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Impacts of land use and land cover changes in phytophysiognomies in the atlantic forest

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Abstract: We evaluated the landscape of the North and Northwest of Rio de Janeiro, determining changes in forest cover by phytophysiognomy using collection 6 of MapBiomas (1985-2020). We worked in the R environment and QGIS. Among the phytophysiognomies, the Lowland forests showed the greatest area loss until 1985 (93%), becoming highly fragmented and isolated in the landscape. Between 1985 and 2020 the loss of forest was reduced. However, this result is related to the balance of secondary vegetation increase that covers up the losses of mature vegetation, with risks to biodiversity. The main driver of vegetation loss was agriculture, and currently less than 8% of the vegetation is protected. The procrastination in the establishment of conservation units and restoration of permanent protection areas will have serious negative consequences for the conservation of the vegetation in this region.

Keywords: Fragmentation; Tropical forests; Physiognomies; Landscape metrics; Conservation.

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Introduction

Fragmentation is a process resulting from the division of a large and continuous habitat into smaller remnants (FORMAN; GODRON, 1981). This event causes loss of area, increased isolation of forest patches, and greater exposure to external disturbances, such as greater entry of light and disturbance by wind; changes in community composition, biomass dynamics, carbon stock, and greater susceptibility to fires. These effects can extend up to 300 m from the edge (LAURANCE et al., 2018; WILSON et al., 2016) and also make the fragment more exposed to the effects of climate change (LAURANCE; VASCONCELOS, 2009), which would result in losses of 13-75% of local diversity (HADDAD et al., 2015; LAURANCE et al., 2018; LAURANCE; VASCONCELOS, 2009). One of the Brazilian biomes that suffer the most from the intense effect of fragmentation is the Atlantic Forest, of which more than 80% of its original area was converted to other uses (JOLY; METZGER; TABARELLI, 2014; RESENDE et al., 2018).

The Atlantic Forest is considered one of the world's hotspots, due to its high biodiversity, level of endemism, and degree of disturbance (MITTERMEIER et al., 2004). Due to these characteristics and its social importance, it was also recognized as a Biosphere Reserve. In addition to being a biodiversity hotspot, it is also a reforestation hotspot in the Neotropical Region (NANNI et al., 2019). This biome presents different forest physiognomies: the Dense Ombrophylous Forest (FOD); Deciduous Seasonal Forest (FED); and Semideciduous Seasonal Forest (FES) (IBGE, 2012; JOLY; METZGER; TABARELLI, 2014), which are subdivided into up to five formations: Alluvial, Lowland, Lower Montane, Montane and High Montane (IBGE, 2012).

Historically, these areas are inserted in a landscape that was the target of an intense colonization process, whose deforestation led to the formation of mosaics of territorial cover composed of agricultural activities (SANTOS et al., 2017). With each new economic cycle, the forests in this region were subjected to new processes of degradation. Soffiati Netto (2011) presented the environmental history of the North and Northwest region of Rio de Janeiro, describing the colonial and republican periods and the beginning of the degradation of the FES. The forest was initially cut down for logging, which aimed to obtain wood for export, charcoal production, and use in the sugarcane agroindustry, and, later, for extensive coffee and sugarcane agriculture and livestock farming. The few forest remnants of these formations are small and disconnected forest patches in the landscape (ABREU; BRAGA; NASCIMENTO, 2014).

Landscape studies and their dynamics aim to relate the effects of changes in land use and cover with their consequences on ecological processes, uniting these two events, which occur at different spatial and temporal scales, to evaluate their interaction to create the structural pattern of the landscape (HADDAD et al., 2015; METZGER, 2001). Anthropogenic activities can promote significant changes in the landscape with the insertion of a matrix that is often inhospitable to some organisms (WILSON et al., 2016). The previously continuous forest area gains new elements, characterizing itself as a mosaic containing patches, corridors, and a matrix (METZGER, 2001).

Landscape metrics support the assessment of the composition and structure of forest formations and are useful for providing development, evaluating weaknesses, determining the relationships between structural characteristics and landscape function, and thus suggesting changes in forms of use (GÖKYER, 2013). Thus, our objective was to analyze the structure, dynamics, and diversity of the landscape and its relationship with land use and cover, from the years 1985 to 2020, in the North and Northwest regions of Rio de Janeiro, using quantitative landscape metrics methods to determine the consequences of changing in land use and cover, in the different physiognomies of the Atlantic Forest, conservation units, and permanent preservation areas in the region. The following questions were addressed: What processes are responsible for the dynamics of land use in the study area? Which type of forest was most affected by fragmentation? Are conservation areas well represented in different physiognomic types?

The central hypothesis of this work is that although fragmentation is a factor of degradation for the entire biome, factors such as the intensity of land use and the type of coverage affected the forest physiognomies of the North and Northwest of Rio de Janeiro in different ways.

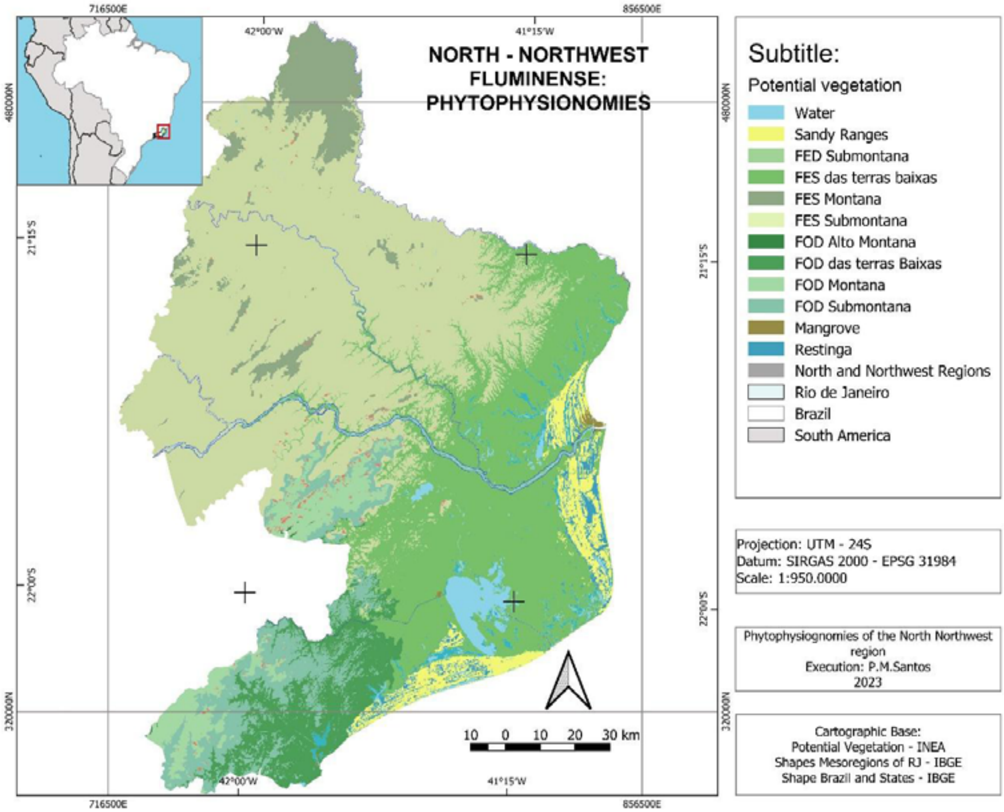
Materials and Methods

Study area

The area evaluated comprises the North and Northwest of Rio de Janeiro (1.513.231,64 ha), a region in which the phytophysiognomies of Seasonal Forest and Ombrophylous Forest predominate (Figure 1).

The region has two well-defined seasons. Summer is the rainiest period and winter is the driest period of the year. The characteristic climate type is AW- hot and humid tropical, with some climatic refuges associated with the relief (ALVARES et al., 2013). The average annual precipitation was 1082.5 mm for the temporal series from 1967 to 2013 (BRITO et al., 2017). The predominant soils are argisols (yellow, red and red-yellow), characterized by having a textural B horizon (EMBRAPA, 2018).

