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ECOLOGICAL ANALYSIS AND IMPACT OF VEGETATION IN THE
UNIVERSITY CAMPUS: EXPLORING DIVERSITY AND ITS ROLE IN
ACADEMIC COMMUNITY WELFARE

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Abstract

Landscapes rich in greenery within college and university settings significantly impact the physiological and psychological well-being of college students. This study aims to evaluate the vegetation from both an aesthetic and functional perspective, as well as the students' perception of the vegetation at the Technical University of Cluj-Napoca campus, Romania. The research addressed three main dimensions of green spaces on university campuses: importance, aesthetics, and functionality. The research methodology involved collecting field data and inventorying the vegetation. Additionally, a key aspect under scrutiny was the analysis of the impact of vegetation on the students' experience on campus. The obtained results provide valuable insights to enhance the aesthetics and functionality of green spaces on campuses, thereby contributing to the students' well-being. Furthermore, the findings serve as the fundamental groundwork for the creation of the requisite documentation essential for a new proposed landscaping project. This project encompasses a comprehensive evaluation of ecological factors, as well as the potential beneficial effects on the holistic welfare of the academic community. Hence, this study not only identified the connections between biological diversity and the surrounding environment but also highlighted the critical importance of green spaces in promoting a healthy and balanced atmosphere within the university campus.

Introduction

In the dynamic landscape of higher education, green spaces within university campuses are not mere embellishments; they are vital components for the well-being and holistic development of the academic community. Recent studies, underscore the undeniable importance of green-enriched environments in higher education institutions [1]. In this context, this article proposes a detailed analysis of the vegetation within the campus of the Technical University of Cluj-Napoca, Romania, to better understand its impact on students' experiences. By addressing multiple dimensions of green spaces, including importance, aesthetic aspects, and functionality, the aim is to contribute to the development of a conducive academic environment that not only fosters academic excellence but also supports the balance and holistic well-being of the students.

Material and method

This study was conducted in Cluj-Napoca, within the Observatory student campus, as well as in the adjacent area near a faculty of the Technical University of Cluj-Napoca, Romania. The urban landscape morphology of Cluj-Napoca is influenced by its location at the confluence of three major relief units: the Apuseni Mountains, the Transylvanian Plain, and the Someş Plateau. This placement creates a complex and diverse morphology, featuring distinct characteristics in the northern slope. Analysis of morphography and morphometrics using GIS techniques has allowed us to identify these differences, map them, and assess the complex morphology of the Cluj urban landscape (Fig. 1).

The main objective of the research was to afford a meticulous and precise exposition of vegetation diversity, necessitating the stratification of the study locale into six discrete zones (Fig. 2). This methodological approach was conceptualized to furnish a thorough comprehension of vegetation diversity across diverse sectors of the campus. The division into zones facilitated a more detailed analysis of the specific characteristics of vegetation in each zone, thereby contributing to a more thorough assessment of the green landscape within the academic environment.

