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URBAN TREE COMPOSITION AND DIVERSITY ASSESSMENT IN A PUBLIC PARK USING TAXONOMIC IMBALANCE INDICATORS: THE CASE OF ATATÜRK PARK, KAHRAMANMARAŞ

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ABSTRACT: This study aims to analyze the urban tree composition of Atatürk Park in Kahramanmaraş through indicators of taxonomic imbalance. 733 tree individuals were identified within the park, representing 25 species, 22 genera, and 14 families. Species diversity was evaluated using 10-20-30 rule in conjunction with the Pest Vulnerability Matrix (PVM). The findings revealed that *Cupressus sempervirens* L. accounted for 30.42% of all individuals, indicating clear dominance at the species level. Additionally, *Gleditsia triacanthos* L. (16.23%) and *Acer negundo* L. (10.10%) exceeded the recommended species thresholds. The five most common species constituted 74.76% of the total, while the top ten species represented 93.99%. At the genus level, *Cupressus* (30.42%) was the most dominant, and at the family level, Cupressaceae (32.20%) exceeded the 30% threshold. These results show taxonomic imbalance ratios of 30.42% for species, 30.42% for genus, and 32.20% for family levels, indicating that the park falls within the high vulnerability category according to the PVM. Among all tree individuals, 59.89% were angiosperms and 40.11% were gymnosperms; phenologically, 59.75% were deciduous broadleaf, 40.11% coniferous, and only 0.14% evergreen broadleaf. Regarding provenance, native species made up 62.76% of the population, while exotic species constituted 37.24%. These findings reveal that the park exhibits insufficient taxonomic diversity and a high dependence on a few taxa, which contributes to ecological vulnerability. As a result, tree-planting strategies based on taxonomic balance and increased use of native species are recommended to promote sustainable urban forestry.

Keywords: Urban tree planting, biodiversity, taxonomic imbalance.

TAKSONOMİK DENGESİZLİK GÖSTERGELERİYLE KENTSEL BİR PARKTA AĞAÇ TÜRÜ ÇEŞİTLİLİĞİNİN DEĞERLENDİRİLMESİ: KAHRAMANMARAŞ ATATÜRK PARKI ÖRNEĞİ

ÖZET: Bu çalışma, Kahramanmaraş Atatürk Parkı'ndaki kentsel ağaç kompozisyonunu taksonomik dengesizlik göstergeleri doğrultusunda analiz etmeyi amaçlamaktadır. Alanda yapılan envanter çalışmasında 733 ağaç bireyi tespit edilmiş olup, bu bireyler 25 tür, 22 cins ve 14 familyaya aittir. Çeşitlilik değerlendirmesinde 10-20-30 kuralı ile Zararlılara Duyarlılık Matrisi (Pest Vulnerability Matrix – PVM) birlikte kullanılmıştır. Bulgular, tür düzeyinde *Cupressus sempervirens* L.'in %30.42'lik oranla baskın olduğunu; ayrıca *Gleditsia triacanthos* L. (%16.23) ve *Acer negundo* L. (%10.10) gibi egzotik türlerin de eşik değerleri aştığını göstermektedir. En yaygın beş tür park genelinin %74.76'sını, ilk on tür ise %93.99'unu oluşturmaktadır. Cins düzeyinde *Cupressus* (%30.42), familya düzeyinde ise Cupressaceae (%32.20) açık ara baskındır. Bu durum, tür, cins ve familya düzeylerinde sırasıyla %30.42, %30.42 ve %32.20 oranlarında taksonomik dengesizlik bulunduğunu ve parkın PVM'ye göre yüksek kırılganlık risk grubunda yer aldığını göstermektedir. Ağaç bireylerinin %59.89'u angiosperm, %40.11'i gymnosperm grubuna aittir; fenolojik olarak %59.75'i yaprağını döken geniş yapraklı, %40.11'i iğne yapraklı, yalnızca %0.14'ü her dem yeşil geniş yapraklıdır. Köken açısından değerlendirildiğinde, bireylerin %62.76'sı yerli, %37.24'ü egzotik türlerden oluşmaktadır. Bu bulgular, parkta taksonomik çeşitliliğin yetersiz olduğunu ve belirli taksonlara aşırı bağımlılığın ekolojik kırılganlık yarattığını ortaya koymaktadır. Sonuç olarak, sürdürülebilir kentsel ormancılık açısından taksonomik dengeye dayalı dikim stratejilerinin benimsenmesi ve yerli türlerin çeşitlendirilerek kullanılması önerilmektedir.

Anahtar kelimeler: Kentsel ağaçlandırma, biyoçeşitlilik, taksonomik dengesizlik.