Figure 1. Distribution of vegetation (phytophysiognomies) for the North and Northwest region of Rio de Janeiro, according to the potential vegetation map of the state of Rio de Janeiro (INEA 2022)



Source: Figure prepared by the author (2023).

Landscape diversity - land use and land cover (LULC)

In the study of the dynamics of land use and coverage on a temporal scale (35 years), the complete collection of the MapBiomas project version 6 - 1985 to 2020 was used. Further details about the methodology can be found on the project website (PROJETO MAPBIOMAS, 2022).

To prepare the transition map the MapBiomas images (raster), originally with 25 classes, they were reclassified into 8 classes (Natural Formation, Forestry, Non-Forest Natural Formation, Pasture, Agriculture, Urban Area, Other Non-Vegetable Areas and Water), in order to facilitate the counting of changes in land use and avoid the influence of possible classification errors, given the extension of the original mapping.

The reclassification was carried out using the tool 'reclassification by table' in the QGIS program version 3.22.4 (TEAM, 2022). The transition analysis was carried out at intervals of five years, using the 'SCP' complement that compares two periods and determines changes in land cover, pixel by pixel (CONGEDO, 2021). This analysis was carried out by phytophysiognomy, type of Permanent Preservation Area (PPA), and category of Conservation Unit-CU (full protection and sustainable use). The maps were designed for the Albers projection and the WGS 1984 datum, in accordance with the IBGE recommendation to ensure accurate area calculation for large regions (IBGE, 2019).

The area of occurrence of each physiognomy was determined according to the potential vegetation map of the state of Rio de Janeiro, produzed by the State Institute of the Environment -INEA, which proposes the distribution of each physiognomy according to the interpolation of bioclimatic variables. In the region can be found forest types such as High Montane Dense Ombrophilous Forest; Lower Montane Dense Ombrophylous Forest; Restinga; Montane Semideciduous Seasonal Forest; Montane Dense Ombrophylous Forest; Lowland Dense Ombrophylous Forest; Lower Montane Deciduous Forest; Lower Montane Semideciduous Seasonal Forest; Lowland Semideciduous Seasonal Forest (INEA, 2022).

The types of PPA considered were: watercourses, natural lakes and ponds, springs, hilltops, and slopes, determined in the Native Vegetation Protection Law (BRASIL, 2012). The shapefiles (vectorial) phytophysiognomy, type of PPA and CU category were obtained from the database of INEA (2022) and the Brazilian Institute of Geography and Statistics - IBGE, with the exception of the watercourse PPA, produced specifically for the main bed of the 5 most important basins in the region (Itabapoana, Macabu, Muriaé, Pomba and Paraíba do Sul) (IBGE, 2021).

Landscape structure - Landscape metrics

To assess forest fragmentation, Mapbiomas images were reclassified into forest and non-forest areas. To avoid redundancy, we use the following set of composition and configuration metrics: AREA, Central Area Index (CAI); Shape Index (SI), and Distance to Nearest Neighbor (DNN) (MCGARIGAL; MARKS, 1995). We used each phytophysiognomy as a landscape cutting unit and measured their respective structural elements in the landscape. In this work, we adopted an edge of 30 meters, considering the small size of the forest patches and the extent of the landscape where the main ecological interactions evaluated occur (LAURANCE et al., 2018).

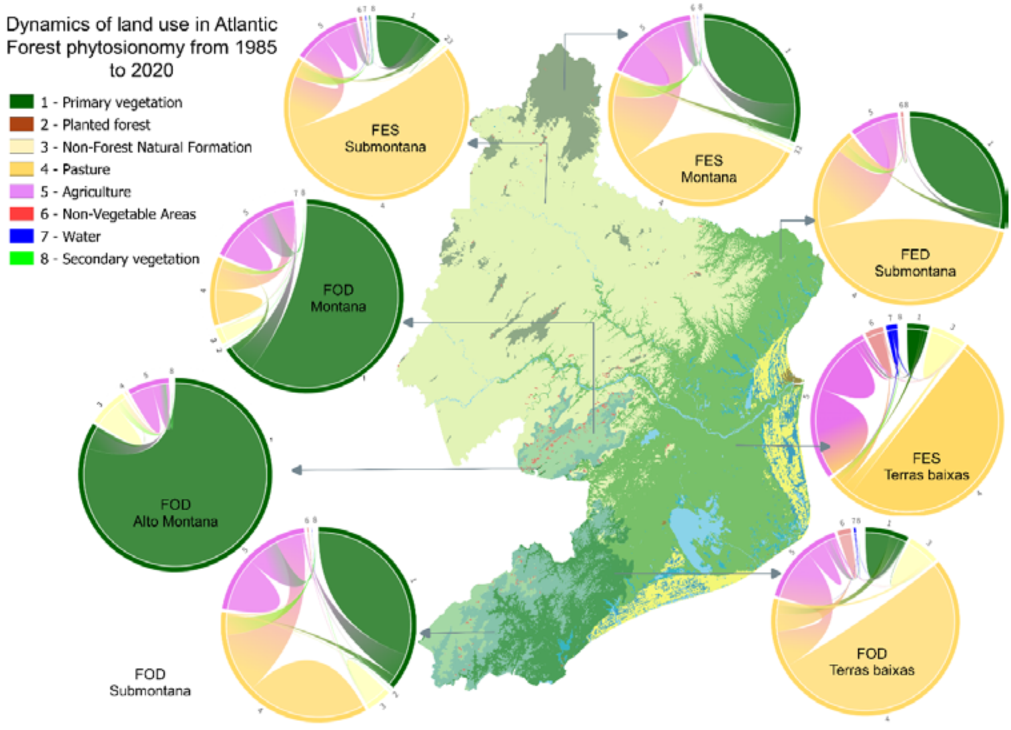
Metrics analyzes were carried out in the R environment version 4.1.1 (TEAM, 2021) using the script developed by Vancine, (2020) and the 'Landscapemetrics' packages; 'sf'; 'raster'; 'rgdal'; 'fasterize'; 'landscapetools'; 'tmap'; 'patchwork'; 'broom'; 'bbmle', and 'tidyverse'.

Results

Landscape diversity

Originally, the North and Northwest regions of Rio de Janeiro had 1,362,400.638 ha of forest coverage, which corresponded to 90% of the region (INEA 2022). By 1985, forest cover in the region had been reduced to 13.16% of the original area. Considering the original distribution of phytophysiognomies, Lowland Semideciduous Seasonal Forest was the most affected by the change of use, with 3% of its original coverage remaining, while High Montane Dense Ombrophilous Forest was the least affected, with 88% of its original coverage remaining (Figure 2).

Figure 2 Land cover dynamics in phytophysiognomies of the Atlantic Forest, in the North and Northwest regions of Rio de Janeiro, from 1985 to 2020. The base of each branched arrow is positioned to show the physiognomy that includes the greatest proportion of change, while the width represents the modified area between the uses and physiognomies at the ends of the arrow. Phytophysiognomies evaluated: SDF – Seasonal Deciduous Forest; SSF – Semideciduous Seasonal Forest; DOF – Dense Ombrophylous Forest. Figure created on the website https://flourish.studio/features/ based on data from the MapBiomas project



Source: MAPBiomas and INEA data (2022). Figure prepared by the author (2023).

The assessment of the structure and diversity of the landscape in the period from 1985 to 2020 (35 years) highlighted the variation in the size of the forest patches and maintenance of the diversity of classes of land use, with changes in the proportion of their occupation in the landscape, over time. Pasture was the land use class that modified the landscape the most, already occupying a large part of the landscape in 1985 and remaining the main use until 2020 (Figure 2). The second predominant land use was for agriculture, followed by forest remnants. Between 1985 and 2020 there was intense growth in urban areas, mainly over pasture areas (Table 1).

Table 1 Dynamics of land cover in phytophysiognomies of the Atlantic Forest in the North and Northwest regions of Rio de Janeiro from 1985 to 2020. Evolution of the area of the different uses found in the region in hectares per year. The colors govern the dynamics shown in figure 2.

