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SPATIAL-TEMPORAL ANALYSIS OF LAND USE AND COVER IN THE COASTAL ZONE OF THE MUNICIPALITY OF CONDE, BAHIA

Análise Espaço-Temporal do Uso e Cobertura da Terra da Zona Costeira do Conde, Bahia

Análisis Espacio-Temporal del Uso y Cobertura de la Tierra de la Zona Costera de Conde, Bahia

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ABSTRACT

This study analyzes the spatio-temporal changes in land use and cover in the coastal zone of the municipality of Conde, state of Bahia, based on decadal intervals, using data from the years 1985, 1995, 2005, 2015, and 2022 from the MapBiomas information data-base. The research considers, as an initial premise based on previous studies, that economic and social development has triggered both positive and negative changes in the environment. Monitoring these impacts is essential to maintain balance in the relationships within the environment as a system that is a substrate for life, a source of natural resources, and a provider of services such as water conservation, soil preservation, and carbon sequestration. The methodological procedures involved the collection of bibliographic data and the acquisition of satellite images from the MapBiomas platform via Google Earth Engine, followed by vectorization, classification, geometry collection, and the use of a field calculator in QGIS software. Maps, charts, diagrams, and tables were created to support this analysis, resulting in the identification of Forest Formation as the class with significant loss over the years, mainly to Pasture and Mosaic of Uses. The results of this study reflect the need for more effective environmental management in the Northern Coast Environmental Protection Area, making more sustainable land use viable.

Palavras-chave: Land Use and Occupation; MapBiomas; Environmental Management.

RESUMO

Esse estudo analisa as mudanças espaço-temporais do uso e ocupação da terra da zona costeira do município do Conde, estado da Bahia, tomando como base intervalos decenais, utilizando dados dos anos de 1985,1995, 2005, 2015 e 2022, da base de informações do MapBiomas. A pesquisa considera, como premissa inicial a partir de estudos pretéritos, que o desenvolvimento econômico e social tem desencadeado mudanças positivas e negativas no ambiente. O monitoramento desses impactos é essencial para manter o equilíbrio nas relações que fazem parte do ambiente enquanto sistema substrato para a vida, fonte de recursos naturais e de serviços como conservação da água, solo e fixação de carbono. Os procedimentos metodológicos envolveram a coleta de dados bibliográficos e obtenção de imagens de satélite da plataforma MapBiomas, por meio do *Google Earth Engine* e posterior vetorização, classificação, coleta de geometrias, uso de calculadora de campo no *software* QGIS. Foram elaborados mapas, gráficos, quadros e tabelas que subsidiaram essa análise e que resultou na identificação da Formação Florestal como classe com expressiva perda, ao longo dos anos, para Pastagem e Mosaico de Usos. Os resultados obtidos nesse estudo refletem a necessidade de uma Gestão Ambiental mais efetiva na Área de Proteção Ambiental do Litoral Norte, que torne viável um uso mais sustentável da terra.

Keywords: Uso e Ocupação; MapBiomas; Gestão Ambiental.

RESUMEN

Este estudio analiza los cambios espacio-temporales en el uso y cobertura de la tierra en la zona costera del municipio de Conde, estado de Bahia, basándose en intervalos decenales, utilizando datos de los años 1985, 1995, 2005, 2015 y 2022 de la base de información de MapBiomas. La investigación considera, como premisa inicial a partir de estudios previos, que el desarrollo económico y social ha desencadenado cambios tanto positivos como negativos en el medio ambiente. El monitoreo de estos impactos es esencial para mantener el equilibrio en las relaciones que forman parte del medio ambiente como sistema sustrato para la vida, fuente de recursos naturales y proveedor de servicios como la conservación del agua, del suelo y la fijación de carbono. Los procedimientos metodológicos involucraron la recopilación de datos bibliográficos y la obtención de imágenes satelitales de la plataforma MapBiomas a través de Google Earth Engine, seguida de vectorización, clasificación, recopilación de geometrías y el uso de una calculadora de campo en el software QGIS. Se elaboraron mapas, gráficos, cuadros y tablas para apoyar este análisis, lo que resultó en la identificación de la Formación Forestal como la clase con pérdida significativa a lo largo de los años, principalmente en favor de Pastizales y Mosaico de Usos. Los resultados de este estudio reflejan la necesidad de una gestión ambiental más efectiva en el Área de Protección Ambiental del Litoral Norte, que haga viable un uso más sostenible de la tierra.

Palabras clave: Uso y Ocupación; MapBiomas; Gestión Ambiental.

1 INTRODUÇÃO

The processes linked to land use and occupation are intrinsically connected to landscape configuration, once the implementation of the former (use) causes changes in the scenery of the latter (occupation). Therefore, the human activities that impact the environment are the core of discussions concerning the challenges of using and occupying land. The men x nature interaction has been the object of several contemporary studies,

with the emphasis on the dynamic landscape analysis as a way to illustrate the transformations throughout the years on several environmental components (Dutra; Brianezi; Coelho, 2020).

Coastal ecosystems in Brazil were the first to suffer from men-made actions, a fact that dates back to the beginning of colonization (Moraes, 2007). The several uses and occupations that have come since the first economic activity performed in the country that was red-wood tree extraction and the building of villages and cities, until later economic activities as fishing, tourism, real estate, oil drilling and others that came after the 19th century, triggered several kinds of coastal environment degradation (Santos; Câmara, 2002).

Thus, a historical analysis of this landscape brings to light the existing problems on the connection between man and environment, in which sustainable development is a challenge. In this respect, aiming that the coastal zone environment remains available as a resource for the future generations and also other fauna and flora species, this study was carried out in the coastal area of Conde, on the State of Bahia and is part of an APA (Environmentally Protected Area) in Litoral Norte (IBGE, 1990).

The Litoral Norte APA was created in March 17th, 1992 as of State Decree number 1.046 and it stretches from Conde to the municipalities of Jandaíra, Esplanada, Entre Rios, Itanagra and Mata de São João for a total of 142.000 ha throughout the Green Line (Bahia, 1992).

An APA, according to Law number 9.985/2000 which institutionalized the National System of Nature Conservation Units (SNUC):

> A usually extensive and important area with a certain degree of human occupation, endowed with abiotic and biotic, aesthetic or cultural attributes especially important for human population's life quality and well-being and has as basic goals to protect biological diversity and discipline the occupation process, ensuring natural resources sustainable use. (Brasil, 2000)

Therefore, considering APAs importance as Conservation Units, territorial space and their environmental resources, there are, mainly in the municipality of Conde, mangrove areas, dunes and sandbanks whose kinds of land use and occupation can collaborate with the decrease in quality and function of these environments. Hence, more studies are needed in this place in order to improve territorial and environmental management.

In this connection, land use identification and classification are essential for knowing the environment and developing techniques that have the attainment and maintenance of

these pieces of information such as geoprocessing as a goal (Ribeiro; Schiebelbein, 2014; Vaeza *et al.,* 2010). According to Silva (2007), geoprocessing is a set of techniques that enable the capture, modeling, handling, recovery, exam, consult, analysis and presentation of geographically referenced data. Its application is key in environmental studies once it allows processing, gathering and storing spatial data related to land surface. This permits the investigation of changes provoked by human activities on the land cover of certain territories, categorizing land occupation forms and dynamics throughout the time (Valério Filho *et al.,* 2005).

That way, the study proposes a spatial-temporal analysis of land use and occupation in the coastal area of Conde, Bahia. The land cover refers to the physical description of the terrestrial surface such as the vegetation, agricultural land and water bodies. On the other hand, the use of land as a supply drives to the environmental changes caused by anthropic actions (Carvalho; Magalhães Filho; Santos, 2021).

