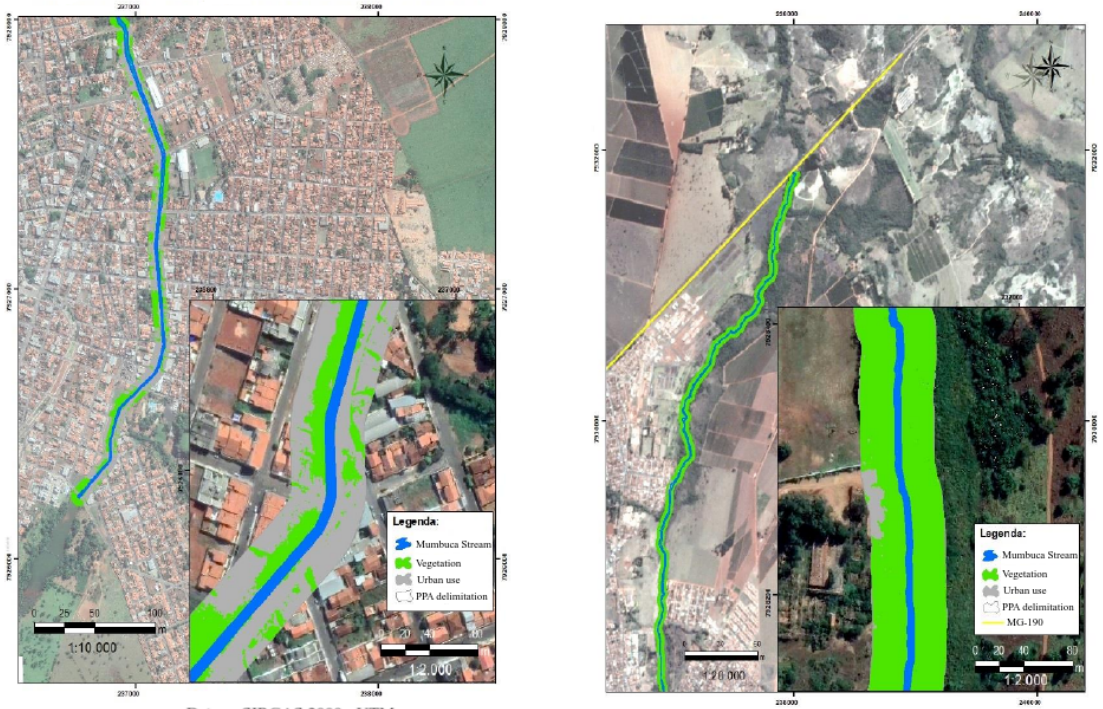
In stretch 1, the vegetation class presented a 0.026 km^2 area and corresponds to only 6.00% of the total PPA, while urban use corresponds to 21.02% (Table 1). About the total area of stretch 1 (0.136 km^2) urban use occupies 66.91% (0.091 km^2) indicating a high index of irregular occupations throughout this section.

In stretch 2, the vegetation class presented an area of 0.253 km^2, corresponding to 58.43% of the total PPA area, and urban use occupies only an area of 0.005 km^2, or 1.15% of the PPA.

The biggest percentage of stretch 2 occupation corresponds to the vegetation class. The area occupied with vegetation in this stretch is almost ten times larger than the area occupied by this class in stretch 1, although the total area of the second stretch (0.296 km^2) is just greater than double the first stretch (0.136 km^2). On the other hand, urban use represents 66.91% of the occupation of stretch 1 and only 1.69% of stretch 2. This indicates a percentage of very different

irregular occupations in the two stretches, which justifies the division and separate analysis in this work of these two areas along the Mumbuca stream.

Figure 6 – Permanent Preservation Areas classification



(a) Stretch 1. (b) Stretch 2.

Source: The authors (2024).

Table 1 – Classification of the use and occupation of the soil in the PPA

Class	Area (km²)			Percentage		
	Stretch 1	Stretch 2	Total	Stretch 1	Stretch 2	Total
Vegetation	0.026	0.253	0.279	6.00	58.43	64.43
Urban use	0.091	0.005	0.096	21.02	1.15	22.17
Water	0.019	0.038	0.058	4.39	8.78	13.39
Total	**0.136**	**0.296**	**0.433**	**31.41**	**68.36**	**100.00**

Source: Prepared by the author.

