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# ANÁLISE DOS ATRIBUTOS ECOLÓGICOS E CONFLITOS DE USO DO SOLO NA BACIA HIDROGRÁFICA DO RIO TAPACURÁ – PE

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## 1 RESUMO

A expansão desordenada da agropecuária, sem avaliação prévia das características do solo representa risco ambiental significativo, pois eleva a erosão e a poluição dos ecossistemas adjacentes, por meio de assoreamento e contaminação com agroquímicos. O Sistema de Informação Geográfica (SIG) é uma ferramenta essencial para monitorar e prever pressões ambientais, especialmente em bacias hidrográficas como a do rio Tapacurá, que abastece a Região Metropolitana do Recife. Este estudo analisou o uso do solo nessa bacia, com foco em conflitos de uso e áreas de preservação permanente (APPs), gerando mapas temáticos e de uso potencial através do QGIS. Identificou-se que o conflito da classe I é marcado por severas limitações para culturas e pastagens, cobre a maior parte da bacia (268,99 km²), enquanto a classe 2, mais adequada para pastagem nativa ou reflorestamento, ocupa 0,08 km². Os resultados destacam a urgência de diretrizes que orientem: o manejo sustentável do solo, mitigando impactos ambientais e melhorando a qualidade de vida. A pesquisa recomenda um planejamento das atividades agropecuárias alinhado às características ambientais, priorizando áreas para conservação e uso adequado da terra.

**Palavras-chave:** degradação ambiental, geoprocessamento, unidade hidrográfica, conservação do solo.

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**ANALYSIS OF ECOLOGIAL ATTRIBUTES AND LAD USE CONFLICTS IN THE TAPACURÁ RIVER BASIN – PE**

## 2 ABSTRACT

The disorderly expansion of agriculture and livestock farming, without prior assessments of soil characteristics, represents a significant environmental risk because it increases the erosion and pollution of adjacent ecosystems through silting and contamination with agrochemicals. A geographic information system (GIS) is an essential tool for monitoring and predicting environmental pressures, especially in river basins such as the Tapacurá River, which supplies the Metropolitan Region of Reef. In this study, land use in this basin was analyzed, with a focus on land use conflicts and permanent preservation areas (PPAs), and thematic and potential use maps were generated through QGIS. The conflict identified in class I is marked by severe limitations for crops and pastures, covering most of the basin (268.99 km²), whereas class 2, which is more suitable for native pasture or reforestation, occupies 0.08 km². The results highlight the urgency of guidelines that guide sustainable soil management, mitigating environmental impacts and improving quality of life. This research recommends planning agricultural activities in line with environmental characteristics and prioritizing areas for conservation and appropriate land use.

**Keywords:** environmental degradation, geoprocessing, hydrographic unit, soil conservation.

## 3 INTRODUCTION

The uncontrolled expansion of agricultural activities, without proper prior analysis of land use conditions and restrictions, can generate significant environmental impacts. When developed inadequately, this practice intensifies the risk of erosion by occupying susceptible areas because of topography, in addition to favoring pollution that compromises nearby ecosystems, either through the silting up of waterways or contamination caused by chemical inputs (Alves *et al.*, 2019; Vieira *et al.,* 2020).

In addition, the significant increase in population and the consequent use of water and soil make it necessary to develop actions aimed at the rational use of natural resources. The effects of climate change and human interference on river basins need to be clarified by investigating metrics that indicate the actual occurrence of the event and the formulation and application of laws that are based on these established metrics (Pissarra *et al.,* 2019).

Thus, efficient management requires the development of a strategic plan based on detailed information about the area of operation to ensure that development actions are conducted more effectively (Sandim; Machado, 2020).

In the process of space occupation and changes in land use, the interests of political, administrative, economic, social, and environmental management come into play (Silva *et al.,* 2021). Environmental management emerges as an urgent need in the face of environmental problems affecting the planet (Dantas; Passador, 2020), and because it is a notable spatial problem, the use of geoprocessing as an auxiliary tool for managers is crucial for the acquisition, manipulation, storage, combination, analysis, and retrieval of information that is highly important for decision-making.

In this context, geographic information systems (GISs) are powerful tools that allow for a spatial view associated with more effective management (Aragão, 2020). Adaptation scenarios and measures with the potential to predict and warn of extreme anthropogenic pressures on water quality, soil, and land use are better determined by GIS, as they vary according to the temporal and spatial uncertainties of river basins.