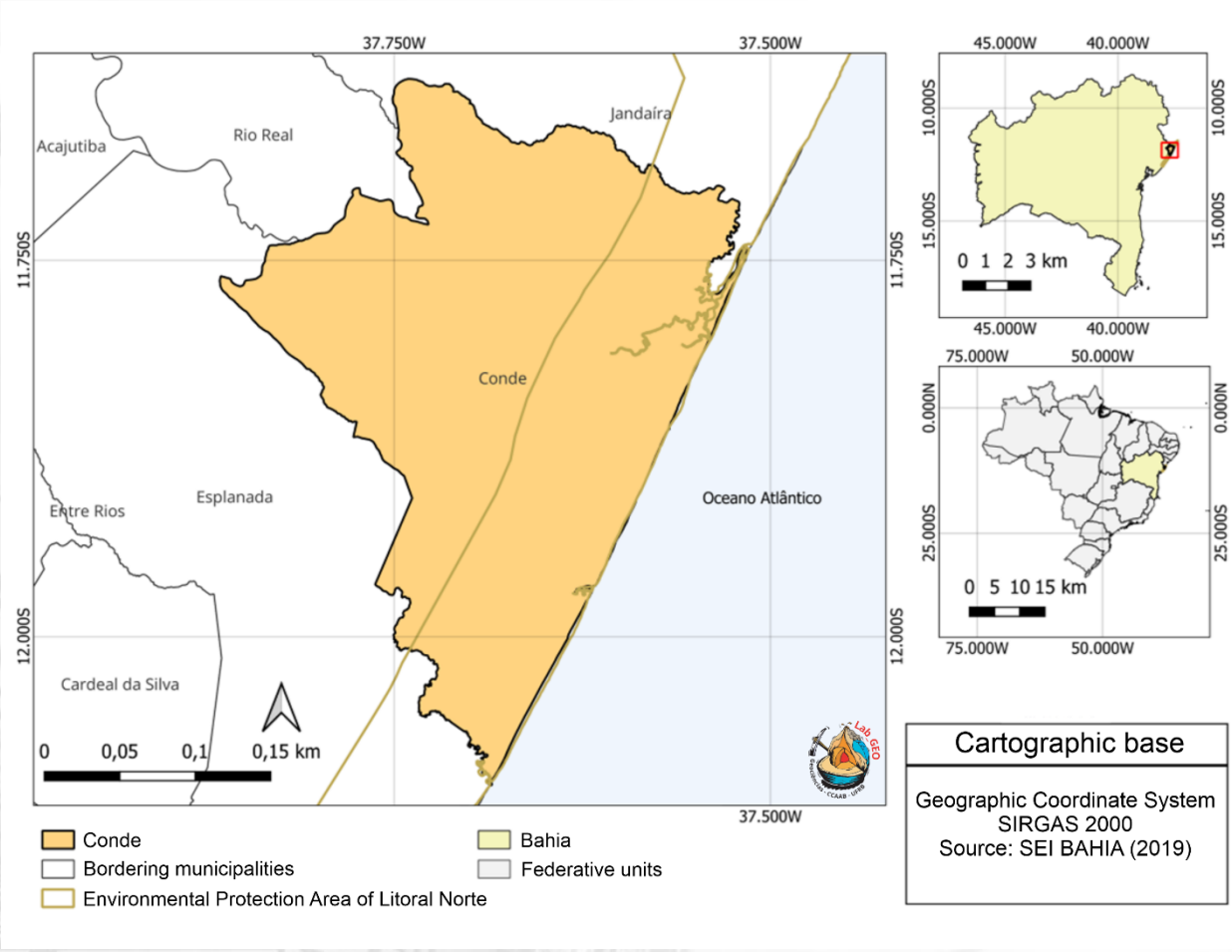
This research considers that social and economic development has triggered both positive and negative changes on the environment. In that regard, the monitoring of these impacts is crucial to keep the balance on the relationships that are part of the environment as a subtract system for life, source of natural resources and services as water and soil conservation and carbon sequestration.

2. MATERIALS AND METHODS

2.1 Study Area

The municipality of Conde, as shown in Figure 01, is located between the coordinates 11º48’ S and 37º37’ W, in Bahia, 180 km away from the capital Salvador. At North it meets the municipality of Jandaíra, making part of the territorial division called Litoral Norte which covers the following municipalities: Camaçari, Cardeal da Silva, Conde, Dias D’ávila, Entre Rios, Itanagra, Jandaíra, Lauro de Freitas and Mata de São João (IBGE, 2010).

Figure 01 - Location map of Conde's municipality, Bahia, Brazil.



Source: The Authors (2024).

Conde is the only municipality whose basis is inserted in the APA. Its GDP is the lowest within all cities that belong to APA Litoral Norte, and is about R$ 10,100.11 (IBGE, 2010). Within Conde's main economic activities there are, forestry, with eucalyptus cultivation for wood industry; cellulose and paper, family agriculture, extensive livestock, fishing and tourism (SEMARH, 2003).

2.2 Methodological Procedures

The current research was performed from qualitative and quantitative approaches for the development of a spatial-temporal analysis of land use and occupation on the coastal zone of Conde's. The research consisted of the following methodological stages: data survey; data processing; analyses and results.

Data survey reviewed the publications of the main concepts involved in the research such as: conservation units, environmental protected areas and land use and occupation.

Information from some specific sites was collected, they were IBGE (1990) and SEMARH (2003) for the regional characterization of the study area.

Later on, a decadal interval has been set, covering the years 1985, 1995, 2005, 2015 and 2022 on the basis of the data provided by MapBiomas Project (Souza *et al.,* 2020).

The reason why a 10-year gap was chosen is supported by the argument that it is in this time-gap that environmental changes are the most evident and substantial, thus allowing image capture through satellites of landscapes whose images have been meaningful, mainly in coastal areas, susceptible to erosion, the advance of the sea and climate change.

The images were taken through MapBiomas Project's Google Earth Engine and processed by the software QGIS version 3.28.13 and then were submitted to vectorization, the adding of land use and occupation classes on the attribute grid after being categorized by MapBiomas and according to what is shown on Chart 01. The image resolution is of 30 meters and the choice for collection 8 happens thanks to it being the latest one attached to the MapBiomas platform.

Chart 01 - Terms used by MapBiomas for the land use and occupation classes and their respective descriptions

Classes identifieds	Description
Urban Area	Areas with a significant density of buildings and roads, including open spaces without buildings and infrastructure.
Mosaic of uses	Atlantic Forest: agricultural areas where it was not possible to distinguish between pasture and agriculture. And urbanised areas: areas of urban vegetation, including cultivated vegetation and natural forest and non forest vegetation.
Other non Vegetated Areas	Areas with impermeable surfaces (infrastructure, urban expansion, or mining) not mapped within specific classes.
Pasture	Areas of planted pasture directly related to agricultural activities. Natural pasture areas are predominantly characterised as grassland or flooded fields, which may or may not be subject to grazing practices.
Forest Plantation	Tree species planted for commercial purposes (e.g., pine, eucalyptus, araucaria).
Hypersaline Tidal Flat	Formations almost always devoid of tree vegetation, associated with a higher, hypersaline, and less flooded zone of the mangrove, generally in the transition between mangrove and dry land.
Wetland	Atlantic Forest: vegetation with fluvial and/or lacustrine influence.
Forest Formation	Dense, Open, and Mixed Ombrophilous Forest and Seasonal Semideciduous Forest, Seasonal Deciduous Forest, and Pioneer Tree Formation.

Formação Savânica	Savannas, Forested, and Arboreal Steppe-Savannas.
Mangrove	Dense, evergreen forest formations, frequently inundated by tides and associated with the coastal mangrove ecosystem.
Beach, Dune and Sand Spot	Sandy ridges, bright white in colour, where no type of vegetation predominates.
Herbaceous Sandbank Vegetation	Atlantic Forest: herbaceous vegetation influenced by fluvio-marine conditions.
River, Lake and Ocean	Rivers, lakes, dams, reservoirs, and other bodies of water.
Other Temporary Crops	Agriculture: Areas occupied with short- or medium-term agricultural crops, generally with a vegetative cycle of less than one year, which require replanting after harvest to produce again.
Other non Forest Formations	Atlantic Forest or other natural non forest formations that could not be categorised.

Source: Adapted from Souza *et al.* (2020).

