

FLORISTIC-STRUCTURAL CHARACTERIZATION OF DEGRADED FOREST IN THE ARC OF DEFORESTATION, BRAZILIAN AMAZON

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Resumo

Caracterização florística-estrutural de floresta degradada no arco do desmatamento, Amazônia Brasileira. Este estudo teve por objetivo caracterizar os aspectos florísticos-estruturais e a distribuição de biomassa acima do solo (AGB) de florestas degradadas localizadas no arco do desmatamento, Sul da Amazônia brasileira. Além da caracterização da floresta como um todo, análises em nível de unidades amostrais foram estabelecidas. Dados de inventário florestal subsidiaram as estimativas de biomassa, bem como a análise florístico-estrutural. Foram levantadas parcelas de 2.500 m² (50 x 50m), diâmetro a altura do peito (DAP >10cm) e altura total (HT) das árvores. A floresta demonstrou alta concentração de espécies distribuídas em poucas famílias botânicas e número elevado de espécies localmente raras. As unidades amostrais apresentaram similaridade florística, identificáveis pela análise de agrupamento. Em contrapartida, demonstraram diferenças estruturais significativas baseada nas variáveis DAP e HT. A estimativa de AGB para a área foi 215,20 Mg ha⁻¹ (± 83,73 Mg ha⁻¹). Esses resultados contribuem para melhor compreender as mudanças nas formações florestais relacionadas à degradação florestal, no Sul da Amazônia brasileira, bem como, para a definição de estratégias de conservação e restauração de florestas degradadas.

Palavras-chave: Inventário florestal, Floresta Estacional Perenifólia, Mato Grosso.

Abstract

The purpose of this study was to characterize the floristic-structural aspects and the distribution of aboveground biomass (AGB) of degraded forests located in the arc of deforestation, southern Brazilian Amazon. In addition to characterizing the forest as a whole, analyses at the level of sampling units were established. Forest inventory data provided support to biomass estimates, as well as floristic-structural analysis. A survey was carried out, collecting from plots of 2,500 m² (50 x 50m) diameter at breast height (DBH >10cm) and total height (HT) of the trees. The forest showed a high concentration of species distributed in a few botanical families and a high number of locally rare species. The sampling units showed floristic similarity, identifiable by cluster analysis. On the other hand, they showed significant structural differences based on the DBH and HT variables. The AGB estimate for the area was 215.20 Mg ha⁻¹ (± 83.73 Mg ha⁻¹). Those results contribute to better understanding the changes in forest formations related to forest degradation in the southern Brazilian Amazon, as well as to the definition of conservation and restoration strategies for degraded forests.

Keywords: Forest inventory, Seasonal Evergreen Forest, Mato Grosso.

INTRODUCTION

Tropical forests are being impacted by forest degradation due to different disturbance processes, such as selective logging and forest fires (ARAGÃO *et al.*, 2014; MATRICARDI *et al.*, 2020). These degradation processes generate changes in biomass and reduce the ability of forests to store carbon, which retain an average of 40% less carbon than undisturbed forests (BERENGUER *et al.*, 2014). A degraded forest is characterized by having the provision of its ecosystem goods and services reduced, and, unlike deforestation, in which the cover is converted to other uses than the original one, degradation does not present complete conversion of the forest cover into another use of the land (MATRICARDI *et al.*, 2020). Reductions in goods and services can appear differently depending on the type and location of the forest, intensity and extent of degradation, according to the degradation process or their combined action (ARAGÃO *et al.*, 2014), so specific monitoring approaches are needed on a regional scale (MITCHELL *et al.*, 2017), in order to propose mitigation strategies aimed at the causes and effects of forest degradation.

Changes in forests caused by the processes of degradation by selective logging and fire can become visible from changes in forest canopies, identifiable from changes in aboveground biomass (AGB) and by the floristic-structural composition of the vegetation (MITCHELL *et al.*, 2017). This is possible, since the changes resulting from the practice of selective logging, which corresponds to the exploration of individuals with larger and commercially attractive diameters, are not limited to the selected trees, impacting the forest through the infrastructures installed for the extraction and transport of the wood, while fire can reach individuals with different diameters depending on its intensity (PEARSON; BROWN; CASARIM, 2014).

In this way, the impacts of degradation can be assessed not only from changes in biomass stocks, since characteristics such as forest structure and composition are altered and disturbed primary forests become increasingly similar to secondary forests (BERENGUER *et al.*, 2014), mainly in relation to aspects of diameter distribution (DUARTE *et al.*, 2018). Secondary forests are the result of a natural regeneration process, after a history of total suppression of primary vegetation (SILVA JUNIOR *et al.*, 2020). Duarte *et al.* (2018) sought to establish the floristic and structural patterns of degraded primary forest and secondary forest in the Southeast Pará mesoregion and identified, among other results, that for individuals with DBH>10, individual density, richness and basal area were statistically similar in areas of medium secondary forest and degraded primary forest.

