International Journal of Landscape Architecture Research
E-ISSN: 2602-4322 8(1): 34-46, 2024
Research Article

EVALUATION OF WOODY PLANT SPECIES IN RECREATION AREAS IN INDUSTRIAL CITIES WITHIN THE SCOPE OF ECOLOGICAL TOLERANCE CRITERIA: THE CASE OF ALIAĞA (İZMİR)

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(Received 15th March 2024; accepted 15th May 2024)

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ABSTRACT. Migration from rural areas to urban areas has rapidly increased urbanization. Industrialization is among the main reasons for these migration movements and urbanization due to the employment opportunities it provides. Industrialization is quite effective on the sustainability of urban open-green areas due to basic abiotic ecological factors such as pollution and drought it creates in the urban environment. Therefore, it has become very essential to pay attention to ecological tolerance criteria in the selection of plant materials to be used in landscape design and planning studies to be carried out in recreation areas in industrial cities. Within the scope of the study, woody ornamental plant species in urban recreation areas in Aliağa, an important industrial city of Türkiye and a district of İzmir province, were examined within the scope of ecological tolerance criteria. Plant species in 5 different recreation areas with different usage types in the city were examined and identified on-site. A total of 67 different woody ornamental plant species were determined in the areas and the ecological demands of these plants were evaluated according to the ecological conditions of Aliağa. The water consumption of woody ornamental plant species in 5 different recreation areas was 44.11% medium and 13.25% high.

Keywords: *Industrialization, urban recreation, woody ornamental plants, ecological tolerance, Aliağa.*

INTRODUCTION

Migration from rural areas to urban areas and uncontrolled population growth due to problems such as lack of technological infrastructure and unemployment have accelerated urbanisation. Especially industrialisation is among the main attractive reasons of urbanisation due to the employment opportunities it provides [1]. The uncontrolled and irregular pace of urbanisation causes negative impacts on the urban environment. Increase in urban heat island, air pollution, decrease in usable water resources, loss of urban biodiversity are some of these environmental problems [2]. For this reason, urban open-green areas are of great importance especially in settlements in industrial cities. Indirectly, the sustainability of urban open-green areas is equally important [3]. Plant materials constitute a significant majority of landscape architecture works. Based on the importance of ensuring the sustainability of urban open-green areas, attention should be paid to the selection of plant materials in the landscape design and planning stages of these areas [4]. In these stages, firstly, the ecological characteristics of the areas to be designed and

planned should be known. Annual rainfall regime, prevailing wind, annual temperature values, sunshine duration, location of the area, pollution, etc. All information about many parameters should be compiled within the scope of preliminary study [5]. The most important issues among ecological approaches in industrial cities are pollution and drought. In the modern era, industrialisation in cities has disrupted the balance in the existing air quality and caused it to decline and greatly increased water consumption [6]. Therefore, in the selection of plant materials in landscape planning and design stages in industrial cities, especially plants should be compatible with arid conditions and tolerant to air pollution [7]. In the literature, there are studies on the necessity of selection of plant materials in accordance with ecological tolerance criteria in landscaping of urban open-green areas. Seydioğlu Akdeniz et al. [8] evaluated the ecological requirements of exotic and coniferous woody ornamental plants in Bursa city landscape. Within the scope of their study, they identified exotic and coniferous plants in the sample areas they determined in the urban landscape and evaluated them within the scope of ecological tolerance criteria. Kösa et al. [9], in their study, created a guide for the selection of plant species that can be used in potential roof garden applications in Antalya province according to their ecological parameters and made evaluations on this issue. Yener et al. [10] stated in their study that the proportional distribution of the intensity of use of woody ornamental plants in landscape areas is quite high in species diversity. Accordingly, they gave separate information about the ecological tolerance criteria that should be considered in the selection of these plants in landscape studies. Puglielli et al. [11] stated in their study that woody plant species are frequently used in ethnobotanical terms as well as in landscape studies due to their longevity. For this reason, they mentioned the need to pay attention to abiotic factors (drought, frost, temperature, pollution) in the cultivation of woody plant species and their use in landscape studies. They also prepared a guide on this subject.

This study was carried out to evaluate woody ornamental plants in recreational areas in industrial cities in terms of ecological tolerance criteria. Within the scope of the study, Aliağa, an important industrial city located in İzmir province of Turkey, was selected as a sample city and the recreational areas there were examined.