Furthermore, the MapBiomas's image editing has begun, first converting TIFF images (raster data) to vectorized files for further manipulation on QGIS. Then, the geometrics were collected so as to group the present classes on the maps, optimizing the analysis process. After that stage, an attribute chart was used to lead the class sorting and identification according to parameters set by collection 8 from MapBiomas.

In the final stage, quantitative data was generated to the natural anthropic classes, defining areas in hectares (ha) and the percentages of each area using a field calculator. This procedure allowed a thorough analysis of the areas covered by each class, expressing results in quantitative form and making it easy to interpret land use characteristics according to the specifications found on collection 8 from MapBiomas. Lastly, sheets and graphics were designed in Excel software in order to carry out comparative analysis from the produced data, dividing classes according to their nature, either anthropic or natural.

Emphasis has also been given to the most relevant classes for each studied year, highlighting the three greatest and the three smallest ones. Through this method, it was possible to observe class changes throughout the defined periods for each year.

3 RESULTS

The study analyzed the evolution of land use and occupation in the coastal zone of Conde's municipality, using maps referring to the years of 1985, 1995, 2005, 2015 and 2022. Throughout this period, sixteen different classes were identified presenting meaningful variations on their individual areas. To better understand these changes, the classes were sorted out in two main categories: anthropic origin, those that result from men's action and

natural origin, representing the preserved or very little changed areas. The tables 01, 02, 03, 04, and 05 detail the observed variation for each class, emphasizing the transformations that took place over the time and allowing a deeper analysis on the impacts of human activities and the natural dynamics in the region.

Table 01 – Percent and hectares of land use and covering classes in 1985, in the coastal zone of Conde's municipality (BA)

Class	Land Use and Cover	Individual Area	Percentage
Natural	Hypersaline Tidal Flat	15.647	0.040
	Wetland	2,978.650	7.556
	Forest Formation	14,403.727	36.538
	Savanna Formation	215.739	0.547
	Mangrove	1,242.860	3.153
	Other non Forest Formations	50.089	0.127
	Beach, Dune and Sand Spot	448.961	1.139
	Herbaceous Sandbank Vegetation	176.927	0.449
	Grassland	12.588	0.032
Anthropic	Forest Plantation	1,789.725	4.540
	Mosaic of Uses	7,155.053	18.150
	Pasture	10,131.954	25.702
	Other non Vegetated Areas	32.169	0.082
	Urban Area	27.273	0.069
Water	River, Lake and Ocean	739.964	1.877
Total		39,421.325	100.000

Source: The Authors (2024).

Table 02 – Percent and hectares of land use and covering classes in 1995, in the coastal zone of Conde's municipality (BA)

Class	Land Use and Cover	Individual Area	Percentage
Natural	Hypersaline Tidal Flat	18.707	0.047
	Wetland	2,701.458	6.853
	Forest Formation	12,510.24	31.736
	Savanna Formation	147.381	0.374
	Mangrove	1,226.78	3.112
	Other non Forest Formations	26.836	0.068
	Beach, Dune and Sand Spot	435.936	1.106
	Herbaceous Sandbank Vegetation	170.109	0.432
Anthropic	Forest Plantation	149.129	0.378
	Mosaic of Uses	9,392.34	23.826
	Pasture	11,609.17	29.45
	Other non Vegetated Areas	72.641	0.184
	Urban Area	80.946	0.205
Water	River, Lake and Ocean	878.254	2.228
Total		39,419.93	100

Source: The Authors (2024).

Table 03 – Percent and hectares of land use and covering classes in 2005, in the coastal zone of Conde's municipality (BA)

Class	Land Use and Cover	Individual Area	Percentage (%)
Natural	Hypersaline Tidal Flat	28.585	0.073
	Wetland	3,153.22	7.999
	Forest Formation	10,488.17	26.606
	Savanna Formation	105.859	0.269
	Mangrove	1,257.98	3.191
	Other non Forest Formations	19.406	0.049
	Beach, Dune and Sand Spot	283.922	0.72
	Herbaceous Sandbank Vegetation	175.616	0.445
	Grassland	12.063	0.031
Anthropic	Forest Plantation	826.067	2.096
	Mosaic of Uses	9,142.859	23.193
	Pasture	13,058.68	33.127
	Other non Vegetated Areas	220.547	0.559
	Urban Area	122.643	0.311
	Outras Lavouras Temporárias	3.147	0.008
Water	River, Lake and Ocean	521.69	1.323
Total		39,420.45	100

Source: The Authors (2024).

Table 04 – Percent and hectares of land use and covering classes in 2015, in the coastal zone of Conde's municipality (BA)

Class	Land Use and Cover	Individual Area	Percentage
Natural	Hypersaline Tidal Flat	36.102	0.092
	Wetland	3,307.68	8.391
	Forest Formation	8,813.74	22.359
	Savanna Formation	70.106	0.178
	Mangrove	1,260.34	3.197
	Other non Forest Formations	17.046	0.043
	Beach, Dune and Sand Spot	292.926	0.743
	Herbaceous Sandbank	173.168	0.439
	Grassland	3.759	0.01
Anthropic	Forest Plantation	955.79	2.425
	Mosaic of Uses	11,425.25	28.984
	Pasture	12,492.76	31.693
	Other non Vegetated Areas	62.938	0.16
	Urban Area	169.409	0.43
	Other Temporary Crops	27.361	0.069
Water	River, Lake and Ocean	310.147	0.787
Total		39,418.53	100

Source: The Authors (2024).

Table 05 – Percent and hectares of land use and covering classes in 2022, in the coastal zone of Conde's municipality (BA)

Class	Land Use and Cover	Individual Area	Percentage
Natural	Hypersaline Tidal Flat	24.389	0.576
	Wetland	3,358.20	8.52
	Forest Formation	10,621.04	26.946
	Savanna Formation	79.46	0.202
	Mangrove	1,266.11	3.212
	Other non Forest Formations	33.742	0.086
	Beach, Dune and Sand Spot	307.087	0.779
	Herbaceous Sandbank Vegetation	111.104	0.282
	Grassland	9.703	0.025
Anthropic	Forest Plantation	1,212.35	3.076
	Mosaic of Uses	10,843.07	27.509
	Pasture	10,714.40	27.183
	Other non Vegetated Areas	84.18	0.214
	Urban Area	227.19	0.576
	Other Temporary Crops	33.043	0.084
Water	River, Lake and Ocean	490.745	1.245
Total		39,415.82	100

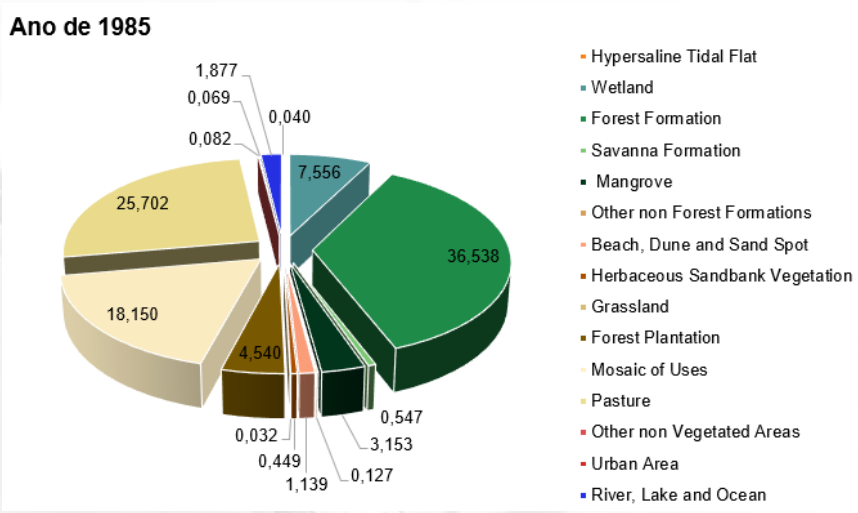
Source: The Authors (2024).

The data refers to a dynamic scenario of transformations on the use and covering of land in the coastal zone of Conde, Bahia, since 1985. There was an expansion in pasture and urban areas rather than native forest formations, while in environmental protected areas such as mangrove, despite anthropic pressure these remained stable. Farming and population growth boosted these changes, affecting biodiversity, hydric resources and local life quality. The analysis of the years 1985, 1995, 2005, 2015 and 2022 identifies trends and offers subsidies for a sustainable management of these resources.

