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Biomass and Carbon Stored Estimated in the forest ecosystem of the Nova Canaã Farm (Porciúncula/RJ)

Global warming has become international concern, culminating with the ratification of the Kyoto Protocol which includes definitions and objectives of the sustainable development mechanisms and features that make it easier for the industrialized countries to jointly compensate for their polluting greenhouse gas emissions. Porciúncula is a city known for its agricultural development and the lack of characterization of ecosystems associated with the Atlantic Forest biome. Facing this chaotic scenario is Nova Canaã farm located in the Ribeirão da Perdição Environmental Preservation Area its forest ecosystem provides a series of environmental services such as carbon storage and CO_2 sequestration. The team of researchers from OM Consultoria Ambiental performed the quantification of the biomass (B_{wood}) of the bole which resulted in estimates of 398.4753 t.ha^{-1} corresponding to 199.2377 tC.ha^{-1}. The estimates obtained for the forest ecosystem of the farm can be used as a reference for the establishment of forest restoration projects under the under the sustainable development mechanism established the Kyoto Protocol.

Keywords: Environmental Service; Atlantic Forest; Forest Inventory; Dendrometry; APA Ribeirão da Perdição.

Biomassa e Estimativa do Carbono Estocado no ecossistema florestal da Fazenda Nova Canaã (Porciúncula/RJ)

O aquecimento global tornou-se preocupação internacional, culminando com a ratificação do Protocolo de Quioto, onde constam as definições e os objetivos dos mecanismos de desenvolvimento sustentável e possui procedimentos flexibilizadores, facilitando aos países industrializados compensar em conjunto suas emissões poluentes de gases do efeito estufa. Porciúncula é um município conhecido pelo desenvolvimento agropecuário e pela descaracterização dos ecossistemas associados ao bioma Mata Atlântica. Frente a este cenário caótico está à Fazenda Nova Canaã, localizada na área de Preservação Ambiental (APA) Ribeirão da Perdição, seu ecossistema florestal é prestador de uma série de serviços ambientais como o estoque de carbono e o sequestro de CO2. A equipe de pesquisadores da OM Consultoria Ambiental, realizou a quantificação da biomassa ($B_{madeira}$) do fuste, que resultou em estimativas de 398,4753 t.ha^{-1}, o que correspondeu a 199,2377 tC.ha^{-1}. As estimativas obtidas para o ecossistema florestal da fazenda podem ser usadas como referência para o estabelecimento de projetos de restauração florestal, no âmbito do Mecanismo de Desenvolvimento Limpo, estabelecido no Protocolo de Quioto.

Palavras-chave: Serviço Ambiental; Mata Atlântica; Inventário Florestal; Dendrometria; APA Ribeirão da Perdição.

Topic: **Uso Sustentável da Biodiversidade**

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INTRODUCTION

Approximately 54.4% of Brazil's territory is occupied by forests (SILVA et al., 2018) and from this percentage, approximately 12.5% corresponds to the area of the Atlantic Rainforest Biome (SOS MATA ATLÂNTICA, 2015), stretching for 17 States of the federation, going from the state of Rio Grande do Sul to Rio Grande do Norte, ranging from the coastal regions, such as plateaus and hills of the interior.

In the state of Rio de Janeiro, the Atlantic Forest biome offers characteristic phytoecological formations constituted by forest ecosystems: Seasonal Semidecicual Forest and Dense Ombrophilous Forest. The latter features subdivisions in its phytophysiognomy, suffering variations according to the altitude range of relief where it is inserted. The divisions are: The Alluvial Lowlands, Submontane Forest, Montana and Alto-Montana (SOS MATA ATLÂNTICA, 2015).

According to SOS Mata Atlântica (2015), in addition to this important set of forest ecosystems, the Atlantic Forest biome also encompasses other associated ecosystems. Such as mangroves, sandbanks, mixed forests (Araucária forest) and altitude fields.

Most of the territory of the Northwest Fluminense is located in the phytoecological region of Seasonal Semideciduous Forest. A small part contemplates the Dense Ombrophilous Forest further south of the region in the São Fidélis city, close to the Desengano State Park.

Soffiati Netto (2011) describes the eco-history of the devastation of seasonal forests in the north-northwest of Rio de Janeiro, between the colonial and republican periods. It emphasizes how the forest was initially felled by logging, behind hardwood, for use in the sugarcane agro-industry. Then by extensive coffee farming and cattle breeding which was responsible for decimating over approximately a century and a half what initially seemed infinite to the first colonizers and travelers.

However, even facing an intense and historical process of deforestation, the Atlantic Forest biome has one of the largest biodiversity in the planet, with high concentrations of endemic species (BERGALLO et al., 2016) and a high level of degradation. Thus, it is possible to consider it as a hotspot, being the conservation of its natural resources of utmost importance to mankind.

The plants are autotrophicorganisms, they need of CO_2 for the production of their food through the photosynthetic process, in woody plants the incorporation of a part of this carbon in the secondary xylem of plant is popularly known as wood (SILVA et al., 2017). There are methods that allow researchers to evaluate the concentration of carbon in woody plants, however in native forests these measurements are only estimated, for in a community there is not a single model of growth and morphotype, because it is a set of populations dependent on the ecological relationships (HENRY et al., 2011).

Carbon sequestration and storage is, among the many environmental services provided by forests, one of great importance. Especially in face of global warming’s intensification (SILVA et al., 2017). The phenomenon mentioned above is cause by the increase of the concentration of greenhouse gases, especially carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), from human emissions (SILVA et al., 2017).

In order to mitigate these impacts arising from the emission of greenhouse gases, the Kyoto Protocol was created, as countries held as their paramount goal the reduction of emissions of these gases in 5.0% during the period from 2008 to 2012, which corresponds to the first commitment period (SILVA et al., 2019). The Protocol officially came into effect in February 2005 and brought three innovative mechanisms to ensure flexibility: Emissions trading, Joint Implementation and Clean Development Mechanism (CDM), by which it is possible to obtain the Certified Emission Reductions (CERS), which are one of the types of carbon credits. It is noteworthy that among these three mechanisms of flexibilization, only the CDM allows the participation of developing countries like Brazil, representing, therefore, a way for the country's participation in the recent and innovative carbon credits market (TORRES et al., 2013).

Nova Canaã farm is located in the Ribeirão da Perdição environmental protection area, which has 6,141 ha, of which 85 springs are preserved. O Ribeirão da Perdição é importante contribuinte do Rio Carangola. The Ribeirão da Perdição environmental preservation area, located in the Ribeirão Caeté microwatershed which is classified by the Ministry of the Environment as a priority for conservation. Reinforcing its importance in the environmental context of the Northwest region of Rio de Janeiro state as well as in Porciúncula city.

Faced with the importance of Nova Canaã farm for the State of Rio de Janeiro and the need to preserve its ecosystem, the team of researchers from OM Consultoria Ambiental, carried out this work, which aimed to quantify biomass in m^3 through the installation of 16 plots (SU) of 500 m^2 arranged systematically in a forest fragment of 440.000 m^2 encompassing a sampling area of 8.000 m^2, with the purpose of estimating the concentration of carbon in $tC.ha^{-1}$ which is concentrated by the forest ecosystem of the farm.