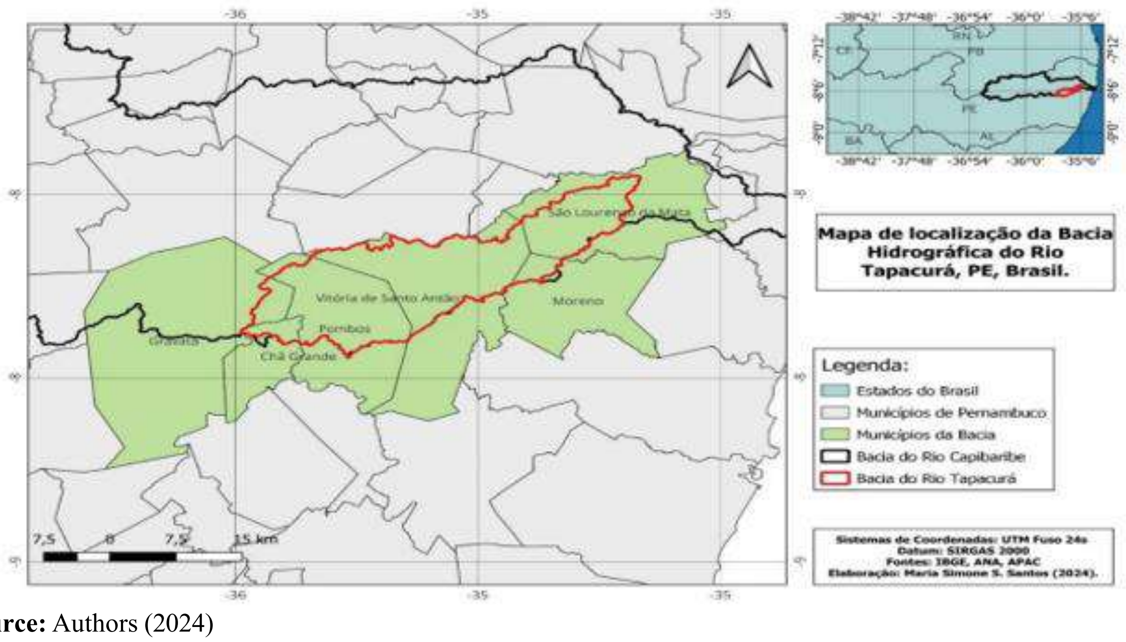
The main objective is to evaluate the attributes of river basin ecosystems to understand their usage patterns and how these attributes influence the quality and quantity of water production for urban supply and the multiple uses of water and soil resources. Furthermore, monitoring and evaluating environmental indicators are essential, given their great relevance to the state of Pernambuco, since this research can significantly contribute to environmental preservation.

## 4 MATERIALS AND METHODS

### 4.1 Area study

The study was conducted in the Tapacurá River Basin, a subbasin of the Capibaribe River, which is located in the state of Pernambuco. This basin is located between the coordinates 35° 30' 00” and 35° 5' 00” west longitude and 8° 13' 00” and 7° 58' 30” south latitude, according to the SIRGAS 2000 reference system (Duarte *et al.,* 2008).

**Figure 1.** Map from the bowl of the Tapacurá River, subbasin of the Capibaribe River




**Source:** Authors (2024)

The study of future trends in the temporal dynamics of land use is fundamental for effective environmental planning, especially in regions affected by constant changes in land use and occupation, such as the expansion of agriculture (Pacheco*,* 2019). The Tapacurá River Basin, in the state of Pernambuco, is a clear example of this scenario. However, it is necessary to establish a transition that directly relates the study area to environmental impacts, explaining how changes in land use affect the basin and justifying the research. The Tapacurá River Basin plays a crucial role in supplying water for human and industrial consumption to a large part of the Recife Metropolitan Region (RMR), which reinforces the importance of understanding the environmental impacts of agricultural activities and promoting guidelines for sustainable soil management.

## 4.2 Processing of data

To create the basis for mapping and data collection, image scenes from the ALOS PALSAR mission, with a spatial resolution of 12.5 m, and a mosaic of *Sentinel-2 images from the Copernicus Earth observation mission were used. This program systematically acquires high spatial resolution optical images of land and coastal waters. The images are freely available on the Alaska Satellite Facility (ASF) and Copernicus Open Access Hub* websites.

Data collection at the National Water and Basic Sanitation Agency (ANA) encompasses the delimitation and drainage of hydrographic basins. On the basis of this information, all the data were processed for the study area in question. Territorial boundaries were obtained from the IBGE website, allowing for the identification of the municipalities that are part of the basin.

The digital modeling was carried out using QGIS software, an open-source environment available for use in the Geotechnologies Laboratory of the Department of Rural Technology at the Federal Rural University of Pernambuco (UFRPE). A routine was executed in QGIS to create a database for storing and organizing information and products (thematic maps), which were subdivided into categories such as topographic and morphometric, land use and conflict, environmental risks, and zoning (Costa *et al.,* 2020).

## 4.3 Characterization Morphometric

Morphometric characterization was performed using GIS to analyze the layers of the Tapacurá River Basin, which were related to drainage areas and the hydrographic network. This analysis was based on mathematical models that relate the geometric characteristics of the basin, the drainage network, and the relief. The parameters were obtained automatically using the *r.watershed tool* of the free software QGIS.

***Geometric characteristics:***

**Basin area (A):** Corresponds to the total extent of the watershed surface. This is a fundamental parameter for calculating several other morphometric metrics. In the present study, the basin area, expressed in km², was automatically determined by creating a field in the layer's attribute table using the *"area function" in the "field calculator* (Schumm, 1956).

**Basin perimeter (P):** This represents the length, in kilometers, of the topographic boundary that delimits the basin. As with the area, the perimeter value was obtained automatically using the *$perimeter function in the "field calculator"* (Schumm, 1956).

### *4.3.2 Hydrographic characteristics:*

**Drainage network (Rd):** This comprises the set formed by the main watercourse and its tributaries, which constitute the drainage system of the hydrographic basin. For this study, the network was delineated using the *r.stream.extract algorithm.*

**Drainage density (Dd):** Dd is the ratio between the total length of the drainage network and the basin area, expressed in km/km² (Horton, 1932). The calculation followed Equation 1:

where:

$$Dd = \frac{Lt}{A} \quad (1)$$

- Dd = Density of drainage (km/km²);

- Ltd. = Total length of canals or rivers (km);
- A = total basin area (km²).