INTRODUCTION

The rapid pace of urbanization poses a significant threat to biodiversity by causing the destruction of natural vegetation and weakening ecosystem services (Seto et al., 2012). In this context, green infrastructure such as urban parks and roadside tree plantings holds critical importance due to both ecological and social functions. Urban green spaces serve as valuable reserves for plant biodiversity while also providing key ecosystem services such as carbon sequestration, air pollution mitigation, noise control, and temperature regulation (Tzoulas et al., 2007; Gómez-Baggethun & Barton, 2013, Ekren et al., 2024, Kordon, 2024).

In urban forestry practices, the diversity of tree species is a crucial indicator of system resilience, particularly against biotic stress factors. Resistance to pests, diseases, and climatic variability is directly related to species- and genetic-level diversity (Laćan & McBride, 2008). In this regard, Santamour (1990) proposed the "10-20-30 rule" to promote biological diversity in urban forests. According to this rule, no single species should comprise more than 10% of the total tree population, no single genus more than 20%, and no single family more than 30%. These thresholds have been widely adopted in urban forestry policies in many countries today.

In addition, research conducted in regions with climatic conditions characteristic of transitional zones between Mediterranean and continental climates has highlighted comparable challenges in urban tree diversity. For instance, studies in Mediterranean-climate cities have revealed that the overrepresentation of certain species not only increases susceptibility to pests and diseases

but also reduces ecological resilience and seasonal variability (Pérez Soba et al., 2015; Sjöman et al., 2016). Likewise, investigations in transitional climate zones, such as Allahabad in India, reported that urban parks were dominated by a few exotic species, creating ecological vulnerabilities and limiting functional diversity (Pandey & Hemant, 2018). These findings suggest that urban landscapes in climatic transition regions share similar risks with Mediterranean environments, where taxonomic imbalance and ecological fragility are frequently observed.

In recent years, research on urban tree biodiversity has significantly increased on a global scale, addressing the impacts of species composition on aesthetics, ecological functionality, climate resilience, and public health in a multidimensional manner (Kendal et al., 2012; Sjöman et al., 2016). Within this framework, approaches that regard species diversity not only as a source of visual richness but also as a form of ecological insurance have gained prominence.

In Türkiye, studies on urban plant diversity have been increasing; however, spatial coverage remains limited. Data from many cities outside of large metropolitan areas is still insufficient. For example, a study conducted by Sever Mutlu et al. (2017) in Antalya revealed that certain species were overrepresented in roadside tree plantings, leading to ecological vulnerability. Similarly, Ögçe et al. (2022) emphasized the ecological risks associated with the overrepresentation of specific species in various urban parks.

This study aims to address this gap by focusing on the city of Kahramanmaraş. The distribution of tree species in Atatürk Park was analyzed at the genus, family, and species levels. Vulnerability was assessed using Family, Genus, and Species Dominance Indicators in conjunction with the Pest Vulnerability Matrix (Laćan & McBride, 2008). The data were interpreted based on Santamour's (1990) 10-20-30 rule to evaluate the park's resilience. In doing so, the study aims to contribute to sustainable green space planning based on plant diversity for local governments.

MATERIALS AND METHODS

The city of Kahramanmaraş was selected as the study area because it represents a transitional zone between Mediterranean and continental climates, making it ecologically significant in terms of plant adaptation and biodiversity. In addition, the city has experienced rapid urban growth in recent decades, which has intensified pressures on its green infrastructure and highlighted the need for sustainable management strategies. Within this context, Atatürk Park was chosen as the research site since it is one of the oldest and largest urban parks in the city and serves as a central recreational space frequently visited by local residents. The park covers an area of approximately 90,000 m² and represents a typical urban green space where both structural and vegetative landscape elements coexist. Located about 2.5 km from the city center at coordinates 37°33′N and 36°55′E, it plays a significant role in the urban ecological structure in terms of both recreational use and vegetation. The park's topography is generally flat, and it is surrounded by residential, commercial, and public buildings. Vegetation is particularly concentrated along roadsides and at the borders of lawn areas. This hybrid landscape structure, shaped by both natural climatic conditions and intensive urban usage pressures, provides a representative case for examining taxonomic imbalance and ecological vulnerability in urban tree populations. The location of Atatürk Park is shown in Figure 1.



Figure 1. The Location of the Study Area within Türkiye and Kahramanmaraş (Google Earth, 2025; OpenStreetMap, 2025).

Kahramanmaraş is located within a transitional zone between the Mediterranean and continental climate regions, and this climatic transition plays an important role in terms of both species' diversity and plant adaptation capacity. According to data from the Turkish State Meteorological Service (2025), the city has an average annual temperature of 16.8 °C and an average annual precipitation of approximately 721 mm. Summers are hot and dry, while winters are cold and rainy.