MATERIALS AND METHODS

Characterization of the study área

The forest fragment is located in the area of influence of Fazenda Nova Canaã (Figure 1) in the environmental preservation area Ribeirão da Perdição. According to the Biosphere Reserve, the farm is inserted in the area of mosaics of Atlantic Forest corridors, one of the 84 areas destined to the conservation of this biome for the Porciúncula city. Most of its vegetation cover is made up of secondary stage forests and pastures. The city Porciúncula, is part of the phytophysionomic domain semideciduous seasonal forest has a mosaic of degraded and impacted forest physiognomies typical of areas with a history of agricultural and livestock activities.

Porciúncula has a tropical climate, with much more rainfall in summer than in winter. The climate is classified as Aw according to Köppen and Geiger. The average temperature in Porciúncula is 22.4 °C. The average annual rainfall is 1188 mm. The driest month is July which has 12 mm of rainfal. The greatest amount of precipitation occurs in december with an average of 225 mm. The warmest month of the year is february with an average temperature of 25.4 °C. with the lowest average temperature of the year, July has an average temperature of 18.7 °C.

The Nova Canaã farm is located in the Ribeirão Caeté microwatershed. Categorized as a priority, this due to the large presence of forest fragments and ecological corridors. Its conservation is important for the maintenance of fauna and flora, the scenic landscape and the dense network of water bodies. Importantly, protection is essential for maintaining the local and regional water balance, in addition to the environmental quality of the water bodies.

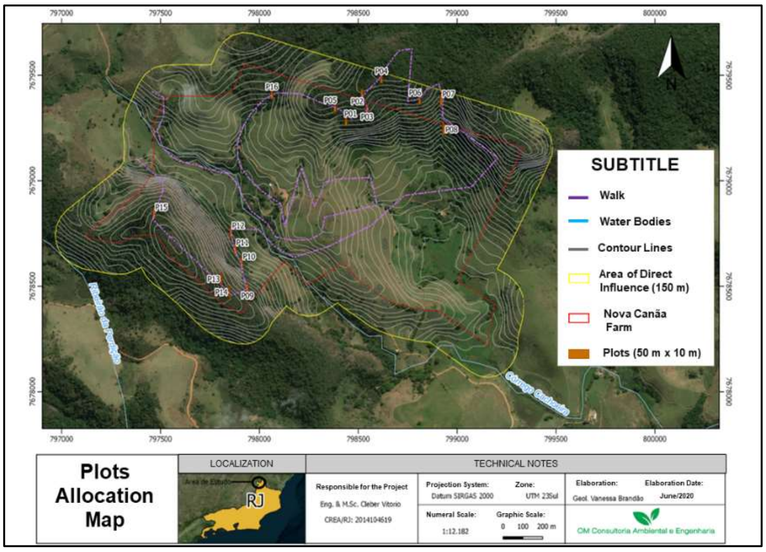

Figure 1: Nova Canaã farm area and design of sample units in the study area.

The study area is inserted in the domain of denudational units in crystalline rocks, dominated by dissected hills and low hills and reach quotas of a maximum of 992 m. The study area is marked by the presence of hills with convex-concave geometry, frankly dissected. It is characterized by a lively relief with slopes of medium to high gradients and rounded to sharp tops. Moderate to high drainage density with subdendritic trellis pattern. Due to its morphology, the present relief is frequently affected by laminar erosion processes and sporadic occurrence of accelerated linear erosion processes. The predominant soils in the study area are: dystrophic red-yellow latosol and eutrophic red-yellow argisols.

Sample Design and Analysis

From 17 april until 24 april 2020, 16 quadratic sampling units (10m x 50 m) were demarcated in the area of the venture, totaling 8.000 m^2 of sample area (Figure 1) the fragment studied has a total area of 440.000 m^2, the field team catalogued all the botanical species existing in the quadratic plots of 500 m^2, theymade these plots with tape and string. Within each quadratic plot they were collected arboreal species with CAP greater than or equal to 5 cm, and estimated the height of sampled individuals. The quadrats were marked with striped tape. The vertex closest to the access to the sampling unit was georeferenced using a GPS with an accuracy of 3 meters under vegetation cover. The individuals were collected and catalogued in the herbarium of the laboratory of forage plants of UFRJ at the zootechnical institute and stored at the Laboratory of Environmental Mapping of UFRRJ (LAMAGEDENASA).

The simple random sampling is the fundamental process of selection from which to derive all other sampling procedures, aiming to increase the accuracy of estimates and to reduce the costs of the survey (RIBEIRO et al., 2009). The simple random sampling is the best method for presentation of the theory of sampling, because it allows estimating the sampling error. The selection of each sampling unit must be free of any choice and totally independent from the selection of the other sample units. The equation for the calculation of the sample sufficiency in simple random sampling is shown below (HUSCH et al., 1982) (Equation 1).

$$n=N\times S^2\times t^2/(N\times(E\times \bar{x})^2+S^2\times t^2 \qquad (1)$$

Where:
n = number of parcels to be raised;
N = total number of samples possible in the area;
t = value of probability distribution ($t_{0.5}$, with n-1 GL);
$\mathbf{S^2}$ **=** variance of the parameter evaluated;
$\bar{\mathbf{x}}$ **=** average
E = Error (10%) and X=Average of the parameter evaluated.

The following are defined the symbols to identify the variables of the Community: the sample sufficiency was calculated on the basis of the parameter biomass (m^3), in view of the interest of the evaluation of the quantification of biomass in m^3 and quantification of carbon stored in the $tC.ha^{-1}$ of plants with secondary xylem and CAP above or equal to 5 cm.

For the analysis of total biomass by species and botanical family we used the volumetric equation of CETEC (1995) which is used by other authors (RIBEIRO et al., 2009), Atlantic Forest vegetation (Equation 2):

$$Vt=0.00007423\times DAP^{1.707348}\times Ht^{1.16873} \qquad (2)$$

Where:
Vt= total volume of the bole;
DAP = 1.30 m above the ground;
Ht = total height of each stem.

The estimate of the bole biomass was performed using the non-destructive method, depending on the impossibility of using the destructive method, due to restrictions of legal orders and operational. Thus, it was evaluated only the biomass of the stem and not other forest compartments, such as branches, leaves, bark and lianas.

The indirect method for quantification of biomass is based on the use of empirical relationships between biomass and other variables in the tree (DBH, total height etc.) (CETEC, 1995), these relations expressed by means of statistical models (SILVA et al., 2017). One needs to be cautious with its implementation, in order to avoid significant error in the calculation of biomass: a careful analysis of the situations of field (ex. hollow trees) and the sample is representative of the area (SILVA et al., 2019).

This method is often considered a more accurate alternative than the direct method, since in the latter, the information obtained usually come from parcels of small size, in a small number and selected intentionally, usually in areas that are more representative of the whole (BROWN et al., 1989). Such conduct could introduce errors of biased estimates, which may lead to over- or underestimation of the average biomass of the forest evaluated.