**Concentration time (Tc):** This represents the time needed, usually measured in hours, for water from the farthest point in the basin to reach the outlet (Kirpich, 1940). It was estimated according to Equation 2:

$$Tc = 85{,}2\ X\ \left(\frac{L_3}{H'}\right)^{0{,}358} \quad (2)$$

**Basin order:** This refers to the hierarchical level of watercourses within the basin. The classification was performed using the *channel network and drainage basin tool*, following Strahler's ordination methodology.

**Length of watercourses:** Determined in QGIS using the *length($geometry) function in the field calculator*, which allows the length of linear features to be measured.

### *4.3.3 Relevant characteristics:*

**Basin shape:** The shape factor (Kf) was used, as shown in Equation 3, which is the ratio between the area and the square of the axial length of the basin (Horton, 1945).

$$Kf = \frac{A}{(La)^2} \quad (3)$$

where:

- Kf = Factor in a way;
- THE = Area from the bowl hydrographic (km²);
- There = Length axial from the bowl (km).

**Channel slope (Ieq):** This parameter expresses the relationship between the difference in altitude and the length of the main channel (Villela; Matos, 1975). Two approaches were adopted for its calculation:

**Slope at the extremes (S1):** calculated by the ratio between the total altimetric variation and the length of the main channel, according to Equation 4.

**Slope between 10% and 85% of the course (S10-85):** obtained by considering the altitudes corresponding to 10% and 85% of the river length, measured from the outlet, according to Equation 5.

In both methods, the results are expressed in meters per kilometer (m/km).

$$S1 = \frac{\Delta H}{L} \quad (4)$$

$$S10 - 85 = \frac{H85\% - H10}{0{,}75\ x\ L} \quad (5)$$

- S1 = slope hydraulics general;
- S10−85 = slope between the 10th and 85th percentiles from the curve hypsometric;
- ΔH = Difference in elevation far from the bowl (m);
- L = Length total from the bowl hydrographic (km);

Note: H85% and H10% = elevation levels corresponding to the 85th and 10th percentiles of the watershed, respectively.

### *4.3.4 Permanent preservation areas*

In this stage, information regarding watercourses and the location of springs was used. Permanent preservation areas (APPs) were defined according to article 4 of Federal Law No. 12.651/2012. For delimitation, the methodology described by (Peluzio; Santos; Fiedler, 2010) was applied, using the *"buffer" command* available in the geoprocessing module of the QGIS software. A radius of 50 meters around each spring was considered, and for watercourses with widths of less than 10 meters—typical of the initial sections of the drainage network—a preservation strip of 30 meters was adopted on each bank.

Maps of environmental factors, including slope classes, drainage networks, and watershed boundaries, were generated from the SRTM digital elevation model (DEM) using QGIS software. The creation of the potential land use map was based on the ruggedness number (RN), as proposed by Rocha and Kurtz (2001). A higher RN value indicates a greater risk of soil erosion. This parameter is fundamental for guiding the potential use of land, helping to determine its suitability for activities such as agriculture, livestock farming, reforestation, or permanent preservation, as detailed in Table 1.

**Table 1.** Classification of fitness of use of soil second the RN*

| Classification second the RN | Indicative of use potential of soil | Weight |
|---|---|---|
| Fitness THE | Agriculture | 1 |
| Fitness B | Livestock farming | 2 |
| Fitness W | Livestock/Forestry | 3 |

*Ruggdeness Number* (Roughness coefficient)
**Source:** Authors (2024)

The roughness coefficient was determined using the equation RN = D × H, where RN represents the roughness coefficient, D is the density of the drainage network (km/km²) and H corresponds to the average slope (%) of the area under study.

For the morphometric analysis, the watershed was divided into 55 hydrological compartments. In each compartment, variables such as area (km²), total drainage network length (km), drainage density (km/km²) and average slope (%) were calculated using the r.watershed tool in QGIS.

The current land use and land cover map was generated from the MapBiomas database using the supervised classification method. For this study, each class was identified according to land cover, considering three land use categories, as shown in Table 2.

**Table 2.** Classes of use current of soil and weights

| Classes | Indicative of use potential of soil | Weight |
|---|---|---|
| Classes THE | Agriculture | 1 |
| Classes B | Pasture | 2 |
| Classes W | Forest | 3 |

**Source:** Authors (2024)

Conflict area maps were generated using the cross-classification method, which consists of overlaying two information layers (map algebra). This process involved overlaying the potential land use maps with the current land use and occupation map, allowing the creation of the land use conflict map. The operation was performed in QGIS, with the aid of the Raster Calculator tool, which facilitated the delimitation and classification of land use conflict areas, according to the methodology proposed by Valle Junior *et al.* (2019).

For example, if the RN weight (Table 1) indicates use for forests and the respective area is currently used for agriculture (Table 2), after cross-classification (3–1 = 2), the existence of a category 2 conflict can be defined (Table 3). When the cross-classification result is negative or zero, it indicates an area of agricultural expansion or an area without land use conflict.