The characterization of the structure and floristic composition of forest formations can be carried out by different evaluation methods and parameters, such as richness, diversity, abundance, dominance, frequency, importance value and cover, and are of critical importance in plans for the recovery and preservation of degraded forests (CHAVES *et al.*, 2013). Studies that sought to characterize the floristic and structural composition of forest formations are not rare for the Brazilian Amazon, however, according to Kunz *et al.* (2014) the southern portion of the Amazon, located in the arc of deforestation in the State of Mato Grosso, is still little acknowledged. Among the studies available in the bibliography, Ivanauskas *et al.* (2008) proposed the phytogeographic classification of the forest of the Upper Xingu River (Evergreen Seasonal Forest) and demonstrated the physiognomic and florist differences between these forest and other rainforest and seasonal forests. Kunz *et al.* (2008, 2010, 2014) sought to describe the floristic composition and phytosociological structure of arboreal components in sections of the Seasonal Evergreen Forest in the municipality of Querência-MT. Studies that sought to characterize degraded forests in the southern Brazilian Amazon are not identified in the literature.

Regarding biomass, the average value for open forests in the southern Brazilian Amazon, determined from allometric equations by Nogueira *et al.* (2008), was equivalent to 266.6 Mg ha⁻¹. Dense forests in the southern Amazon region can have biomass values ranging from 286.8 Mg ha⁻¹ (NOGUEIRA *et al.*, 2008) up to 533 Mg ha⁻¹ (CUMMINGS *et al.*, 2002).

The guiding question of this study is: what are the effects of forest degradation on the floristic composition, structure and biomass of forests subjected to these processes? The hypothesis is that the floristic-structural characterization of degraded forests can help in understanding the effects of degradation processes on forest composition, structure and biomass. Therefore, the aim of this study was to characterize the floristic-structural aspects and aboveground biomass distribution of forests in the southern Brazilian Amazon, arc of deforestation, subjected to degradation processes by fire and selective logging.

MATERIAL AND METHODS

Study area

The study area corresponds to a region of the arc of deforestation of the Brazilian Amazon, located in the State of Mato Grosso, more specifically in the municipalities of Feliz Natal and Cláudia (Figure 1). These municipalities are part of the Sinop micro-region and belong to the area of influence of the BR-163 highway, whose economy is based on highly productive and mechanized agribusiness focused on the production of soy, corn, cotton and beef for export. The region is also known for unsustainable and often illegal logging, as well as forest degradation processes (MATRICARDI *et al.*, 2020).

The study area is located on the ecological tension limit, that is, the contact area between the Seasonal Forest and the Ombrophyllous Forest. The vegetation in the study area can be classified as Seasonal Evergreen Forest, which, although it has different climatic periods, has little leaf deciduousness in the dry season, the period of greatest criticality (IVANAUSKAS *et al.*, 2008; IBGE, 2023). The submontane formation occurs especially in the Alto Rio Xingu (Upper Xingu River) region, where the altitude varies between 300 and 450 m. The structure and physiognomy of the Seasonal Evergreen Forest are quite variable, ranging from complex structures with high species diversity to less complex structures with low diversity and species with low commercial value (IVANAUSKAS *et al.*, 2008). It presents itself as a vegetation mosaic, where the community assumes different structural variations (KUNZ *et al.*, 2010). The Seasonal Evergreen Forest is one of the most threatened types of forest in the Amazon, mainly due to deforestation and forest degradation (KUNZ *et al.*, 2014).

The climate in the region, according to the Köppen classification, is type Aw (Tropical Climate with Dry Season in winter), with average temperatures in the coldest month above 18°C and annual variations in precipitation between 1200 and 2000 mm (ALVARES *et al.*, 2013). The dry season goes from May to September, while the wet season runs from October to April. The predominant soil in the region is the Dystrophic Red Latosol, with soils in an advanced stage of weathering, with good viability for agricultural crops and associated with land with low slope. The region is formed by sedimentary deposits and is part of the geomorphological unit called “surface of the Alto Rio Xingu (Upper Xingu River)” (IBGE, 2017).