Unfortunately, the inadequate use of the permanent preservation areas is the reality of most Minas Gerais state municipalities (GUIMARÃES; CARVALHO, 2013; ROSA et al., 2019). In a similar study carried out in the city of Moeda-MG, inappropriate use of over 50% of the municipality's PPA was observed, especially in the areas closest to the Paraopeba river (GUIMARÃES; CARVALHO, 2013). Similarly, the micro-basin of the Jataí stream, located in Uberaba-MG, has only about one-third of the PPA preserved, being livestock activity the predominant occupation of the area (JUNIOR et al., 2011). The undue occupation of micro-basin PPAs causes a major injury to the fauna and flora of the region, aggravating the imbalance of the ecosystem and the watercourse contamination with waste from agriculture and livestock,

since vegetation functions as a natural biological filter for agricultural defenses, like a retainer of erosion particles (JUNIOR et al., 2011).

In general, these occupations assessments of the PPAs are fundamental guidelines for both the current situation of the study area, such as what should be done for continuity and maintenance of preserved areas. They also guide what medium and long-term measures municipal authorities should adopt to avoid irregular occupations.

The Mumbuca stream has the main guidance in the north-south direction, and the Monte Carmelo city developed following its longitudinal axis. As most Brazilian cities with a population of fewer than 50,000 inhabitants, the sewage collection system does not meet 100% of the population (BRASIL, 2019). Stretch 1, with a higher urbanization rate, contributes to a higher sewage discharge in the stream. In this stretch, there will probably have no longer longitudinal growth and some neighborhoods of the far west are consolidated. In this region, there should be transversal growth to the south of the urban area. On the east side of the city, the implementation of new road access interconnected some neighborhoods, providing the installation of new real estate enterprises.

As stretch 2 is more preserved, it is easy to deploy public preservation policies, avoiding irregular occupation of PPAs. In addition, the preservation of the humid areas, even if they exceed the 30-meter limit, would be a recommended practice, since they are areas seasonally occupied by the stream bed (CUNHA; PIEDADE; JUNK, 2015). The reforestation of the stretch would also bring more biological diversity and would avoid irregular waste disposal, as currently occurs. Registration for Rural Environment is another important tool for PPA management that allows integrating the environmental information from rural properties and possessions, composing database for control, monitoring, environmental and economic planning, and against deforestation (ROSA et al., 2019).

The implementation of linear or Greenway parks, which are urbanist interventions throughout watercourses to ensure the soil permeability of wetlands, protecting and recovering the ecosystem, harboring leisure practices, and controlling floods is also another option that will contribute to the conservation of the margins of the Mumbuca stream (MEDEIROS; ULIANA; ARAÚJO, 2020). The implementation of linear parks enables better environmental awareness and preservation of water resources, as well as promotes improvement in the quality of life of the population through practices of physical activity and contact with nature (BARTALINI, 2004).

CONCLUSIONS

The mapping allowed the evaluation of the occupations along the urban stretch of the Mumbuca stream that infringed the laws of PPAs use and occupation and pointed out the main environmental consequences of these forms of irregular occupation of the soil.

Stretch 1, has the highest rate of urbanization and presents 21.02% of the PPA committed to irregular occupations, which also lead to disposal of sewers and solid waste in the stream. In stretch 2, only 1.15% of the PPA area is compromised with irregular occupations and has better conditions for implementing public policies to prevent this area from being hampered by disordered urban growth.

The Municipal Director Plan of Monte Carmelo has projects to recover the environmental conditions and replant vegetation along the banks of the Mumbuca stream, in addition to an extension of the sewer and rainy network, to eliminate the irregular discharge of sewage. Another Director Plan goal is the creation of environmental awareness campaigns to reduce the launch of sewage and solid waste, including construction waste and debris.

REFERENCES

ARANA, Alba Regina Azevedo; JARDIM, Adriano Moreno; ARANA, Daniel. Áreas de preservação permanente na bacia do Ribeirão da Confusão no município de Rancharia-SP. **Rev. Bras. Geogr. Física**, v. 10, n. 01, p. 280–295, 2017. ISSN 1984-2295.

BARTALINI, Vladimir. Os córregos ocultos e a rede de espaços públicos urbanos. Pós. **Revista do Programa de Pós-Graduação em Arquitetura e Urbanismo da FAUUSP**, n. 16, p. 82–96, dez. 2004. DOI: 10.11606/issn.2317-2762.v0i16p82-96.

BRASIL. Lei n 12.651, de 25 de maio de 2012. **Código Florestal Brasileiro**. [S.l.: s.n.], 2012.

BRASIL. **Lei n. 4.771, de 15 de Setembro de 1965**. [S.l.: s.n.], 1965.