**Table 3.** Description of categories of conflict of use of soil (Degradation Environmental)

| Weight from the fitness – Weight of current use | Categories of conflict | Description |
|---|---|---|
| Examples: | Lands with risks or limitations permanent | |
| 4 – 3 = 1<br>3 – 2 = 1<br>2 – 1 = 1 | Category 1 | Harsh soils when used for annual crops and In the case of pastures, their use should be guided by the implementation of joint conservation techniques. of soil (vegetative, mechanical character). |
| Examples:<br>4 – 2 = 2<br>3 – 1 = 2 | Category 2 | Land unsuitable for intensive farming, but still suitable for grazing. native, reforestation or environmental preservation. |
| Examples:<br>4 – 1 = 3 | Category 3 | Lands unsuitable for intensive farming and grazing, but still adapted. for reforestation or preservation environmental. |

**Source:** Adapted from Valley Junior *et al.* (2019)

## 5 RESULTS AND DISCUSSION

The Tapacurá River Basin, with an area of 467.574 km² and a perimeter of 216.77 km, is classified as a large basin. These values, when considered together, determine the shape of the basin, that is, whether it is more elongated or circular.

On the basis of the determination of the basin shape (Kf), the value of 0.18 demonstrates that the study region has an elongated and irregular shape because of structural influences such as the presence of faults and fractures, indicating a low risk of flash floods and inundations.

**Table 4. Characteristics** of the Tapacurá River Basin.

| Features | Results |
|---|---|
| Basin area (A) | 467,574 $^{km^2}$ |
| Basin perimeter (P) | 216.77 km |
| Length of waterways | 127.85 |
| Form factor (Kf) | 0.18 |
| Drainage density (Dd) | 0.27 km.km $^{-2}$ |
| Order of watercourses | 3rd |
| Channel slope ($S_1$) | 5.36 m/km |
| Channel slope ($S_{10-85}$) | 2.37 m/km |
| Time of concentration (Tc) | 9:15 PM |

**Source:** Authors (2024)

Although the shape of the studied basin does not naturally favor the occurrence of floods, it is important to highlight that part of its middle section is located in an urbanized area of the municipality of Vitória de Santo Antão. In this region, the significant presence of irregular settlements has resulted in the suppression of riparian vegetation and the direct disposal of solid waste, as well as untreated domestic and industrial effluents, into the Tapacurá River (Lorena *et al.,* 2018). These interventions cause relevant alterations in the hydrological cycle, increasing the basin's susceptibility to flooding, especially during intense rainfall events.

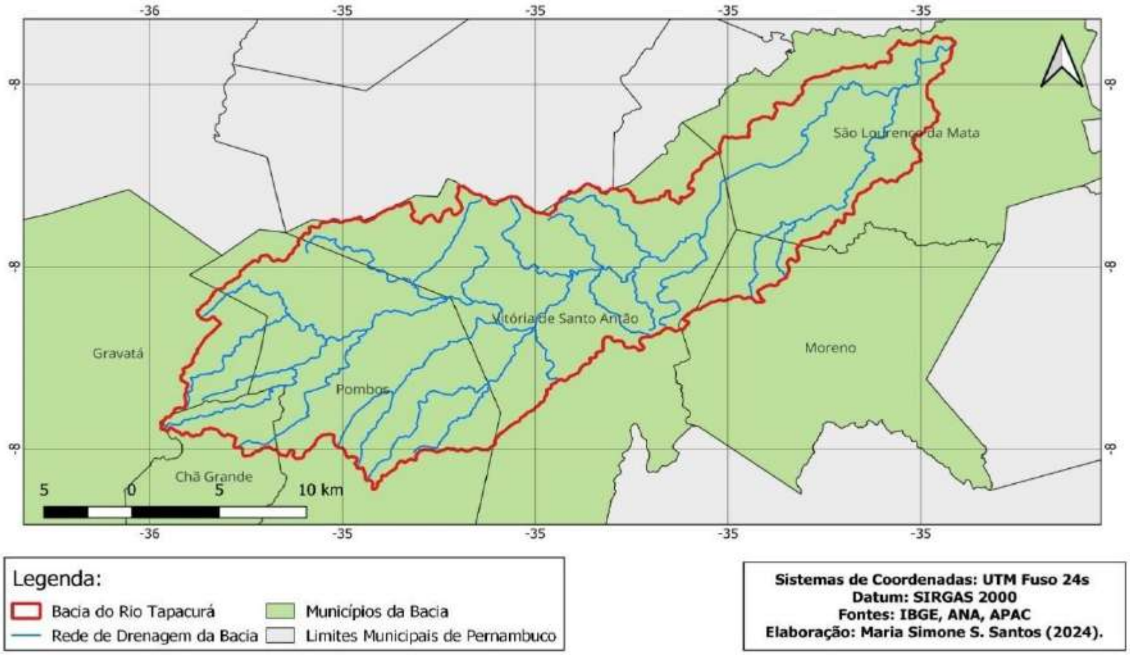
In addition to significantly irregular urban occupation, the middle course of the basin has a high propensity for flooding because of the interaction of several natural factors, including geological characteristics, soil type, and high local rainfall (Miranda *et al.,* 2017). The morphostructural analysis of this portion reveals the presence of rock formations and soils with low infiltration capacity, which intensifies surface runoff and favors water accumulation, especially during periods of extreme precipitation.

Drainage density (Dd) is a parameter used to assess whether the hydrographic network of a basin has low or high efficiency (Souza *et al.,* 2021). In the case of the Tapacurá River Basin, the value of 0.88 km/km² indicates intermediate conditions, indicating a regular drainage pattern. According to Smichowski and Contreras (2023), higher Dd values tend to be associated with faster basin responses to intense precipitation events because of the higher speed of surface runoff. On the other hand, lower values generally indicate soils with greater resistance to erosion or high permeability, as well as smoothed relief, which slows down water movement (Costa *et al.,* 2020).