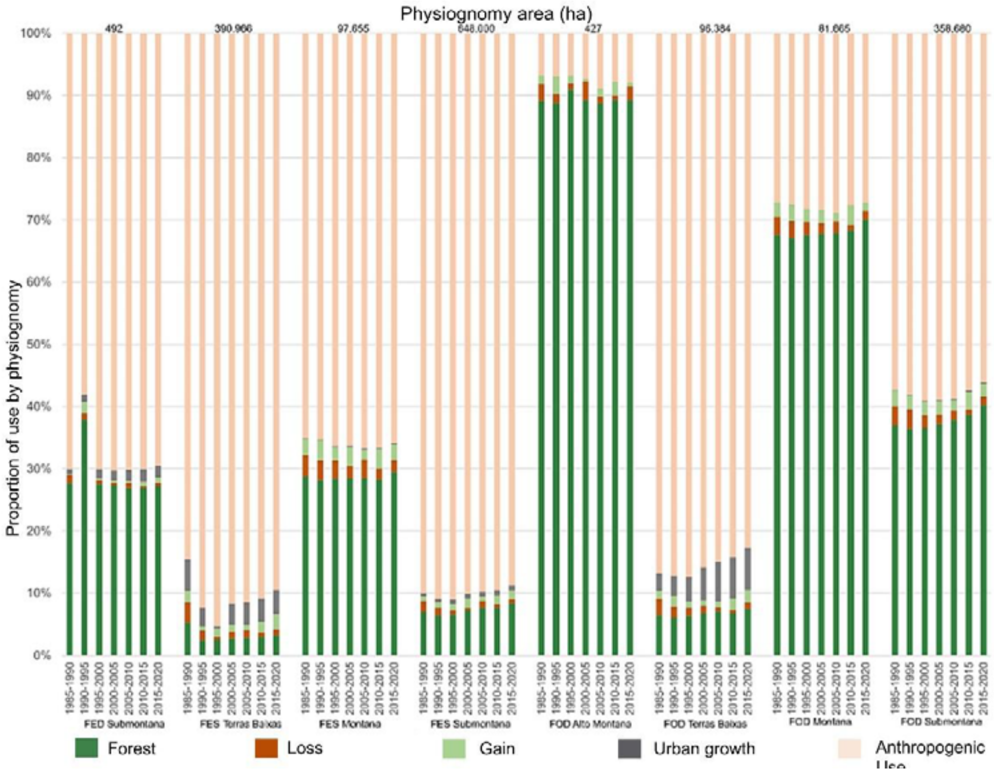
	Class	1985	1990	1995	2000	2005	2010	2015	2020
1	Natural Training		173.39			181.48			196.62
2	Forestry	57	39	38	41	44	24.2	43.9	47.3
3	Non-Forest Natural Formation	60.84	65.50	53.67	74.03	67.38	63.25	74.30	80.37
4	Pasture		953.67	957.88		899.89			901.99
5	Agriculture		234.67	238.39		276.58			242.83
6	Other Non-Vegetable Areas	27.96	26.54	28.85	24.75	19.44	21.67	19.99	18.26
	Urban area	12.92	16.96	19.44	22.62	24.81	26.21	28.29	29.16
7	Water	43.73	40.08	42.92	37.20	41.20	42.84	37.29	41.12
8	Secondary vgetation		8.09	13.97	19.32	27.10	31.67	36.33	

Source: Figure prepared by the author (2023).

The predominant use of land for pasture did not differ between phytophysiognomies, with the exception of DOF areas, where the land cover is still predominantly forest (Figure 2). On the contrary, the Lower Montane SSF formation showed the greatest loss of absolute area, with 585 thousand hectares by 1985, considering the INEA map (2022) with the original vegetation of the biome, and a further 46,300 hectares by 2020 (Figure 3).

An apparent balance between vegetation losses and gains from 1985 to 2020 was observed (Figure 3). However, the losses occurred mostly in old forest remnants (i.e. in forest patches composed of forests as early as 1985), while the gains obtained were in reforestation or abandoned areas converted into secondary forests (Figure 3). The 'Secondary vegetation' class represents the areas previously mapped as anthropic use and which returned to forest after 1985. Thus, we observed the continuous degradation of the oldest forest remnants and the gain in secondary forests, with cycles of regeneration and clear cutting of approximately five years (Figure 3). Forestry areas had been reduced during the evaluated period.

Figure 3 Types transition of landscape use from 1985 to 2020, by time intervals (5 in 5 years), in different phytophysiognomies of the North and Northwest of Rio de Janeiro, discriminating above the original area, in hectares, the phytophysiognomies of the region, according with the INEA Rio de Janeiro potential vegetation map



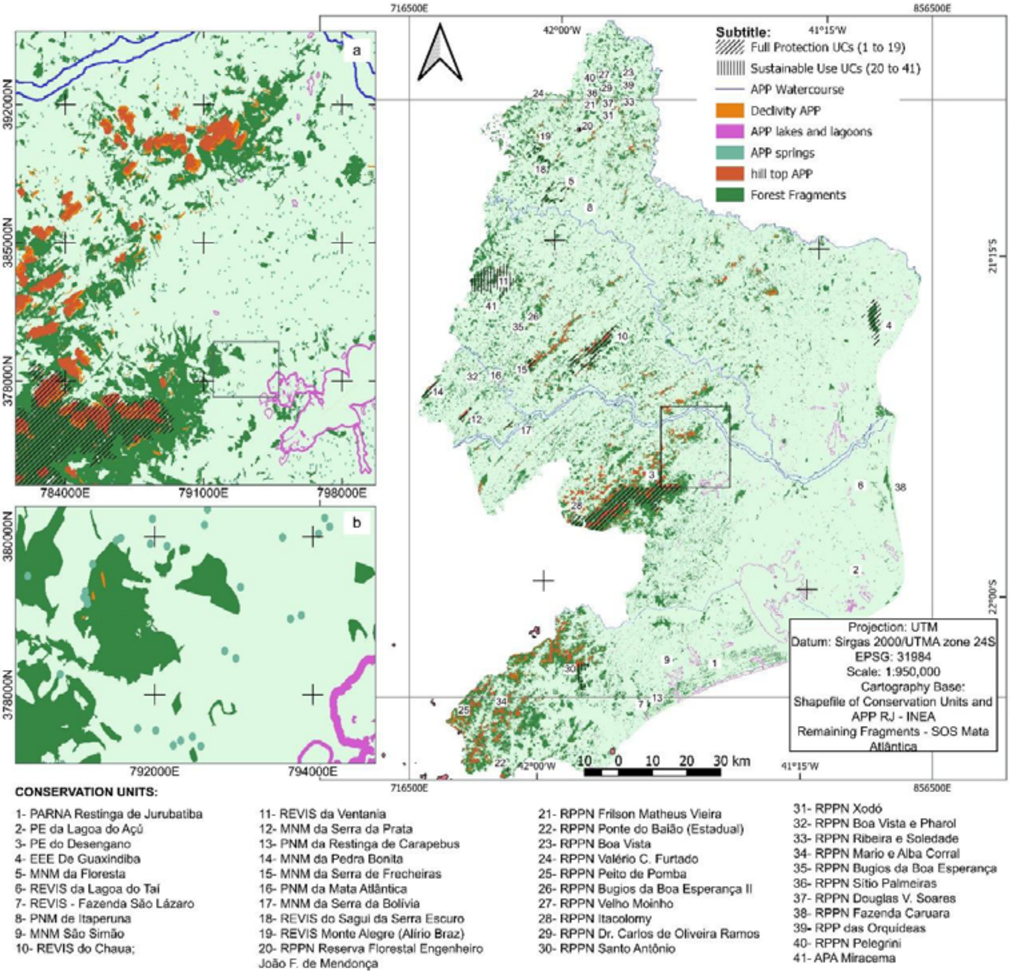
Source: Figure prepared by the author (2023).

