Watershed of the Cafezal Stream in Paraná, Brazil – Temporal Analysis of Land Use and Land Cover Using Thematic Image Classification

Prates, K.V.M.C[*,**], Moreira, F.H.Z[*], Piacenza, L.B. [**] and Urata, S.L. [**]

*Academic Master's Degree in Environmental Engineering, Federal University of Technology of Paraná (UTFPR), Avenida dos Pioneiros, 3131, Londrina, PR, Brazil, 86036-370.
**Department of Environmental and Sanitary Engineering, Federal University of Technology of Paraná (UTFPR), Avenida dos Pioneiros, 3131, Londrina, PR, Brazil, 86036-370.

Highlights:

- Urban expansion concentrated around Rolândia, Cambé, and Londrina, altering the landscape of the Ribeirão Cafezal watershed.
- Over 35 years, there has been a 0.22% loss of vegetated area, predominantly riparian vegetation along river sections.
- Soybean cultivation has expanded significantly, covering 37.89% of the area by 2020, reflecting economic shifts in agriculture.

Keywords: remote sensing; landscape transformation; thematic class.

INTRODUCTION

According to Nunes and Roig (2015), how land is used and occupied in urban and rural watersheds can compromise water quality. Deforestation, paving, and intensified surface runoff cause erosion, siltation, and water contamination. When poorly managed, agricultural activities pollute the water with fertilizers and pesticides.

To ensure proper land use and occupation and minimize the negative effects generated, it is necessary to monitor and analyze natural resources, providing different types of information to identify the sources of water contamination.

In this context, this study aimed to examine the Ribeirão Cafezal watershed, which supplies 40% of the populations of Cambé and Londrina, with 107,341 and 555,965 inhabitants respectively (IBGE, 2022), correlating land use and urban expansion over the past 35 years.

METHODOLOGY

The Ribeirão Cafezal watershed covers an area of 20,621.7 hectares, located in the municipalities of Rolândia, Cambé, and Londrina in northern Paraná. The watershed includes 23 direct and 10 indirect tributaries, distributed along the 41.8 km length of the Ribeirão Cafezal (Silva, 2006).

For the multitemporal analysis, a 5-year interval was defined between representations (from 1985 to 2024) to detail the transformations occurring in the watershed drainage area. The maps were constructed using the database from the MapBiomas platform (MapBiomas, 2021) – collection 6, classified into 10 categories. The study presents 3 maps, with percentage areas for each class derived from attribute tables.

RESULTS AND CONCLUSIONS

Table 1 presents the percentages of area occupied by each of the 10 thematic classes the watershed covers.

Table 1 - Percentage values of classified areas over 35 years.

Classe	1985	1990	1995	2000	2005	2010	2015	2020
					%			
Forest formation	12,68	10,61	10,61	10,27	11,95	11,76	11,59	12,45
Pasture	13,24	9,07	7,54	8,04	6,57	5,69	4,27	3,34
Sugarcane	0,02	0,01	0,01	0,01	0,06	0,01	0,01	0,00
Agropastoral mosaic	18,66	19,69	19,12	17,67	25,19	23,46	21,67	22,59
Urban area	5,90	8,09	9,55	12,11	13,98	15,26	16,51	17,83
Other non-vegetated areas	0,30	0,12	0,11	0,19	0,19	0,26	0,41	0,56
Rivers and lakes	0,30	0,31	0,31	0,28	0,30	0,31	0,28	0,30
Soybean	2,82	7,19	7,65	18,45	27,80	32,05	37,88	37,89
Other temporary crops	40,57	39,37	42,03	28,11	10,83	8,90	6,56	4,25
Coffee	5,46	5,48	3,02	4,82	3,02	2,20	0,52	0,43

Table 1 - Percentage values of classified areas over a 35-year period.