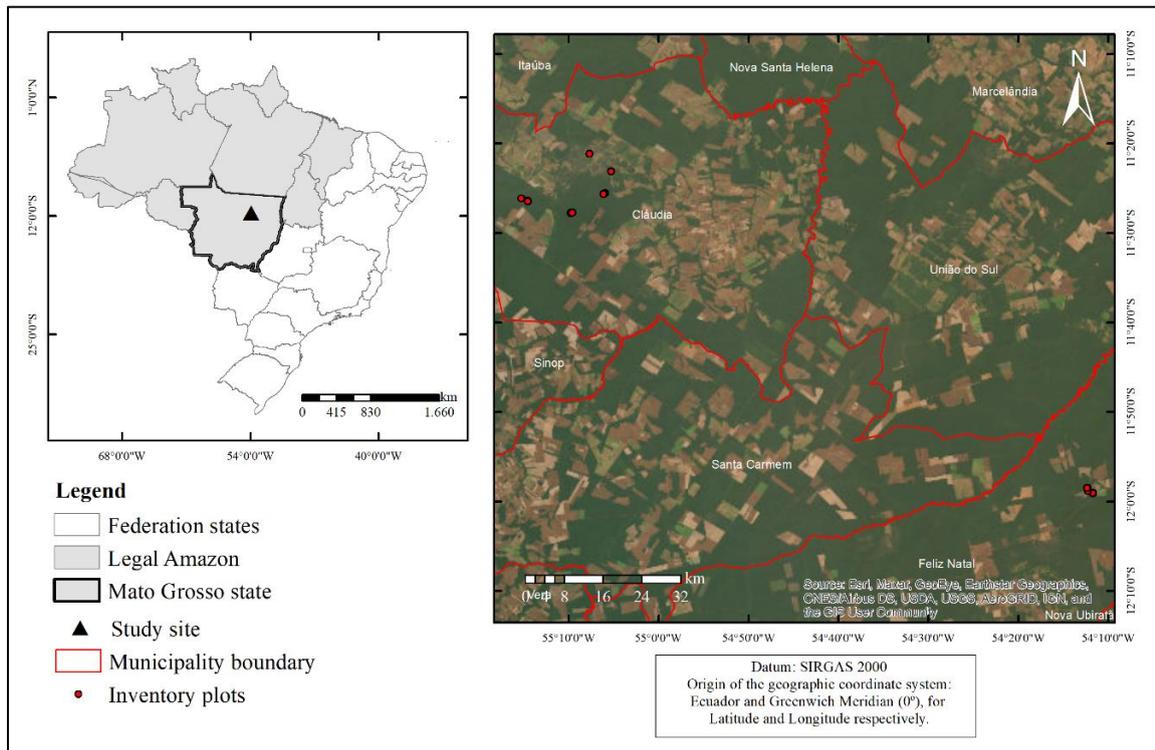


Figure 1. Location of the study area and positioning of the inventory plots.

Figura 1. Localização da área de estudo e posicionamento das parcelas de inventário.

Data and Methodological Approach

The main methodological procedures used in this study are summarized in Figure 2.

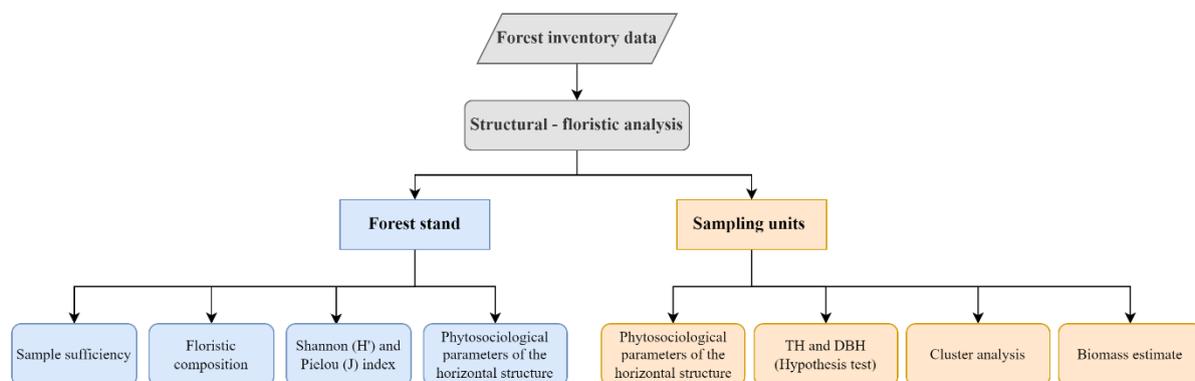


Figure 2. Flowchart of methodological procedures used in this study.

Figura 2. Fluxograma dos procedimentos metodológicos usados neste estudo.

Forest Inventory and Floristic-Structural Analysis

The data for this study were obtained from a forest inventory conducted in 2017. 17 temporary plots measuring 50x50 m (0.25 ha) were inventoried in areas degraded by fire and selective logging. Data on diameter at breast height (DBH) of trees with DBH greater than or equal to 10 cm and visual estimates of the total height in meters of all inventoried trees were obtained. Standing dead individuals were included in the sampling and in the biomass estimates, but excluded from the floristic-structural analysis. The plots were geographically positioned with the aid of a GPS (Global Positioning System) accuracy using the DGPS positioning technique (Differential GPS) and GPS navigation. The botanical determination of the species was carried out in the field using a local identifier, regarding its common and scientific name. Information on the basic density of the wood (g cm^{-3}) of all inventoried individuals were obtained from the literature (PHILLIPS *et al.*, 2019).

The analyses related to the floristic-structural variation of the vegetation were carried out at two levels.

The first deals with the characterization of the forest as a whole; the second deals with the characterization of the sample units separately. The sampling sufficiency of the inventory data was evaluated using the species-area curve method, which uses the graphical element of the 'species x area sampled' relationship, a technique to assess the degree of effectiveness of sampling in a forest survey (VIBRANS *et al.*, 2020). The saturation point of the cumulative number of species was determined by visual analysis of the curve. The floristic composition was analyzed based on the distribution of individuals in species and families and on the Shannon-Weaver diversity (H') and Pielou evenness (J) indices. The importance value index (IVI) and coverage index (IVC) were calculated from the sum of the relative values of the phytosociological parameters.