For 2020, only 199,217 hectares of forest were registered, which represents 13.16% of the original area, distributed in 12,140 forest patches, ranging in size from 1 to 12,581 hectares (Supplement 1). Smaller forest patches (1-5 ha) dominated the landscape of all phytophysiognomies, representing around 66% of all forest patches in the region, while large forest patches (> 50 ha) represented only 4%. These, in turn, corresponded to 64.5% of the total area of forest remnants. The Lower Montane SSF was the phytophysiognomy with the greatest number of large forest patches and consequently, the greatest forest cover (n= 236).

Approximately 8% of the North and Northwest regions of Rio de Janeiro, with 4.4% in CUs (3.2% of Integral Protection and 0.8% of Sustainable Use) and 3.6% in PPAs, correspond to areas that can be included in some protection category provided in the legislation (Figure 4). However, of these CUs, only 73% correspond to forest areas. This scenario is worsened by the loss of forest in Full Protection (1.7%, 915 ha) and Sustainable Use (2.6%, 315 ha) CUs. Losses in PPA areas until 1985 reached 90% in the Lowland

and Lower Montane SSF. In the period from 1985 to 2020 there was an additional loss of 16% of forest areas in APPs.

Figure 4 Distribution of Federal, State and Municipal APPs and UCs (Full Protection and Sustainable Use), in the North and Northwest regions of Rio de Janeiro. Cutting (a) detail for the hilltop and slope APPs; cutting (b) detail for the springs APPs.



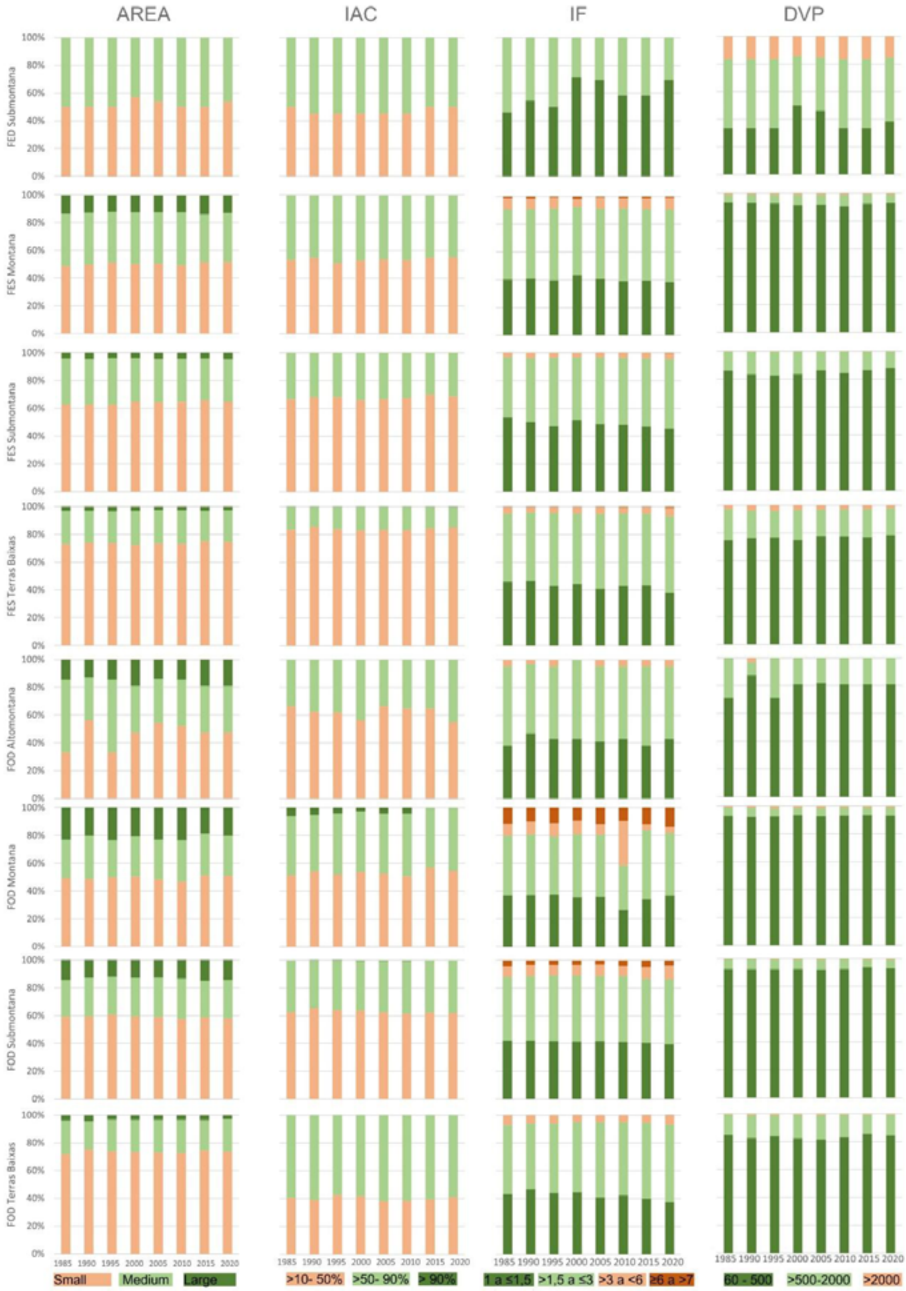
Source: Figure prepared by the author (2023).

Considering landscape statistics as a fragment area in association with the IAC, IF, and DVP indices, we found that the phytophysiognomies of the North and Northwest of Rio de Janeiro are extremely fragmented. Most of its forest patches, 10 to 500 meters apart, have an area of less than 5 ha. The evaluation of the edge effect showed that in most patches 10 to 50% of the central area remains, an effect intensified by the great variety in their shapes. The shape index ranges from 1.01 to 18.56, with most patches between 1.5 and 3.

The average size of the forest patches for each phytophysiognomies in 2020 was: Lower Montane DSF (11.4 ha); Montane SSF (36.4 ha); Lower Montane SSF (12.1 ha); Lowland SSF (11.4 ha); High Montane DOF (20.5 ha); Montane DOF(755 ha); Lower Montane DOF (92 ha) and Lowland DOF (8 ha) (Supplement 2), with a reduction in average size and consequent increase in the number of smaller forest patches observed between 1985 and 2020.

Based on the IAC, the phytophysiognomies that lost the most effective habitat area were the Lower Montane SSF, with most forest patches maintaining only 10 to 50% of their area, followed by the Lowland and Montane SSF (Supplement 3). Considering the IF, the physiognomies with the highest values were Montane DOF (18.56); the Lower Montane DOF (11.40) and the Lowland SSF (9.54). The phytophysiognomies that presented the lowest range of MSI values were Lower Montane DSF (1.01-2.02) and High Montane DOF (1.03-3.45) (Supplement 4). An increase in the number of small patches was observed in all phytophysiognomies, as well as an increase in the number of patches that have 50 to 90% of their area under the edge effect, more indented and distant from each other (Figure 5).

Figure 5 Number of forest patches evaluated (1985-2020) for each category of metrics and phytophysiognomy of the Atlantic Forest, in the North and Northwest of Rio de Janeiro. AREA – Area of landscape forest patches; IAC-Central area index; IF- Shape index; DVP- Distance to the nearest neighbor



Source: Figure prepared by the author (2023).

Discussion

Historically, the Atlantic Forest has suffered a high level of deforestation (DE LIMA et al., 2020; SOFFIATI NETTO, 2011). In 1985, most of the Biome's landscape had already been converted to anthropogenic use, leaving small forest patches (≤5 ha) isolated in the landscape (CABRAL; FREITAS; FISZON, 2007; RIBEIRO et al., 2009; ROSA et al., 2021). This pattern was also observed for the region addressed in this study. Many of these remnants are either part of the Legal Reserve (RL) area, a concept provided for in the first forest code of 1934, or hilltop PPA (BRASIL, 2012; METZGER et al., 2019).

Observing at the Biome scale, Freitas et al. (2010) highlighted that forest deforestation is related to topography, land use, and road density, and that these factors facilitate the degradation of forest remnants. For all the phytophysiognomies studied, we observed that the relief was the determining factor for the prevalence of one use over the other. In flat or low-slope terrain, pastures were dominant; in areas with irregular relief, the conversion of forests to other uses was less frequent. This pattern was found mainly in the FOD and FES Montana phytophysiognomies (CABRAL; FREITAS; FISZON, 2007; ROSA et al., 2021).