Considering the use of non-destructive method, we performed the selection of species with secondary xylem in the area (CETEC, 1995). Then, we obtained the values of basic density for each lignified species selected, based on existing studies (LORENZI, 2014; IBAMA, 2016). To determine the basic density of species not identified (Indet), we collected bodies of evidence, using a Pressler probe. The collections were always carried out in the morning, in order to avoid possible variations of the values of which could be caused by changes in water potential and perspiration after noon and the samples were stored individually in a plastic bag sealed until laboratory measurements. Synthesized the methodology for determining the basic density of the wood in the lab, as it is instructed in the norm ABNT NBR 11941 NBR11941, as for deceased individuals, we used an average value of the bodies of evidence sampled.

The basic density values obtained, already converted into Ton.m-3, it was calculated the average basic density (d) of all the mature forest, weighted by the value of coverage, according to Equation 3:

$$d=\sum_{i-=1}^{n} [\![Db_i\times\left(\frac{VC_i}{\sum_{i-=1}^{n} VC_i}]\!]\right) \qquad (3)$$

Where:
n = number of selected species;
Dbi = basic density of the ith species selected, in Ton.m^{-3}; and
VCi = average value of coverage of the i-th species with secondary xylem.

The biomass of wood present in the stem of each tree was estimated by multiplying the average wood basic density by volumes of the stems (equation 2), according to Equation 4.

$$B_{wood}=d\times\bar{x}\times Vt \qquad (4)$$

Where:
B = biomass of the stem, in Ton;
d= average basic density of the wood, in Ton.m^{-3}; and
Vt = total volume estimated de Stem, in m^3.

The carbon stored in the bole biomass was estimated by means of the multiplication of the estimates of biomass obtained by factor 0.5, considering that the dry biomass contains approximately 50% of carbon (RIBEIRO et al., 2009; SILVA et al., 2019). Then, the stock of carbon was extrapolated to tons per hectare.

RESULTS AND DISCUSSION

The forest inventory was planned and executed in order to meet an error limit of 5% to 95% probability. Were measured 1224 trees (1257 shafts), distributed in 39 families, 89 taxa were identified at the species level. No dead individuals were found for the 16 sample plots. For the calculation of the sample sufficiency in simple random sampling having as a variable of interest the biomass (m^3) for lignified individuals, met a n= 16 sample units (S.U) for the total area of 440.000 m^2. Other parametric static parameters of interest for sample sufficiency were: N = 880; S2 = 12.33934717; S= 3,512741; Std. Error= 0,8781852; CV= 32,43165 %; CI= (9,217306597≤ μ ≤ 12,44511928), so the allocation of 16 plots of 500 m^2 during the pilot inventory, was a representative sample for this work, concluding, therefore, that the sampling was sufficient.

Table 1: List of species found on the Nova Canaã farm (Porciúncula / RJ) according to dendrometric variables. Legend: Σ G (m²) = sum of the basal area; DBH x -bar = mean diameter at chest height; H x -bar = average height value.

Family	Taxa	Specimens	Stems	Σ G (m²)	DBH x-bar	H x-bar
Lamiaceae	*Aegiphila integrifolia*	3	3	0.036817	11.52	7.3
Fabaceae	*Albizia polycephala*	5	5	0.10438	15.23	10.1
Euphorbiaceae	*Alchornea glandulosa*	2	2	0.015794	9.18	5.0
Sapindaceae	*Allophylus edulis*	5	5	0.090121	13.90	9.2
Sapindaceae	*Allophylus sp.1*	1	1	0.004974	7.96	5.0
Verbenaceae	*Aloysia virgata*	1	1	0.003993	7.13	3.0

Rubiaceae	*Amaioua guianensis*	17	17	0.090142	7.85	5.2
Fabaceae	*Anadenanthera colubrina*	36	37	0.807902	12.74	7.8
Nyctaginaceae	*Andradea floribunda*	1	1	0.027513	18.72	9.0
Annonaceae	*Annona cacans*	1	1	0.058037	27.18	14.0
Annonaceae	*Annona dolabripetala*	11	11	0.127776	11.46	9.7
Annonaceae	*Annona sp.1*	2	2	0.015751	10.01	12.0
Annonaceae	*Annona sylvatica*	6	11	0.056979	8.01	4.6
Euphorbiaceae	*Aparisthmium cordatum*	2	2	0.008027	6.99	5.3
Fabaceae	*Apuleia leiocarpa*	34	41	0.670099	13.56	8.8
Arecaceae	*Astrocaryum aculeatissimum*	3	3	0.02958	11.17	4.3
Anacardiaceae	*Astronium graveolens*	7	7	0.119287	13.41	8.7
Rubiaceae	*Bathysa australis*	12	24	0.213667	9.96	6.0
Fabaceae	*Bauhinia forficata*	1	1	0.042756	23.33	7.0
Moraceae	*Brosimum guianense*	24	30	0.26155	9.84	6.8
Moraceae	*Brosimum sp.1*	5	6	0.032493	7.97	6.7
Malpighiaceae	*Byrsonima sp.1*	4	4	0.363731	33.26	16.8
Myrtaceae	*Campomanesia guaviroba*	17	19	0.130326	8.59	5.4
Lecythidaceae	*Cariniana legalis*	2	2	0.654893	51.65	15.3
Salicaceae	*Casearia arborea*	3	3	0.008458	5.98	4.8
Salicaceae	*Casearia commersoniana*	6	7	0.324347	18.63	11.4
Salicaceae	*Casearia sp.1*	4	5	0.0447	10.15	6.4
Salicaceae	*Casearia sylvestris*	17	21	0.209299	10.01	6.5
Urticaceae	*Cecropia hololeuca*	3	4	0.318885	30.50	16.8
Urticaceae	*Cecropia pachystachya*	1	1	0.005175	8.12	5.0
Meliaceae	*Cedrela fissilis*	3	3	0.181657	21.95	9.7
Malvaceae	*Ceiba speciosa*	1	1	0.091962	34.22	20.0
Chrysobalanaceae	*Chrysobalanaceae 1*	1	1	0.003057	6.24	6.0
Sapotaceae	*Chrysophyllum aff. gonocarpum*	2	4	0.018414	7.17	4.6
Sapotaceae	*Chrysophyllum sp.1*	3	4	0.01084	5.84	5.8
Rutaceae	*Citrus sp.1*	1	1	0.009582	11.05	4.5
Boraginaceae	*Cordia trichoclada*	2	2	0.022293	11.90	5.0
Rubiaceae	*Coussarea sp.1*	2	4	0.031053	9.86	8.0
Sapindaceae	*Cupania oblongifolia*	11	16	0.193104	11.18	7.1
Cyatheaceae	*Cyathea sp.1*	1	1	0.009748	11.14	4.0
Fabaceae	*Dalbergia nigra*	19	19	0.133099	8.70	5.5
Fabaceae	*Dalbergia sp.1*	1	1	0.087734	33.42	12.0
Sapotaceae	*Ecclinusa ramiflora*	3	3	0.10179	17.78	9.8
Lauraceae	*Endlicheria sp.1*	1	3	0.077972	15.82	6.8
Fabaceae	*Enterolobium contortisiliquum*	1	1	0.006418	9.04	7.5
Malvaceae	*Eriotheca sp.1*	1	1	0.052728	25.91	23.0
Fabaceae	*Erythrina verna*	2	2	0.077288	20.13	11.3
Erythroxylaceae	*Erythroxylum coelophlebium*	13	13	0.085478	8.79	7.0
Erythroxylaceae	*Erythroxylum pulchrum*	46	47	0.751991	11.91	7.1
Arecaceae	*Euterpe edulis*	33	34	0.31885	10.56	7.6
Fabaceae	*Fabaceae 1*	16	23	0.32707	12.54	7.2
Fabaceae	*Fabaceae 2*	1	1	0.261857	57.74	24.0
Fabaceae	*Fabaceae 3*	1	1	0.037231	21.77	15.0
Rubiaceae	*Faramea sp.1*	3	3	0.01745	8.37	5.7
Moraceae	*Ficus clusiifolia*	1	1	0.560944	84.51	18.0
Nyctaginaceae	*Guapira opposita*	2	2	0.008074	6.99	4.5
Meliaceae	*Guarea guidonia*	83	96	3.284336	15.78	7.8
Annonaceae	*Guatteria ferruginea*	32	34	0.565845	13.32	10.0
Bignoniaceae	*Handroanthus chrysotrichus*	2	2	0.008841	7.48	5.5
Indeterminada	*Indeterminada 1*	1	1	0.135522	41.54	18.0
Indeterminada	*Indeterminada 2*	1	1	0.013247	12.99	12.0
Indeterminada	*Indeterminada 3*	1	1	0.003644	6.81	5.0
Indeterminada	*Indeterminada 4*	1	2	0.081733	22.65	10.0
Indeterminada	*Indeterminada 5*	1	1	0.017955	15.12	12.0
Fabaceae	*Inga laurina*	1	1	0.010371	11.49	7.5
Caricaceae	*Jacaratia spinosa*	1	1	0.007647	9.87	7.0
Euphorbiaceae	*Joannesia princeps*	1	1	0.014714	13.69	17.0
Lacistemataceae	*Lacistema pubescens*	12	13	0.114994	9.53	6.6
Lecythidaceae	*Lecythidaceae sp.*	3	4	0.065493	13.23	9.5
Lecythidaceae	*Lecythis pisonis*	1	1	0.035403	21.23	12.0
Chrysobalanaceae	*Licania sp.1*	1	1	0.021518	16.55	13.5
Malvaceae	*Luehea divaricata*	13	14	0.290585	14.18	6.8
Euphorbiaceae	*Mabea fistulifera*	114	129	1.516042	10.50	8.6