The 10 families and forest species with the highest IVI were ranked and discussed. The diameter structure was characterized by means of distributions of the number of trees by diameter class, adopting a class interval of 12 cm.

The characterization of the sampling units was based on the description of the variables obtained by the forest inventory and by the floristic-structural analysis at the plot level. The HT and DBH variables were used to characterize the structure of the sampling units and to test the hypothesis that there are significant differences between them, based on the Kruskal-Wallis non-parametric test, since the sampling units were obtained in two municipalities. In addition, the sampling units were compared using the Jaccard Similarity Index (SJ), which expresses the similarity between environments, based on the number of common species. The resulting Jaccard floristic similarity matrix was used for cluster analysis, using the Unweighted Pair-Group Method with Arithmetic Mean (UPGMA).

Biomass estimate

The biomass of the plots was estimated by the indirect method, using the global allometric equation of Chave *et al.* (2005), which uses the DBH, HT and the basic density of the wood (ρ) as independent variables (Equation 1). The equation proposed by Chave *et al.* (2005), aimed to improve the quality of tropical biomass estimates and bring consensus on the contribution of tropical forests to the global carbon cycle. The equation was tested by Nogueira *et al.* (2008) for the southern Brazilian Amazon and found that the model accurately estimated both the biomass of the trees sampled and the normalized biomass per hectare.

$$\text{AGB estimated} = \text{EXP}(-2.977 + \ln(\rho * \text{DBH}^2 * \text{H})) \quad (1)$$

in which: AGB estimated in kg, DBH is given in cm, basic density (ρ) in g cm^{-3} and total height (H) in meters. Standard error in biomass estimation of 12.5% and R^2 0.989 (CHAVE *et al.*, 2005).

RESULTS

Forest Characterization

In the total sampled area, 2,404 tree individuals were found, belonging to 136 species (S) and 44 botanical families. Out of this total, 21 individuals were dead and were not identified. The graphic representation of the relationship between the number of species and the sampling area resulted in a standard curve (Figure 3), which allowed verifying the sample sufficiency.

Species diversity was assessed using the Shannon-Weaver index (H'), which was equivalent to 3.9. The Pielou evenness index (J) was 0.79. The total forest density and absolute dominance was $560.71 \text{ ind ha}^{-1}$ and $24.84 \text{ m}^2 \text{ ha}^{-1}$, respectively. The ten botanical families and the ten species with the highest importance indices are shown in Figure 4.

Out of the total number of individuals surveyed, approximately 74% (1,775) belong to the listed families. As for species richness, the families with the highest number of species were Fabaceae (23), Moraceae (10), Melastomataceae (9), Annonaceae (7), Lauraceae (6) and Sapotaceae (6); together these six families comprised 45% of the total number of inventoried species (136). Although few families have a considerable number of species, 17 families (38.6%) contributed with only one species each, representing the locally rare species.

Figure 4 also presents, in descending order, the species with the highest IVI. Together, the five species with the highest IVI comprised 44% of the inventoried individuals (2,383). Another 40 species (approximately 30% of the total) contributed with a maximum of two individuals each. This fact indicates that the inventoried areas are or have gone through the process of degradation by anthropic actions, modifying the local phytosociology.

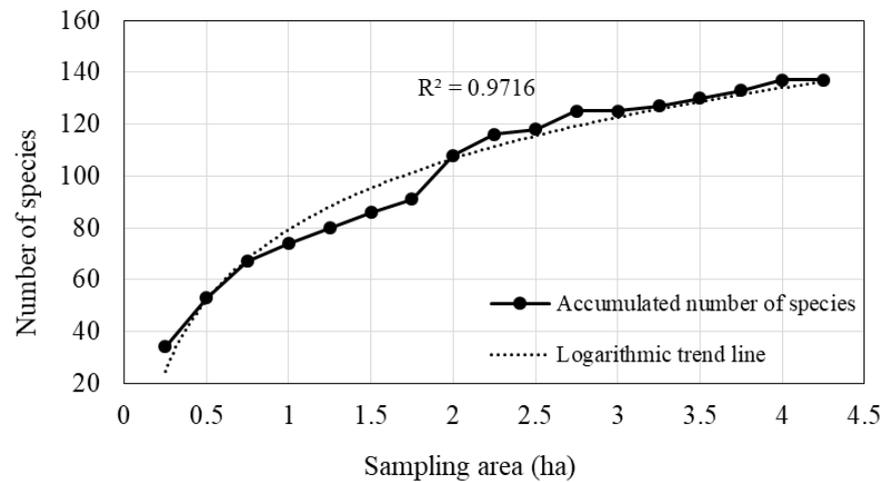


Figure 3. Curve of the accumulated number of species per unit area.
Figura 3. Curva do número acumulado de espécie por área.