Within the scope of this research, the park area was systematically surveyed during the spring of 2025, and all tree individuals were identified using direct field observation. Each individual was counted only once (non-repetitive sampling) and recorded at the species, genus, and family levels. The identification process benefited from the researchers' professional expertise in landscape plants, and observations were carried out in situ based on morphological characteristics such as leaf shape, fruit, flower, and bark texture. In cases of uncertainty or potential misidentification, diagnoses were confirmed using Flora of Turkey and the East Aegean Islands (Davis, 1985) as the primary reference. To verify the current taxonomic status and scientific names of the identified plant species, international botanical databases such as The Plant List (2013), Plants of the World Online (POWO, 2025), and the USDA Plants Database (USDA NRCS, 2025) were consulted. These sources provide reliable information on accepted names, synonyms, and family classifications and were used as primary references to ensure taxonomic accuracy. In the taxonomic evaluation, cultivars and varieties were assessed at the species level in order to maintain consistency in diversity analyses and to avoid artificial inflation of species richness due to horticultural selections or intraspecific categories. For each identified species, the following attributes were also recorded:

Individual distribution: Number and percentage of total individuals,
Genus distributions: Number and percentage distribution of individuals by genus,
Family distributions: Number and percentage distribution of individuals by family,
Taxonomic Group: Classified as either angiosperm or gymnosperm,
Phenological Status: Categorized as coniferous (CON), deciduous broadleaf (DBL), or evergreen broadleaf (EBL),
Provenance: Identified as either native or exotic.

Through these classifications, the vegetative structure of the park could be evaluated in terms of visual continuity, shading capacity, ecosystem resilience, and maintenance requirements. In the diversity analysis, three primary indicators of taxonomic imbalance were calculated:

- Species Dominance Indicator (SDI),
- Genus Dominance Indicator (GDI),
- Family Dominance Indicator (FDI).

Each indicator was calculated by dividing the number of individuals in the dominant taxon group by the total number of individuals in the park. These ratios were computed using the diversity imbalance formula (1) proposed by Laćan & McBride (2008).

$$XDI = \frac{n_{dominant}}{N_{total}} \; x \; 100 \qquad (1)$$

In this formula, XDI refers to the taxonomic dominance indicator (SDI, GDI, or FDI); $n_{dominant}$ represents the number of individuals belonging to the most dominant family, genus, or species; and N_{total} refers to the total number of individuals recorded in the park.

The calculated ratios were evaluated against the 10-20-30 rule proposed by Santamour (1990) for urban forestry, which suggests the following thresholds for maintaining adequate diversity:

- No single species should exceed 10% of the total,
- No single genus should exceed 20% of the total,
- No single family should exceed 30% of the total.

In addition, the overall diversity structure of the park was analyzed using the Pest Vulnerability Matrix (PVM) developed by Laćan & McBride (2008). The PVM graphically illustrates the vulnerability of an urban green space to pests, diseases, and stress factors by examining the balance of diversity at the family, genus, and species levels. If more than one of the FDG, CDG, or TDG thresholds is exceeded, the park is classified as being in the high-risk group. All data analyses were performed using Microsoft Excel 365; calculations, ratio evaluations, and diversity charts were generated using this software.

RESULTS AND DISCUSSION

The inventory conducted in Atatürk Park recorded 733 tree individuals, belonging to 25 species, 22 genera, and 14 families (Table 1). Although the total area of the park is approximately 90,000 m², not all of it is covered with vegetation. The park includes exhibition areas, enclosed structures, and large hard-surfaced open spaces, which occupy about 30,000 m². Accordingly, the actual vegetated green space is estimated to be around 60,000 m² (6 hectares). Based on this, the tree density is approximately 122 individuals per hectare, which can be considered as a moderate-to-high value in the context of urban parks. Previous studies conducted in different cities worldwide have reported densities ranging roughly between 46 and 235 trees per hectare (Birdsey & Heath, 1995; Yang et al., 2005; Zhao et al., 2010; Nagendra & Gopal, 2011; Nyambane et al., 2016; Pandey & Hemant, 2018; Xie, 2018). However, there is no universally accepted threshold to classify low, medium, or high density, and such comparisons should therefore be regarded as contextual reference.

In this context, the tree density of 122 individuals per hectare in Atatürk Park is relatively high compared to many other urban parks, indicating the strong provision of ecosystem services such as carbon sequestration, air quality improvement, noise mitigation, and shading. However, such high densities can also introduce ecological risks, including interspecific competition, limited light availability, and the spread of pests and diseases. Therefore, spatial sustainability and the physiological requirements of tree species should be carefully considered in site management and future planting plans, and appropriate density control measures should be implemented.

Nevertheless, the data reveals a significant imbalance in plant diversity. The 10-20-30 rule proposed by Santamour (1990) was developed as a diversity threshold model to create urban forests that are more resistant to pests, diseases, and climatic stress. All of these thresholds appear to be exceeded in Atatürk Park. In particular, *Cupressus sempervirens* L. alone accounts for 30.42% of all individuals, indicating an extreme dominance at the species level (Table 1, Figure 2). This ratio is approximately three times the recommended threshold. In addition, exotic species such as *Gleditsia triacanthos* L. (16.23%) and *Acer negundo* L. (10.10%) also exceed the limit, while *Fraxinus angustifolia* Vahl (9.96%) approaches it critically. This concentration of a few species suggests that the park's vegetative composition is shaped predominantly by a limited number of taxa, posing a high risk of species-level monodominance.