MATERIALS AND METHODS

The main material of the study consists of woody ornamental plants in 5 different areas with different usage characteristics located in Aliağa district of İzmir province. In the study, 5 different areas including 1 hospital, 1 sports complex, 1 city park, 1 coastal area landscaping and 1 school were examined. The study areas are Aliağa State Hospital, Zeytinli Park, Petkim Atilla Uzun Sports Hall, Aliağa Coast and Şehit Oğuz Özgür Çevik Anatolian High School (Fig. 1).

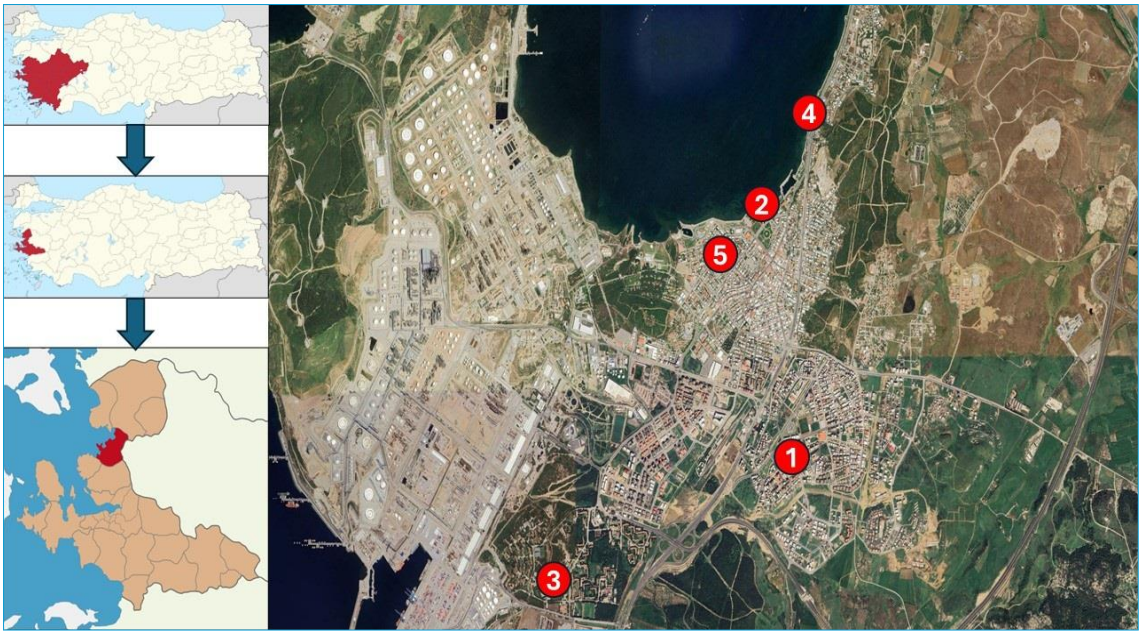

Fig. 1. *Study areas. 1)Aliaga State Hospital, 2) Zeytinli Park, 3) Petkim Atilla Uzun Sports Hall, 4) Aliağa Beach, 5) Şehit Oğuz Özgür Çevik Anatolian High School [12, 13, 14, 15]*

Aliağa is a district of İzmir Province located in the Coastal Aegean Region of the Aegean Region. The district is neighboured with Manisa in the east, Bergama in the north, Menemen in the south and Foça in the south-west. The distance of the district to İzmir city centre is 71.4 km [16]. According to the address-based population registration system of TÜİK, the population of Aliağa is 106168 as of 2023 [17]. Aliağa is located in the Mediterranean climate zone. The dominant wind in the district is the northwest wind. For this reason, although the summer months are cool in the district, the average temperature values vary between 24-37 ºC. In winter months, the temperature drops to 7 ºC [18,19,20].

The method of the study was carried out in 3 stages. These stages are as follows;

1. Stage: The study areas were visited on-site, and woody plant species were identified.
2. Stage: The identified plant species were listed according to their water consumption (low, medium, high), light requirements (shadow, semi-shadow, semi-shadow/sunny conditions, sunny conditions), ecological tolerances (frost, heat, salinity, air pollution and wind).
3. Stage: Using IBM SPSS 27 statistical programme, the listed plants were proportionally distributed according to their plant diversity, water consumption, light requirements and ecological tolerances. At the end of the study, recommendations were made for the district and similar industrial cities [21].

RESULTS AND DISCUSSION

The woody plants identified in the areas examined in Aliağa city centre were examined in terms of taxonomic group, life forms, family and genus distributions. As a result of the on-site investigations, 67 different woody ornamental plant species belonging to the taxonomic groups of Angiosperms and Gymnospermae were identified in all areas (Fig. 2).