The hydrographic network of the Tapacurá Basin falls into the third order, according to the hierarchical classification method of watercourses, evidencing a structure with good branching and a significant presence of first-order tributaries (Strahler, 1957). This configuration contributes to the maintenance of aquatic habitats and reflects a level of organization that favors the structural definition of drainage.

To visualize the entire study area, the map shown in Figure 2 was created.

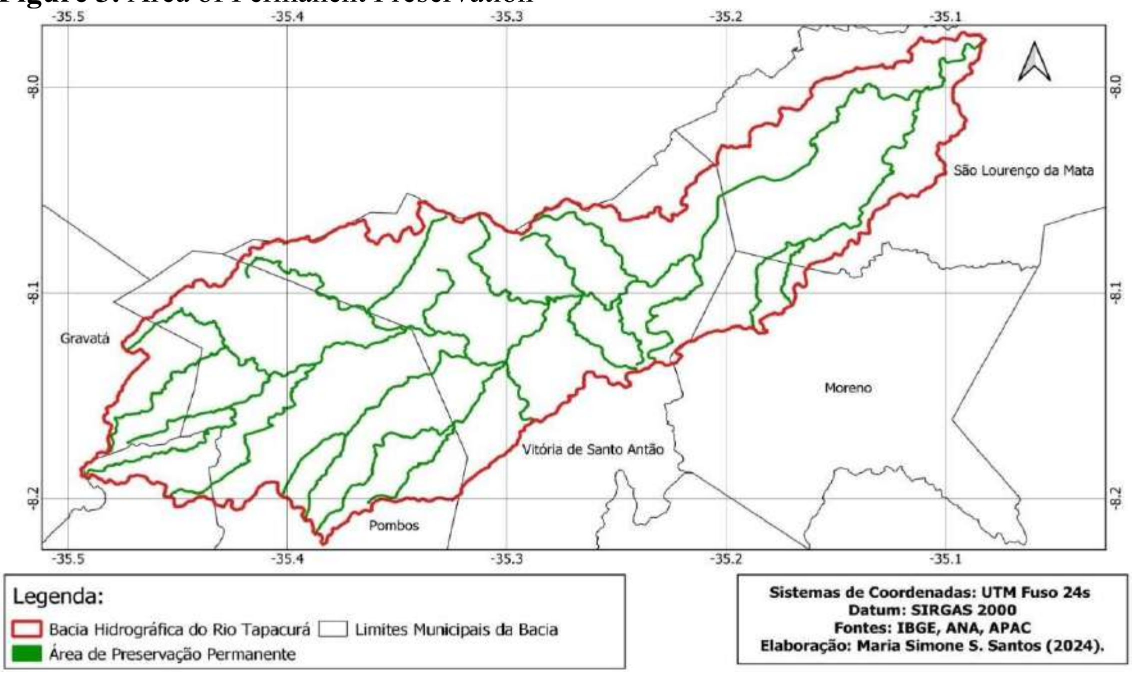
**Figure 2.** Map from the network drainage




**Source:** Authors (2024)

On the basis of morphometric data and the digital elevation model (DEM), permanent preservation areas (APPs) were generated using the QGIS buffer module, facilitating the understanding of the interactions between local biodiversity, ecosystems, and human activities, as shown in Figure 3.

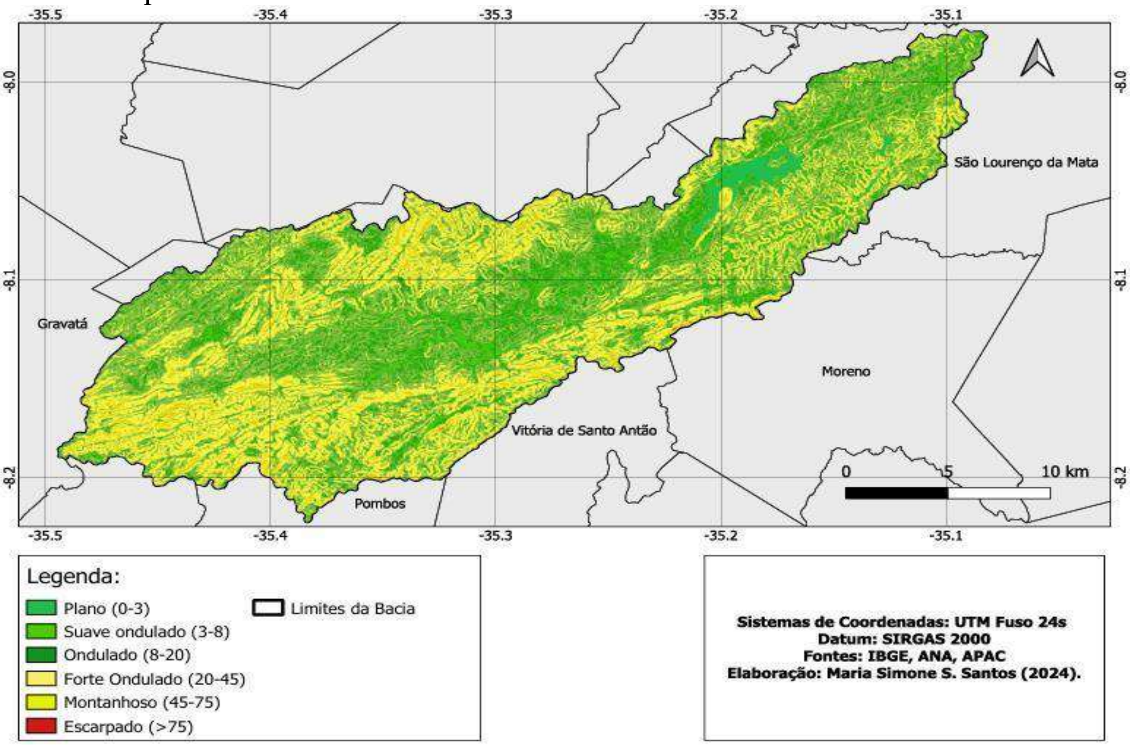
**Figure 3.** Area of Permanent Preservation