Table 1. Distribution of Tree Species by Taxonomic and Functional Traits.

No.	Speices	Taxonomic Group	Pheonological type	Provenance	Number of trees	% of total
1	*Cupressus sempervirens* L	Gymnosperm	CON	Native	223	30.42*
2	*Gleditsia triacanthos* L.	Angiosperm	DBL	Exotic	119	16.23*
3	*Acer negundo* L.	Angiosperm	DBL	Exotic	74	10.10*
4	*Fraxinus angustifolia* Vahl	Angiosperm	DBL	Native	73	9.96
5	*Platanus orientalis* L.	Angiosperm	DBL	Native	59	8.05
6	*Pinus brutia* Ten.	Gymnosperm	CON	Native	56	7.64
7	*Robinia pseudoacacia* L.	Angiosperm	DBL	Exotic	41	5.59
8	*Morus alba* L.	Angiosperm	DBL	Native	16	2.18
9	*Populus alba* L.	Angiosperm	DBL	Native	15	2.05
10	*Platycladus orientalis* (L.) Franco	Gymnosperm	CON	Exotic	13	1.77
11	*Tilia tomentosa* Moench	Angiosperm	DBL	Exotic	11	1.50
12	*Ficus rubiginosa* Desf. ex Vent.	Angiosperm	EBL	Exotic	4	0.55
13	*Fraxinus excelsior* L.	Angiosperm	DBL	Native	4	0.55
14	*Salix alba* L.	Angiosperm	DBL	Native	4	0.55
15	*Hibiscus syriacus* L.	Angiosperm	DBL	Exotic	3	0.41
16	*Morus nigra* L.	Angiosperm	DBL	Native	3	0.41
17	*Catalpa bignonioides* Walt.	Angiosperm	DBL	Exotic	2	0.27
18	*Cedrus libani* A. Rich.	Gymnosperm	CON	Native	2	0.27
19	*Liquidambar orientalis* Mill.	Angiosperm	DBL	Native	2	0.27
20	*Paulownia tomentosa* Steud.	Angiosperm	DBL	Exotic	2	0.27
21	*Prunus armeniaca* L.	Angiosperm	DBL	Exotic	2	0.27
22	*Ulmus glabra* Huds.	Angiosperm	DBL	Native	2	0.27
23	*Aesculus hippocastanum* L.	Angiosperm	DBL	Exotic	1	0.14
24	*Albizia julibrissin* Durazz.	Angiosperm	DBL	Exotic	1	0.14
25	*Ficus carica* L.	Angiosperm	DBL	Native	1	0.14
				TOTAL	**733**	**100.00**

*Species above Santamour's (1990) 10% threshold.
CON: Coniferous; DBL: Decidious broadleaf; EBL: Evergreen broadleaf.

The dominance of exotic species in particular threatens the sustainability of ecological balance (Almas & Conway, 2018). Taxonomic dominance is not only associated with increased disease vulnerability but also leads to aesthetic monotony, reduced ecosystem functionality, lack of seasonal variation, and limited plant interactions (Nowak & Dwyer, 2007; Kendal et al., 2012). Such conditions may negatively affect users' spatial experience and restrict multiple ecosystem services such as microclimate regulation, carbon storage, shading, and habitat diversity provided by the landscape.

The inventory conducted in Atatürk Park revealed that the five most common species account for 74.76% of all trees, while the top ten species represent 93.99% of the total (Table 1). These figures indicate that the park's vegetation is largely dominated by a limited number of species, reflecting a significant degree of species concentration. This level of dominance is particularly striking when compared with international examples. For instance, Kara (2012) reported that in the city of Aydın, eight species comprised 86% of all urban trees, with Citrus aurantium alone accounting for 50%. Similarly, Nagendra & Gopal (2011) found that the five most dominant species made up approximately half of the urban tree population in Bangalore. Pandey & Hemant (2018) noted that the ten most common species in Allahabad's urban parks represented 48% of all individuals. In Nairobi, the five most dominant species comprised 50% of the total tree population, though most of these species were native (Nyambane et al., 2016). A study conducted in Novi Sad revealed that four of the top five species were native, highlighting their contribution to urban biodiversity (Lakicevic et al., 2022).

In contrast, in Atatürk Park, half of the ten most common species are of exotic origin, suggesting a relatively balanced composition in terms of native species diversity. However, such a high dependency on a limited number of species creates ecological vulnerability, particularly in the face of potential threats such as disease, pest outbreaks, or climatic stress. Therefore, long-term landscape planning should prioritize increasing species diversity, promoting native species, and achieving a more balanced vegetative composition.