The pattern of changes in forest cover observed in the north and northwest of Rio de Janeiro, with a marked loss of cover until the beginning of the 90s, followed by later gains due to natural regeneration in abandoned areas or reforestation, is in accordance with studies of Lira et al. (2012), Petroni et al. (2022), Rezende et al. (2015) and Rosa et al. (2021), who associated this process with agropastoral dynamics, changes in law, abandonment of charcoal production and rural exodus. These events also occurred in some of the areas of the present study, such as the State Ecological Station of Guaxindiba – EEEG, which before its creation was known as "Mata do Carvão", due to the extensive removal of wood for the production of charcoal (VILLELA et al., 2006).

Another important fact for the dynamics of the region was the decrease in agricultural production both in quantity (CEPERJ, 2019c) and in production area, mainly sugar cane (CEPERJ, 2019a). Livestock data, on the other hand, show a constant increase in the cattle herd, in the historical series from 1974 to 2017 (CEPERJ, 2019b). However, between 1985 and 2020, there was little variation in the planted area (increase in perennial and temporary crops), a fact related to the reduction of pasture areas, which in the period was 6.5%, with a loss of 62,644 ha, as well as the conversion of forest areas.

More recently established livestock breeding techniques make it possible to increase the herd without necessarily increasing the area allocated to pastures. Dias-Filho (2016) evaluated the history of cattle breeding in Brazil and pointed out this trend as a result of adjustments in stocking (heads of cattle/hectare of pasture); increasing replacement of natural pastures by planted pastures; and the reuse of already open areas, through the recovery of degraded pastures. Strassburg et al. (2014) highlight that Brazilian agricultural production capacity is idle. It is estimated that current productivity is around 32 to 34% of the total potential to be achieved. Thus, using current planting and production techniques, it would be possible to allocate more than 18 million hectares for restoration, in the Atlantic Forest Biome alone. This is an example of a strategy easily applicable to the region analyzed in this study.

In a study carried out on a global scale, Curtis et al. (2018) found that, although loss factors vary according to regional issues, the main promoter of vegetation loss, in global terms, was agriculture for commodities (soybean and sugarcane planting) and beef cattle raising. Our results corroborate these considerations by showing the same activities occupying 85% of the landscape, data also corroborated by Lopes et al. (2018). However, we highlight that urban growth is a threat to the remaining Atlantic Forest in the region (ROSA et al. 2021).

Among the phytophysiognomies evaluated, the regions covered by Lower Montane and Montane DOF maintained a significant part of the natural land cover, probably due to the difficulty and economic cost of converting these areas to agriculture (LOPES et al., 2018; RIBEIRO et al., 2009). The relief of the Atlantic Forest is an important determinant of both deforestation and forest regeneration. Rezende et al. (2015) demonstrated that steeper areas are more favorable to regeneration while flatter areas are more susceptible to deforestation, considering that transportation and mechanization of farming are facilitated, a pattern also described by Freitas et al. (2010).

At the opposite extreme, we have the Lowland SSF, the most degraded phytophysiognomy in the region, with 1,400 forest forest patches covering less than 3% of the area. Most patches have less than 5 ha, and only 30 forest patches have more than 50 ha. As a consequence of degradation, ecosystem services such as water supply and local and regional temperature regulation are depleted, strongly affected by changes in land use. It is estimated that for every 25% of area converted to anthropogenic use there is an increase of 1 Celsius degree in the local temperature (METZGER et al., 2009; PETRONI; SIQUEIRA-GAY; GALLARDO, 2022; WANDERLEY et al., 2019). In the study region, some researchers have suggested changing the climate classification of the North (ANDRÉ; MARQUES; PINHEIRO, 2005) and Northwest regions of Rio de Janeiro (SILVA; DE ANDRADE; SOUZA, 2006), due to changes in rainfall regimes, promoted mainly by human activities (ANDRÉ et al., 2008; BOHN et al., 2013).

The current spatial configuration of the Lowlands SSF is extremely worrying. Actions to recover this area require effective government attitudes both in applying existing legislation and in expanding the number of ecological restoration projects being carried out. The restoration of the PPA and LR areas, an obligation provided for by law (BRASIL, 2012), would reestablish a large part of the region's connectivity, adding approximately 55,000 ha of forest in PPA areas and 20,360 ha in LR areas, representing an increase of 5% in the region's forest coverage. Strassburg et al. (2016) draw attention to the importance of natural regeneration as a low-cost and high-impact tool, with significant ecological and social benefits (REZENDE et al., 2015). It is important to highlight that the region is dominated by areas of ephemeral regeneration, where the natural regeneration process begins but is interrupted by a new cutting cycle (PIFFER et al., 2022).

Restored or regenerated areas are important carbon sinks. Silva Junior et al. (2020) showed the importance of secondary forests in the Atlantic Forest, responsible for absorbing 260 Tg C between 1988 and 2018. However, even with the total restoration of this environmental liability, the landscape of the North and Northwest of Rio would not reach 30% of coverage forest, the minimum necessary to maintain the biological and phylogenetic integrity of the community (BANKS-LEITE et al., 2014).

Arroyo-Rodríguez et al. (2020) highlight the importance of proposing conservation strategies not only at the patch level but mainly at the landscape scale, prioritizing the increase in forest cover and connectivity (OLIVEIRA-JUNIOR et al., 2020). Thinking about the configuration of the landscape means thinking about maintaining the biodiversity of the spots (ABREU; BRAGA; NASCIMENTO, 2014; CARVALHO; BRAGA; NASCIMENTO, 2015; OLIVEIRA; SANTOS; TABARELLI, 2008), preserving the ecological processes involved (BEBBER; BUTT, 2017; LI et al., 2022; VILLELA et al., 2006) and the coexistence with human activities, generally harmful to biodiversity (BOESING; NICHOLS; METZGER, 2018; DE LIMA et al., 2020). In this way, studies that evaluate landscape connection are a fundamental step to provide information for conservation planning (OLIVEIRA-JUNIOR et al., 2020).

The intense fragmentation observed in the phytophysiognomies studied is also a consequence of the lack of UCs or areas destined to the protection of remnants in the region. The Submontana FES, a landscape that has lost the most absolute area, although it presents a greater number of large fragments, is one of the phytophysiognomies in the North and Northwest of Rio de Janeiro most lacking in UCs and whose protection is still precarious (INEA, 2014), despite the high priority for conservation (SCARANO et al., 2009).

Large forest patches associated with structural connectivity and a larger core area are parameters that can help in assessing the landscape and choosing priority remnants for conservation. De Lima et al. (2020) highlight the importance of fully protected CUs for the conservation of biodiversity in the Atlantic Forest, according to which the larger the area and its level of protection, the lower the losses induced by human action. This correlation is corroborated by the present study in which we found lower losses in fully protected CUs (BEBBER; BUTT, 2017; DE LIMA et al., 2020). Defries et al. (2005) demonstrated that the surrounding areas of CUs are also important elements for maintaining the connectivity of these areas in the landscape, conserving ecosystem services (PETRONI; SIQUEIRA-GAY; GALLARDO, 2022) essential for sustaining current food systems. Ensuring environmental sustainability, maintaining wildlife, in addition to reducing the effects of climate change, are some of the objectives of the 2030 agenda. These objectives permeate ecological studies, with a view to conserving a healthy and balanced environment for present and future generations (IBGE, 2022b).

Brazil is recognized for having a well-structured set of environmental laws to reduce deforestation and regulate the restoration of degraded areas (BRANCALION et al., 2016). These prove to be more effective when associated with interventions in production chains in order to reduce deforestation (FERREIRA; COELHO, 2015; NEPSTAD et al., 2014). However, this legal structure has been modified in recent years, which may compromise the maintenance of many forest patches currently present in the landscape (ATHAYDE et al., 2022; BARBOSA; ALVES; GRELLE, 2021; SILVA; FEARNSIDE, 2022; VALE et al., 2021).

