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ANALYSIS OF THE SPATIAL DISTRIBUTION OF TREES AND BUSHES BY SIZE, TAXONOMY AND USE THROUGH A GEOGRAPHIC INFORMATION SYSTEM

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ABSTRACT

Urban forests provide environmental, social and economic benefits, making studies on spatial distribution of trees and bushes important to better understand the life quality and welfare a place can provide. The objective of this work was to identify trees and bushes on the Agricultural Science Center of the Federal University in Espírito Santo and analyze their spatial distribution by size, taxonomy and use. Data were collected with a GPS Garmin eTrex H HS and maps were made using TerraView 4.0.0 free software. A total of 218 points were collected, related to 22 taxonomic groups and an average density of approximately 54.5 plants/ha. Fabaceae was the family with greater relative frequency (22.48%), followed by Myrtaceae (12.39%), Bignoneaceae and Rosaceae (10.09%), Chrysobalanaceae (9.17%) and Arecaceae (8.72%). Large-sized individuals predominated, mostly on streets or on squares and in the parking area and medium and small-sized trees were located in plant beds. Regarding use, mostly were ornamental, whose wide distribution contributes to a pleasant environment. However, some irregularities were detected, such as fruit trees in a parking lot and forest trees near buildings. Maps of the distribution of trees and bushes can give basis for preservation and adequacy of urban forest on campus.

Keywords: Urban Forest; GPS; Geoprocessing.

ANÁLISE DA DISTRIBUIÇÃO ESPACIAL DE ÁRVORES E ARBUSTOS QUANTO AO PORTE, À TAXONOMIA E À UTILIZAÇÃO ATRAVÉS DE SISTEMA DE INFORMAÇÃO GEOGRÁFICA

RESUMO

A arborização urbana proporciona benefícios ambientais, sociais e econômicos, tornando o estudo da distribuição espacial de árvores e arbustos importante no conhecimento da qualidade de vida e bem-estar que um local oferece. O objetivo do trabalho foi identificar os componentes arbóreos e arbustivos do Centro de Ciências Agrárias da Universidade Federal do Espírito Santo e analisar a distribuição espacial destes quanto ao porte, à taxonomia e ao uso. Os pontos foram coletados com um GPS Garmim eTrexH HS e confeccionou-se mapas com auxílio do *software* livre TerraView 4.0.0. Foram coletados 218 pontos referentes a 22 grupos taxonômicos e foi encontrada uma densidade média de aproximadamente 54,5 plantas/ha. Fabaceae foi a família com maior freqüência relativa (22,48%), seguida por Myrtaceae (12,39%), Bignoneaceae e Rosaceae (10,09%), Chrysobalanaceae (9,17%) e Arecaceae (8,72%). Espécimes de grande porte predominaram, a maioria acompanhando vias ou dispostas em praças e estacionamentos, e as de médio e pequeno porte compondo canteiros. Quanto à utilização, a maioria é ornamental, cuja ampla distribuição colabora para um ambiente agradável. Entretanto, observaram-se irregularidades, como frutíferas em um estacionamento e espécimes florestais próximas a prédios. Mapas de distribuição de árvores e arbustos podem fornecer subsídios para manutenção e adequação da arborização do campus.

Palavras-chave: Arborização Urbana; GPS; Geoprocessamento.

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INTRODUCTION

Alegre is a municipality situated in the Caparaó Region in the state of Espirito Santo – Brazil –, and is popularly known as the "Garden City" because of its natural beauty and its large number of squares decorated with plants. However, little information is available about the distribution and characterization of plants in the city, and knowledge of the vegetation composition would allow a greater appreciation of plant specimens by residents and arouse greater interest to researchers.