At the genus level, the analysis revealed that individuals belonging to the *Cupressus* genus constituted 30.42% of all trees (Table 2, Figure 2). This figure clearly exceeds the 20% genus-level threshold recommended by Santamour (1990). The *Gleditsia* genus also reached a notable proportion within the overall composition, accounting for 16.23% of the total.

Table 2. Number and Percentage Distribution of Tree Individuals by Genus.

No.	Genus	Number of trees	% of total
1	*Cupressus*	223	30.42[†]
2	*Gleditsia*	119	16.23
3	*Fraxinus*	77	10.50
4	*Acer*	74	10.10
5	*Platanus*	59	8.05
6	*Pinus*	56	7.64
7	*Robinia*	41	5.59
8	*Morus*	19	2.59
9	*Populus*	15	2.05
10	*Thuja*	13	1.77
11	*Tilia*	11	1.50
12	*Ficus*	5	0.68
13	*Salix*	4	0.55
14	*Hibiscus*	3	0.41
15	*Catalpa*	2	0.27

16	*Cedrus*	2	0.27
17	*Liquidambar*	2	0.27
18	*Paulownia*	2	0.27
19	*Prunus*	2	0.27
20	*Ulmus*	2	0.27
21	*Aesculus*	1	0.14
22	*Albizia*	1	0.14
	Total	**733**	**100.00**

†Above the 20% genus-level threshold proposed by Santamour (1990).

At the family level, individuals belonging to the Cupressaceae family made up 32.19% of the total tree composition in the park (Table 3, Figure 2). This percentage exceeds the 30% family threshold, indicating an overrepresentation at the family level as well. The high number of *Cupressus sempervirens* L. individuals highlights a significant lack of diversity and points to ecological vulnerability at the species, genus, and family levels. Indeed, the literature contains numerous findings indicating that in park systems where diversity is low at the genus or family level, potential threats can spread rapidly throughout the entire population (Laćan & McBride, 2008; Sjöman et al., 2012).

Table 3. Number and Percentage Distribution of Trees by Family.

No.	Family	Number of trees	% of total
1	Cupressaceae	236	32.20◊
2	Fabaceae	161	21.96
3	Pinaceae	117	15.96
4	Oleaceae	77	10.50
5	Aceraceae	74	10.10
6	Moraceae	24	3.27
7	Salicaceae	19	2.59
8	Malvaceae	14	1.91
9	Altingiaceae	2	0.27
10	Bignoniaceae	2	0.27
11	Paulowniaceae	2	0.27
12	Rosaceae	2	0.27
13	Ulmaceae	2	0.27
14	Sapindaceae	1	0.14
	Total	**733**	**100.00**

◊Above the 30% family-level threshold proposed by Santamour (1990).

These findings indicate that Atatürk Park exhibits a monodominant structure in terms of plant diversity, raising concerns about various ecological risks. Numerous studies have emphasized that urban afforestation efforts concentrated around a single species or genus are more vulnerable to pests, diseases, and climate-related stressors (Alvey, 2006; Raupp et al., 2006). For instance, in North America and Europe, widespread use of *Ulmus americana* Huds. led to massive population losses due to Dutch Elm Disease (DED). This outbreak, caused by *Ophiostoma novo-ulmi* Braiser, had catastrophic consequences in urban forests with low species diversity (USDA Forest Service, 2020). Similarly, in Europe, *Aesculus hippocastanum* L. suffered extensive physiological decline and aesthetic damage due to infestation by the pest *Cameraria ohridella* Deschka & Dimić; in urban parks where this species was widely planted, a significant loss of resistance was reported (Kenis et al., 2005). These examples serve as warnings for the potential vulnerabilities associated with the overuse of certain species in Atatürk Park. To reduce such risks and enhance the ecological resilience of the park, it is

essential to adopt planting strategies that prioritize taxonomic diversity in landscape management.

