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Anthropogenic expansions and their implications for land use and land cover in the Córrego do Galante watershed – SP

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SUMMARY

This study aims to investigate, over a period of 35 years, the variations in land use and land cover in the Córrego do Galante watershed, located in Oeste Paulista. For this to be possible, it was necessary to choose data validated by the Annual Mapping of Coverage and Land Use in Brazil by MapBiomas and, using the Qgis software (3.30.1), the mask of the study area was delimited. After that, clippings of files were exported to the ArcGis software (10.5), in order to verify the spatial behavior of each class and, in addition, a statistical analysis software, Minitab, was used, where the classes found in the area were separated. of study in anthropic activities and non-anthropic activities, making it possible to assess the intensity of practices in the natural environment. A layout was prepared showing the variations in land use and land cover during the analyzed years. The results indicated that the analyzed area has been impacted by anthropogenic activity, where, in the beginning, it is characterized by livestock production and currently maintains a growing economy marked by the cultivation of sugarcane. It is concluded that there is a need to advance initiatives that enable the recovery of degraded points, aiming at the balance of ecosystem services and the mitigation of adversities and thus stimulate sustainable development in the activities carried out in this watershed.

KEYWORDS: MapBiomas. Land use and land cover. Anthropogenic activity.

1 INTRODUCTION

Changes in land use resulting from human activities, when not adequately controlled, have the capacity to negatively impact the environment (SOUZA JR., 2020; KLEIN; BERRETA, 2023). Thus, it is increasingly essential to carry out environmental analysis and monitoring of areas that have undergone anthropogenic changes intensively and without adequate planning (NEED, 2021).

Mendes and Costa (2022) point out that the modifications caused by changes in land use and occupation are considered as the main factor in the degradation of the natural environment, such as soil and water, as they have the capacity to affect them in different ways.

Also according to the authors, from the moment the reasons for the variations in land use and occupation of an area are understood, it is possible to analyze how this space was filled and also its forms of relationship with the environment, in order to evaluate the changes that provided improvements, losses and possible risks to the ecosystem, according to related studies (HUSSAIN; KARUPPANNAN, 2023; SCHÜLE et al., 2023; MALEDE et al., 2023; DUAN et al., 2023).

In view of the anthropogenic activities that have grown over the years and require temporal monitoring, agricultural production, urban expansion, and industrial and mining activities stand out, because from the moment the vegetation cover is reduced in an uncontrolled way, without the necessary remediation to increase these practices, the microclimate can be altered (SANTOS et al., 2023), impact soil and water (TRENTIN et al., 2023), extinguish animal and plant species and, consequently, impact the economy and population (PIROLI; LEVYMAN, 2020).

When analyzed historically, perceptions and analyses of the different forms of land use and occupation began to change based on the impacts caused by intensive deforestation and consequent silting of water bodies and increase in degraded areas (ANDRADE et al., 2010). Therefore, and in view of the definitions of the Política Nacional de Recursos Hídricos (Law nº

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9.433/97), some studies have begun to emphasize these analyses with a focus on watersheds, using them for territorial planning purposes (BRASIL, 1997).

In view of the possible forms of analysis of this medium, it is important to highlight the growing use of images from Remote Sensing (RS) and geoprocessing techniques, used for the development of research focused on geographic space (LEANDRO; ROCHA, 2023), being characterized by mathematical and computational processing equipment and methods that aim to analyze and process images, offering alternatives to understand the occupations and uses of the environment in time and space (FITZ, 2008; MENDES, 2019; PIROLI; LEVYMAN, 2020).

With this growth, in Brazil, the country's Annual Land Cover Mapping Project (MapBiomas) stands out, being an example of reliable technological development to produce a historical series of land use and occupation maps of the entire national territory and developed from a collaborative network initiative of public and private institutions and NGOs, aiming at the production of these products reliably, especially when compared to conventional techniques (CAPANEMA et al., 2019).

Therefore, with the intensive increase of cities, industrial activities, agricultural expansion and deforestation, knowledge of the modifications of these uses becomes fundamental for the management of natural resources. Thus, the monitoring of land cover and land use, through these technologies, becomes extremely useful, especially in regions that have been, and are, negatively impacted by them.

There is the watershed of the Córrego do Galante, which is intensely occupied by agricultural activities, in which cattle breeding and sugarcane cultivation stand out. Nothing is known, so far, about what this growth has led to in the classes of land use and occupation, which is the justification for the development of the present work, which aims to analyze the variation of land use and land cover in this geographic space.