**Source:** Authors (2024)

The map with slope classes is divided into six categories: flat (0–3%), gently undulating (3–8%), undulating (8–20%), strongly undulating (20–45%), mountainous (45–75%), and steep/mountainous (>75%) (Figure 4). A morphometric analysis of the basin revealed that the predominant slope class is Undulating, covering more than 40% of the total area. In contrast, the least significant slope class is steep/mountainous, which represents less than 1% of the Tapacurá River Basin area.

**Figure 4.** Classes of slope recommended for the EMBRAPA SOILS from the Bowl of the Tapacurá River

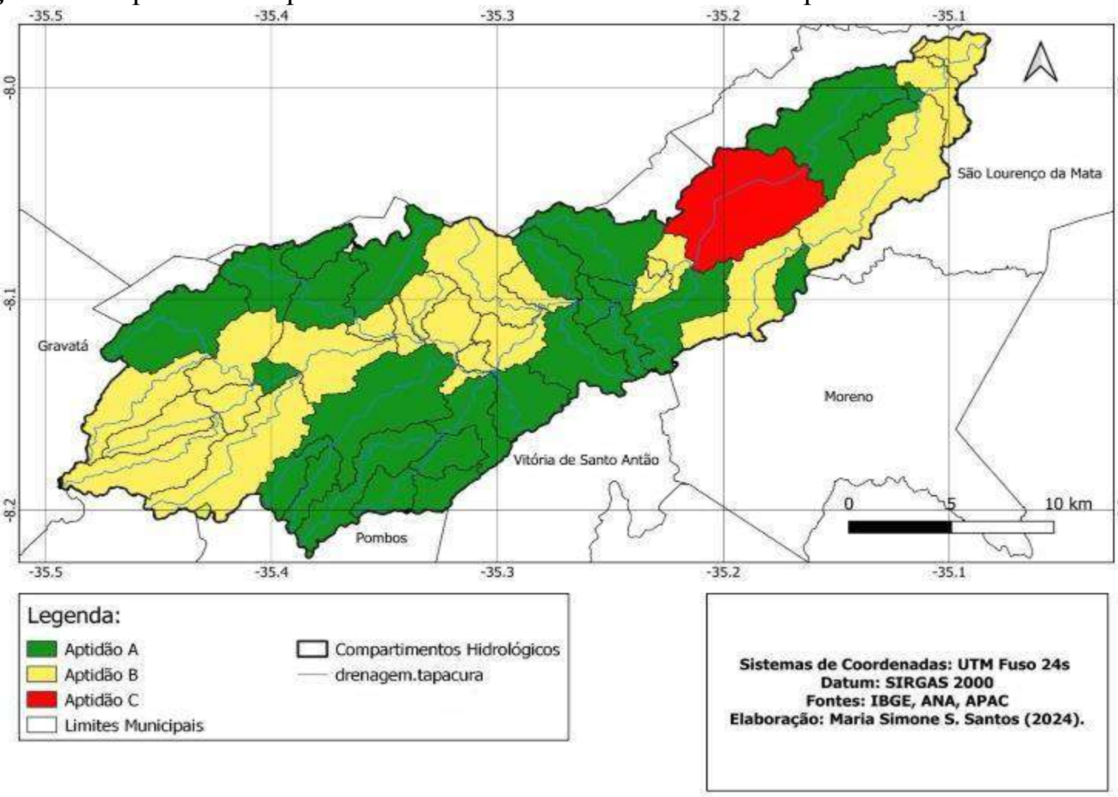



**Source:** Authors (2024)

The generated maps allowed for a comprehensive analysis of the morphometric characteristics of the Tapacurá River Basin and served as the basis for developing a potential land use map of the region. Together with the current land use map, these data were analyzed to identify the spatial distribution of land use conflict areas.

The surfaces were defined by the roughness coefficient, which is indicative of agricultural, livestock, and forestry uses. Since the roughness coefficient is an environmental parameter that guides the potential use of land and implies the soil's susceptibility to erosion, as shown in Figure 5, the areas most susceptible to erosion are observed in type C aptitudes.

**Figure 5.** Map of the use potential of soil from the Bowl of the Tapacurá River




**Source:** Authors (2024)

Land use capability is an essential concept in the sustainable planning and management of agricultural land. Inadequate land use can lead to degradation and decreased crop productivity, especially in areas subject to erosion. Determining land use capability is fundamental for sustainable management, allowing for the prediction of soil adaptability for various crops and pastures and ensuring the maintenance of productivity without compromising the soil. This diagnosis involves the analysis of the physical conditions of the soil, such as erosion, soil type, water, and climate, allowing for the identification of areas most susceptible to degradation and those that are underutilized.

Land use capability and the Roughness Coefficient (RN) coincide in 99.9% of the cases, leading to the proposal to replace land use capability with RN, as it is a more agile method that eliminates the need for field sample collection, which has been particularly beneficial from an economic standpoint.