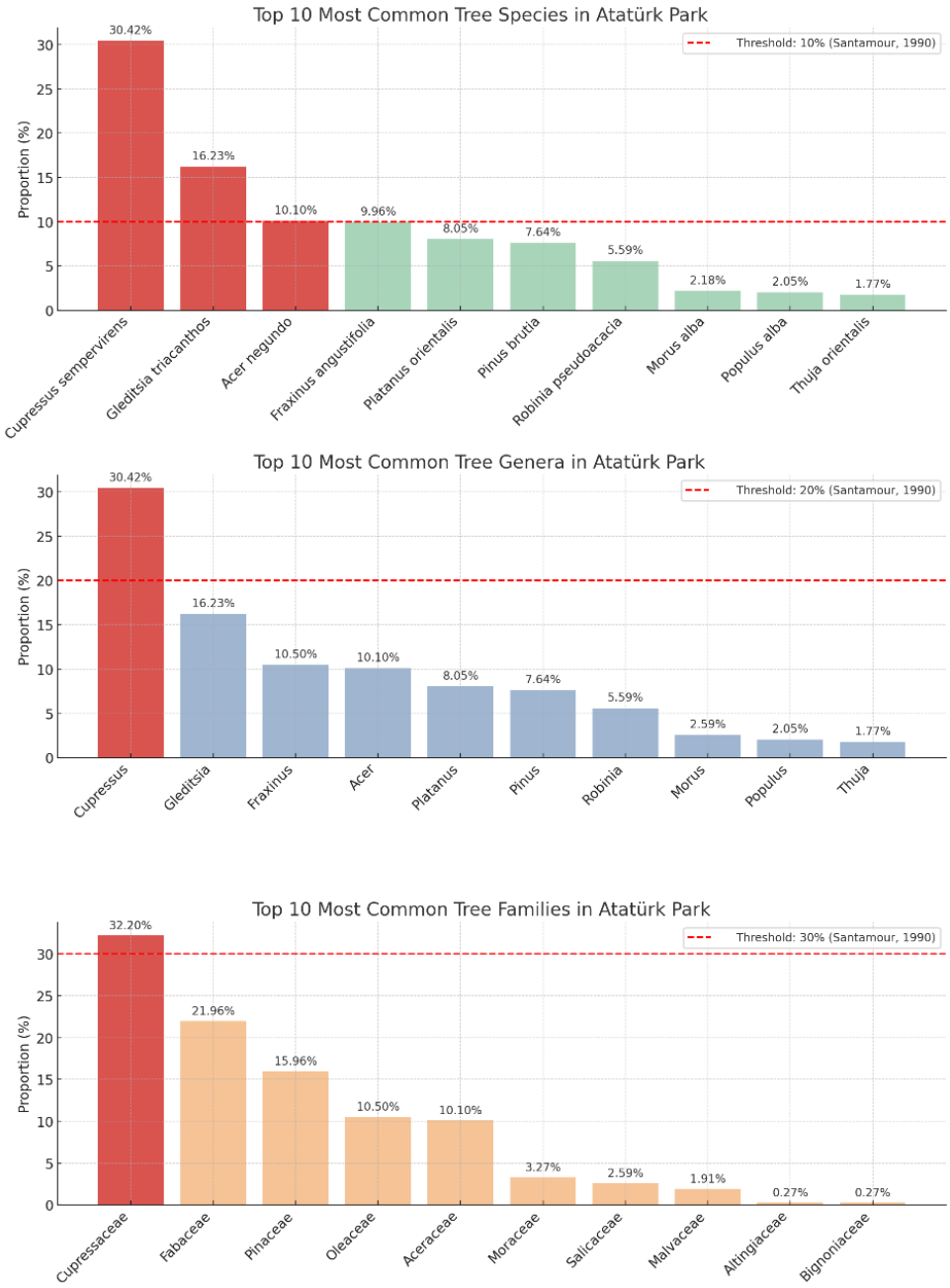


Figure 2. Taxonomic Dominance Structure of Tree Species in Atatürk Park.

The evaluation conducted using the PVM further revealed a pronounced imbalance in the park's tree composition. Dominance levels were calculated as 37.1% at the species level (SDI), 28.4% at the genus level (GDI), and 32.2% at the family level (FDI). These values substantially exceed the thresholds proposed by Laćan & McBride (2008): FDI > 30%, GDI > 20%, and SDI > 10%. According to the PVM framework, surpassing one threshold indicates a moderate risk, whereas exceeding two or more thresholds classifies an area as highly vulnerable. Based on this classification, the current composition of Atatürk Park places it within the high-risk category.

This implies that the park is potentially highly susceptible to biotic stressors, such as pest infestations or disease outbreaks. In particular, the 32.2% dominance of the Cupressaceae family may pose risks of reduced ecosystem services, diminished aesthetic diversity, and a decline in resilience due to single-family dominance (Sjöman et al., 2016). These findings clearly demonstrate the need for a diversity-based planning strategy in future planting efforts within the park.

These results indicate that the current plant composition of Atatürk Park is excessively dependent on certain taxa, which may pose a risk to the overall functionality of the landscape, particularly if the dominant species are exposed to pests, diseases, or environmental stressors. Therefore, diversity assessments based solely on species richness are insufficient; instead, there is a need for comprehensive analyses that consider imbalances at the family, genus, and species levels simultaneously. In this context, to enhance the ecological resilience of the park, plant selection should be based on taxonomic balance, and spatial sustainability should be reinforced by jointly applying Santamour's (1990) 10-20-30 rule and the Pest Vulnerability Matrix (PVM) approach. Additionally, integrating PVM outputs with vulnerability matrices in future planning processes would provide decision-makers with more functional and strategic guidance.