Fabaceae	*Machaerium nyctitans*	2	2	0.022873	11.84	7.0
Fabaceae	*Machaerium sp.1*	1	1	0.046693	24.38	14.0
Fabaceae	*Machaerium sp.2*	1	1	0.009472	10.98	8.0
Fabaceae	*Machaerium sp.3*	1	1	0.227281	53.79	23.0
Moraceae	*Maclura tinctoria*	1	1	0.007946	10.06	7.0
Euphorbiaceae	*Maprounea guianensis*	1	1	0.016114	14.32	8.0
Sapindaceae	*Matayba guianensis*	3	3	0.018295	8.23	5.0
Melastomataceae	*Miconia dodecandra*	5	5	0.144859	17.91	12.0
Melastomataceae	*Miconia prasina*	8	10	0.060135	8.30	5.8
Melastomataceae	*Miconia sp.1*	1	1	0.007896	10.03	9.0
Myrtaceae	*Myrcia splendens*	24	25	0.245366	10.49	8.1
Primulaceae	*Myrsine guianensis*	6	6	0.094588	14.01	8.9
Primulaceae	*Myrsine sp.1*	2	2	0.077319	21.77	13.5
Lauraceae	*Nectandra membranacea*	4	4	0.173976	19.63	12.5
Lauraceae	*Nectandra oppositifolia*	1	1	0.008666	10.50	10.0
Lauraceae	*Nectandra sp.1*	1	1	0.002578	5.73	3.0
Lauraceae	*Ocotea sp.1*	1	1	0.003852	7.00	5.0
Lauraceae	*Ocotea sp.2*	1	1	0.056552	26.83	20.0
Lauraceae	*Ocotea sp.3*	1	1	0.001962	5.00	4.5
Ochnaceae	*Ouratea cuspidata*	2	2	0.007394	6.78	6.0
Piperaceae	*Piper amalago*	1	1	0.0023	5.41	4.0
Piperaceae	*Piper arboreum*	4	4	0.014879	6.73	4.3
Fabaceae	*Piptadenia gonoacantha*	10	10	0.593228	24.84	13.2
Asteraceae	*Piptocarpha macropoda*	1	1	0.033518	20.66	13.0
Fabaceae	*Plathymenia reticulata*	4	4	0.685817	42.76	16.5
Fabaceae	*Platycyamus regnellii*	9	15	0.881794	25.00	13.2
Fabaceae	*Platypodium elegans*	2	2	0.041383	14.04	9.0
Urticaceae	*Pourouma guianensis*	2	4	0.053255	12.22	8.8
Sapotaceae	*Pouteria aff.guianensis*	1	2	0.528627	44.01	20.0
Sapotaceae	*Pouteria sp.1*	1	1	0.007162	9.55	5.0
Fabaceae	*Pseudopiptadenia contorta*	83	85	2.33976	14.61	9.3
Rubiaceae	*Psychotria vellosiana*	5	5	0.013012	5.72	4.4
Araliaceae	*Schefflera morototoni*	1	1	0.012166	12.45	12.0
Phytolaccaceae	*Seguieria americana*	1	2	0.005326	5.81	5.0
Euphorbiaceae	*Senefeldera verticillata*	3	4	0.046944	10.96	7.1
Fabaceae	*Senna macranthera*	1	1	0.028172	18.94	13.0
Siparunaceae	*Siparuna guianensis*	70	74	0.242587	6.38	4.5
Solanaceae	*Solanum sp.1*	1	1	0.023291	17.22	10.0
Malvaceae	*Spirotheca rivieri*	1	1	0.003279	6.46	4.0
Fabaceae	*Sweetia fruticosa*	2	3	0.101536	18.47	9.8
Arecaceae	*Syagrus romanzoffiana*	5	5	0.081674	13.87	5.2
Apocynaceae	*Tabernaemontana laeta*	1	2	0.036578	14.64	6.0
Fabaceae	*Tachigali paratyensis*	2	2	0.17017	26.74	13.0
Meliaceae	*Trichilia elegans*	88	95	0.719674	9.29	6.0
Meliaceae	*Trichilia hirta*	3	3	0.050182	13.79	7.5
Meliaceae	*Trichilia pallida*	51	51	0.295874	8.25	5.6
Meliaceae	*Trichilia sp.1*	1	1	0.029903	19.51	13.0
Myristicaceae	*Virola gardneri*	4	4	0.12367	15.34	10.4
Annonaceae	*Xylopia brasiliensis*	17	17	0.328091	14.71	12.4
Annonaceae	*Xylopia sericea*	10	10	0.420654	17.62	11.1
Rutaceae	*Zanthoxylum rhoifolium*	1	1	0.006284	8.94	7.5
Bignoniaceae	*Zeyheria tuberculosa*	3	3	0.013966	7.44	3.8

Among the trees and palm trees found in the arboreal stratum, 125 species were registered, distributed among 41 families (Table 1). The families with the highest species richness were: Fabaceae with 24 species, Lauraceae and Annonaceae with 7 species and Meliaceae and Euphorbiaceae with 6 species. According to Silva et al. (2018), for floristic inventories carried out in the Atlantic Forest biome, Fabaceae and Lauraceae are among the most prominent botanical families. For they are families that have coevolution with many species of fauna, having a high potential for dispersion. While Bignoniaceae, which presented two (2) species, has greater increments of absolute richness for open areas of pastures and scrub, due to the effect of facilitating dispersion of seeds by wind.