The Center for Agricultural Sciences of the Federal University of Espírito Santo (CCA-UFES), located in Alegre, currently offers 17 undergraduate and four graduate courses. While some of these courses are not directly related to agricultural sciences, the campus was created based on the interest in agronomy. Many of these courses have in their curriculum, disciplines that involve knowledge on plants, such as Plant Anatomy, Plant Organography and Systematics, Ecology, Landscaping and Ornamental Plants, Plant Physiology and Wood Anatomy. The importance of knowledge on taxonomy, use and size of plant specimens on campus is justified not only for their use in the disciplines, but also for allowing greater appreciation and understanding of the university environment.

There are many studies on vegetation composition at universities (Zuany et al. (2007) and Castro et al. (2011)) and the role of universities in environmental education and dissemination of botanical knowledge in the community has been extensively discussed. The use of GPS in surveys of vegetation cover is becoming widely disseminated due to the high precision that some devices offer, as well as the easiness to use the equipment and the practicality of using geocoding software programs, many of which are free, making it easy to handle and process data.

At the University Center of North of Espírito Santo (CEUNES) in São Mateus, there is an afforestation project implemented, and, to date, over 800 seedlings have been planted to be used in classes of Botany and Ecology. Besides, they will contribute to the preservation of ecological features and to the formation of sites for public visits, mainly squares. This same procedure is adopted on Goiabeiras campus situated in the municipality of Vitória – Espírito Santo state – Brazil (INFORMA, 2010). However, so far, no studies have been conducted on the afforestation project of the CCA-UFES. Moreover, there is forecast for an organized implementation of tree specimens on campus, which is paradoxical, given that this campus offers courses in this field of study and because it is located in a town that has a toponym of "Garden City".

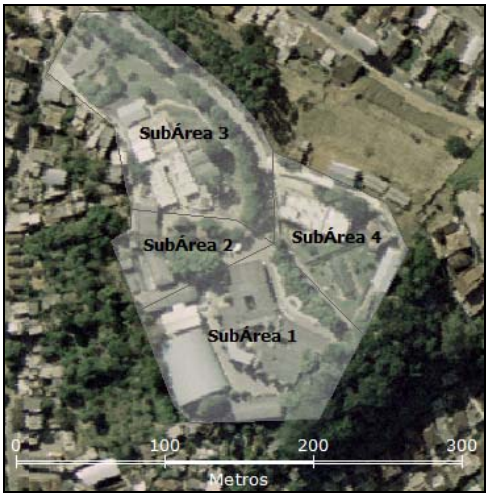
Thus, the objective of this study was to obtain information about the composition of trees and shrubs on campus of the CCA-UFES and perform analysis of the spatial distribution of these plants regarding their size, taxonomy and use, aiming to identify the trees organization and possible irregularities of the current afforestation process, using GPS techniques and Geographic Information Systems (GIS).

MATERIALS AND METHODS

The study was conducted at the Agricultural Science Center at the Federal University of Espírito Santo, CCA-UFES (Latitude 20°45', Longitude -41°32'), located in the municipality of Alegre – Espírito Santo state – Brazil (Figure 1) with a Cwa predominant climate, i.e., tropical hot and humid with cold and dry winter (Köppen classification), with an average annual temperature of about 23ºC and average annual rainfall of about 1,300mm (Lima et al., 2008).

Figure 1. Localization of Agricultural Science Center of UFES

Figure 2. Division scheme of the CCA-UFES area in four subareas used for GPS points of collection



Source: Adapted from IEMA (2007) by the author

The area of the CCA-UFES was divided into four sub-areas (Figure 2) to facilitate the collection of points and avoid repeated points.

The collection of points was performed in all four sub-areas with the use of a GPS Garmin eTrex H High Sensitivity, configured to the projection system UTM datum WGS84.

As collection criteria, we considered only plants trees and shrubs, given their greater longevity and dominance (NOBLICK et al., 1983), not in pots, in construction sites or buildings. After the collection of each point, we recorded information on size, taxonomy and use of the plant (Table 1). The criteria adopted for size followed those presented by Mascaró and Mascaró (2005).