3.1 Variations of land use and occupation classes in 1985

The class that showed the largest area in the year 1985 was Forest Formation which corresponded to 36.54% of the total area (14,403.72 hectares), followed by Pastures with 25.70% (10,131.95 hectares) and Mosaic of Uses with 18.15% (7,155.05 hectares). The least representative classes were Grassland with 0.032% (12.58 hectares); Hypersaline Tidal Flat 0.04% (15.64 hectares; and Urban Area with 0.069% (27.27 hectares) (Figure 02).

Figure 02 – Percent of land use and occupation classes in the year 1985 in the coastal zone of Conde's municipality

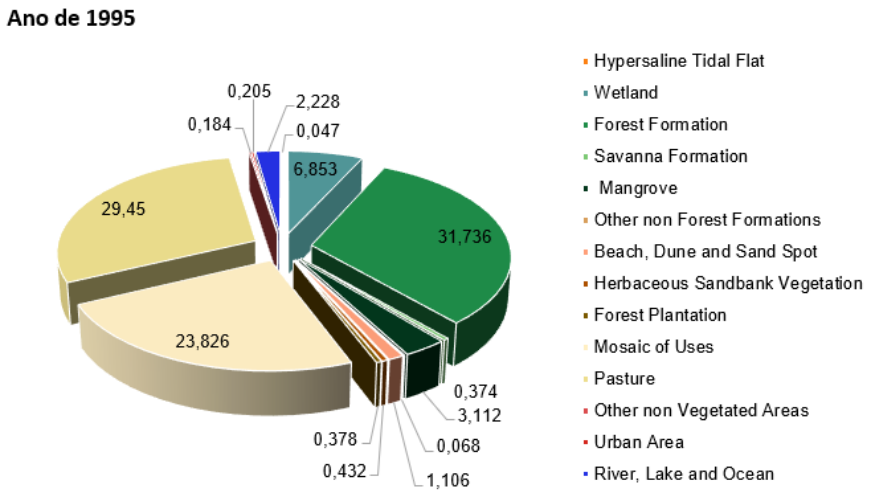


Source: The Authors (2024).

3.2 Variations of land use and occupation classes in 1995

In 1995, the most representative class was Forest Formation with 31.73% of the area (12,510.24 hectares), followed by Pastures with 29.45% (11,609.17 hectares) and Mosaic of Uses with 23.82% (9,392.34 hectares). The classes whose values were the lowest were Hypersaline Tidal Flat with 0.047% (18.70 hectares). Other non Forest Formations were 0.068% (26.83 hectares); and Other non Vegetated Areas 0.184% (72.64 hectares) (Figure 03).

Figure 03 – Percent of land use and occupation classes in the year 1995 in the coastal zone of Conde's municipality

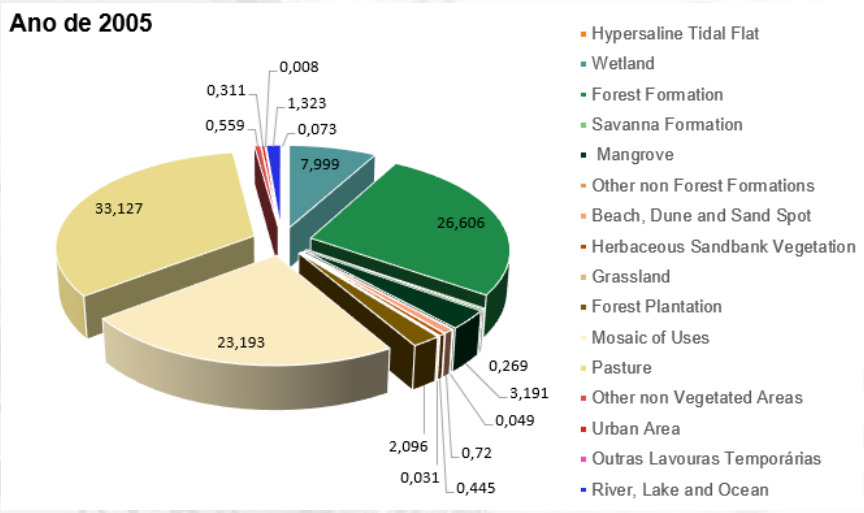


Source: The Authors (2024).

3.3 Variations of land use and occupation classes in 2005

In 2005, Pastures presented 33.12% (13,058.68 hectares) representing the highest percentage in 2005, followed by Forest Formation with 26.60% (10,488.16 hectares) and Mosaic of Uses with 23.19% (9,142.85 hectares). The classes with the lowest values were: Other Temporary Crops with 0.008% (3.14 hectares); Grasslands Zones with 0.031% (12.06 hectares) and Other non Forest Formations with 0.049% (19.40 hectares) (Figure 04).

Figure 04 – Percent of land use and occupation classes in the year 2005 in the coastal zone of Conde's municipality

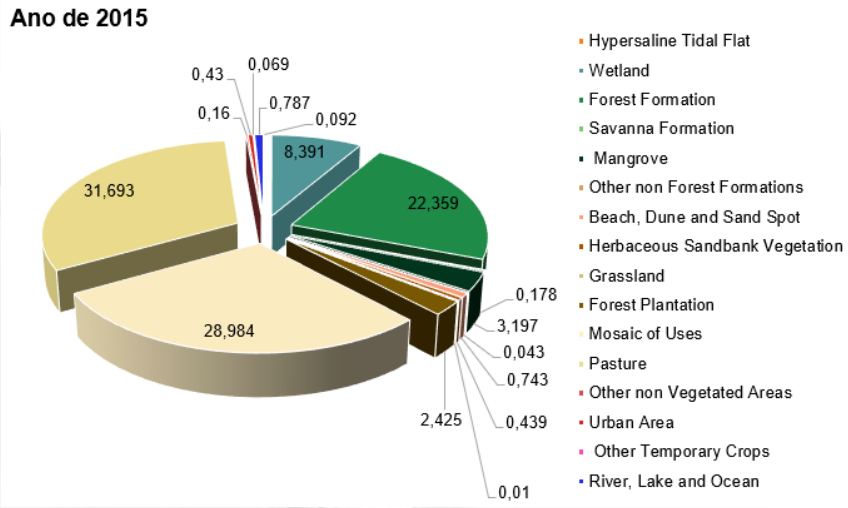


Source: The Authors (2024).

3.4 Variations of land use and occupation classes in 2015

In the year 2015, the following classes were found with the highest percents: Pastures with 31.69% (12,492.75 hectares); Mosaics of Uses 28.98% (11,425.25 hectares): and Forest Formation with 22.35% (8,813,74 hectares). The lowest percents were observed on the following classes: Grassland with 0.01% (3.75 hectares); Other non Forest Formations with 0.043% (17.046 hectares); and Other Temporary Crops with 0.069% (27.36 hectares) (Figure 05).

Figure 05 – Percent of land use and occupation classes in the year 2015 in the coastal zone of Conde's municipality

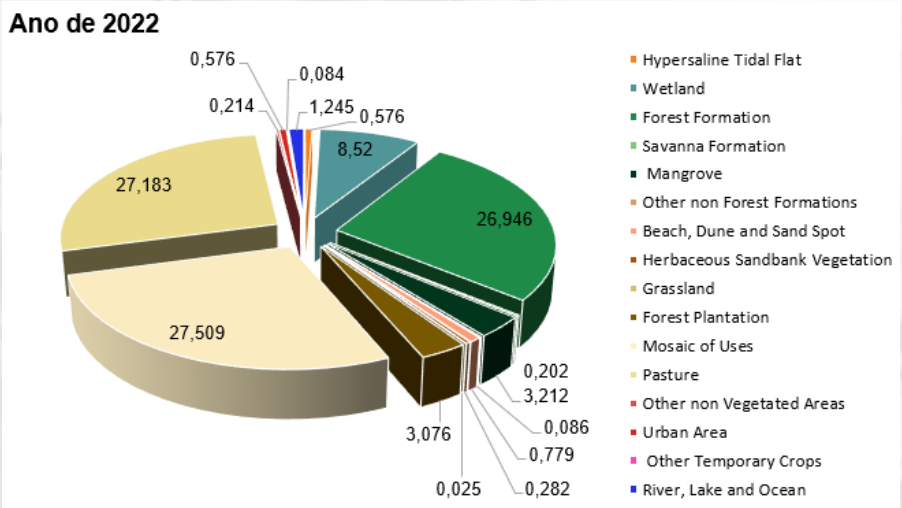


Source: The Authors (2024).