The lands classified as suitable for agriculture, livestock farming, and livestock/forestry cover 234.29 km², 200.30 km², and 31.01 km², respectively, corresponding to 50.3%, 43.0%, and 6.7% of the total basin area (Table 5).

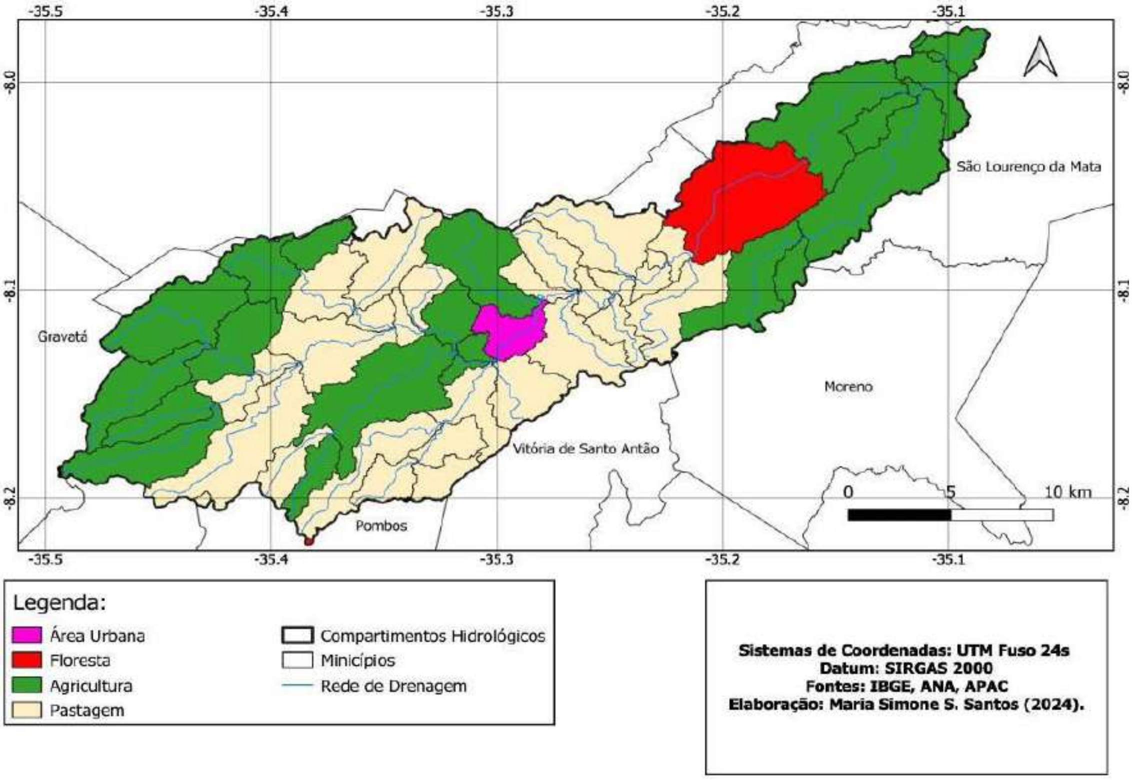
**Table 5.** Areas of the indicators of use potential from the ground from the Bowl of the Tapacurá River

| Indicative of use potential of soil | Areas (km $^2$) | %* |
|---|---|---|
| Fitness THE – Agriculture | 234.29 | 50.3 |
| Fitness B – Livestock farming | 200.30 | 43.0 |
| Fitness W – Livestock/Forestry | 31.01 | 6.7 |
| Total | 465.6 | 100 |

**Source:** Authors (2024)

For the land use analysis, vegetation cover, anthropogenic activities, and the natural environment of the region were considered. In these native areas, the importance of preserving natural heritage, as stipulated by Brazilian environmental legislation, was highlighted. The map in Figure 6 illustrates the spatial distribution of land use and occupation in the Tapacurá River Basin, encompassing the classes of pasture, agriculture, forestland, and urban areas.

**Figure 6.** Map of use current of soil from the Bowl of the Tapacurá River




**Source:** Authors (2024)

The current land use types identified in the Tapacurá River Basin included an area of 224.12 km2 of agriculture, 31.09 km2 of forestland, 203.31 km2 of pasture area and 7.07 km2 of urban area, which is equivalent to 48.14%, 6.68%, 43.67% and 1.52% of the area of the Tapacurá River Basin, respectively (Table 6).

**Table 6.** Areas of the use current of soil from the Bowl of the Tapacurá River

| Use Current | Areas (km2) | %* |
|---|---|---|
| Agriculture | 224.12 | 48.14 |
| Forest | 31.09 | 6.68 |
| Pasture | 203.31 | 43.67 |
| Area urban | 7.07 | 1.52 |
| Total | 465.6 | 100 |