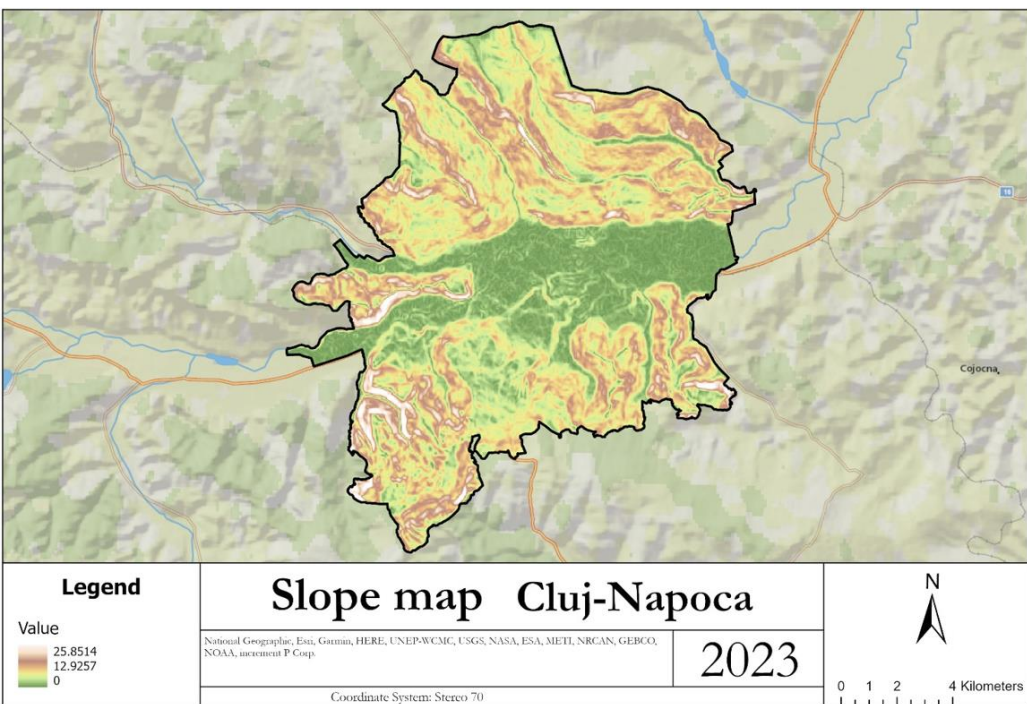


Fig.1 Slope map of Cluj-Napoca



Fig.2 Zonal representation of the study area: subdivision of sectors

The total area of the studied site is approximately 6 hectares, with vegetated areas comprising about 62% of this total (Fig. 3). Within this framework, a total of 50 species were identified and recorded, including 34 trees and 16 shrubs, amounting to a total of 689 individuals. Subsequent categorization delineated them into two taxonomic subsets: deciduous and coniferous. Observations highlighted the predominance of deciduous species in this area. To ensure a comprehensive approach, each individual was assessed in terms of overall appearance, health status, crown shape, and foliage density.