3.5 Variations of land use and occupation classes in 2022

In the year 2022, the classes with the highest percentage values were Mosaics of Uses with 27.50% (10,843.072 hectares); Pastures with 27.18% (10,714.397 hectares); and Forest Formation with 26.94% (10,621.039 hectares). Classes whose values were the lowest were: Grasslands with 0.025% (9.703 hectares); Hypersaline Tidal Flats with 0.57% (24.389 hectares); and Other Temporary Crops with 0.084% (33.043 hectares) (Figure 06).

Figure 06 – Percent of land use and occupation classes in the year 2022 in the coastal zone of Conde's municipality

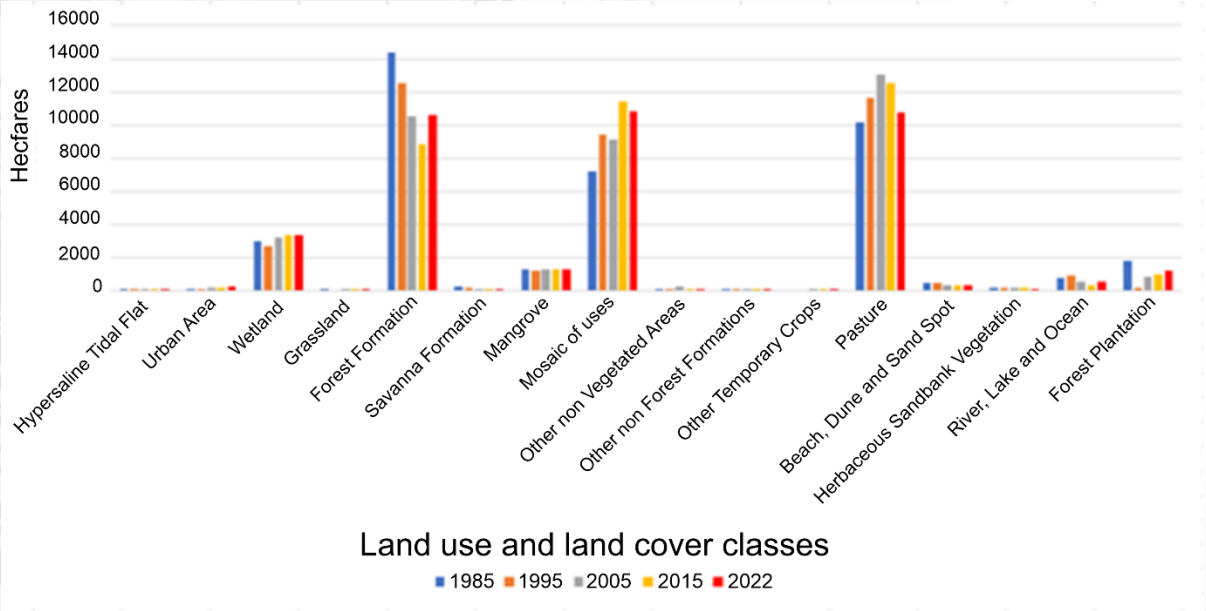


Source: The Authors (2024).

3.6 Analysis of loss/gain of the classes through the studied years

The study identified an unequal distribution on the values of land use and occupation classes every ten years (Figure 07). The Forest Formation one presented the highest values in 1985 with 14,403.72 hectares, corresponding to 36.53% from the total area in which the land concentration stays both at North and South of the study area. In the consecutive years 1995, 2005 and 2015 there was loss on the Forest Formation areas which resulted in 12,510.24 hectares (31.73% from the total area), respectively, and finishing with 10,612.039 hectares (26.94% from the total area) in 2022.

Figure 07 – Hectares distribution of land use and occupation classes for the years 1985, 1995, 2005, 2015 and 2022 in the coastal zone of Conde's municipality (BA)



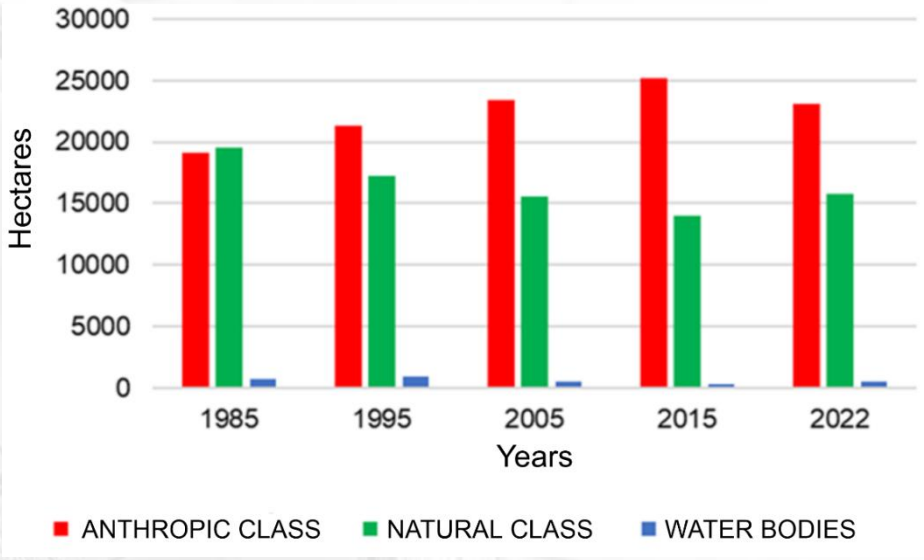
Source: The Authors (2024).

The natural classes' lost areas were substantially replaced by anthropic classes: Pasture, that in 1985 covered 10,131.95 hectares (25.70% from the total area), in 2022 showed an increase to 10,714.39 hectares (27.18% from the total area); and Mosaic of Uses with 7,155.05 hectares (27.50% from the total area) in 2022.

The Urban Area grew from 27.27 hectares (0.06% from the total area) in 1985 to 227.19 hectares (0.57% from the total area) in 2022. The main landscape changes were caused more by the conversion of Forest Formation in Pasture and Mosaic of Uses, than by real estate speculation. In 2022, there was a relevant increase in Forest Formation class on

the South portion of the study area, totaling 10.621.03 hectares (26.94% from the total area) (Figure 08)

Figure 08 – Hectares distribution of anthropic and natural land use and occupation for the years 1985, 1995, 2005, 2015, and 2022 in the coastal zone of Conde's municipality (BA)



Source: The Authors (2024).