Table 1. Classification criteria of plants whose points were collected by GPS

Size	Taxonomy	Use
Small (até 6 m)	Plant family.	Ornamental
Medium (6 a 10m)	If gymnosperm, Philo.	Fruit
Large (> 10m)		Forest

The points were uploaded into a computer and stored in a shapefile (shp) using the free software DNR Garmin. The shapefile containing the points of plants location and an orthophoto of Alegre provided by IEMA (UTM WGS84 datum) were imported into TerraView 4.0.0. In the Information Plan containing the location of the plants, we created in the table for attributes columns for "size", "taxonomy" and "use", and the table was fed with data obtained from field observations. New Information Plans have been created containing approximate polygons of the buildings, squares and parking lots, and lines representing the streets on campus of CCA-UFES, both procedures based on observations of the georeferenced orthophoto of IEMA of the municipality of Alegre. A recent image of the CCA-UFES from Google Maps® was also georeferenced based on orthophoto provided by IEMA in order to add polygons of newly constructed buildings.

In TerraView 4.0.0, we quantified the number of individuals of each family found. The sampling points are separated by size, taxonomy and use (Table 1). For taxonomy, we considered only families that had more than 10 specimens, and the remaining points were grouped in "Others".

RESULTS AND DISCUSSION

Table 2. Number of specimens (QTY) and relative frequency occurrence (FREQ) of each taxonomic group found in CCA-UFES

Taxonomic Group	QTY	FREQ	Taxonomic Group	QTY	FREQ
Fabaceae	49	22.48%	Melastomataceae	6	2.75%
Myrtaceae	27	12.39%	Caricaceae	2	0.92%
Bignoniaceae	22	10.09%	Meliaceae	2	0.92%
Rosaceae	22	10.09%	Solanaceae	2	0.92%
Chrysobalanaceae	20	9.17%	Agavaceae	1	0.46%
Arecaceae	19	8.72%	Annonaceae	1	0.46%
Euphorbiaceae	9	4.13%	Apocynaceae	1	0.46%
Anacardiaceae	8	3.67%	Lauraceae	1	0.46%
Gymnosperma	8	3.67%	Plumbaginaceae	1	0.46%
Moraceae	8	3.67%	Proteaceae	1	0.46%
Malvaceae	7	3.21%	Rubiaceae	1	0.46%

We collected a total of 218 points regarding trees and shrubs within the limits of CCA-UFES distributed in 22 taxonomic groups (Table 2).