Of the 125 species surveyed, 6 have threat status according to the list of ordinance MMA nº 443/2014 and National Center for Conservation of Flora (CNC), they are: *Apuleia leiocarpa* (Vogel) J.F. Macbr. (CNC-VU; MMA-VU), *Dalbergia nigra* (Vell.) Allemão ex Benth. (CNC-VU; MMA-VU), *Zeyheria tuberculosa* (Vell.) Bureau ex Verl. (CNC-VU; MMA-VU), *Euterpe edulis* Mart. (CNC-VU; MMA-VU), *Cedrela fissilis* Vell. (CNC-VU; MMA-VU) and *Cariniana legalis* (Mart.) Kuntze (CNC-VU; MMA-VU).

The diameters of the trees measured (DBH) in the inventory were distributed in five classes with an amplitude of 18 cm (Figure 2), whose distribution of frequencies is shown in Figure 2. The configuration of the graph in the form of an inverted 'J', characteristic of natural forests where there are all gradations of age and size, and there are also several stages of regeneration. In native forests, there is a great diversity of species, in consonance with the disposition of distinct luminosity and other influential factors for this high differentiation. Silva et al. (2017) consider it as expected, for this type of forest formation, where the sampled area is largely composed of initial secondary species. Such species have abundant regeneration characteristics, concentrating large numbers of individuals in the first diameter classes.

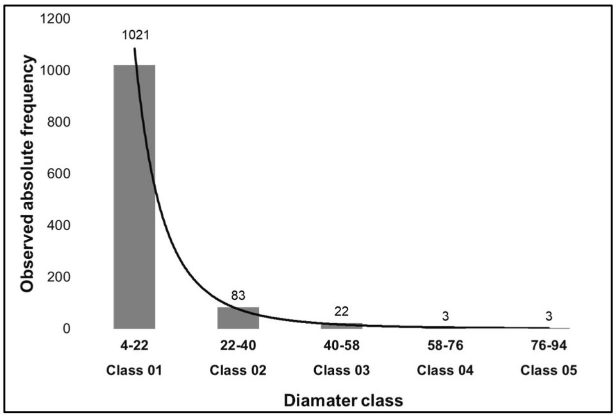

Figure 2: Distribution of frequency per class of DBH of trees measured.

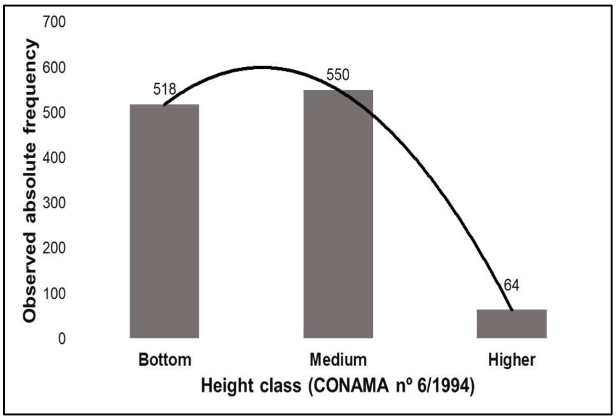

Figure 3: The vertical structure of the forest ecosystem.

According to Martins (1991), the height estimates of shrub and tree individuals can provide important information both for the interpretation of vertical forest structure and to help understand the population dynamics that compose it. The heights of the trees measured in the inventory were divided into three classes (Figure 3), bottom <6.2 m, medium 6.2 m <14.2 m and higher> 14.2 m according to CONAMA Resolution nº 06/1994. Of the 1132 trees measured, 518 individuals are in the lower stratum, 550 in the middle stratum and 64 in the upper stratum. The species that presented individuals with the highest average height increments were: *Ceiba speciosa*, *Ocotea sp.2*, *Pouteria aff.guianensis*, *Ficus clusiifolia* and *Joannesia princeps*, all with specimens whose heights exceed or equal 17 m. Indicating a regeneration environment and recruiting new individuals in each stratum of the forest ecosystem.

For the biomass analysis (m^3), in the 8.000 m^2 of study area, 172.3614 m^3 of biomass were quantified, distributed to the 16 sample plots (Figure 4), as well as for each hectare of woody area of the Nova Canaã farm it is expected the quantification of 215.4517 m^3. The families that showed the highest biomass expression in m3 (Table 2) are: Fabaceae (67, 592 m^3), Meliaceae (26.615 m^3) and Annonaceae (12.378 m^3).

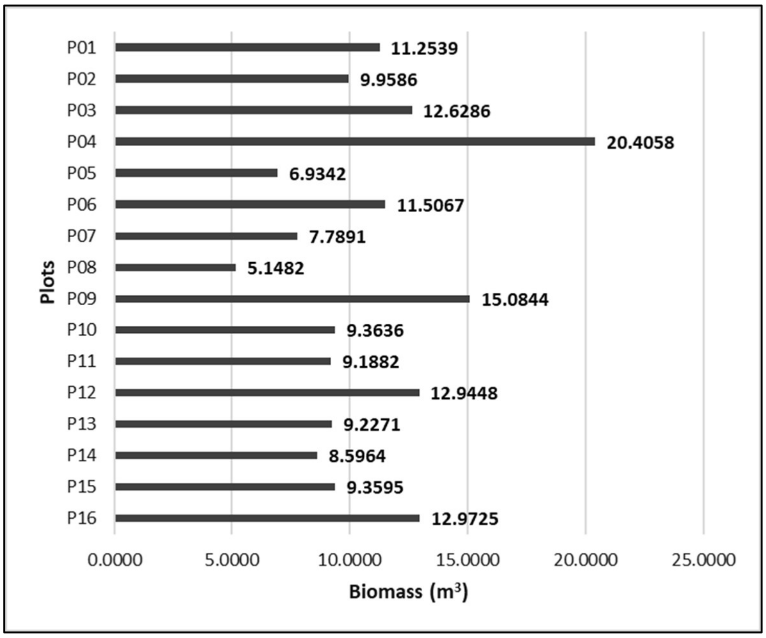

Figure 4: Biomass (m^3) per plot.

Table 2: Total biomass (m^3), by sampled botanical family.