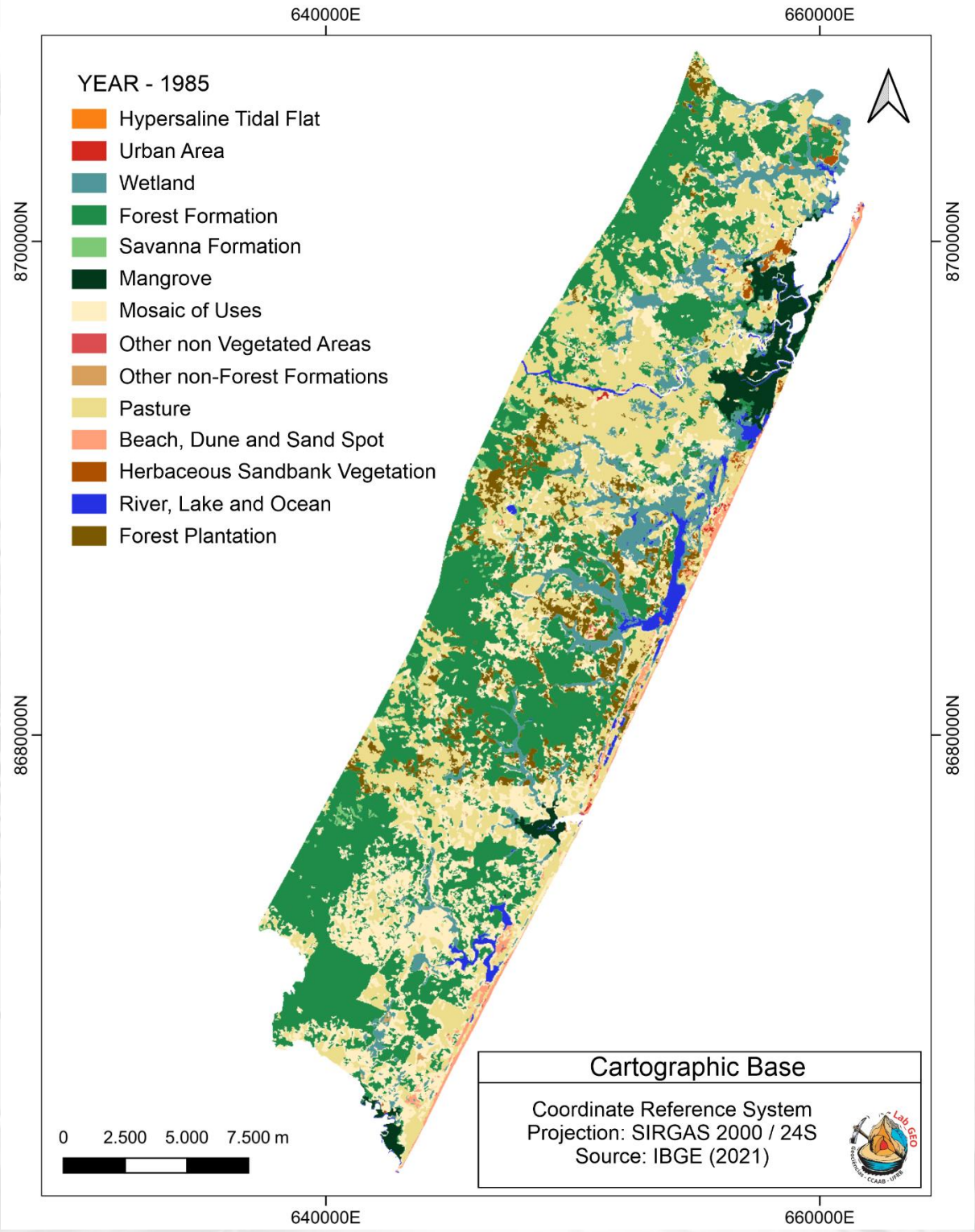
Forest Plantation in the year 1985 was found spaced out in the studied area, spreading over center-west and north end portions, totaling 1,798.72 hectares (4.54% from the total area), decreasing in 1995 to 149.12 hectares (0.37% from the total area) and in 2005, 2015 and 2022 it increased to 826.06 hectares (2,09% from the total), 955.79 (2,42% from the total) and 1,212.35 hectares (3.07% from the total), respectively, concentrated along the south of the studied area.

Grassland in 1985 showed 12.58 hectares (0.03% from the total area), in the year 1995 the class disappeared and in 2005 it came back with 12.06 hectares (0.03% from the total area), decreasing in 2015 to 3.75 hectares (0.01% from the total area) and increasing to 9.70 hectares (0.02% from the total area in 2022.

The class Other Temporary Crops was identified to the studied area from the year 2005 on, presenting 3.14 hectares (0.008% from the total area), in 2015 with 27.36% hectares (0.06% from the total area) and in 2022 with 33.04% (0.084% from the total area).

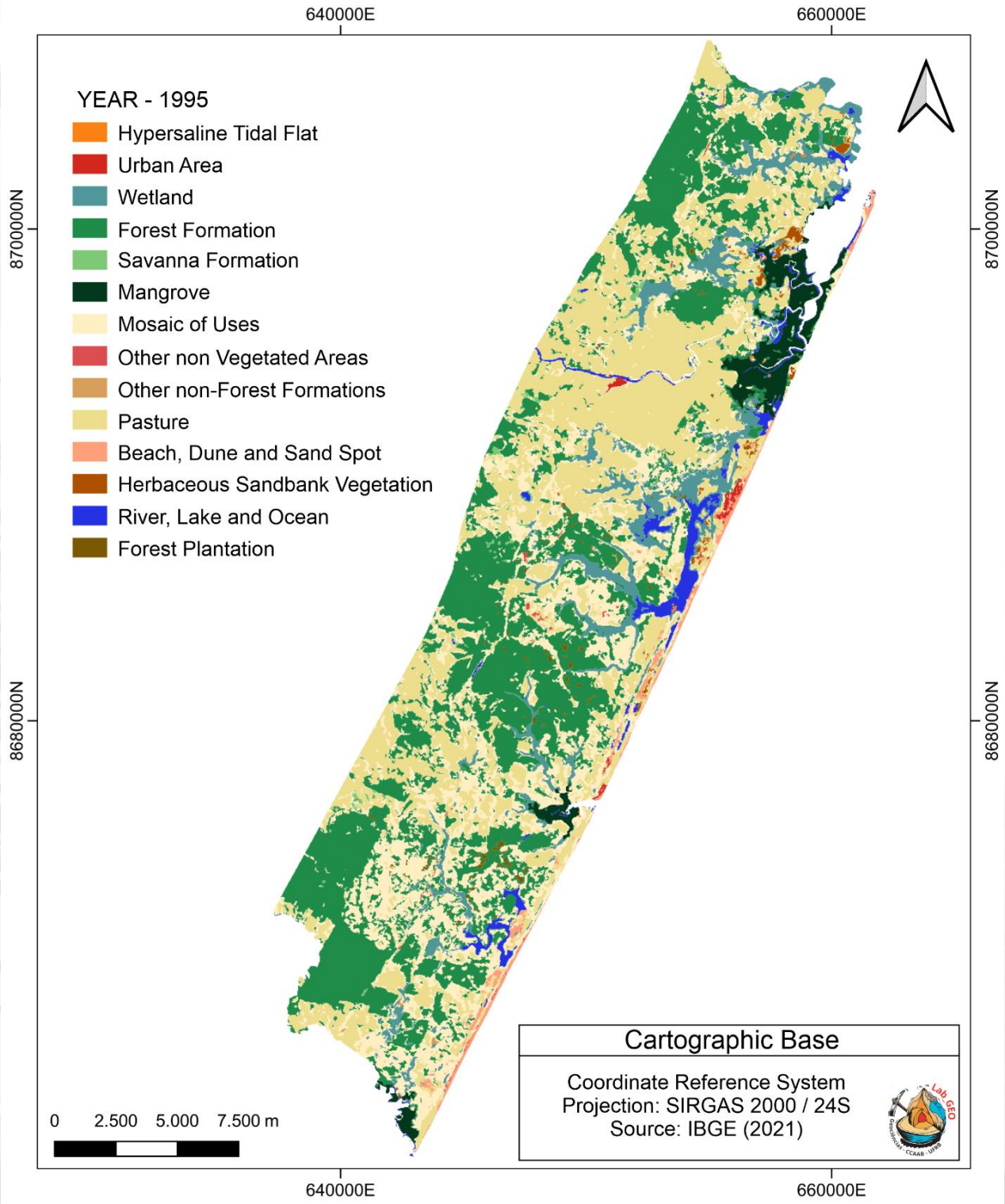
These analyses can be better understood from the figures 09 to 13, from the spatialization of land use and occupation classes for the studied years.