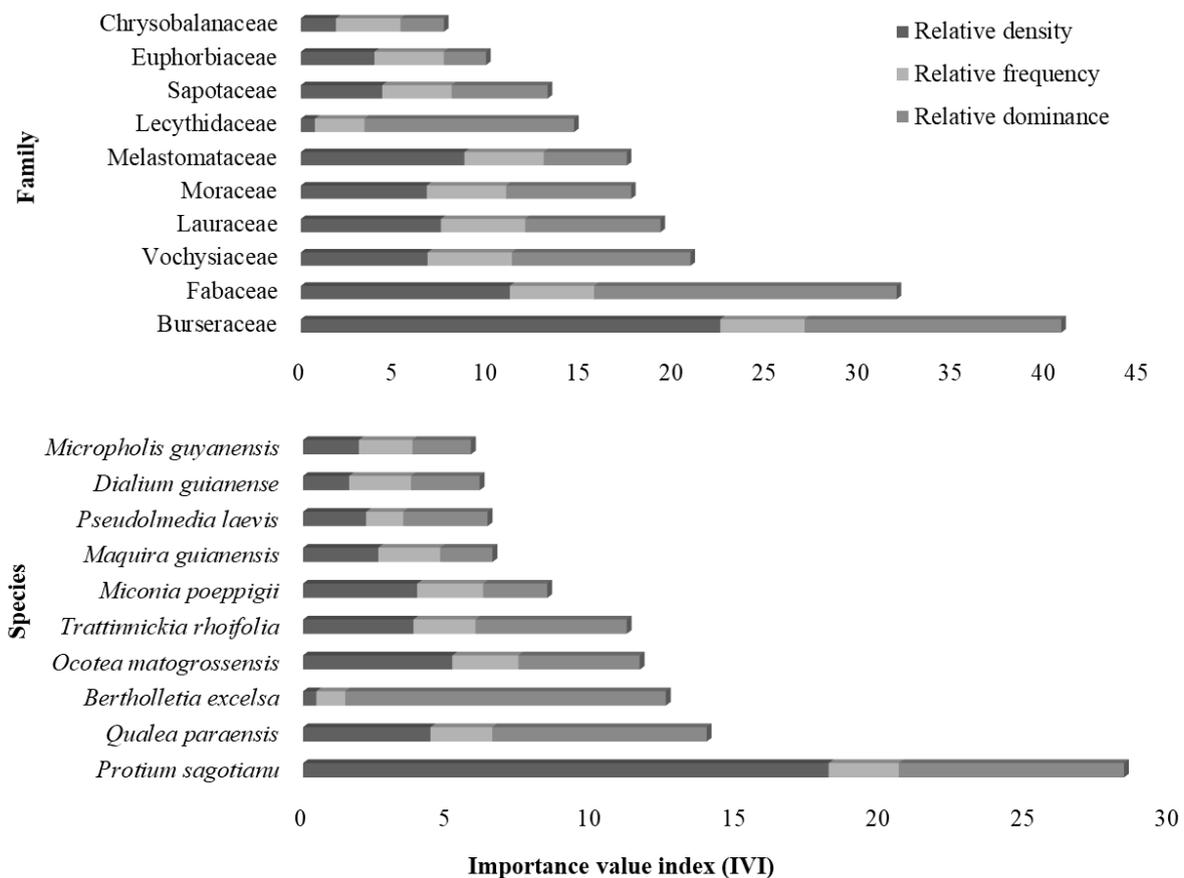


Figure 4. Families and species with higher IVI (importance value index) values.
Figura 4. Famílias e espécies com os maiores valores de IVI (índice de valor de importância).

The diameter distribution of the forest (Figure 5) followed the usual pattern for uneven-aged forests, commonly known as inverted-J, which is characterized by a higher frequency of individuals in the smaller diameter classes. About 90% of the individuals were concentrated in the first diameter classes, up to the approximate limit of 34 cm DBH.

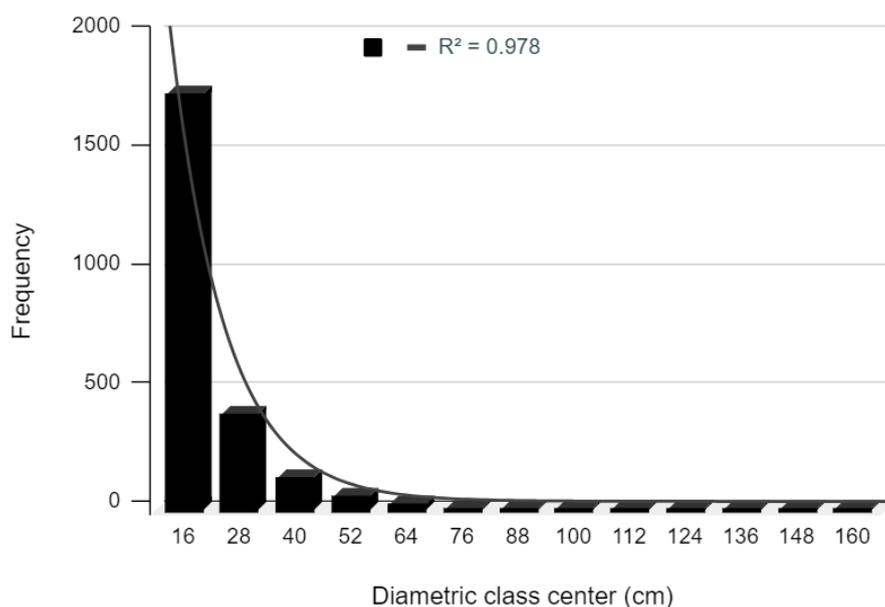


Figure 5. Diameter distribution of the sampled individuals in the forest inventory.