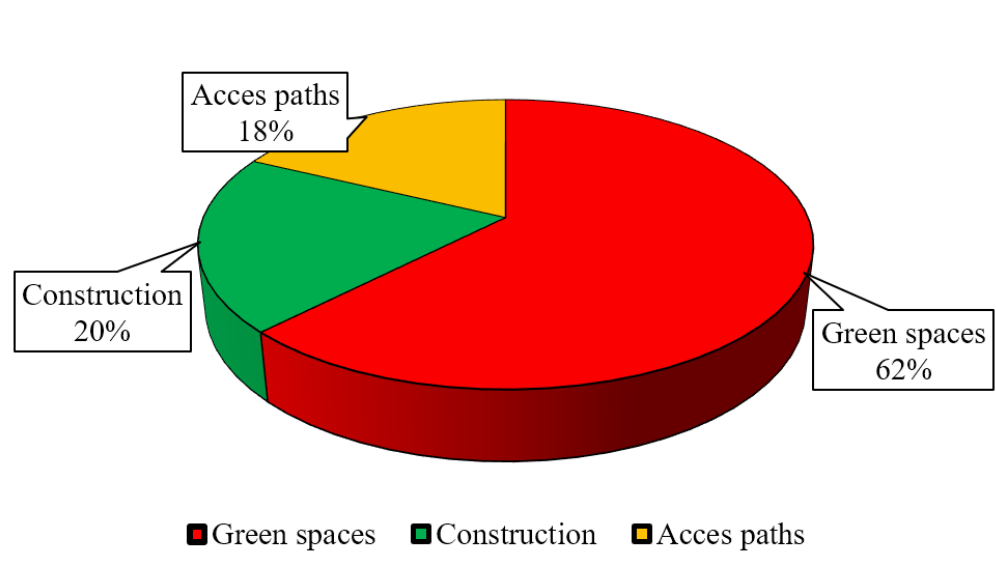


Fig.3 Study site land use distribution

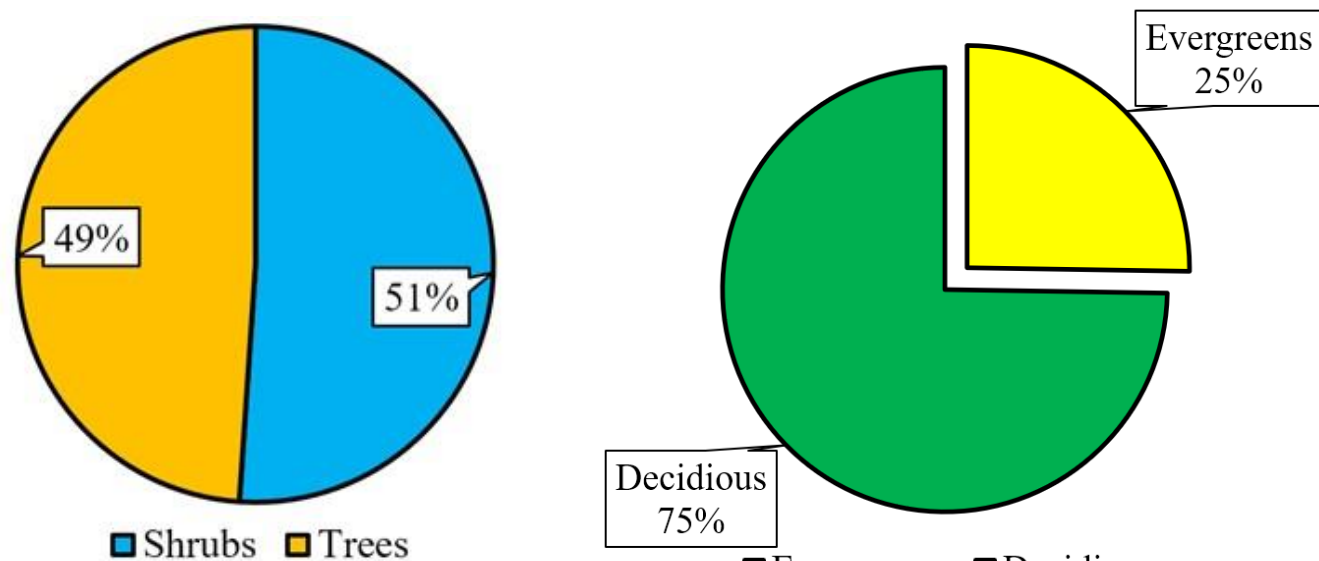


Fig.4 Percentage distribution of vegetation types represented by shrubs and trees in the studied ecosystem

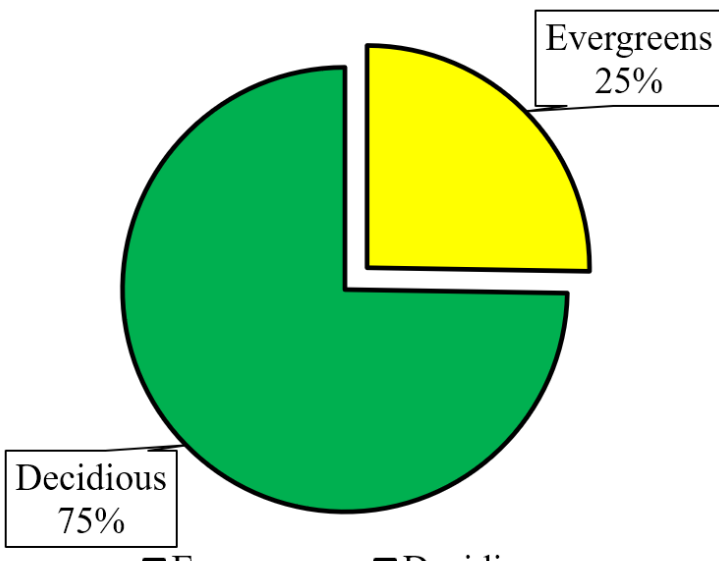


Fig. 5 Representation of the types of species distribution

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Results and discussions

The Fig. 4 depicts the percentage of trees and shrubs studied, revealing a close correlation between these two categories. Observations indicate that shrubs represent the largest proportion, reaching 51% with 352 of individuals, while the trees represent 49% with 337 individuals. This percentage is comprised of 16 shrub species, such as *Chaenomeles japonica*, *Symphoricarpus albus*, *Corylus avellana*, and others. The species *Corylus avellana* exhibits the highest count of individuals. This species present significant ecological relevance, serving as a food source for a diverse array of fauna, encompassing rodents, avian species, and various wild mammals. Its fruits act as sustenance for numerous bird species, while the shrub functions as a refuge for smaller wildlife [3]. Its ecological role extends to soil stabilization and erosion control, attributed to the hazel's robust root system.