Figure 09 – Spatialization of land use and occupation classes for the year 1985 in the coastal zone of Conde's municipality (BA)



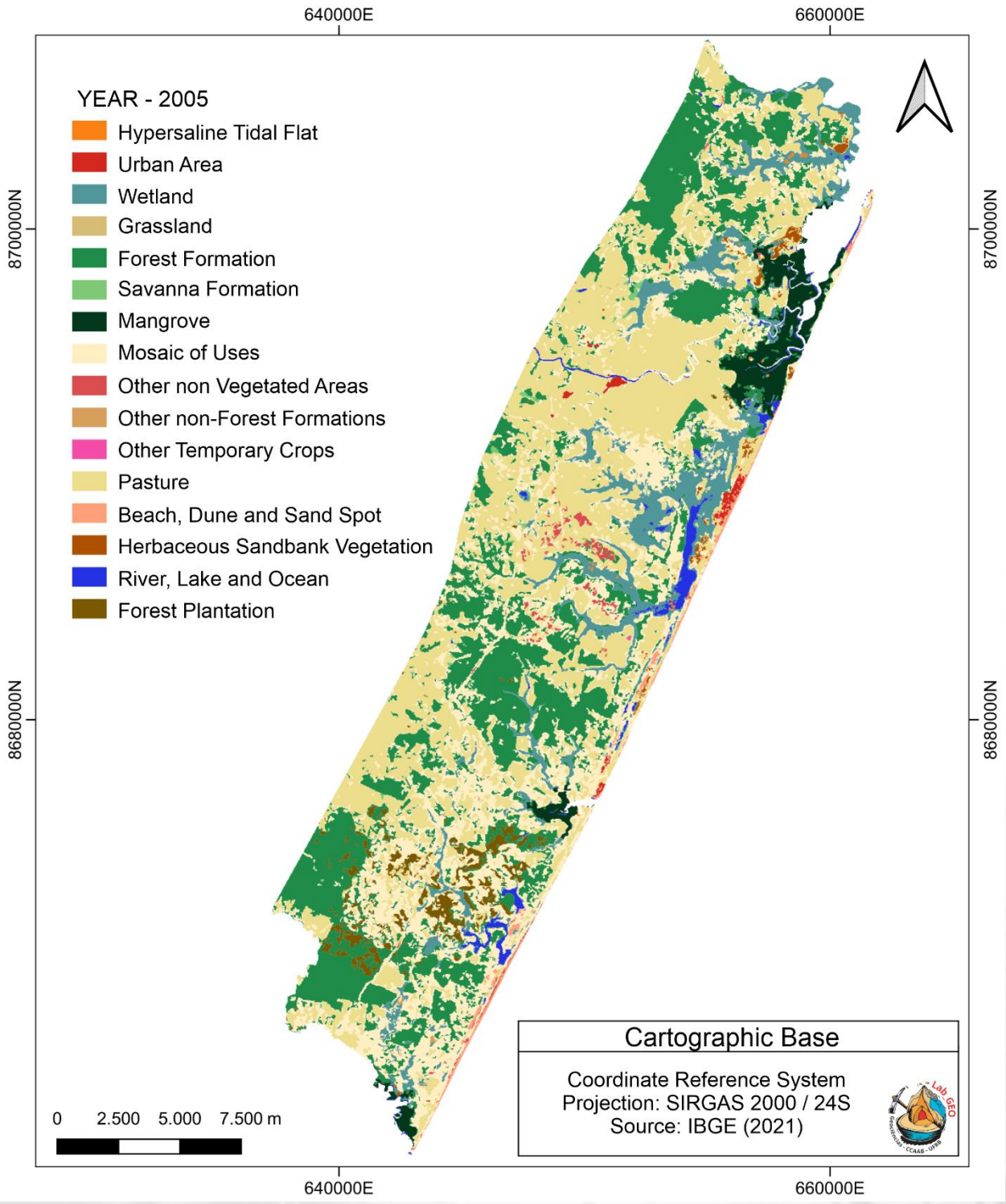
Drafting - The Authors (2024).

Figure 10 – Spatialization of land use and occupation classes for the year 1995 in the coastal zone of Conde's municipality (BA)



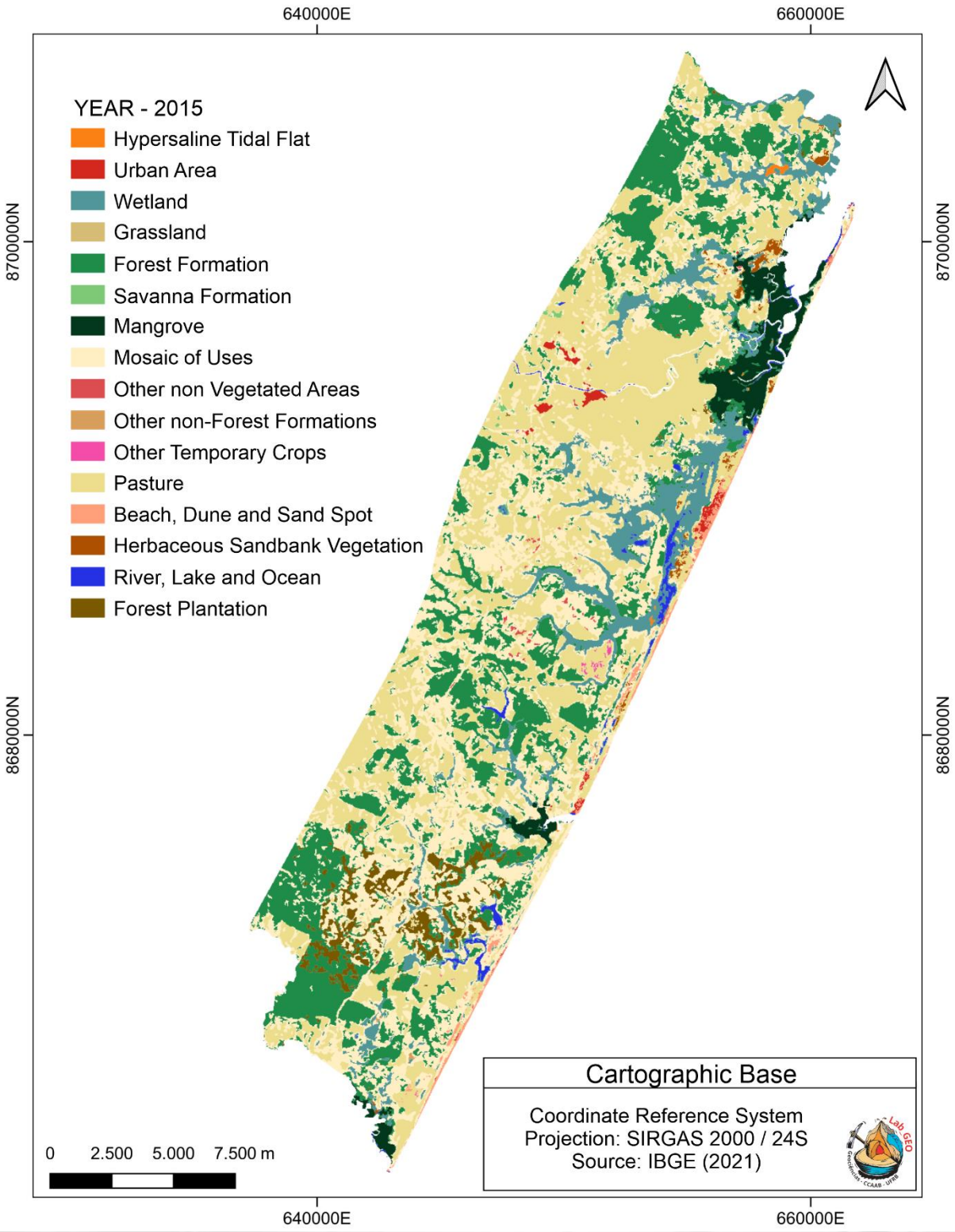
Drafting - The Authors (2024).