Figura 5. Distribuição diamétrica dos indivíduos amostrados no inventário florestal.

Characterization of sampling units (SU)

Table 1 presents, for each SU, the total number of individuals sampled, DeA, DoA, basal area (G), HT (average), DBH (average), species richness (S) and estimated biomass in each plot. The Kruskal-Wallis non-parametric test showed that the structure of the SU, represented by the HT and DBH variables, showed significant differences at 5% confidence.

Table 1. Floristic-structural attributes and estimated biomass of sampling units.

Tabela 1. Atributos florístico-estruturais e biomassa estimada das unidades amostrais.

| SU | N | DeA (N ha ⁻¹) | G (m ²) | DoA (m ² ha ⁻¹) | Average HT (m) | Average DBH (cm) | S | AGB (Mg) |
|----|-----|------------------------------|------------------------|---|----------------------|------------------------|----|-------------|
| 1 | 131 | 524 | 4.97 | 19.88 | 13.05 | 19.21 | 34 | 35.773 |
| 2 | 121 | 484 | 4.95 | 19.81 | 14.34 | 20.12 | 42 | 38.357 |
| 3 | 147 | 588 | 5.61 | 22.45 | 12.66 | 18.01 | 39 | 38.328 |
| 4 | 131 | 524 | 5.99 | 23.98 | 15.97 | 21.36 | 45 | 50.234 |
| 5 | 149 | 596 | 5.92 | 23.68 | 14.35 | 19.51 | 42 | 48.278 |
| 6 | 163 | 652 | 4.26 | 17.05 | 12.93 | 16.56 | 40 | 29.030 |
| 7 | 164 | 656 | 5.23 | 20.93 | 14.30 | 17.77 | 38 | 36.880 |
| 8 | 136 | 544 | 6.20 | 24.80 | 11.83 | 19.05 | 49 | 58.331 |
| 9 | 120 | 480 | 10.89 | 43.54 | 14.38 | 23.80 | 47 | 120.236 |
| 10 | 154 | 616 | 7.00 | 27.99 | 15.78 | 20.32 | 38 | 58.438 |
| 11 | 168 | 672 | 6.67 | 26.66 | 14.68 | 19.39 | 51 | 57.711 |
| 12 | 160 | 640 | 6.45 | 25.81 | 14.49 | 19.37 | 40 | 61.125 |
| 13 | 159 | 636 | 7.54 | 30.15 | 14.64 | 20.63 | 52 | 66.816 |
| 14 | 168 | 672 | 7.08 | 28.31 | 14.39 | 20.05 | 54 | 56.561 |
| 15 | 145 | 580 | 7.56 | 30.22 | 15.50 | 22.22 | 45 | 72.067 |
| 16 | 158 | 632 | 6.18 | 24.72 | 13.96 | 20.09 | 40 | 41.918 |
| 17 | 9 | 36 | 3.07 | 12.30 | 15.01 | 46.77 | 5 | 44.428 |

N is the number of individuals; DeA is absolute density; DoA is absolute dominance; G is the basal area; HT is total height; DBH: is the diameter at breast height; S is the richness – number of species, and; AGB is Aboveground Biomass.

The estimated AGB values for each sampling unit ranged from 29.03 Mg to 120.24 Mg. The average estimated AGB for the area is 215.20 Mg ha⁻¹ and the standard deviation (S) is 83.73 Mg ha⁻¹. Considering that the carbon content in the vegetation of the Brazilian Amazon is approximately 47% (IPCC, 2019), that is, 47% of the dry biomass is composed of carbon, the average carbon is 101.14 ton ha⁻¹ (S = 36.84 Mg ha⁻¹).

The dendrogram in Figure 6 represents the result of the pair-group analysis (UPGMA) based on the Jaccard similarity indices. The indices ranged from 0.04 to 0.49, with the greatest similarity occurring between plots 4 and 5. The dendrogram indicated the formation of two groups of similar sampling units. Only plot 17 was not grouped into these groups because it does not show floristic similarity. Group 1 is formed by plots 8, 9, 10, 11, 12, 13, 14, 15 and 16, while group 2 is formed by plots 1, 2, 3, 4, 5, 6 and 7. Sampling unit 17, although it differed from the others in the analysis of floristic similarity, when the AGB value was evaluated, it was similar to the others. On the other hand, plot 9, even with higher AGB values, presents structural floristic characterization similar to the others.

The pair groups corresponded exactly to the geographic location of the sampling units. The plots of group 1 were surveyed in the municipality of Cláudia-MT, while group 2 in the municipality of Feliz Natal - MT, thus demonstrating the spatial variability and heterogeneity of the Seasonal Evergreen Forest. The ungrouped plot (17) is located in the municipality of Cláudia - MT.