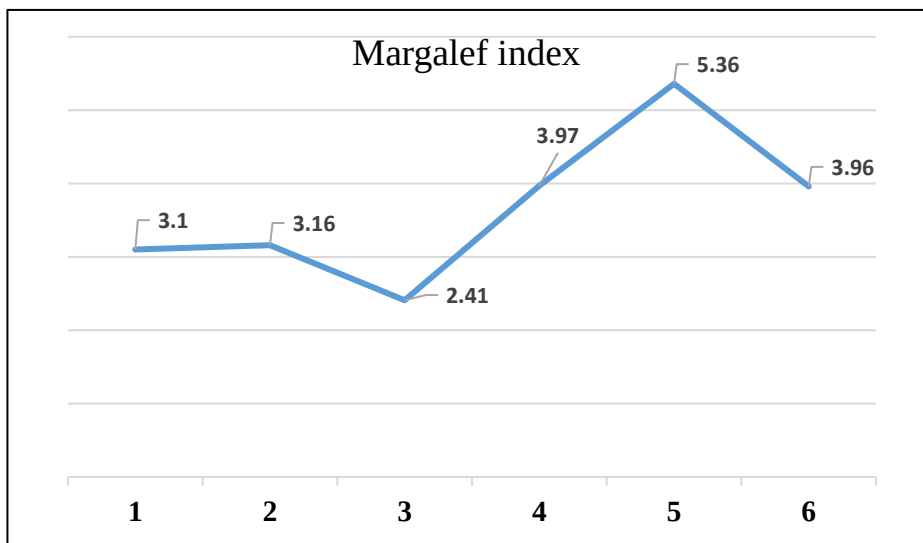


Fig. 6 Margalef index for all the sample plots analyzed

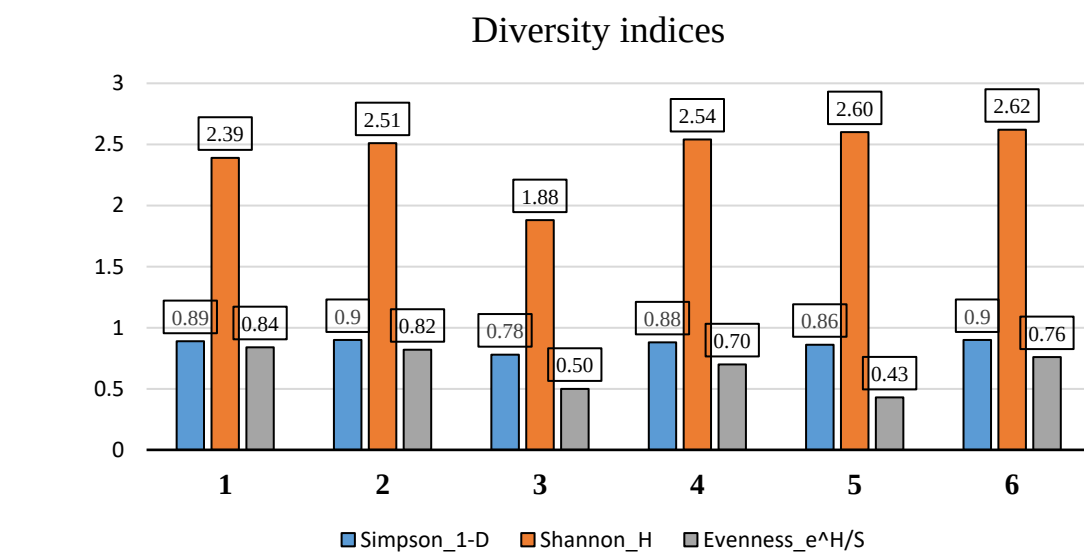


Fig. 7 Diversity indices compared (Simpson, Shannon and their evenness) for all the sample plots analyzed

From the analysis of Figure 4, it is evident that the majority is represented by deciduous species, accounting for 74% of the total species in the studied ecosystem (with 515 individuals). This category encompasses a diverse array of shrub species, prominently featured within the site. Within the conifer category, tree species such as *Pinus*, *Picea*, *Thuja*, *Abies*, and *Larix* were identified as the most significant species. The Margalef Index provides a measure of the ecological diversity of a community, taking into account both the number of species and the abundance of each species [2]. For this index, higher values indicate greater diversity. In our experimental conditions, a notable diversity is noticed in sample plot five, followed by sample plots four and six (Fig. 6). This suggests that sample plot five has a richer variety of species, contributing to a more ecologically diverse environment compared to the others.

Analyzing the presented indices, it can be noticed that for all sample plots, the Shannon-H index recorded the highest values (Fig. 7). Additionally, it is noticeable that the values of this index are almost similarly for sample plots 5 (2,60) and 6 (2,62), while the lowest value was recorded in sample plot 3 (1,88). The proximity of values for sample plots 5 and 6 suggests a comparable level of diversity between these plots. On the other hand, the lower value in sample plot 3 indicates a relatively lower diversity in comparison to the other sample plots. This information provides insights into the distribution and evenness of species in different areas under study.

Hierarchical clustering refers to a clustering analysis technique used to group similar data points or objects into clusters or larger groups. In our experimental conditions, a grouping into two main clusters can be observed among the six sample plots. Specifically, sample plot 5 forms one cluster, while the others form a separate cluster. Additionally, a group of clusters is observed concerning the identified species in this study (Fig.8).