The apparent stability in vegetation losses in the Atlantic Forest was recently described by Rosa et al. (2021). These authors clarify that gains in secondary vegetation can compensate for losses in older vegetation in quantitative terms, but not in qualitative terms, which brings enormous losses to biodiversity. Although secondary vegetation plays an important role in restoring the biome, by connecting the remaining forest patches, maintaining primary vegetation must be a priority.

Therefore, we draw attention to the urgency in the implementation of new CUs and the establishment of new restoration projects for PPA and LR areas, in the North and Northwest regions of Rio de Janeiro, in view of the serious threats to the Atlantic Forest Biome, one of the most important hotspots in the world, addressed in this work. The delay in implementing measures such as those suggested previously already has negative consequences for the conservation of these phytophysiognomies and their environmental services.

Conclusion

Although the Atlantic Forest has a history of fragmentation throughout its extension, it was evidenced by the temporal analysis (1985 to 2020) that in the North and Northwest regions of Rio de Janeiro there are phytophysiognomies that are more intensely affected than others, with the Lowland SSF being the most affected. From a structural point of view, this physiognomy has a greater number of small forest patches; areas under edge effect, and greater distance between patches. This result confirms our central hypothesis that the region's physiognomies would be impacted differently, depending on the intensity of use and forms of land occupation.

The North and Northwest regions of Rio de Janeiro comprise large areas of priority for conservation and restoration. The creation of new CUs to protect the region's biodiversity is an urgent issue, given the large forest losses over time, mainly for the Lower Montane SSF, the predominant phytophysiognomy in the region.

It is important to consider that the region has an enormous environmental liability that can be converted into improvements in the conditions of the remaining forest patches and promotion of landscape connectivity. As mentioned previously, only the implementation of public policies aimed at restoring PPA and LR areas, mainly in lowland phytophysiognomies, would represent a 5% gain in vegetation cover, promoting greater landscape connectivity.

The quality of the remaining areas is compromised, considering that the majority have an area of less than five hectares. Furthermore, the regeneration processes in secondary vegetation are not completed, which compromises the restoration of these forest patches in the region. Therefore, the maintenance of forest patches of the Atlantic Forest in the North and Northwest of Rio de Janeiro must constitute an effort on three fronts: maintaining the standing mature forest; restoration of degraded areas, and the conservation secondary forest patches in regeneration, until they reach protection status, in accordance with the provisions of the Atlantic Forest law.

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References

ABREU, K. M. P. DE; BRAGA, J. M. A.; NASCIMENTO, M. T. Tree species diversity of coastal lowland semideciduous forest fragments in Northern Rio de Janeiro state, Brazil. **Biociencias Journal**, v. 30, n. 5, p. 1529–1550, 2014.

ALVARES, C. A. et al. Köppen's climate classification map for Brazil. **Meteorologische Zeitschrift**, v. 22, n. 6, p. 711–728, 2013.

ANDRÉ, R. G. B. et al. Identificação de regiões pluviometricamente homogêneas no Estado do Rio de Janeiro, utilizando-se valores mensais. **Revista Brasileira de Meteorologia**, v. 23, n. 4, p. 501–509, dez. 2008.

ANDRÉ, R. G.; MARQUES, V. DA S.; PINHEIRO, F. M. A. Water available to the Norte Fluminense Region. **Revista Brasileira de Agrometeorologia**, v. 13, n. 1, p. 135–142, 2005.

ARROYO-RODRÍGUEZ, V. et al. Designing optimal human-modified landscapes for forest biodiversity conservation. **Ecology Letters**, v. 23, n. 9, p. 1404–1420, 1 set. 2020.

ATHAYDE, S. et al. Viewpoint: The far-reaching dangers of rolling back environmental licensing and impact assessment legislation in Brazil. **Environmental Impact Assessment Review**, v. 94, p. 106742, 1 maio 2022.

BANKS-LEITE, C. et al. Using ecological thresholds to evaluate the costs and benefits of set-asides in a biodiversity hotspot. **Science**, v. 345, n. 6200, p. 1041–1045, 23 jul. 2014.

BARBOSA, L. G.; ALVES, M. A. S.; GRELLE, C. E. V. Actions against sustainability: Dismantling of the environmental policies in Brazil. **Land Use Policy**, v. 104, p. 105384, 1 maio 2021.

BEBBER, D. P.; BUTT, N. Tropical protected areas reduced deforestation carbon emissions by one third from 2000–2012. **Scientific Reports** v. 7, n. 1, p. 1–7, 25 out. 2017.

BOESING, A. L.; NICHOLS, E.; METZGER, J. P. Biodiversity extinction thresholds are modulated by matrix type. **Ecography**, v. 41, n. 9, p. 1520–1533, 1 set. 2018.

BOHN, L. et al. Susceptibilidade à desertificação no estado do Rio de Janeiro baseada em índices climáticos de aridez**.** Belém XVIII **C.B. Agrometeorologia**, 2013. Disponível em: <http://www.sbagro.org/files/biblioteca/3235.pdf>. Acesso em: 20 set. 2022

BRANCALION, P. H. S. et al. A critical analysis of the Native Vegetation Protection Law of Brazil (2012): updates and ongoing initiatives. **Natureza & Conservação**, v. 14, p. 1–15, 1 abr. 2016.

BRASIL. **Lei Nº 12.651, de 25 de Maio de 2012 - Código Florestal**. Disponível em: <http://www.planalto.gov.br/ccivil_03/_ato2011-2014/2012/lei/l12651.htm>. Acesso em: 20 mar. 2022.

BRITO, T. T. et al. Multivariate analysis applied to monthly rainfall over Rio de Janeiro state, Brazil. **Meteorology and Atmospheric Physics**, v. 129, n. 5, p. 469–478, 2017.

CABRAL, D. DE C.; FREITAS, S. R.; FISZON, J. T. Combining sensors in landscape ecology: imagery-based and farm-level analysis in the study of human-driven forest fragmentation. **Sociedade & Natureza**, v. 19, n. 2, p. 69–87, 2007.

CARVALHO, F. A.; BRAGA, J. M. A.; NASCIMENTO, M. T. Tree structure and diversity of lowland Atlantic forest fragments: comparison of disturbed and undisturbed remnants. **Journal of Forestry Research,** v. 27, n. 3, p. 605–609, 16 out. 2015.

CEPERJ. **Series Históricas Cana-de-açúcar - Área colhida Rio de Janeiro**. Disponível em: <http://arquivos.proderj.rj.gov.br/sefaz_ceperj_imagens/Arquivos_Ceperj/ceep/dados-estatisticos/series-historicas/excel/cope/1.1.2 Prod Agro - Agric. - Lav. Temporária/Tab 1.1.2.10.html>. Acesso em: 6 jun. 2022a.

CEPERJ. **Séries Históricas Efetivo pecuária – Bovinos 1974 a 2017**. Disponível em: http://arquivos.proderj.rj.gov.br/sefaz_ceperj_imagens/Arquivos_Ceperj/ceep/dados-estatisticos/series-historicas/excel/cope/1.2.0%20Prod%20Agro%20-%20Pecu%C3%A1ria/Tab%201.2.0.22.html. Acesso em: 6 jun. 2022b

CEPERJ. **Series Históricas Cana-de-açúcar-Quantidade produzida**. Disponível em: <http://arquivos.proderj.rj.gov.br/sefaz_ceperj_imagens/Arquivos_Ceperj/ceep/dados-estatisticos/series-historicas/excel/cope/1.1.2 Prod Agro - Agric. - Lav. Temporária/Tab 1.1.2.11.html>. Acesso em: 6 jun. 2022c.

CURTIS, P. G. et al. Classifying drivers of global forest loss. **Science**, v. 361, n. 6407, p. 1108–1111, 2018.

DE LIMA, R. A. F. et al. The erosion of biodiversity and biomass in the Atlantic Forest biodiversity hotspot. **Nature Communications 2020 11:1**, v. 11, n. 1, p. 1–16, 11 dez. 2020.

DEFRIES, R. et al. Increasing isolation of protected areas in tropical forests over the past twenty years. **Ecological Applications**, v. 15, n. 1, p. 19–26, 2005.