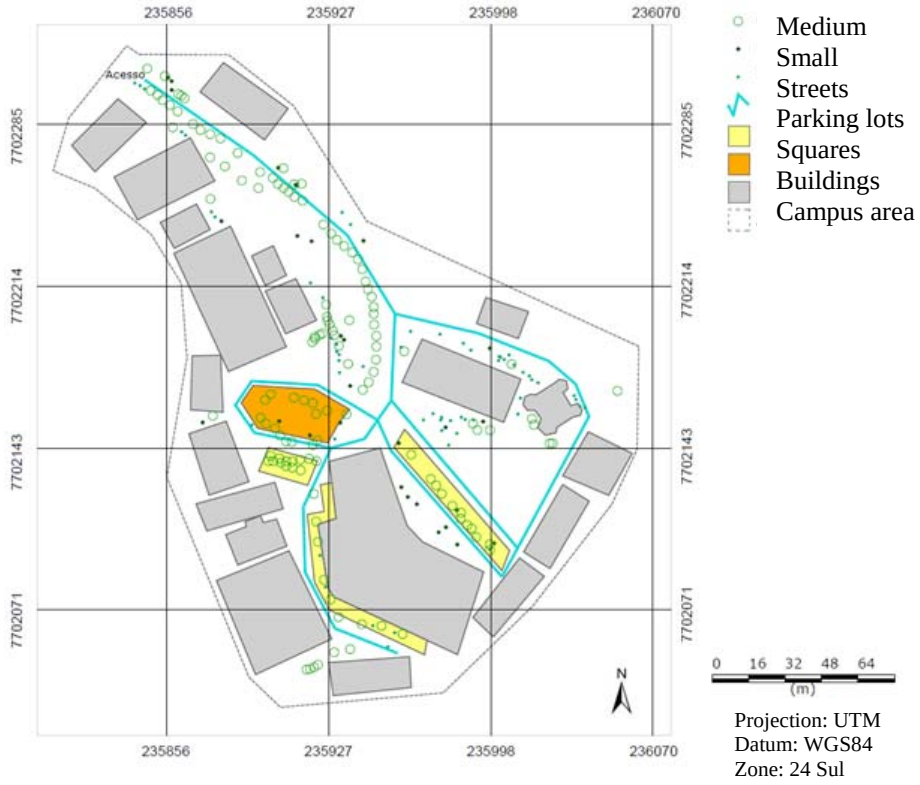
The campus area of CCA-UFES corresponds to approximately 4.0 hectares, and considering the 218 points collected, we have an approximate density of trees and shrubs of 54.5 specimens/ha. Kurihara et al. (2005) found 5,011 trees in a study area of the 111-acre campus of the University of Brasilia – Brazil –, corresponding to a density of approximately 45 trees/ha. In terms of number of taxonomic groups, the result (21 families and 1 (one) Philo) was lower than in other studies conducted in university campuses, where 49 families were found (KURIHARA et al, 2005), 41 families (CASTRO et al., 2011), 52 families (LOMBARDI and MORAIS, 2003) and 43 families (RIZZO et al, 1993). This may be attributed to the fact that CCA-UFES relies on a single team of workers for the maintenance of wodded areas, neglecting the production of renovation projects and deployment of greater plant diversity. Moreover, the increase in the number of courses offered by the campus required the construction of new buildings or expansion

of the old ones, which may have contributed to reducing the diversity of tree families. Fabaceae is one of the largest families of Angiosperms, and is mostly used in urban afforestation in Brazil (SOUZA and LORENZI, 2008), which corroborates the results found in this study, since 22.48% of the trees and shrubs belong to this family. Dantas and de Sousa (2004) analyzed the urban afforestation of the city of Campina Grande – Paraíba state – Brazil –, and Fabaceae was also the most representative taxonomic group.

Corroborating the results reported by Lombardi and Morais (2003), Myrtaceae, and Arecaceae Bignoneaceae significantly represented families in the composition of trees of the CCA-UFES campus. Chrysobalanaceae is commonly used in afforestation of squares, parks and streets, like Oiti (SOUZA and LORENZI, 2008). Rosaceae is widely used in decoration of plant beds, justifying the relative significant frequency of these families on the CCA-UFES campus.