From the perspective of carbon dioxide uptake, *Acer* sp. registers the highest value, while *Tilia* records the lowest. Specifically, carbon sequestered is 668 kg for *Acer* and 6.83 kg for *Tilia*. In terms of CO₂ equivalent, *Acer* records a value of 2450 kg, whereas *Tilia* registers only 25 kg. In the section on stormwater mitigation, two different species record superior values. For runoff avoided, *Quercus* registers 55 liters, while for rainfall intercepted, *Tilia* reports the highest value of 167 liters. On the contrary, the lowest values are recorded by *Thuja* sp. From the perspective of air pollution removal, all species record a consistent value for carbon monoxide. However, they differ in the other categories, with *Tilia* registering the highest value, while *Thuja* records the lowest among them. From an aesthetic perspective, a sense of routine is observed within the plant assortment in the studied site. The landscape dynamics lack key elements in providing volumetric, chromatic, and textural contrast attributed to shrubbery. The wintry ambience is minimally provided by the alignments of *Thuja* specimens. The landscape is predominantly characterized by medium and tall arboreal vegetation, lacking the transition to other vegetative tiers (Table 1).

Species	Quercus sp.	Acer sp.	Pinus nigra	Tilia sp.	Thuja sp.
Carbon Dioxide Uptake (kg)					
Carbon Sequestered	287.963	668.13	239.37	6.83	167.75
CO ₂ Equivalent	1055.868	2450.76	877.71	25.05	615.71
Storm Water Mitigation (l)					
Runoff Avoided	55.327	18.73	22.87	25.72	8.006
Rainfall Intercepted	113.645	121.83	148.76	167.32	52.08
Air Pollution Removal (kg)					
Carbon Monoxide	0.003	0.003	0.003	0.003	0.003
Ozone	2.24	2.38	2.51	3.27	1.01
Nitrogen Dioxide	1.6	1.7	1.8	2.35	0.73
Sulfur Dioxide	0.64	0.69	0.73	0.95	0.29
PM _{2.5}	0.46	0.49	0.52	0.68	0.21

Table 1 Estimating benefits of trees with superior phenotypic traits

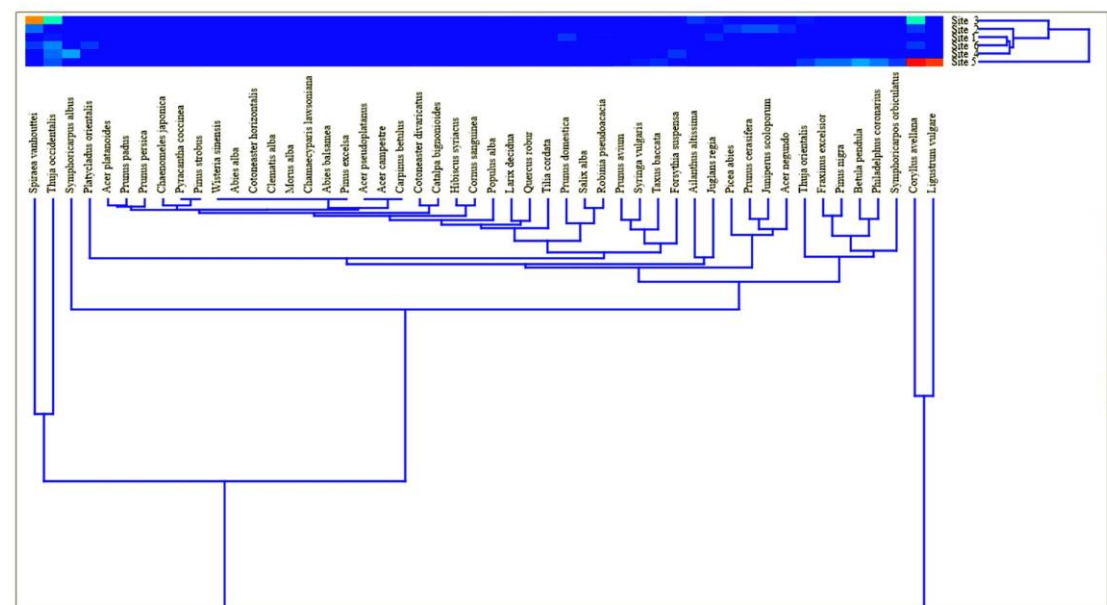


Fig. 8 The hierarchical cluster analysis dendrogram of the woody species and the six analysed sites

Conclusions

The multifaceted role of trees and shrubs in landscape architecture extends beyond mere ornamentation, encompassing ecological, aesthetic, and functional dimensions. Analyzing the ecological impact of vegetation encourages a culture of environmental awareness and sustainable practices within the academic community. This awareness can extend to ecological conservation and sustainable landscaping practices. Investigating the ecological aspects and impact of vegetation on a university campus must go beyond aesthetics. It has far-reaching implications for the overall well-being of the academic community, environmental sustainability, and the integration of nature within the educational environment.