Botanical Families	Σ Biomass (m^3)
Fabaceae	67.592
Meliaceae	26.615
Annonaceae	12.378
Euphorbiaceae	9.417
Lecythidaceae	7.148
Moraceae	5.867
Salicaceae	4.830
Sapotacaeae	4.617
Erythroxylaceae	4.592
Urticaceae	3.526
Malpighiaceae	3.519
Malvaceae	3.338
Lauraceae	3.104
Indeterminada	2.000
Myrtaceae	1.951
Rubiaceae	1.758
Sapindaceae	1.721
Myristicaceae	1.334
Melastomataceae	1.251
Primulaceae	1.189
Sapotaceae	0.829
Siparunaceae	0.781
Anacardiaceae	0.778
Lacistemataceae	0.655
Asteraceae	0.262
Chrysobalanaceae	0.201
Lamiaceae	0.187
Nyctaginaceae	0.170
Apocynaceae	0.148
Solanaceae	0.141
Araliaceae	0.100
Bignoniaceae	0.069
Boraginaceae	0.067
Rutaceae	0.059
Piperaceae	0.052
Caricaceae	0.036
Ochnaceae	0.034
Phytolaccaceae	0.020
Verbenaceae	0.008

Among the 121 species endowed with secondary xylem, the most representative in biomass (m^3) was *Pseudopiptadenia contorta*, the second was *Guarea guidonia*, the two alone represent about 25.21% of biomass (m^3) in the analyzed forest community. These species also had the highest coverage (CV), importance value (IV) and stored carbon per hectare (Table 3). As for the ecological diversity of the study area, the Shannon-Weaver Index of 3.748 nats.Ind $^{-1}$ was found, a value considered high for the Atlantic Forest according to CONAMA Resolution nº 06/1994 and the Pielou Equitability was 0.7762. Indicating that there is a dominance in forest biocenosis, regarding the distribution of species to the sample allocation space of the 16 plots (S.U).

Table 3: List of species found on the Nova Canaã farm (Porciúncula/RJ) according to the importance value (IV) and the coverage value (CV). Legend: VI= importance value; CV= coverage value; B_{wood}= wood biomass; SC= stored carbon.

Nome Científico	Σ Biomass (m^3)	Biomass ($m3.ha^{-1}$)	ρ wood (ton/m^3)	IV	CV	B_{wood} (ton/m^3	SC (t)	SC ($tC.ha^{-1}$)
Guarea guidonia	20.554	25.6925	0.76	22.84	21.18	137.3251	68.66257	85.828218
Pseudopiptadenia contorta	22.909	28.63625	0.62	19.86	17.2	101.3834	50.69168	63.364601
Mabea fistulifera	8.836	11.045	0.5	18.13	16.46	41.4629	20.73145	25.914314
Trichilia elegans	3.083	3.85375	0.78	12.8	10.81	11.43633	5.718164	7.1477053
Anadenanthera colubrina	6.939	8.67375	0.93	8.248	6.587	7.651238	3.825619	4.7820239
Erythroxylum pulchrum	4.157	5.19625	0.85	9.893	7.235	5.879604	2.939802	3.6747524
Apuleia leiocarpa	4.503	5.62875	0.83	1.054	0.39	3.703753	1.851876	2.3148456
Guatteria ferruginea	4.181	5.22625	0.59	6.874	5.213	2.057721	1.02886	1.2860755
Trichilia pallida	1.272	1.59	0.74	7.746	5.753	1.380364	0.690182	0.8627275
Platycyamus regnellii	7.959	9.94875	0.81	5.51	4.514	1.30942	0.65471	0.8183875
Siparuna guianensis	0.781	0.97625	0.43	11.19	7.207	0.846975	0.423488	0.5293594
Piptadenia gonoacantha	5.171	6.46375	0.75	4.714	3.385	0.656432	0.328216	0.4102702
Xylopia brasiliensis	3.016	3.77	0.7	4.214	2.885	0.517845	0.258922	0.3236528
Brosimum guianense	1.429	1.78625	0.88	5.881	3.223	0.486265	0.243132	0.3039154
Myrcia splendens	1.468	1.835	0.79	5.148	3.155	0.43903	0.219515	0.2743938
Xylopia sericea	3.469	4.33625	0.7	3.986	2.657	0.322686	0.161343	0.2016787
Fabaceae 1	1.712	2.14	0.7	4.122	2.793	0.26776	0.13388	0.1673498
Plathymenia reticulata	6.038	7.5475	0.55	4.242	3.246	0.215548	0.107774	0.1347172
Casearia commersoniana	3.556	4.445	0.84	2.562	1.898	0.170064	0.085032	0.1062899
Luehea divaricata	1.553	1.94125	0.64	4.699	2.374	0.153409	0.076704	0.0958804
Casearia sylvestris	1.032	1.29	0.7	3.713	2.384	0.146434	0.073217	0.091521
Byrsonima sp.1	3.519	4.39875	0.78	2.552	1.887	0.103609	0.051805	0.0647556
Dalbergia nigra	0.544	0.68	0.87	4.898	2.24	0.100771	0.050385	0.0629817
Cariniana legalis	6.399	7.99875	0.53	3.603	2.938	0.099661	0.04983	0.062288
Bathysa australis	0.966	1.2075	0.64	2.958	1.961	0.072746	0.036373	0.0454664
Cupania oblongifolia	1.028	1.285	0.67	2.451	1.786	0.067691	0.033845	0.0423067
Campomanesia guaviroba	0.483	0.60375	0.76	3.717	2.055	0.064109	0.032054	0.0400679
Annona dolabripetala	0.938	1.1725	0.61	3.504	1.511	0.047544	0.023772	0.0297149
Erythroxylum coelophlebium	0.435	0.54375	1	2.506	1.509	0.042643	0.021321	0.0266517
Pouteria aff.guianensis	4.594	5.7425	0.71	2.65	2.318	0.037799	0.0189	0.0236244
Amaioua guianensis	0.347	0.43375	0.67	3.875	1.882	0.037155	0.018577	0.0232218
Lacistema pubescens	0.655	0.81875	0.57	2.542	1.545	0.034609	0.017304	0.0216305
Cecropia hololeuca	3.138	3.9225	0.43	2.606	1.61	0.032584	0.016292	0.0203647
Astronium graveolens	0.778	0.9725	0.97	2.45	1.121	0.02961	0.014805	0.0185063
Nectandra membranacea	1.992	2.49	0.65	1.751	1.087	0.028145	0.014072	0.0175905
Miconia dodecandra	0.957	1.19625	0.73	2.049	1.053	0.018375	0.009188	0.0114845
Ficus clusiifolia	4.242	5.3025	0.34	2.786	2.454	0.017696	0.008848	0.0110601
Virola gardneri	1.334	1.6675	0.56	1.539	0.875	0.013072	0.006536	0.00817
Fabaceae 2	3.098	3.8725	0.7	1.525	1.193	0.012934	0.006467	0.0080835
Albizia polycephala	0.741	0.92625	0.7	2.543	0.882	0.011433	0.005717	0.0071459
Machaerium sp.3	2.612	3.265	0.8	1.379	1.047	0.010939	0.005469	0.0068368
Cedrela fissilis	1.196	1.495	0.55	1.363	1.031	0.010177	0.005089	0.0063609
Myrsine guianensis	0.568	0.71	0.61	1.593	0.929	0.00965	0.004825	0.0060312
Tachigali paratyensis	1.906	2.3825	0.52	1.227	0.894	0.008862	0.004431	0.0055385
Allophylus edulis	0.621	0.77625	0.64	1.818	0.822	0.00816	0.00408	0.0051001
Ecclinusa ramiflora	0.711	0.88875	0.95	1.027	0.694	0.007031	0.003516	0.0043946