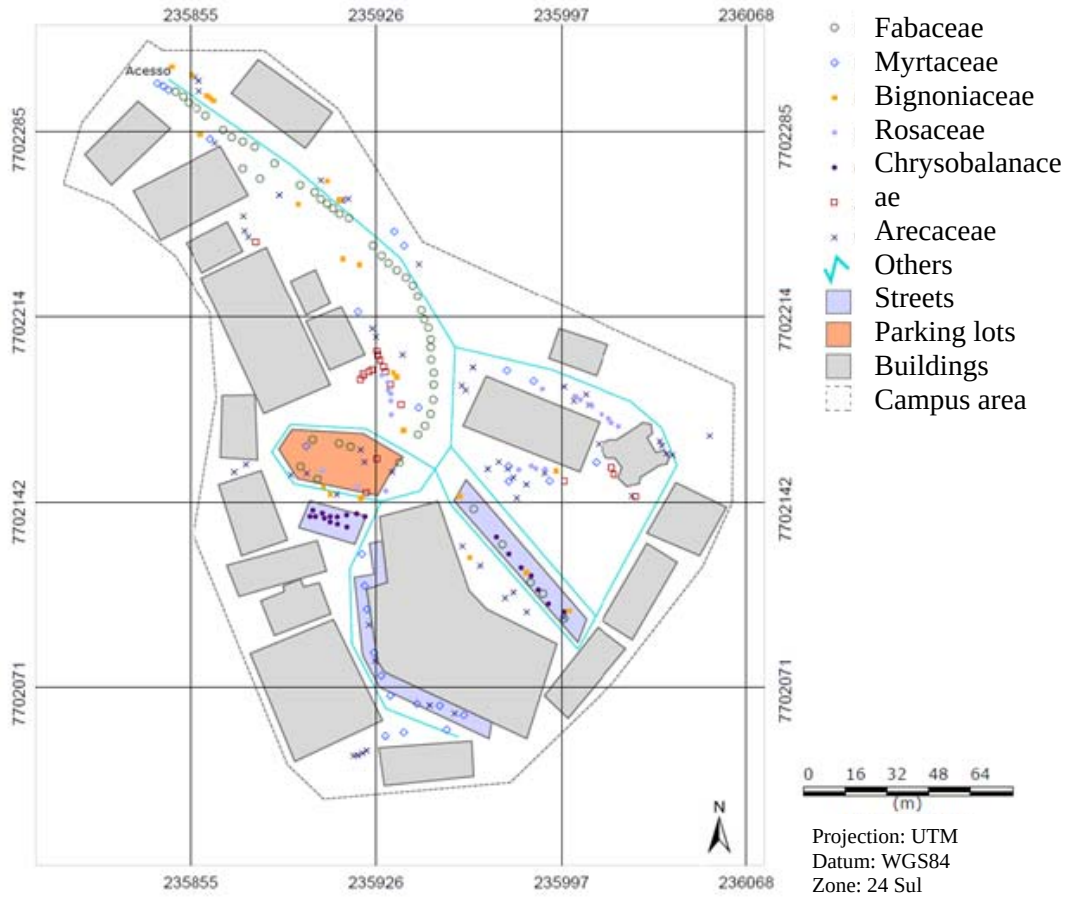
The distribution of trees regarding their size can be observed in Figure 3.