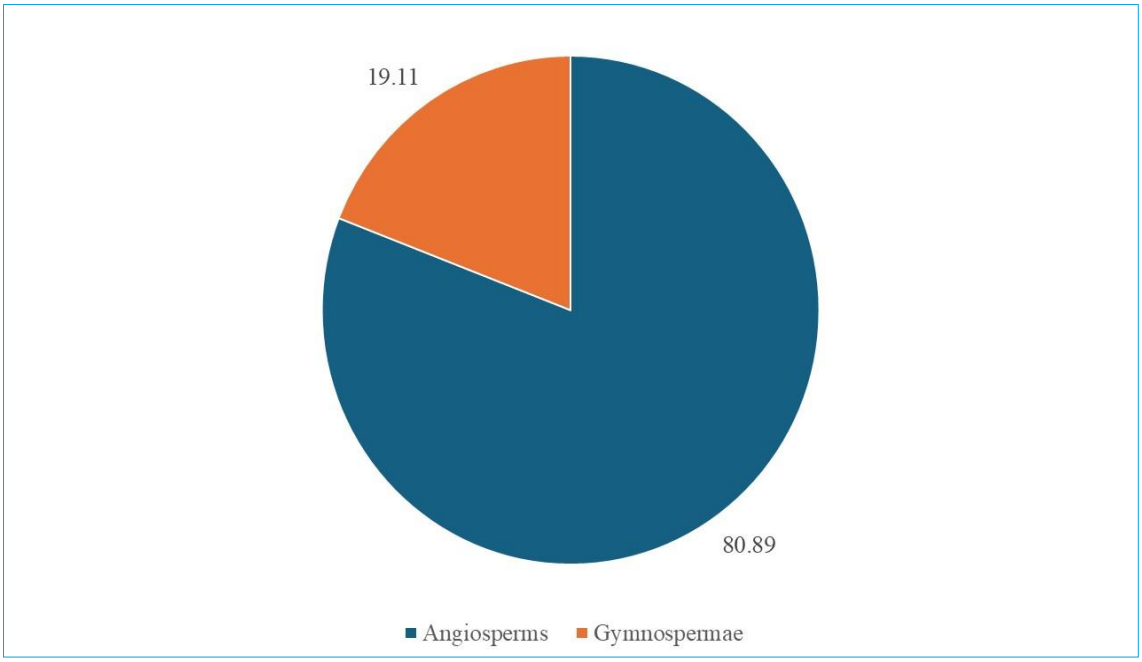

Fig. 2. *Proportional distribution of plant species identified in the study areas according to taxonomic groups (%)*

The proportional distribution of woody ornamental plants in taxonomic groups according to their life forms was calculated. Accordingly, 44.44% of the Angiosperms taxonomic group are trees. In the taxonomic group Gymnospermae; 61.53% are trees and 38.47% are small tree (Fig. 3).

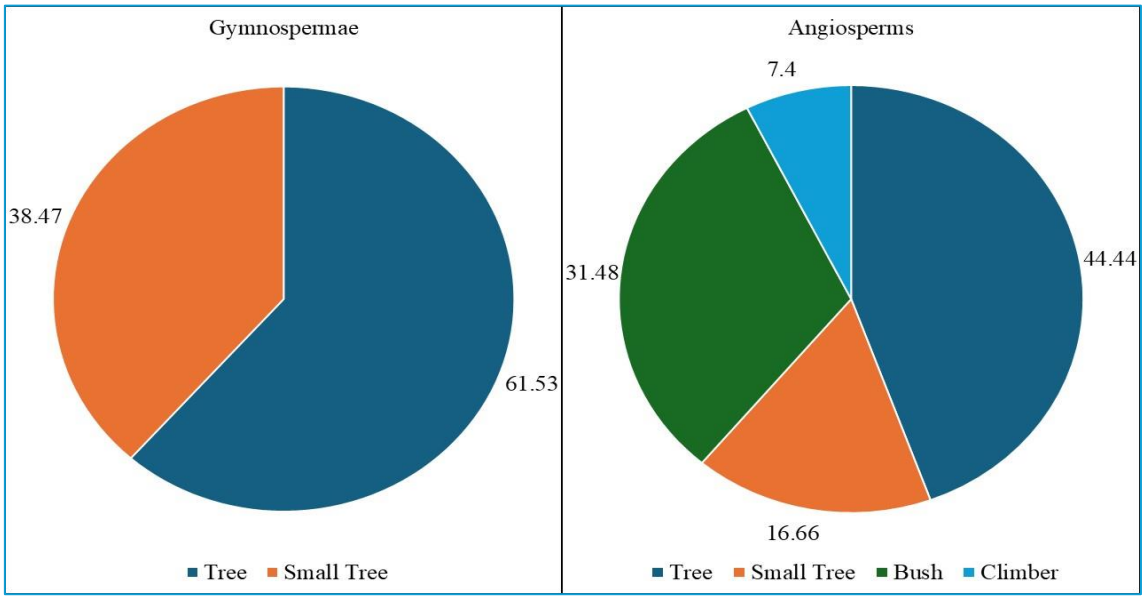

Fig. 3. *Proportional distribution of plant species by life form in taxonomic groups (%)*