Among the 733 individual trees identified in the study area, 59.89% belonged to angiosperms and 40.11% to gymnosperms (Table 4). While this distribution indicates the dominance of angiosperms, the relatively high proportion of gymnosperms is also noteworthy. In a study conducted by Lakicevic et al. (2022) in the city of Novi Sad, 89% of the woody plant species in urban landscapes were reported to be angiosperms, while only 11% were gymnosperms. Similarly, Ogwu et al. (2016) reported that, on the main campus of the University of Benin in Nigeria, 84% of tree species were angiosperms and 16% were gymnosperms. Compared to these studies, the proportion of gymnosperms in the present study is remarkably higher. This finding suggests that coniferous species (e.g., *Pinus* spp., *Cupressus* spp., *Platycladus* spp.) are more frequently used in the landscape design of the study area and that they are highly adapted to the local climatic conditions. Indeed, previous research by Del Tredici (1995) and Richardson (2000) has emphasized that gymnosperm species are commonly preferred in urban afforestation due to their drought tolerance, longevity, and low maintenance requirements.

Based on the phenological leaf-type classification, it was determined that 59.75% of the trees in the park were deciduous broadleaf (DBL) species, 40.11% were coniferous (CON) species, and only 0.14% were evergreen broadleaf (EBL) species (Table 4). This distribution indicates that seasonal variability is reflected in the landscape aesthetics of the park, and that visual continuity throughout the year is balanced by the presence of coniferous species. However, the near absence of EBL species (only 0.14%) reveals that this foliage group is almost entirely underrepresented in the park's composition. This finding differs significantly from species selection strategies observed in some other urban parks. For instance, Jim & Chen (2008) reported that native EBL species dominate the urban tree population in Taipei. Similarly, Wang & Zhang (2022) found that 55.2% of urban trees in Hong Kong were composed of EBL species, while 23.3% were DBL, 12.1% were palms, and only 9.4% belonged to the CON group. The dominance of EBL species in these cities can be attributed to factors such as favorable subtropical climate conditions, the desire for year-round vegetative continuity, and lower maintenance costs. On the other hand, the DBL dominance in Atatürk Park aligns with the findings of Pandey & Hemant (2018), who reported that the urban tree flora in Allahabad is largely composed of deciduous species. Furthermore, Xie (2018) reported that in Dublin, 88% of trees were broadleaf species, and 12% were conifers. This structure, also observed in Atatürk

Park, suggests that while broadleaf species are generally preferred in urban landscapes, coniferous species are proportionally more represented in this specific case.

These proportions present a reasonable distribution for regions such as Kahramanmaraş, where the Mediterranean-continental transitional climate prevails. Deciduous species provide shade during the summer and allow light transmission in winter by shedding their leaves, thereby enhancing seasonal user comfort (Nowak & Dwyer, 2007). Meanwhile, it is well established that coniferous species offer advantages in terms of year-round carbon sequestration and visual continuity (Konijnendijk et al., 2006). The balanced representation of coniferous species in the park indicates a positive diversity from the perspective of seasonal functionality.

The phenological composition of Atatürk Park is primarily based on DBL species that highlight seasonal changes, which aligns with both the temperate climate conditions and traditional landscape practices. However, the near absence of EBL species clearly limits the continuity of foliage cover and year-round visual aesthetics. This suggests that increasing the presence of EBL species in future planting strategies could enhance not only aesthetic appeal but also ecosystem functionality and species diversity.

In terms of provenance, it was determined that native species dominate the area with a rate of 62.76%, while exotic species account for 37.24% (Table 4). This result indicates that native species are relatively more preferred in comparison to the exotic species dominance frequently observed in many urban green spaces. For example, Almas & Conway (2018) reported that the proportion of native species in many urban parks in southern Canada remains below 30%, with exotic species dominating due to their appealing visual appearance, rapid growth, and low maintenance requirements. Similarly, the proportion of exotic species has been reported as 76% in Hong Kong (Wang & Zhang, 2022), 59% across four states in Brazil (Santos et al., 2019), 75% in the city of Benin (Ogwu et al., 2016), and 77% in Bangalore (Nagendra & Gopal, 2011). These findings reveal that exotic species are extensively used in landscape practices, especially in parallel with increasing urbanization.

Table 4. Distribution of Tree Individuals by Taxonomic Group, Phenological Type, and Provenance.

Category	Type	Number of trees	% of total
Taxonomic Group	Angiosperm	439	59.89
	Gymnosperm	294	40.11
	Total	**733**	**100.00**
Phenological Type	CON	294	40.11
	DBL	438	59.75
	EBL	1	0.14
	Total	**733**	**100.00**
Provenance	Native	460	62.76
	Exotic	273	37.24
	Total	**733**	**100.00**

CON: Coniferous; DBL: Decidious broadleaf; EBL: Evergreen broadleaf; Native = species indigenous to the region; exotic = non-native or introduced species.