DIAS-FILHO, M. B. **Uso de Pastagens para a Produção de Bovinos de Corte no Brasil: Passado, Presente e Futuro. Embrapa Amazônia Oriental**, Belém - PA: [s.n.]. Disponível em: <https://www.infoteca.cnptia.embrapa.br/infoteca/bitstream/doc/1042092/1/DOCUMENTOS418.pdf>. Acesso em: 7 jun. 2022.

EMBRAPA. **Sistema Brasileiro de Classificação de Solos**. 5. ed. Brasília: EMBRAPA, 2018.

FERREIRA, M. D. P.; COELHO, A. B. Desmatamento Recente nos Estados da Amazônia Legal: uma análise da contribuição dos preços agrícolas e das políticas governamentais. **Revista de Economia e Sociologia Rural**, v. 53, n. 1, p. 91–108, 2015.

FORMAN, R. T. T.; GODRON, M. Patches and structural components for a landscape ecology. **BioScience**, v. 31, n. 10, p. 733–740, 1 nov. 1981.

FREITAS, S. R.; HAWBAKER, T. J.; METZGER, J. P. Effects of roads, topography, and land use on forest cover dynamics in the Brazilian Atlantic Forest. **Forest Ecology and Management**, v. 259, n. 3, p. 410–417, 25 jan. 2010.

GÖKYER, E. Understanding Landscape structure using landscape metrics. **Advances in Landscape Architecture**, 1 jul. 2013.

HADDAD, N. M. et al. Habitat fragmentation and its lasting impact on Earth ' s ecosystems. **Advancement of Science**, v. 1, n. March, p. 1–10, 2015.

IBGE. **Manual Técnico da Vegetação Brasileira. 2. ed. Rio de Janeiro: Instituto Brasileiro de Geografia e Estatística - IBGE, 2012. 1–271 p.**

IBGE. **Acesso e uso de dados geoespaciais**. 14. ed. Rio de Janeiro: IBGE, 2019. v. 14

IBGE. **Downloads | IBGE Bacias Hidrograficas do Brasil**. Disponível em: <https://www.ibge.gov.br/geociencias/downloads-geociencias.html?caminho=informacoes_ambientais/estudos_ambientais/bacias_e_divisoes_hidrograficas_do_brasil/2021/Divisao_Hidrografica_Nacional_DHN250/vetores/>. Acesso em: 27 maio. 2022.

IBGE. **Campos dos Goytacazes (RJ) | Cidades e Estados | IBGE**. Disponível em: <https://www.ibge.gov.br/cidades-e-estados/rj/campos-dos-goytacazes.html>. Acesso em: 24 jun. 2022a.

IBGE. **Indicadores para os objetivos de Desenvolvimento Sustentável.** Disponível em: <https://odsbrasil.gov.br/>. Acesso em: 25 jun. 2022b.

INEA. **Unidades de Conservação da Natureza no Estado do Rio de Janeiro**. Disponível em: <http://www.inea.rj.gov.br/cs/groups/public/documents/document/zwew/mdm4/~edisp/inea0038136.pdf>. Acesso em: 27 maio. 2022.

INEA, I. E. DO A. **GeoServer: visualização de camada - INEA**. Disponível em: <https://geoservicos.inde.gov.br/geoserver/web/wicket/bookmarkable/org.geoserver.web.demo.MapPreviewPage?2&filter=false>. Acesso em: 12 mar. 2022.

JOLY, C. A.; METZGER, J. P.; TABARELLI, M. **Experiences from the Brazilian Atlantic Forest: Ecological findings and conservation initiativesNew Phytologist**Blackwell Publishing Ltd, , 1 nov. 2014. Disponível em: <https://nph.onlinelibrary.wiley.com/doi/10.1111/nph.12989>. Acesso em: 19 jun. 2020

LAURANCE, W. F. et al. An Amazonian rainforest and its fragments as a laboratory of global change. **Biological Reviews**, v. 93, n. 1, p. 223–247, 1 fev. 2018.

LAURANCE, W. F.; VASCONCELOS, H. L. Consequencias ecológicas da fragmentação florestal na Amazônia. **Oecologia Brasiliensis**, v. 13, n. 3, p. 434–451, 2009.

LI, Y. et al. Deforestation-induced climate change reduces carbon storage in remaining tropical forests. **Nature Communications,** v. 13, n. 1, p. 1–13, 12 abr. 2022.

LIRA, P. K. et al. Land-use and land-cover change in Atlantic Forest landscapes. **Forest Ecology and Management**, v. 278, p. 80–89, 2012.

LOPES, E. R. DO N. et al. Losses on the Atlantic Mata vegetation induced by land use changes. **CERNE**, v. 24, n. 2, p. 121–132, 1 abr. 2018.

MCGARIGAL, K.; MARKS, B. J. FRAGSTATS: spatial pattern analysis program for quantifying landscape structure. **Gen. Tech. Rep. PNW-GTR-351. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 122 p**, v. 351, 1995.

METZGER, J. P. O que é ecologia de paisagens? **Biota Neotropica**, v. 1, n. 2, p. 1–9, 2001.

METZGER, J. P. et al. Time-lag in biological responses to landscape changes in a highly dynamic Atlantic forest region. **Biological Conservation**, v. 142, n. 6, p. 1166–1177, 1 jun. 2009.

METZGER, J. P. et al. Why Brazil needs its Legal Reserves. **Perspectives in Ecology and Conservation**, v. 17, n. 3, p. 91–103, 1 jul. 2019.

MITTERMEIER, R. A. et al. **Hotspots revisited**. Mexico: CEMEX, 2004.

NANNI, A. S. et al. The neotropical reforestation hotspots: A biophysical and socioeconomic typology of contemporary forest expansion. **Global Environmental Change**, v. 54, p. 148–159, 1 jan. 2019.

NEPSTAD, D. et al. Slowing Amazon deforestation through public policy and interventions in beef and soy supply chains. **Science**, v. 344, n. 6188, p. 1118–1123, 6 jun. 2014.

OLIVEIRA-JUNIOR, N. D. DE et al. Prioritizing landscape connectivity of a tropical forest biodiversity hotspot in global change scenario. **Forest Ecology and Management**, v. 472, p. 118247, 15 set. 2020.

OLIVEIRA, M. A.; SANTOS, A. M. M.; TABARELLI, M. Profound impoverishment of the large-tree stand in a hyper-fragmented landscape of the Atlantic forest. **Forest Ecology and Management**, v. 256, n. 11, p. 1910–1917, 20 nov. 2008.

PETRONI, M. L.; SIQUEIRA-GAY, J.; GALLARDO, A. L. C. F. Understanding land use change impacts on ecosystem services within urban protected areas. **Landscape and Urban Planning**, v. 223, p. 104404, 1 jul. 2022.

PIFFER, P. R. et al. Turnover rates of regenerated forests challenge restoration efforts in the Brazilian Atlantic forest. **Environmental Research Letters**, v. 17, n. 4, p. 45009, 2022.

PROJETO (MAPBIOMAS). **Coleção [6.0] da Série Anual de Mapas de Cobertura e Uso de Solo do Brasil - Metodologias MapBiomas**. Disponível em: <https://mapbiomas.org/visao-geral-da-metodologia>. Acesso em: 22 mar. 2022.

RESENDE, C. et al. From hotspot to hopespot : An opportunity for the Brazilian Atlantic Forest. **Perspectives in Ecology and Conservation**, v. 16, n. 4, p. 208–214, 2018.

REZENDE, C. L. DE et al. Atlantic Forest spontaneous regeneration at landscape scale. **Biodiversity and Conservation**, v. 24, n. August, p. 2255–2272, 2015.

RIBEIRO, M. C. et al. The Brazilian Atlantic Forest: How much is left, and how is the remaining forest distributed? Implications for conservation. **Biological Conservation**, v. 142, n. 6, p. 1141–1153, 1 jun. 2009.