2 METHODOLOGY

2.1 Characterization of the study area

Located in the western region of the State of São Paulo (SP), the Córrego do Galante watershed (Figure 1) has an area of approximately 107 km², with a strong index of agriculture sustained by the cultivation of sugarcane, coffee, annatto and milk production (IBGE, 2017). Its source is close to the urban perimeter of the municipality of Tupi Paulista and its mouth in the rural area of the city of Monte Castelo, where it flows into the Aguapeí River – a tributary of the Paraná River.

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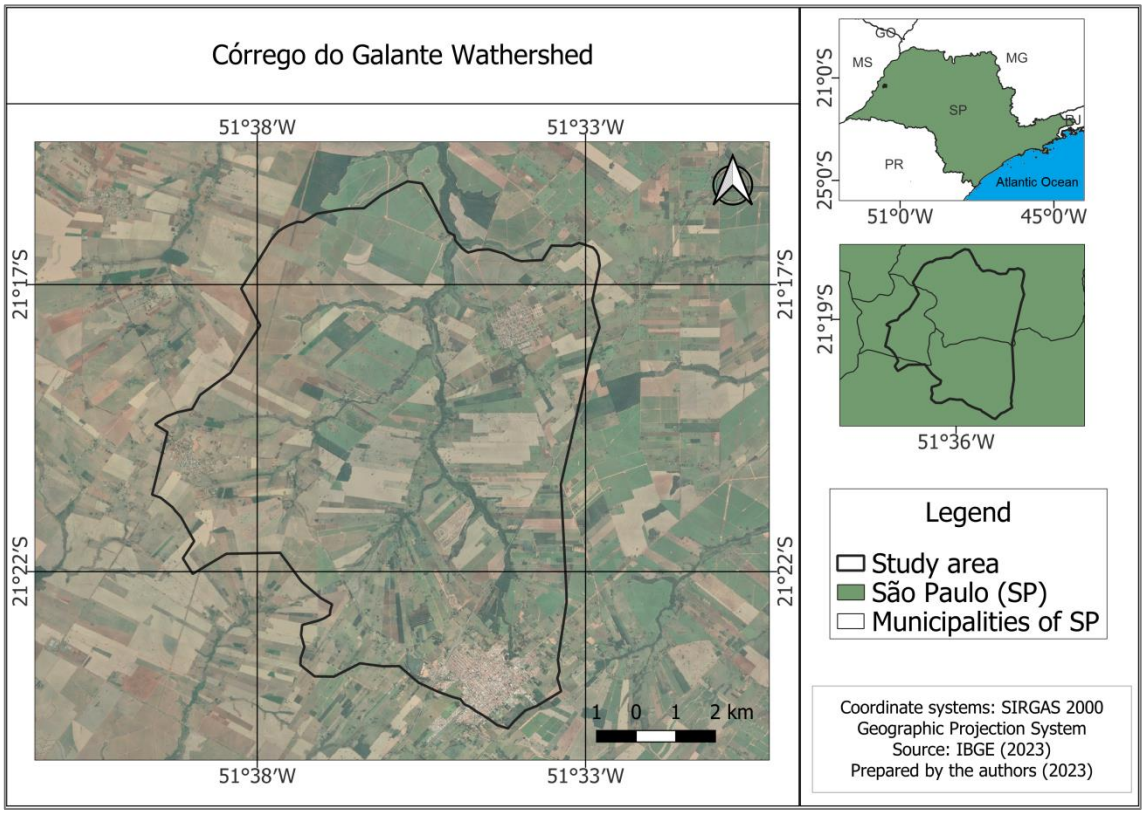
Figure 1 – Study area



Source: The Authors, 2023.

The watershed is located in a territory, with a predominance of sandy-clayey soil distributed in a plain of wide undulations, where the local fauna and flora have characteristics of the Atlantic Forest biome (DATAGEO, 2023). The dominant climate is the tropical highland of the order Aw and Cwa on the Köppen scale (KÖPPEN, 1931). The average annual temperature is 24.7°C, reaching 30.2°C in warmer seasons and 20°C in cold seasons (INMET, 2023).

2.2 Methodological procedures

For this work, the choice of data validated by the MapBiomas Annual Mapping of Land Cover and Land Use in Brazil, which gathers associative information from the areas of Geographic Information System (GIS), RS, computer sciences, land use and biomes (MORAES, 2020; BAEZA et al., 2022; RIBEIRO, 2022; MAGALHÃES et al., 2023; ALVES et al., 2023).