Figure 3. Distribution of trees and bushes in CCA-UFES regarding their size



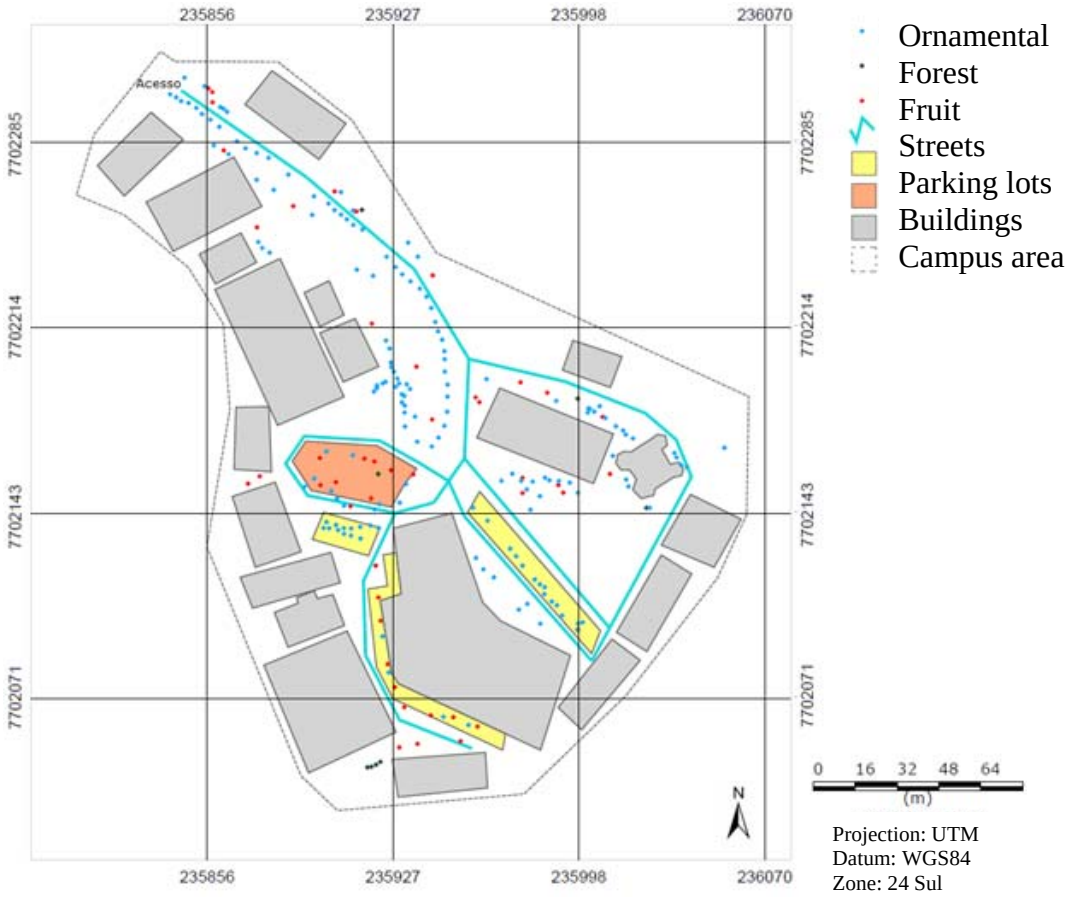
We observe the predominance of large-sized specimens, and some of these trees are arranged in a disorganized way, while others probably followed a deployment planning. The trees arranged in a disorganized way are found in the slope of access from the entrance to the campus and in the area of squares and parking lots. Considering only the large-size trees, they are desirable in such places because of the shade they provide (SANTANA and SANTOS, 1999); therefore, collaborating to reduce direct solar radiation to vehicles, and to decrease temperatures on the access slope and on squares, which represents a meeting place primarily for students. We also observed that medium and small-sized trees (less representative categories) are practically found near the buildings, forming plant beds. Figure 4 shows the distribution of trees and bushes regarding their taxonomy.

Figure 4. Distribution of trees and bushes in CCA-UFES regarding taxonomy



We can observe in Figure 4 that Fabaceae has representatives mainly on the streets while Rosaceae and Arecaceae are distributed in practically around all buildings. Specimens of Chrysobalanaceae are found only in parking lots, possibly to the shade they provide and because their small and light fruits (Oitis) do not represent risks to vehicles. Bignoniaceae and Myrtaceae, as well as other taxonomic groups grouped to "Others" are well-distributed around the campus, although there is no evident planning for their planting, given that the specimens do not follow a distribution pattern. The distribution of trees and shrubs regarding their use is shown in Figure 5.

Figure 5. Distribution of trees and bushes in CCA-UFES regarding use



Regarding use (Figure 5), we can observe that most plants are ornamental and that there are specimens spread throughout the CCA-UFES campus, which contributes to a more beautiful and pleasant environment. Fruit trees represent the second most significant, and the only problem regarding their distribution is the presence of individuals in one of the parking lots, which can pose risks to the vehicles because of fruit drop. The forest specimens are practically negligible in terms of number and its distribution is not planned. This is because most of these species have an extremely aggressive root system, which can pose risks to underground pipelines, sidewalks and buildings nearby.

CONCLUSIONS

Compared to other campuses of Brazilian Universities, CCA-UFES showed relative poor composition of tree families in the arboreal and tree planting, however, the number of specimens per hectare can be considered satisfactory.

Overall, the distribution of trees and bushes covers a good part of the total area of the campus; however, we can observe irregularities in the location of some specimens, such as fruit families located in one of the parking lots and forest species in inadequate sites.

The mapping of the spatial distribution of the vegetation cover with the use of a GPS and geoprocessing techniques allow, besides the collection of data on tree and bush cover, efficient identification of the organization and irregularities of tree planting, providing important basis for the preservation and adequacy of afforestation on campus.

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