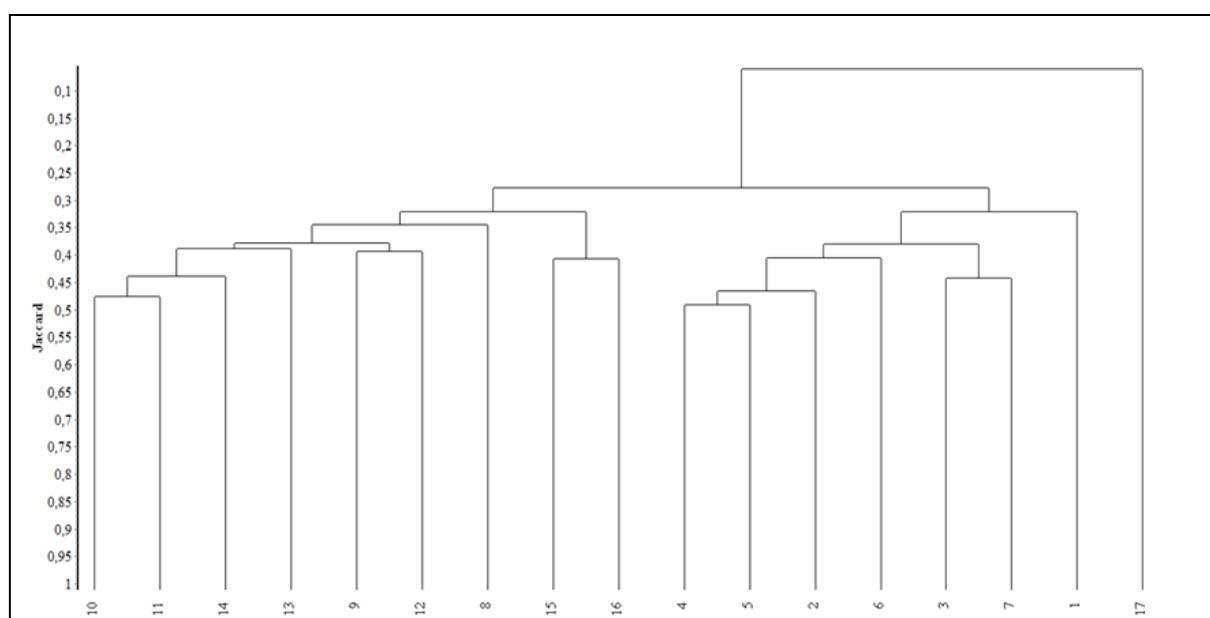


Figure 6. Dendrogram generated from the Jaccard similarity index between sampling units.

Figura 6. Dendrograma gerado a partir do índice de similaridade de Jaccard entre as unidades amostrais.

DISCUSSION

The sampling sufficiency curve indicated a stabilization trend from 4.0 ha sampled. Characteristically, the curve rises quickly and tends to stabilize as the addition of new species does not significantly change the number of observed species. In addition, the stabilization of the curve is an indication of the cost-benefit ratio between the sampling effort and the registration of new species (VIBRANS *et al.*, 2020). It is common knowledge that inventories in the Brazilian Amazon require high sampling intensity due to floristic heterogeneity, however, the addition of new species can extend to large areas, making this step unfeasible due to the operational and technical costs involved in data collection.

The Shannon (H') (3.9) and Pielou (J') (0.79) indices indicated the stabilized and balanced representativeness of the individuals present in the sampled area. For the same vegetation type, Kunz *et al.* (2008) got a 3.17 H' and a 0.81 J' . In the Tapajós National Forest, represented by the Dense Ombrophylous Forest affected by fire, the H' values found by Andrade *et al.* (2020) varied between 4.27 and 4.38 before and after the fire, respectively. In degraded forests in Southeastern Pará, results similar to those found in this study were identified by Duarte *et al.* (2018), being H' 3.88 and J' 0.81. In area of Dense Ombrophylous Forest under forest management, in the municipality of Portel - Pará, the average of the H' and J' index was 3.82 and 0.84, respectively (RAMOS *et al.*, 2019).

The Burceraceae family, with the highest IVI, is represented in the study area by three species, the *Protium*

sagotianum being the more representative species in number of individuals (433), contributing to the high value of importance of the family and also of the species. The species of the *Protium* genus are popularly known as “breus” (rosins); they are trees or shrubs, quite representative in the Amazon region (KUNZ *et al.*, 2010) and their use is related to the use of resins. The high number of families and species with low density indicate the presence of locally rare species. According to Andrade *et al.* (2020) changes in the floristic composition of a primary forest generated over time after the incidence of fires are defined, mainly, by the inflow and outflow of locally rare species. This characteristic associated with the occurrence of few species with high density increases the risks of human actions leading to the extinction of species with low abundance (ANDRADE *et al.*, 2020).