Miconia prasina	0.245	0.30625	0.73	2.621	0.96	0.006878	0.003439	0.0042987
Sweetia fruticosa	0.792	0.99	0.99	1.269	0.605	0.004743	0.002372	0.0029645
Annona sylvatica	0.179	0.22375	0.61	1.767	0.77	0.002522	0.001261	0.0015761
Indeterminada 1	1.262	1.5775	0.6	0.992	0.66	0.002497	0.001249	0.0015609
Lecythidaceae sp.	0.5	0.625	0.6	0.873	0.541	0.002433	0.001217	0.0015208
Brosimum sp.1	0.159	0.19875	0.88	0.911	0.579	0.002023	0.001011	0.0012642
Myrsine sp.1	0.621	0.77625	0.61	1.167	0.503	0.001904	0.000952	0.0011902
Casearia sp.1	0.212	0.265	0.7	0.874	0.542	0.001608	0.000804	0.0010051
Trichilia hirta	0.272	0.34	0.78	1.141	0.477	0.001519	0.00076	0.0009496
Senefeldera verticillata	0.233	0.29125	0.79	0.795	0.463	0.001277	0.000639	0.0007983
Dalbergia sp.1	0.542	0.6775	0.87	0.791	0.458	0.00108	0.00054	0.0006752
Erythrina verna	0.612	0.765	0.32	1.167	0.503	0.000985	0.000492	0.0006153
Platypodium elegans	0.33	0.4125	0.82	1.016	0.351	0.000951	0.000475	0.0005941
Ocotea sp.2	0.677	0.84625	0.76	0.659	0.327	0.00084	0.00042	0.0005252
Ceiba speciosa	1.025	1.28125	0.34	0.808	0.476	0.00083	0.000415	0.0005185
Aegiphila integrifolia	0.187	0.23375	0.68	1.417	0.42	0.000804	0.000402	0.0005023
Indeterminada 4	0.478	0.5975	0.68	0.765	0.433	0.000704	0.000352	0.0004398
Pourouma guianensis	0.37	0.4625	0.42	0.733	0.401	0.000624	0.000312	0.0003901
Eriotheca sp.1	0.751	0.93875	0.43	0.643	0.311	0.000501	0.000251	0.0003133
Annona cacans	0.456	0.57	0.61	0.665	0.333	0.000463	0.000232	0.0002895
Endlicheria sp.1	0.35	0.4375	0.58	0.749	0.417	0.000423	0.000212	0.0002646
Psychotria vellosiana	0.041	0.05125	0.7	0.829	0.497	0.00036	0.00018	0.0002253
Machaerium sp.1	0.379	0.47375	0.66	0.617	0.285	0.000356	0.000178	0.0002228
Coussarea sp.1	0.175	0.21875	0.65	0.972	0.308	0.00035	0.000175	0.0002185
Machaerium nyctitans	0.106	0.1325	1.12	0.938	0.273	0.000325	0.000162	0.0002029
Zeyheria tuberculosa	0.035	0.04375	1.8	0.988	0.324	0.000308	0.000154	0.0001928
Fabaceae 3	0.338	0.4225	0.7	0.578	0.245	0.000291	0.000145	0.0001816
Lecythis pisonis	0.25	0.3125	0.88	0.57	0.238	0.000261	0.000131	0.0001632
Trichilia sp.1	0.237	0.29625	0.84	0.547	0.214	0.000214	0.000107	0.0001336
Annona sp.1	0.138	0.1725	0.61	0.575	0.243	0.000205	0.000102	0.0001279
Faramea sp.1	0.073	0.09125	0.53	0.671	0.339	0.000195	9.77E-05	0.0001222
Bauhinia forficata	0.156	0.195	0.9	0.601	0.269	0.000189	9.45E-05	0.0001181
Licania sp.1	0.187	0.23375	0.99	0.511	0.179	0.000166	8.30E-05	0.0001038
Matayba guianensis	0.055	0.06875	0.57	1.339	0.342	0.000162	8.10E-05	0.0001012
Chrysophyllum sp.1	0.049	0.06125	0.7	0.643	0.311	0.000159	7.97E-05	0.0000996
Piper arboreum	0.045	0.05625	0.4	1.413	0.416	0.00015	7.52E-05	9.404E-05
Piptocarpha macropoda	0.262	0.3275	0.45	0.562	0.23	0.000135	6.76E-05	8.453E-05
Senna macranthera	0.226	0.2825	0.55	0.539	0.207	0.000129	6.43E-05	8.033E-05
Andradea floribunda	0.144	0.18	0.85	0.537	0.204	0.000125	6.25E-05	7.81E-05
Chrysophyllum aff. gonocarpum	0.069	0.08625	0.7	0.919	0.254	0.000123	6.15E-05	7.693E-05
Casearia arborea	0.03	0.0375	0.84	0.965	0.301	0.000114	5.68E-05	7.103E-05
Tabernaemontana laeta	0.148	0.185	0.6	0.575	0.243	0.000108	5.39E-05	6.741E-05
Cordia trichoclada	0.067	0.08375	0.5	0.935	0.271	9.13E-05	4.57E-05	5.708E-05
Solanum sp.1	0.141	0.17625	0.64	0.519	0.187	8.43E-05	4.21E-05	5.267E-05
Indeterminada 5	0.14	0.175	0.7	0.496	0.164	8.03E-05	4.02E-05	5.02E-05
Handroanthus chrysotrichus	0.034	0.0425	1.01	0.546	0.214	7.33E-05	3.67E-05	4.582E-05
Joannesia princeps	0.177	0.22125	0.52	0.483	0.15	6.93E-05	3.47E-05	4.333E-05
Alchornea glandulosa	0.06	0.075	0.4	0.908	0.243	5.79E-05	2.90E-05	3.621E-05
Indeterminada 2	0.108	0.135	0.65	0.476	0.144	5.06E-05	2.53E-05	3.16E-05
Guapira opposita	0.026	0.0325	0.83	0.875	0.211	4.51E-05	2.26E-05	2.82E-05
Ouratea cuspidata	0.034	0.0425	0.64	0.54	0.208	4.50E-05	2.25E-05	2.812E-05
Maprounea guianensis	0.079	0.09875	0.72	0.489	0.156	4.47E-05	2.23E-05	2.792E-05
Schefflera morototoni	0.1	0.125	0.62	0.472	0.14	4.34E-05	2.17E-05	2.715E-05
Aparisthmium cordatum	0.031	0.03875	0.52	0.875	0.211	3.41E-05	1.70E-05	2.129E-05
Machaerium sp.2	0.05	0.0625	1.04	0.461	0.128	3.37E-05	1.68E-05	2.103E-05
Inga laurina	0.051	0.06375	0.71	0.464	0.132	2.37E-05	1.18E-05	1.481E-05
Miconia sp.1	0.05	0.0625	0.73	0.454	0.122	2.20E-05	1.10E-05	1.375E-05
Nectandra oppositifolia	0.061	0.07625	0.54	0.457	0.125	2.05E-05	1.02E-05	1.279E-05
Maclura tinctoria	0.037	0.04625	0.88	0.454	0.122	1.99E-05	9.96E-06	1.245E-05
Pouteria sp.1	0.023	0.02875	0.94	0.451	0.119	1.28E-05	6.39E-06	7.989E-06
Enterolobium contortisiliquum	0.034	0.0425	0.54	0.448	0.115	1.05E-05	5.23E-06	6.535E-06
Zanthoxylum rhoifolium	0.033	0.04125	0.5	0.447	0.115	9.46E-06	4.73E-06	5.913E-06
Citrus sp.1	0.026	0.0325	0.54	0.461	0.129	9.04E-06	4.52E-06	5.65E-06
Seguieria americana	0.02	0.025	0.59	0.443	0.111	6.44E-06	3.22E-06	4.023E-06
Allophylus sp.1	0.017	0.02125	0.64	0.442	0.109	5.88E-06	2.94E-06	3.674E-06
Chrysobalanaceae 1	0.014	0.0175	0.7	0.433	0.101	4.86E-06	2.43E-06	3.04E-06
Indeterminada 3	0.013	0.01625	0.67	0.436	0.104	4.48E-06	2.24E-06	2.798E-06