To this end, the use and occupation rasters for the chosen years (1985, 2005 and 2020) were downloaded and, afterwards, the mask of the study area was used to cut out the place of interest. The years were chosen in such a way that it was possible to visualize the temporal changes in the classes of land use and occupation, and the watershed was delimited using the Qgis software, in its version 3.30.1 (QGIS, 2023), based on knowledge of the exutory point.

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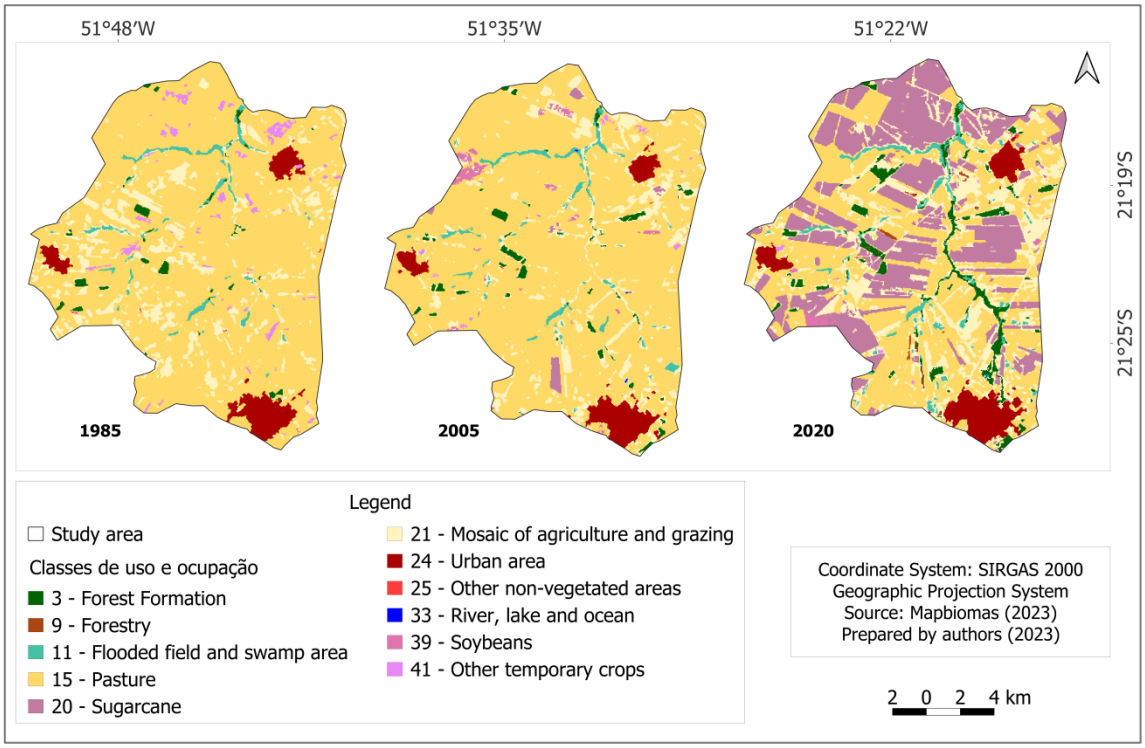
Level 6 of the MapBiomas classification was considered and the following classes of use and coverage were found for all periods: a) Forest Formation (3); (b) forestry (9); c) flooded field and swamp area (11); d) Pasture (15); (e) sugarcane (20); f) Mosaic of Agriculture and Grazing (21); g) Urban area (24); h) Other Non-Vegetated Areas (25); (i) River, Lake and Ocean (33); (j) soybeans (39); and k) Other Temporary Crops (41).

Once this was done, file clippings were exported to the ArcGis software (10.5) (ARCGIS, 2023), in order to verify the spatial behavior of each class, and also to a statistical analysis software, Minitab, where the classes found in the study area were separated into anthropogenic activities (classes 9, 15, 20, 21, 24, 25, 39, 41) and non-anthropogenic activities (3, 11, 33), making it possible to assess the intensity of activities in the natural environment. A layout was elaborated in the Qgis software, showing the variations in land use and land cover of the study area during the years analyzed.

3 RESULTS AND DISCUSSION

Based on the classifications resulting from the MapBiomas platform, Figure 2 portrays the spatiotemporal variations of land use and land cover. Then, in Table 1, we can find the disposition of the number of classes by year analyzed.

Figure 2 – Variation in land use and land cover of the Córrego do Galante watershed – SP



Source: The Authors, 2023.