Figure 1 shows the thematic maps for land use and occupation in the years studied in the Ribeirão Cafezal watershed.
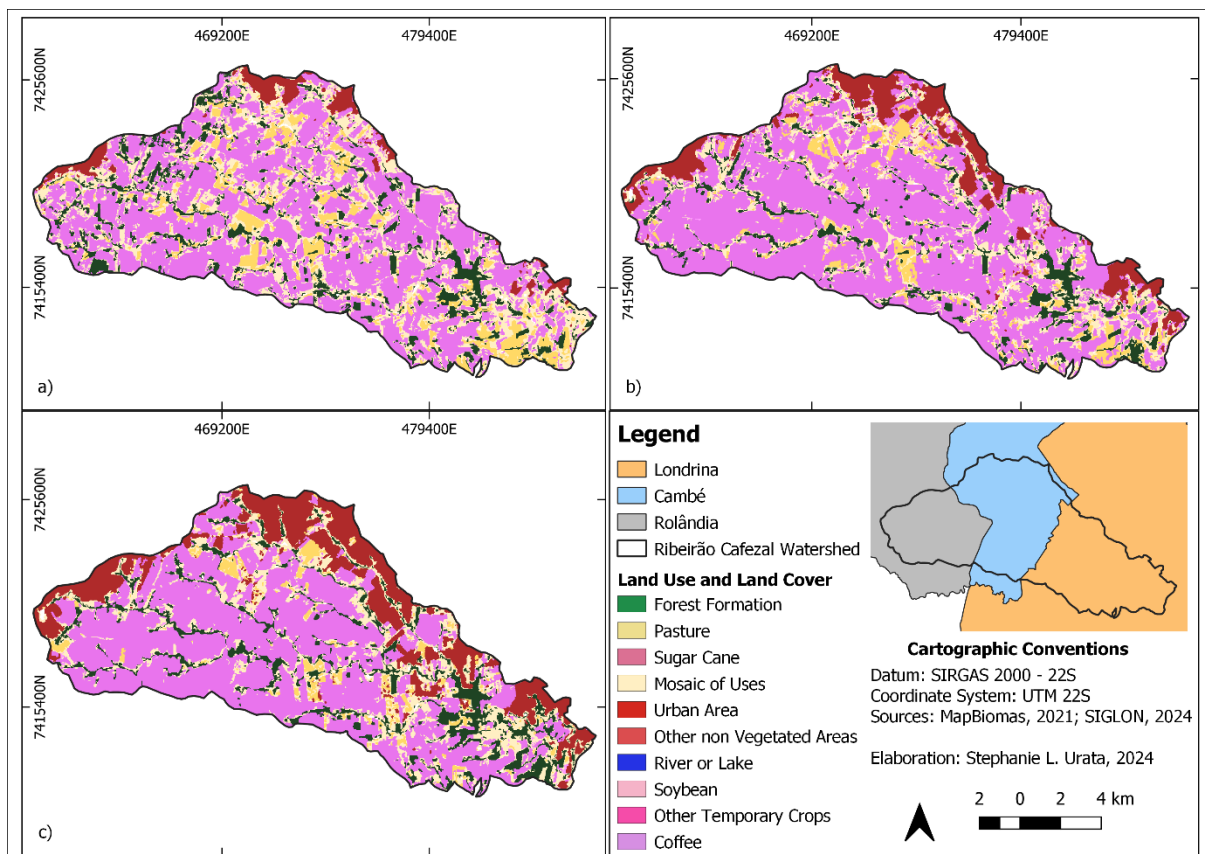

Figure 1 - Thematic maps of land use and land cover for the years: a) 1985, b) 2000, and c) 2020

An analysis of the data shows a significant expansion of urban areas and the growth of soybean cultivation, which has replaced other crop-related classes (Figure 1). Urban expansion has concentrated around the urban centers of Rolândia, Cambé, and Londrina. Morais (2015) suggests that the Ribeirão Cafezal watershed is undergoing a phase of landscape transformation, with a retreat of agricultural areas and an advance of urban regions, as observed in Figure 1.

There is a noticeable loss of approximately 0.22% (0.46 ha) of vegetated area over the 35 years analyzed. The predominant vegetation consists mainly of riparian vegetation following the river sections, classified as Forest Formation (grouped as Vegetated Area class).

Regarding rural and urban areas, there is a noticeable decline in the former and a rise in the latter, with a difference between the areas from 1985 to 2020 showing a loss of about 11.98% of rural area and a gain of about 11.93% of urban area. This suggests that the "lost" rural areas are being used for new subdivisions, contributing to the increase in urban areas.

For the classes of other temporary crops, such as soybeans, and Coffee, there has been a substantial expansion in the soybean class, which increased its area by about 1270%. In 1985, it occupied about 2.82% (5.81 ha), whereas in 2020, it occupied 37.89% (78.17 ha). This expansion indicates a replacement of other crops, explained by the economic importance that soybean has gained internationally, becoming one of Brazil's primary export commodities.

The results of this study, using data from the MapBiomas platform to construct land use and occupation maps, allowed us to visualize the transformation of the predominantly rural landscape of the watershed into an urbanized one over 35 years. This change is due to the growing urban expansion of the metropolitan areas of Rolândia, Cambé, and Londrina. The immediate effects of urban areas advancing into the watershed's drainage area include soil impermeabilization and the deposition of solid waste from human activities into the riverbed.

Therefore, periodic monitoring of the Ribeirão Cafezal watershed is necessary, as it is one of the primary water sources for Londrina and the surrounding region. Additionally, actions to mitigate the damage caused by human activities in the area are essential.

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