ROCHA, É. T. DA S.; PONTES, C. DE A.; SIQUEIRA, R. **Campos dos Goytacazes Perfil 2018**. 1. ed. Rio de Janeiro: Pourbaix, Ana Raquel de S., 2018. v. 1

ROSA, M. R. et al. Hidden destruction of older forests threatens Brazil's Atlantic Forest and challenges restoration programs. **Science Advances**, v. 7, n. 4, 20 jan. 2021.

SANTOS, J. F. C. et al. Fragmentação florestal na Mata Atlântica: o caso do município de Paraíba do Sul, RJ, Brasil | Santos | **Revista Brasileira de Biociências**. Disponível em: <http://www.ufrgs.br/seerbio/ojs/index.php/rbb/article/view/3758/1367>. Acesso em: 17 abr. 2022.

SCARANO, F. R.; COSTA, D. P.; FREITAS, L.; LIMA, H. C.; MARTINELLE, G.; NASCIMENTO, M. T.; SÁ, C. F. C.; SALGUEIRO, F.; ARAUJO, D. S. D.; RAÍCES, D. S. L. Conservação da flora do Estado do Rio de Janeiro: até onde a ciência pode ajudar. In: BERGALLO, H. G.; FIDALGO, E. C. C.; ROCHA, C. F. D.; UZÊDA, M. C.; COSTA, M. B.; ALVES, M. A. S.; VAN SLUYS, M.; SANTOS, M. A.; COSTA, T. C. C.; COZZOLINO, A. C. R. (Ed.). . **Estratégias e ações para conservação da biodiversidade no estado do Rio de Janeiro.** 1. ed. Rio de Janeiro: Instituto Biomas & Secretaria do Estado de Ambiente/INEA, 2009. p. 221–233.

SILVA, M. D. DA; FEARNSIDE, P. M. Brazil: environment under attack. **Environmental Conservation**, p. 1–3, 2022.

SILVA JUNIOR, C. H. L. et al. Benchmark maps of 33 years of secondary forest age for Brazil. **Scientific Data**, v. 7, n. 1, p. 1–9, 2020.

SILVA, M.; DE ANDRADE, T.; SOUZA, O. **Aspectos dos problemas ambientais da região noroeste do estado do Rio de Janeiro, brasil: um estudo de caso**. Disponível em: <http://observatoriogeograficoamericalatina.org.mx/egal12/Procesosambientales/Impactoambiental/53.

pdf>. Acesso em: 20 set. 2022.

SOFFIATI NETTO, A. A. Breve estudo de eco-história sobre a utilização humana das florestas estacionais do norte-noroeste entre os períodos colonial e republicano. **Revista Vértices**, v. 13, n. 2, p. 7–30, 2011.

STRASSBURG, B. B. N. et al. When enough should be enough: Improving the use of current agricultural lands could meet production demands and spare natural habitats in Brazil. **Global Environmental Change**, v. 28, n. 1, p. 84–97, 1 set. 2014.

STRASSBURG, B. B. N. et al. The role of natural regeneration to ecosystem services provision and habitat availability: a case study in the Brazilian Atlantic Forest. **Biotropica**, v. 48, n. 6, p. 890–899, 1 nov. 2016.

TEAM, D. **QGIS Geographic Information System**. Open Source Geospatial Foundation Project. http://qgis.osgeo.orgOpen Source Geospatial Foundation Project., , 2022. Disponível em: <http://qgis.osgeo.org>

TEAM, R. C. **R: A language and environment for statistical computing. R Foundation for Statistical Computing.** Vienna, Austria R Foundation for Statistical Computing, 2021. Disponível em: <https://www.r-project.org/.>

VALE, M. M. et al. The COVID-19 pandemic as an opportunity to weaken environmental protection in Brazil. **Biological Conservation**, v. 255, p. 108994, 1 mar. 2021.

VANCINE, M. **Script / script_landscapemetrics.R · master · GeoCastBrasil / LandScapeMetrics · GitLab**. Disponível em: <https://gitlab.com/geocastbrasil/landscapemetrics/-/blob/master/01_script/script_landscapemetrics.R>. Acesso em: 23 mar. 2021.

VILLELA, D. M. et al. Effect of selective logging on forest structure and nutrient cycling in a seasonally dry Brazilian Atlantic forest. **Journal of Biogeography**, v. 33, n. 3, p. 506–516, 1 mar. 2006.

WANDERLEY, R. L. N. et al. Relationship between land surface temperature and fraction of anthropized area in the Atlantic forest region, Brazil. **PLOS ONE**, v. 14, n. 12, p. e0225443, 1 dez. 2019.

WILSON, M. C. et al. Habitat fragmentation and biodiversity conservation: key findings and future challenges. **Landscape Ecology**, v. 31, n. 2, p. 219–227, 1 fev. 2016.

Supplementary links:

Suplemento 1

https://docs.google.com/document/d/10ARnJFOq-I9dzNqcn5t2-Eiyc_z2Ro7z/edit?usp=sharing&ouid=107837079258265063119&rtpof=true&sd=true

Suplemento 2

https://docs.google.com/document/d/12Y-K5Ps6MgruCN4-5YSr7taAuXZ-5JyI/edit?usp=share_link&ouid=107837079258265063119&rtpof=true&sd=true

Suplemento 3

https://docs.google.com/document/d/12UgUR9MqgFu6UKG3_puRNMxWAB1pKFRi/edit?usp=share_link&ouid=107837079258265063119&rtpof=true&sd=true

Suplemento 4

https://docs.google.com/document/d/12Wob3PQcXvsAbQpiq4XdWfa_tYdYoJ2_/edit?usp=share_link&ouid=107837079258265063119&rtpof=true&sd=true

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AMBIENTE & SOCIEDADE 25 anos años years

SciELO

Impactos das mudanças de uso e cobertura da terra em fitofisionomias da Mata Atlântica

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São Paulo. Vol. 27, 2024

Artigo Original

Resumo: Avaliamos a paisagem das regiões Norte e Noroeste fluminense determinando as mudanças na cobertura florestal por fitofisionomia, utilizando a coleção 6 do MapBiomas (1985-2020). Trabalhamos no ambiente R e no QGIS. Entre as fitofisionomias, as Florestas de Terras Baixas apresentaram maior perda de área até 1985 (93%), tornando-se altamente fragmentadas e isoladas na paisagem. Entre 1985 e 2020, houve redução nas perdas de cobertura florestal. Entretanto, este resultado é fruto do balanço dos ganhos de vegetação secundária que mascaram as perdas de vegetação madura, com prejuízos para biodiversidade. O principal promotor da perda de vegetação foi a agropecuária e atualmente menos de 8% da vegetação está protegida. A procrastinação na criação de Unidade Conservação e restauração das Áreas de Proteção Permanente trará consequências sérias e negativas para a conservação da vegetação nas regiões Norte e Noroeste fluminense.

Palavras-chave: Fragmentação; Florestas tropicais; Fisionomias; Métricas de paisagem; Conservação.

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Impactos de los cambios en el uso y la cobertura del suelo en las fitofisonomía del Bosque Atlántico

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São Paulo. Vol. 27, 2024

Artículo Original

Resumen: Evaluamos el paisaje de la región Norte y Noroeste de Río de Janeiro, determinando los cambios en la cobertura forestal por fitofisonomía, utilizando la colección MapBiomas 6. Trabajamos en ambiente R y en QGIS. Entre las fitofisonomías, los Bosques de Tierras Bajas presentaron mayores pérdidas de área hasta 1985 (93%), volviéndose altamente fragmentados y aislados en el paisaje. Entre 1985 y 2020, hubo poca pérdida de cobertura forestal. Sin embargo, este resultado es el resultado del balance de ganancias de vegetación secundaria que cubre las pérdidas de vegetación madura, con pérdidas para la biodiversidad. El principal impulsor de la pérdida de vegetación fue la agricultura y la ganadería y actualmente menos del 8% de la vegetación está protegida. El retraso en la creación de las UC y la restauración de las APP tendrá graves y negativas consecuencias para la conservación de la vegetación de la región.

Palabras-clave: Fragmentación; Bosques tropicales; Fisonomías; métricas del paisaje; Conservación.