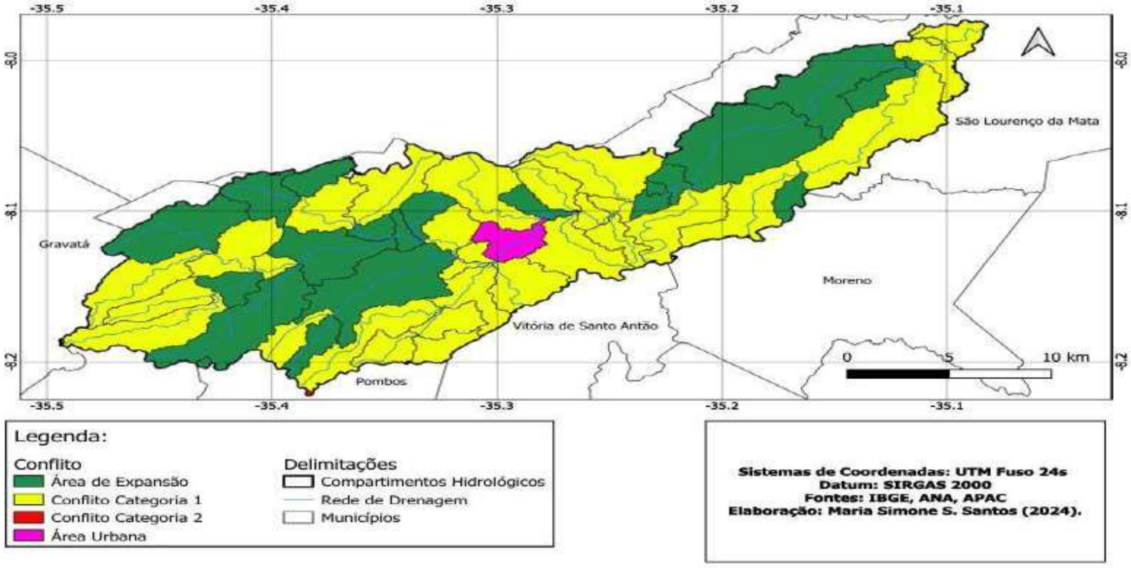
*Percentage in relationship to the area total from the bowl
**Source:** Authors (2024)

The main land use in the Tapacurá River Basin is agriculture, with sugarcane cultivation being the most prominent, occupying the largest area. Sugarcane is the primary raw material for the production of sugar and ethanol and is fundamental to the regional economy. Cultivation is carried out extensively, with large continuous areas and intensive soil management due to the use of machinery and tractors. Therefore, it is crucial that this management be carried out in a conservationist manner.

Pastured areas also constitute a significant portion of the basin and are characterized by long periods of land occupation by animals. Although producers are concerned with improving the use of forage, proper management is not a common practice. A lack of such management often results in soil degradation. A pasture is considered degraded when extensive areas are invaded by invasive plants or when the soil is exposed. This degradation has led to the emergence of erosional gullies, whose development is closely related to the natural characteristics of the environment.

The spatial distribution of land use conflict areas in the Tapacurá River Basin is shown in Figure 7. Although land use conflict can occur without necessarily causing anthropogenic erosion, it is crucial to implement appropriate management practices in the region's agricultural activities to avoid such degradation.

**Figure 7.** Conflict map of use of soil in the Bowl of the Tapacurá River




**Source:** Authors (2024)

Table 7 presents the values in km² and the percentages of the three conflict categories identified in the Tapacurá River Basin. Of the basin's 467.57 km², 268.99 km² are in conflict zones, with conflict class 1 being the most predominant. These areas, which face severe risks or limitations for use with annual crops and pastures, account for 99.97% of the conflict area and require integrated soil conservation techniques.

**Table 7.** Area of categories of conflict of use for the Basin of the Tapacurá River

| Class of Conflict | Areas ($km^2$) | %* |
|---|---|---|
| Category 1 | 268.99 | 99.97 |
| Category 2 | 0.08 | 0.03 |
| Total | 269.07 | 100 |

*Percentage in relationship to the area total from the bowl.
**Source:** Authors (2024)

Conflict class 2, which encompasses lands unsuitable for intensive cultivation but still appropriate for native pasture, reforestation, or environmental preservation, covers 8.59 km², representing 1.82% of the Tapacurá River Basin area. In these areas, the adoption of conservation practices is recommended to minimize soil loss and, consequently, improve the supply of nutrients to plants.

Campos *et al.* (2009) highlight the importance of permanent preservation areas, which play crucial roles in the maintenance, preservation, and conservation of ecosystems. These areas should always be covered by the original vegetation, as vegetation cover helps reduce erosion and soil leaching and contributes to the regulation of water flow, decreasing the siltation of watercourses and reservoirs and directly benefiting fauna and the human population.

Brazilian environmental legislation.

It is crucial to remember that federal, state, and municipal laws protect the area's natural resources. Therefore, the region must adopt land use and occupation plans on the basis of studies such as this one, in addition to promoting rigorous oversight to preserve these resources for future generations.

## 6 CONCLUSION

The analysis of the Tapacurá River Basin, with emphasis on land use conflicts, highlights the relevance of geoprocessing tools, such as geographic information systems (GISs), for effective environmental management. Morphometric characterization and the assessment of permanent preservation areas (APPs) allowed for a deeper understanding of the basin's dynamics and the identification of risk areas and the impacts of disordered agricultural activities.

The results indicate that Class 1 conflict, associated with lands with risks or severe permanent limitations for use in annual crops and pastures, covers most of the basin, totaling 268.99 km². Class 2 conflict, which includes lands unsuitable for intensive cultivation but appropriate for native pasture, reforestation, or environmental preservation, covers only 0.08 km², which corresponds to 0.03% of the total basin area.

This study highlights the critical need to assess the limitations of land use, since inappropriate use can unbalance the natural characteristics of the landscape, thereby compromising the environmental system and the quality of human life. Therefore, it is essential to better understand the dynamics of the bowl to establish guidelines that guide the use, management and implementation of conservation measures for natural resources, as well as to establish safer restrictions for land use and management.

Careful planning of production system implementation activities is recommended, which is aligned with environmental characteristics, as well as the identification of priority areas for land use planning and replanning.

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