The richness of the Fabaceae family was evidenced by Kunz *et al.* (2008) in the Seasonal Evergreen Forest (Querência-MT). In the same region, Kunz *et al.* (2010) showed the richness of Annonaceae and Lauraceae families. In other stretches of the Amazon, the Fabaceae family also stood out, as in the Tapajós National Forest (Pará) (GONÇALVES; SANTOS, 2008). For Dense Ombrophylous Forest affected by fire (Tapajós National Forest - Pará), the families Fabaceae, Sapotaceae, Lecythidaceae, Moraceae and Annonaceae, in this order, presented greater species richness (ANDRADE *et al.*, 2020). In Dense Ombrophilous Forest under forest management in the municipality of Portel, Pará, the families Fabaceae, Lecythidaceae and Sapotaceae were those that obtained the highest importance values and the greatest representation of individuals (RAMOS *et al.*, 2019). The Fabaceae family frequently appears in studies of degraded and secondary forests in the Amazon rainforest (DUARTE *et al.*, 2018), confirming the results observed in this study.

The total forest density (560.71 ind ha⁻¹) was similar to that obtained by Ivanauskas *et al.* (2004) for the same forest typology, where the average density of individuals was 546 ind ha⁻¹. Whereas Kunz *et al.* (2010), when comparing two portions of Seasonal Evergreen Forest, one altered and the other preserved, found higher densities, 909 ind ha⁻¹ and 772 ind ha⁻¹, respectively. The authors report that such values may be related to secondary succession, typical of forests that have experienced disturbance. For primary forests affected by fire in the Eastern Amazon, Andrade *et al.* (2020) identified an average value of 1,120 ind ha⁻¹.

The average of absolute dominance (24.84 m² ha⁻¹) was comparable to the values verified in portions of the Seasonal Evergreen Forest in Mato Grosso, which ranged from 18.63 m² ha⁻¹ (IVANAUSKAS *et al.*, 2004), 24.77 m² ha⁻¹ (KUNZ *et al.*, 2008) at 25.80 (KUNZ *et al.*, 2010). In the Tapajós National Forest, subjected to selective logging, the result was also similar, 22.5 m² ha⁻¹ (GONÇALVES; SANTOS, 2008). A value higher than these was verified for primary forests affected by fire in the Eastern Amazon: 29.98 m² ha⁻¹ (ANDRADE *et al.*, 2020).

The shape obtained from the diameter distribution curve (Figure 5) suggests a self-regenerating community, with a balance between mortality and recruitment of individuals in the forest and, from a production standpoint, it indicates the stock of wood available in the different diameter classes (GONÇALVES; SANTOS, 2008). In this sense, the low representativeness of individuals in the larger diameter classes in the area concerned, indicates a process of forest degradation by selective logging, which is characterized by the suppression of species with higher economic value. The accumulation of trees in classes with smaller diameters and the reduction of individuals in classes with higher DBH characterize the behavior of secondary forests and degraded primary forests, as demonstrated by Duarte *et al.* (2018).

According to the survey by Nogueira *et al.* (2008), the average biomass for open forests in the Brazilian Amazon is equivalent to 266.6 Mg ha⁻¹ and the average biomass considering dense forests is 286.8 Mg ha⁻¹. Cummings *et al.* (2002) found superior results for 20 sites in the Western Amazon region, where the average aboveground biomass (DBH ≥ 10cm) can reach 239 Mg.ha⁻¹ in open forests and 307 Mg ha⁻¹ in dense forests.

Degraded forests, although presenting a reduction in their ecosystem goods and services, demonstrate ecological interest when analyzed from floristic, structural and biomass storage aspects. Maintaining and expanding the conservation of biodiversity in these altered forests requires knowing them so that, through restoration projects and sustainable management plans, assertive measures can be promoted.

CONCLUSIONS

The analyses carried out allow us to conclude that:

- The studied forest was characterized by the concentration of a large number of tree individuals in a few botanical families.
- Out of the total number of individuals inventoried, approximately 74% belong to just 10 botanical families, with the Fabaceae family having the highest species richness.
- The diameter structure followed the pattern of uneven-aged forests, however, the reduced number of individuals in diameter classes greater than 35 cm, indicate that forest degradation can compromise the sustainability and ecological functions of the forest in the long term, if continuously inflicted.
- The patterns of floristic similarity showed, from the cluster analysis, the existence of patterns between the

- sampling units, based on the distribution of the species and their location.
- Sampling units showed significant differences regarding total height and DBH.
 - Regarding biomass, the estimate obtained (215.20 Mg ha⁻¹) is lower than expected for the area. This result signals a reduction in forest biomass and stored carbon due to forest degradation processes. And thus, it allows us to conclude that the forest alterations caused by the degradation could be verified from the analysis of the floristic-structural composition of the vegetation.
 - The results of this study contribute to a better understanding of changes in forest formations related to forest degradation in the southern Brazilian Amazon, which directly impact on biomass stocks, floristic composition and structure of forests.
 - The characterization of the structure and floristic composition of degraded forests serves as a basis for defining conservation and restoration strategies for forests under similar conditions.
 - For future studies, it is recommended to increase the number of field samples to obtain inventory data, contributing directly to the breadth and scope of information.

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