On the other hand, landscapes dominated by native species offer significant advantages in terms of ecological sustainability. Alvey (2006) emphasized that native species establish stronger relationships with natural ecosystems and provide more suitable habitat conditions for local fauna. Notable examples of cities where native species are predominantly used include Taipei with 63% (Jim & Chen, 2008), Potsdam with 81% (Maurer et al., 2000), Chonju with

over 70% (Zerbe et al., 2004), and Nairobi with 69% native tree presence (Nyambane et al., 2016). Additionally, Lakicevic et al. (2022) reported that native and exotic species are represented in equal proportions in urban parks in Novi Sad. In this context, the findings of the present study suggest a preference for a plant composition that is more compatible with local flora, more resilient, and more functional in terms of ecosystem services. The preservation of native species at this proportion is considered a substantial gain, particularly in terms of maintaining biodiversity and enhancing ecological resilience.

The predominance of native species in Atatürk Park presents an ecological advantage through better compatibility with the ecosystem, symbiotic relationships with local fauna, and reduced maintenance costs (Kendal et al., 2012; Almas & Conway, 2018). Moreover, the limited presence of exotic species—approximately one-third—contributes to minimizing risks such as biological invasions and disease outbreaks (Kenis et al., 2005).

In addition to enhancing diversity, the preference for native species also helps strengthen urban biodiversity by providing suitable habitats for local fauna (Aronson et al., 2017). Prioritizing native taxa in urban landscapes can contribute to reducing maintenance costs, lowering water usage, and promoting environmental sustainability (Kendal et al., 2012). From this perspective, the current composition of Atatürk Park should be reassessed, and future planning efforts should be grounded in principles of ecological functionality and diversity. In conclusion, the case of Atatürk Park reaffirms the necessity of diversity-oriented planning in urban parks.

CONCLUSIONS

This study demonstrated that Atatürk Park in Kahramanmaraş suffers from significant taxonomic imbalance at species, genus, and family levels, creating ecological vulnerability and reducing long-term resilience. The dominance of a few species has produced a monodominant structure that places the park in a high-risk category in terms of biodiversity. These findings underline the necessity of future planting strategies that prioritize taxonomic balance rather than purely aesthetic or short-term considerations.

Exotic species with high dominance such as *Gleditsia triacanthos* L. and *Acer negundo* L. should be gradually reduced, while underrepresented native taxa with strong adaptive capacity should be prioritized. Species such as *Ulmus glabra* Huds., *Liquidambar orientalis* Mill., *Populus alba* L., and *Tilia tomentosa* Moench have the potential to enhance ecological stability and visual diversity, whereas regionally native but currently absent taxa including *Alnus glutinosa* (L.) Gaertn., *Acer hyrcanum* Fisch. & C.A.Mey., *Celtis australis* L., and *Juniperus foetidissima* Willd. could be introduced to further support diversification. This strategy is consistent with urban forestry literature that highlights the ecological and adaptive advantages of native species (Alvey, 2006; Kendal et al., 2014). In light of these findings, several concrete recommendations can be drawn:

- Establish comprehensive and periodically updated plant inventories for urban green spaces.
- Suspend the use of taxa exceeding threshold values in new plantings.
- Systematically prioritize underrepresented native species with strong adaptive potential.
- Gradually reduce exotic and potentially invasive species with high representation.
- Adopt biodiversity-based planting guidelines, such as the 10-20-30 rule, as official criteria in urban forestry planning.

- Implement long-term monitoring programs to track changes in taxonomic balance over time.

Considering that Kahramanmaraş is a region facing increasing water scarcity, future planting strategies should also adopt xeriscape-oriented approaches and prioritize drought-tolerant species that require minimal irrigation. Plant material selection must therefore address not only taxonomic balance but also ecological sustainability under limited water resources. If exotic species are to be included, they should be restricted to ecologically compatible, non-invasive taxa that are well-adapted to the regional climate, so that they contribute positively without threatening local biodiversity.

Specifically, for Kahramanmaraş Atatürk Park, limiting the use of Cupressaceae in new plantings, increasing the representation of local species, introducing evergreen broadleaf taxa to strengthen year-round functionality, and gradually reducing exotic species should be considered priority strategies. Furthermore, adopting the 10-20-30 rule as an official planning criterion, establishing regular inventory and monitoring programs, and ensuring public participation in these processes will significantly strengthen the ecological resilience of urban parks in Kahramanmaraş. While the current imbalances of Atatürk Park can be gradually revised with such strategies, in newly established parks these principles must be integrated from the very beginning of the planning process.

AUTHOR CONTRIBUTIONS

Mert Çakır: Conceptualization, methodology, investigation, resources, formal analysis, visualization, writing - original draft, writing – review & editing, project administration. **Mahmut Tuğluer:** Conceptualization, methodology, investigation, data curation, formal analysis, writing - original draft, writing – review & editing.

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The authors declare no conflict of interest.

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This study does not require an ethics committee approval.

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