Figure 11 – Spatialization of land use and occupation classes for the year 2005 in the coastal zone of Conde's municipality (BA)



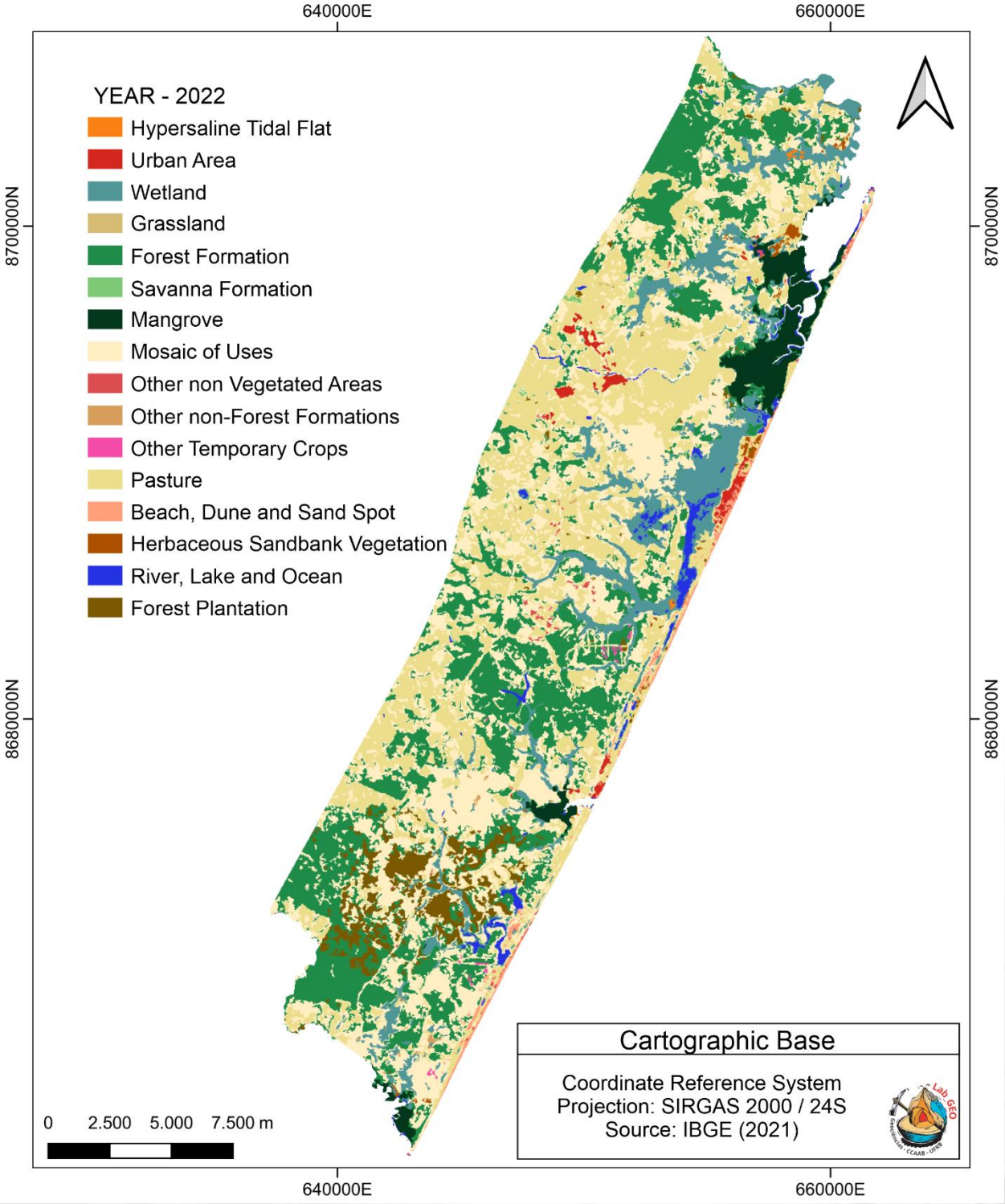
Drafting - The Authors (2024).

Figure 12 – Spatialization of land use and occupation classes for the year 2015 in the coastal zone of Conde's municipality (BA)



Drafting - The Authors (2024).

Figure 13 - Spatialization of land use and occupation classes for the year 2022 in the coastal zone of Conde's municipality (BA)



Drafting - The Authors (2024).

The growing urbanization in the studied area is one of the main factors to landscape modification. Santos (2023) emphasizes that this process does not only widens urban areas, but also performs meaningful pressure over natural ecosystems, turning forest formations

into pastures and mosaics of use as a result, doing it more than real estate speculation actually does. These transformations reflect the dynamics of urbanization and their environmental consequences.

This change also can be analyzed in the light of territorial planning discussed by Lacaze (1998), which stresses the importance of an integrated territory management so as to mitigate negative impacts from human activities. The replacement of natural areas by pastures and mosaics of use, plus the increase of forest plantation, highlight the need for land use policies that consider their long-term environmental impact.

The modifications on the use of land are equally associated with the growing environmental risks. Beck (2011) suggests that modern society needs to be aware of inherent risks to their practices and develop strategies to minimize them. The loss of forest coverage and the intensification of human activities increase territory vulnerability to natural disasters and compromise environmental sustainability. In the same line, Leopold (2020) argues that a sustainable relation with land demands respect towards the ecological processes and commitment to environmental conservation.

Finally, Vieira, Berkes and Seixas (2005) point out the importance of integrating ecological, economic and social aspects for an effective territorial management that fosters sustainability. A comparative analysis of land use trends through the time suggests that public politics must search a balance between economic development and environmental conservation, ensuring human activity expansion does not undermine natural resources and future generations' life quality.

4 FINAL CONSIDERATIONS

The spatial-temporal analysis of land use and occupation in the coastal zone of the city of Conde, Bahia, from 1985 to 2022 brings to light meaningful changes to natural and anthropic landscapes, highlighting the replacement of natural classes by anthropic classes in spite of the creation of an environmentally protected area (APA) at Litoral Norte in 1992 and the handling plan in 1995. During this period, the Forest Formation areas waned substantially, declining from 14,403.72 hectares (36.53% from the total area) in 1985 to 10,621.03 hectares (26.94% from the total area) in 2022. This decrease was followed by the increase of Pasture and Mosaics of Use that grew considerably, showing an increase in anthropic activities.

Pastures that used to cover 10,131.95 hectares (25.70% from the total area) in 1985 increased to 10,714.39 hectares (27.18% from the total area) in 2022. Similarly, Mosaics of

Uses expanded from 7,155.05 hectares (18.15% from the total area) to 10,843.07 hectares (27.50% from the total area) at the same period. Moreover, there was an increase of Urban Area, moving from 27.27 hectares (0.06% from the total area) in 1985 to 227.19 hectares (0.57% from the total area) in 2022. Although the urban growth impact is less expressive compared to the increase of pasture and mosaics of use areas, it contributes to landscape transformation.

The analysis suggests that diverse economic activities such as forest exploration, tourism companies and the construction of road BA-099 (Linha Verde) collaborated to a disorganized urban growth bringing relevant environmental consequences. The substitution of natural areas by pastures and mosaics of uses implies in the absence of natural coverage, stressing the need for a more efficient environmental and territorial management.

The data also shows a partial recovery of Forest Formation in the south portion of the studied area in 2022, suggesting reforestation or natural regeneration initiatives have taken place. Forest Plantation, which initially showed a decline, resumed growth in the last decades, reflecting a more intense handling of those areas. Grasslands and Other Temporary Crops dynamics were less meaningful in terms of area, nevertheless these classes have shown variations throughout the time, stressing the diversity and complexity of land uses in the region.

These results bring to light that the most expressive landscape changes in the coastal zone of Conde's were driven by the substitution of natural areas by anthropic uses, mainly due to the expansion of pastures and mosaics of uses and less by urban expansion. The evolution of these changes points to a continuous pressure on natural resources, building a need for handling and conservation strategies so as to balance human development and environmental preservation.

The use of technologies in environmental analyses such as geoprocessing is seen as crucial to identify and monitor diverse use areas. This study is important for the reconstruction of temporary scenarios and in cartographic product generation that may aid on local territorial management strategies, subsidizing decisions for environmental preservation and conservation. Deeper studies supported by multidisciplinary analysis should be performed to better understand human activities' impact on landscape and local ecosystem configuration in the sights of APA do Litoral Norte, Bahia.

In the end, the analysis of the changes in land use and occupation in the coastal area of Conde's emphasizes environmental management complexity in the coastal zone and the importance of integrative policies that consider both environmental conservation and social-

economic development in a reasonable manner.

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