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Table 1 – Spatiotemporal variation of land use and land cover classes in the Córrego do Galante watershed – SP

	Area (km²)			
Classes	**1985**	**2005**	**2020**	**Variation in 35 years**
3 - Forest formation	1,1	1,58	4,20	+ 281,81%
9 - Forestry	0,00	0,00	0,45	-
11 - Flooded field and swamp area	1,85	2,00	2,49	+ 34,6%
15 - Pasture	85,33	85,16	42,13	- 50,63%
20 - Sugarcane	0,00	0,71	29,13	-
21 - Mosaic of agriculture and grazing	12,75	12,11	22,23	+ 74,35%
24 - Urban area	4,15	4,10	5,26	+ 26,75%
25 - Other non-vegetated areas	0,05	0,02	0,02	- 60,00%
33 - River, lake and ocean	0,00	0,02	0,02	-
39 - Soybeans	0,00	1,08	0,55	-
41 - Other temporary crops	1,46	0,24	0,12	- 91,78%
Total	107 km²			-

Source: The Authors, 2023.

In view of the above, the Pasture class, for the years 1985 and 2005, corresponded to 85.33 and 85.16 km², respectively, of the total area of the Córrego do Galante watershed. The Mosaic class of agriculture and pasture was characterized as the second most representative, establishing values of 12.75 and 12.11 km², respectively. It is worth noting that during this interval, the region invested intensively in dairy cattle breeding and milk production and did little for the conservation and environmental preservation of this area (MARTINS et al., 2018; GHOBRIL et al., 2018).

Related studies show that in the years 1985 and 2005 the Pasture and Mosaic classes of agriculture and pasture, made available by MapBiomas, are potentially observed and identified in land use and land cover analyses in Brazil, since they anthropically influence the environment, modifying areas and their ecosystems (LEITE; ALVES, 2022; GALINA et al., 2022; RODRIGUES et al., 2022; SILVA et al., 2023).

Silva et al. (2023) report that between 1965 and 1979 there was a euphoric moment regarding agrarian monetization in Brazil, where the crucial factor was the establishment of the Sistema Nacional de Crédito Rural (SNCR) through Law No. 4,829/65. This period led to the development of the food and agricultural inputs industries, in addition, the credit system was favorable to those who offered guarantees for mechanization and the adoption of crops for export, thus showing the government's interest in modernizing the countryside, however, without taking care of regional and local land and environmental issues. resulting in reflexes that are currently being analyzed (BRASIL, 1965; SILVA et al., 2023).

This context changes when the thematic profile of the year 2020 is analyzed, which portrays the expansion of sugarcane cultivation. In this period, from 2005 to 2020, there was the arrival of sugar and alcohol mills – Usina Caité (2007); Rio Vermelho Plant (2007); and Usina Ypê (2008) – in the western region of the State of São Paulo, intensifying and influencing

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the modification of the territorial agrarian model (INVESTSP, 2010; PEDRA AGROINDÚSTRIA S/A, 2018; CARLOS LYRA GROUP, 2023).

The Pasture class still remains predominant in this description, however, it has a deficit of 43.03 km², resulting in a current value of 42.13 km². It is followed by the Cane class, with an area of 29.13 km², where it presents a significant jump of 28.42 km², when compared to 2005. The Mosaic class of agriculture and pasture also shows an increase in the same analysis, where it shows an increase of 10.12 km².

The cultivation of sugarcane in Brazil has been taking proportions, in which it qualifies as the largest producer in the world, followed by India and China (EMBRAPA, 2022). In addition, between 2003 and 2018, it doubled its production, with emphasis on the state of São Paulo, a national highlight in sugarcane expansion (IBGE, 2019). In addition, the west of São Paulo has been showing strong sugarcane development and establishing intense economic movement in the state (IBGE, 2017; KODAMA; LOURENZANI, 2021).

It is important to analyze the ecosystem classes – Forest formation; Flooded field and swampy area; and River, lake and ocean – which also showed changes in the periods selected for this study. These changes, over the years analyzed, are positive, as they characterize an increase of 3.1 km² for the Forest Formation class, 0.74 Km² for the Flooded field and swampy area class and 0.02 Km² for the River, lake and ocean class.

The spatiotemporal evolution of the classes presents characteristics of environmental degradation, with the absence of riparian forests in the surroundings of water resources, a fact that negatively influences the physical, chemical, and biological characteristics of natural resources (MENDES et al., 2022; RIBEIRO et al., 2022; SIMIONATTO; CARVALHO, 2022).

There is the variation in the Urban area class, which shows an increase of 1.11 km², when compared to the years 1985 and 2020. This value is associated with the low population growth of the region in which the watershed is located, which resulted in 0.43% in the projection made by the Brazilian Institute of Geography and Statistics (IBGE) in 2021 (IBGE, 2021).