BRASIL. **Sistema Nacional de Informações sobre Saneamento:** 25 Diagnóstico dos Serviços de Água e Esgotos. Brasília, DF, 2019. p. 183.

CAMPAGNOLO, Karla et al. Área de preservação permanente de um rio e análise da legislação de proteção da vegetação nativa. **Cienc. Florest**., Universidade Federal de Santa Maria, v. 27, n. 3, p. 831–842, 2017. ISSN 19805098. DOI: 10.5902/1980509828633.

COELHO, Raul Candido; BUFFON, Iuri; GUERRA, Teresinha. Influência do uso e ocupação do solo na qualidade da água: um método para avaliar a importância da zona ripária. **Ambient. e Agua - An Interdiscip. J. Appl. Sci**., v. 6, n. 1, p. 104–117, abr. 2011. ISSN 1980993X. DOI: 10.4136/ambi-agua.177.

COMITÊ BRASIL. **Promoção: Comitê Brasil em Defesa das Florestas e do Desenvolvimento Sustentável** (coordenação: Conselho Nacional dos Bispos do Brasil-CNBB; WWF-Brasil; Greenpeace; Via Campesina Brasil; Ordem dos Advogados do Brasil-OAB; Instituto de Pesquisas Ambientais. Brasília, DF, 2012.

CUNHA, Catia Nunes da; PIEDADE, Maria Teresa Fernandes; JUNK, Wolfgang J. **Classificação e Delineamento das Áreas Úmidas Brasileiras e Seus Macrohabitats**. Cuiabá: EdUFMT, 2015. p. 165. ISBN 978-85-327-0557-0.

GUIMARÃES, Felipe Silva; CARVALHO, Grazielle Anjos. Determinação de áreas de preservação permanente no município de Moeda-MG, utilizando bases de diferentes escalas topográficas Determination of permanent preservation areas in the Moeda municipality-MG, using bases in different scales topographic. **Cad. Geogr**., v. 23, n. 39, p. 22–43, 2013. ISSN 0103-8427.

IBGE. **Monte Carmelo (MG)** | Cidades e Estados | IBGE. [S.l.: s.n.], 2010.

JUNIOR, Renato Farias do Valle et al. Diagnóstico das áreas de preservação permanente na microbacia hidrográfica do Córrego Jataí. **Rev. Caatinga**, v. 24, n. 3, p. 153–157, 2011.

MEDEIROS, José Marcelo Martins; ROMERO, Marta Adriana Bustos et al. Conflitos e Possibilidades em Áreas de Preservação Permanente Urbanas na Amazônia - Estudo na Lagoa dos Índios. Paranoá **Cad. arquitetura e Urban**., n. 20, p. 1–12, 2018. ISSN 1677-7395. DOI: 10.18830/issn.1679-0944.n20.2018.07.

MEDEIROS, José Marcelo Martins; ULIANA, Brenda Beserra; ARAÚJO, Dayanne dos Santos. Áreas de Preservação Permanente Urbanas e Parques Lineares na Região Norte: conflitos na Lagoa dos Índios, Macapá Amapá. Risco **Revista de Pesquisa em Arquitetura e Urbanismo (Online)**, v. 18, p. 1–19, ago. 2020. DOI: 10.11606/issn.1984-4506.v18i0p1-19.

QGIS DEVELOPMENT TEAM. **QGIS Geographic Information System**. [S.l.], 2021.
ROSA, Cristiano Niederauer da et al. Relação entre aquíferos susceptíveis à contaminação e Áreas de Preservação Permanente Hídrica em Ijuí, RS. Pesqui. em **Geociências**, v. 46, n. 3, e0781, nov. 2019. ISSN 1807-9806. DOI: 10.22456/1807-9806.97674.

SAS.PLANET. **SAS.Planet**. [S.l.]: SAS.Planet Development Team. General Public License, 2020.

SOUZA, João Maurício Fernandes et al. Evaluation of conflict of land use in the Lamarão river watershed, federal district. **Cienc. Florest**., Universidade Federal de Santa Maria, v. 29, n. 2, p. 940–954, jun. 2019. ISSN 19805098. DOI: 10.5902/198050984784.

VARGAS, Hilda Ledoux. Ocupação Irregular De App Urbana: Um Estudo Da Percepção Social Acerca Do Conflito De Interesses Que Se Estabelece Na Lagoa Do Prato Raso , Em Feira De Santana , Bahia. **Sitientibus**, v. 39, p. 7–36, 2008.