Ocotea sp.1	0.014	0.0175	0.62	0.437	0.105	4.38E-06	2.19E-06	2.738E-06
Cecropia pachystachya	0.017	0.02125	0.41	0.442	0.11	3.93E-06	1.96E-06	2.454E-06
Aloysia virgata	0.008	0.01	0.6	0.437	0.105	2.42E-06	1.21E-06	1.512E-06
Spirotheca rivieri	0.009	0.01125	0.5	0.434	0.102	2.32E-06	1.16E-06	1.448E-06
Ocotea sp.3	0.007	0.00875	0.66	0.429	0.097	2.14E-06	1.07E-06	1.338E-06
Nectandra sp.1	0.005	0.00625	0.77	0.431	0.099	2.02E-06	1.01E-06	1.26E-06
Piper amalago	0.007	0.00875	0.4	0.43	0.098	1.31E-06	6.57E-07	8.213E-07
Jacaratia spinosa	0.036	0.045	0.01	0.453	0.121	2.17E-07	1.08E-07	1.355E-07
Astrocaryum aculeatissimum	-	-	-	8.819	5.829	-	-	-
Cyathea sp.1	-	-	-	0.462	0.129	-	-	-
Euterpe edulis	-	-	-	5.921	4.26	-	-	-
Syagrus romanzoffiana	-	-	-	1.783	0.786	-	-	-

For the quantification of wood biomass (B_{wood}), 318.7802 t were found for the total area of 8000 m^2, which correspond to the 16 plots (S.U), extrapolating this result to hectares, we will have 398.4753 t. ha^{-1}. As for the stored carbon (SC), the value of 199.2377 tC.ha^{-1} was obtained.

The biomass and carbon estimates found were similar to studies in which biomass estimates were obtained from the shellless stem of Ribeiro et al. (2009), which accounted for 319 tree species, belonging to 177 genera and 60 families. The quantification of biomass (Bwood) of the stem bark resulted in estimates of 166.67.ha^{-1}, for a carbon stock of 83.34 tC.ha^{-1}, in a mature forest in Viçosa, MG according to CONAMA Resolution nº 29/1994. Silva et al. (2019), sampled for the initial (ecesis) and medium forest ecosystem of the Billings Reservoir in São Bernardo do Campo (SP) the value of 113,73 t.ha^{-1} which corresponded to 56.87 tC.ha^{-1} stored carbon. Silva et al. (2018), conducted a similar study for the Municipal Natural Park of Curió, whose specie of greatest importance was also *Guarea guidonia*, the estimated wood biomass was 212.39 t.ha^{-1} and the stored carbon was 106, 19 tC.ha^{-1}. In comparison with these studies, the density of species per sampling unit of the forest ecosystem of the Nova Canaã farm was the main differentiating factor, hence the abundance of individuals per hectare was two to three times higher compared to the other studies cited here.

The dendrometric variables for the secondary stage forest ecosystem (Table 1), in turn, are in accordance with that presented in CONAMA Resolution nº 06/1994, for forests in early and medium stages. According to Fukuda et al. (2003), younger forests tend to use more carbon than mature ones. It is also noteworthy that the forest ecosystem of the Nova Canaã farm has large densities of the species *Syagrus romanzoffiana*, *Cyathea sp.1*, *Astrocaryum aculeatissimum* and *Euterpe edulis*, species that do not produce secondary xylem, as mentioned before. Therefore, it is important to use other methods of measuring biomass and carbon storage in non-lignified vegetables, preferably non-destructive methods. It is important to note that the species Euterpe edulis is threatened and endemic to the Atlantic Forest and the species Cyathea sp.1 is of great importance for anuran amphibians, being an important micro-habitat for this order of amphibians.

For studies performed in the Amazon Biome we have: Santos et al. (2018), in a study in mature forest in central Amazonia, acquired estimates of biomass (B_{wood}) of the bole wood with bark ranging between 299.60 and 29.46. tC.ha^{-1}, with a mean of 327.8 ± 41.9. tC.ha^{-1}. Saldarriaga et al. (1988), in a study on ecological succession in the Amazon region, found wood biomass (B_{wood}) of the stem in four stands of mature forests ranging between 107 and 145. tC.ha^{-1}.

In general it is observable that the results found for estimates of biomass (Bwood) and carbon stored above ground in the Amazon biome, provided higher values than this study. However the results were close to those found by Ribeiro et al. (2009) and for the studies by Silva et al. (2018) and Silva et al. (2019) all in the Atlantic Forest biome. It is therefore conclusive that the forest ecosystem of the Nova Canaã farm proved to be extremely capable in carrying out the environmental service of carbon sequestration and storage, benefiting society and the environment.

CONCLUSIONS

Through the study carried out it was possible to observe the importance of the conservation of forest fragments in the northwest of Rio de Janeiro, especially those destined to the conservation of biodiversity and the maintenance of the mesoclimate and microclimate. The diversity of the forests of the Atlantic Forest, attenuate the negative effects of climate change, as they enable the significant removal of CO_2 from the atmosphere, through biomass and carbon stored in the secondary xylem.

The determination of the stored carbon (SC) by species, indicates which are the ones with the greatest potential for fixation, being a relevant indicator in the studies of forest restoration focusing on the sale of carbon credits. Among the analyzed species, *Guarea guidonia* was the one that stood out the most similar to the studies by Silva et al. (2018) in the municipal natural park of Curió (Paracambi/RJ).

The immobilization of CO_2 by rural properties is an alternative to the use of environmental services. As carbon sequestration it is extremely important that areas such as the Nova Canaã farm be inserted in the carbon credit Market receiving support from public and private entities, such as river basin committees and carbon credit certifiers. Thus subsidizing and corroborating with projects focused on the Clean Development Mechanism (CDM) developed in these properties.

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