There is the variation of anthropic and non-anthropic activities, which, by means of Figure 3, presents the spatiotemporal behavior of these classes in the watershed of the Córrego do Galante.

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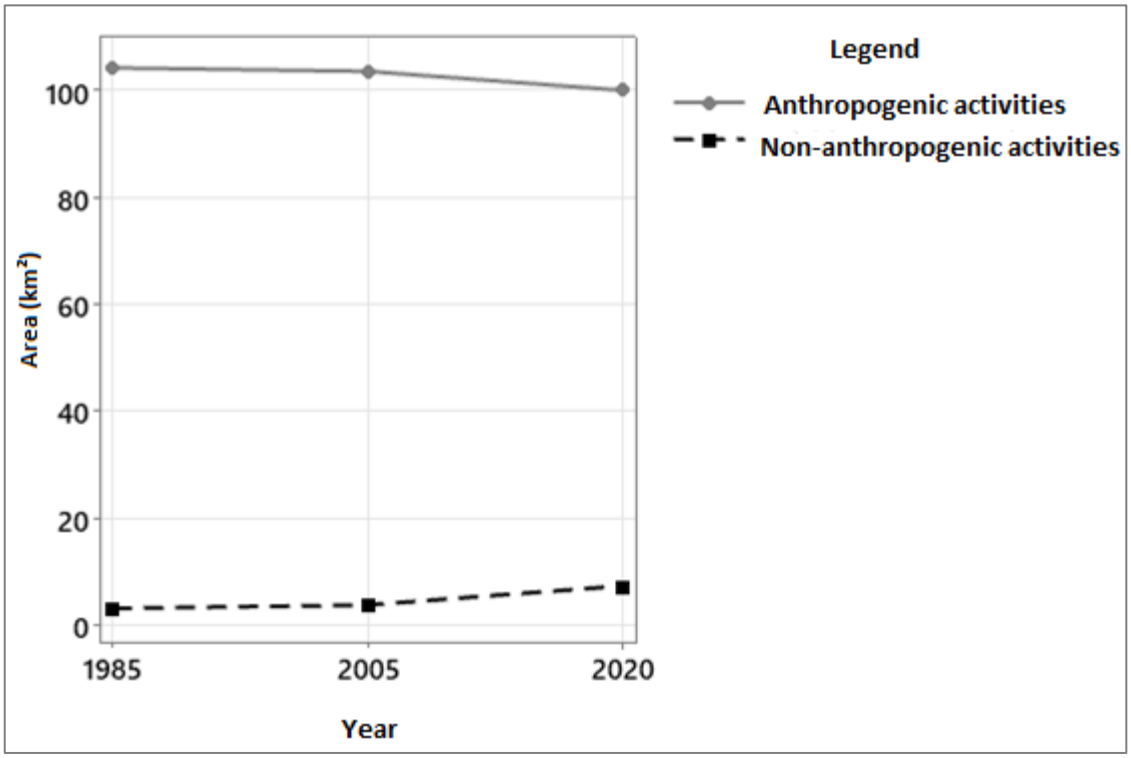
Figure 3 – Variation of anthropogenic and non-anthropogenic activities in the Córrego do Galante watershed



Source: The Authors, 2023.

It is notorious that anthropogenic activities are potentially present in the three periods analyzed, and this factor differs from methodologically similar studies that report an increase in anthropogenic activities and a decrease in non-anthropogenic activities (MENDES et al., 2022; SILVA et al., 2022; AZEVEDO; FONSECA, 2022; LIRA et al., 2022). However, it should be noted that this factor is associated with decades of behaviors associated with agrarian production and cultivation, in which the Western São Paulo region has a historical link (SOUZA, 2008; CORREA, 2021). To this end, since the anthropic activity, in this case marked by agricultural production, will not establish an outcome, it is hoped that a sustainable development based on the valorization of the ecosystem balance, aiming at the quality of life of present and future generations.

4 CONCLUSION

Concluded with this study that the watershed of Córrego do Galante, in an interval of 35 years, has been supporting intense anthropogenic activity, in which the production of cattle and, currently, the cultivation of sugarcane are evidenced, implying considerable negative impacts linked to the biodiversity of this area, such as the degradation of riparian forests, alteration of the water quality of water resources and the fragility of the soil due to monoculture.

It is necessary to advance initiatives that enable the recovery and ascension of the Forest Formation class, aiming at the balance of ecosystem services and the mitigation of

adversities and thus stimulate sustainable development in the activities carried out in this micro-basin.

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