When the woody ornamental plants identified in the areas were evaluated according to their families, it was determined that the most species were in the *Cupressaceae* and *Rosaceae* families with 6 species. In the evaluations made on the water use of ornamental plants, which is one of the most important elements of landscape design and planning, the

identified plant species were divided into three water consumption classes as Low, Medium and High (Table 1). The proportional distribution of water consumption requirements of the identified plants is shown in Fig. 4.

Table 1. *Classification of woody ornamental plants identified in the study areas according to their water consumption [22, 23, 24].*

Water Consumption	Plant Species	Family
LOW	*Acacia dealbata*	*Fabaceae*
	Agave americana	*Asparagaceae*
	Ailanthus altissima	*Simaroubaceae*
	Albizia julibrissin	*Fabaceae*
	Archontophoenix cunninghamiana	*Arecaceae*
	Atriplex halimus	*Amaranthaceae*
	Berberis thunbergii	*Berberidaceae*
	Bougainvillea spectabilis	*Nyctaginaceae*
	Citrus limon	*Rutaceae*
	Cotoneaster franchetii	*Rosaceae*
	Cotoneaster horizontalis	*Rosaceae*
	Cupressus arizonica	*Cupressaceae*
	Cupressus macrocarpa	*Cupressaceae*
	Lavandula angustifolia	*Lamiaceae*
	Lonicera japonica	*Caprifoliaceae*
	Melia azederach	*Meliaceae*
	Morus alba	*Moraceae*
	Phoenix canariensis	*Arecaceae*
	Pinus brutia	*Pinaceae*
	Pinus pinea	*Pinaceae*
	Pyracantha coccinea	*Rosaceae*
	Robinia pseudoacacia	*Fabaceae*
	Ruscus aculeatus	*Asparagaceae*
	Schinus molle	*Anacardiaceae*
	Sophora japonica	*Fabaceae*
	Viburnum opulus	*Viburnaceae*
	Viburnum tinus	*Viburnaceae*
	Washingtonia filifera	*Arecaceae*
	Washingtonia robutsa	*Arecaceae*
MEDIUM	*Abelia grandiflora*	*Caprifoliaceae*
	Acer platanoides	*Sapindaceae*
	Casuarina equisetifolia	*Casuarinaceae*
	Cedrus deodara	*Pinaceae*
	Cercis siliquastrum	*Fabaceae*
	Cupressocyparis leylandi	*Cupressaceae*
	Cycas revoluta	*Cycadaceae*
	Euonymus japonicus	*Celastraceae*
	Euryops pectinatus	*Asteraceae*
	Ficus carica	*Moraceae*
	Fraxinus excelsior	*Oleaceae*
	Hedera helix	*Araliaceae*
	Juglans regia	*Juglandaceae*
	Juniperus horizontalis	*Cupressaceae*

	Juniperus sabina	*Cupressaceae*
	Ligustrum ovalifolium	*Oleaceae*
	Ligustrum vulgare	*Oleaceae*
	Liquidambar orientalis	*Altingiaceae*
	Magnolia grandiflora	*Magnoliaceae*
	Malus floribunda	*Rosaceae*
	Nandina domestica	*Berberidaceae*
	Olea europaea	*Oleaceae*
	Parthenocissus quinquefolia	*Vitaceae*
	Photinia x fraserii	*Rosaceae*
	Pistacia lentiscus	*Anacardiaceae*
	Pittosporum tobira	*Pittosporaceae*
	Platanus orientalis	*Platanaceae*
	Quercus cerris	*Fagaceae*
	Rosa semperflorens	*Rosaceae*
	Yucca filamentosa	*Asparagaceae*
HIGH	*Buxus sempervirens*	*Buxaceae*
	Chamaerops excelsa	*Arecaceae*
	Cineraria maritima	*Asteraceae*
	Cortaderia selloana	*Poaceae*
	Morus nigra var. pendula	*Moraceae*
	Nerium oleander	*Apocynaceae*
	Populus alba	*Salicaceae*
	Thuja orientalis	*Cupressaceae*

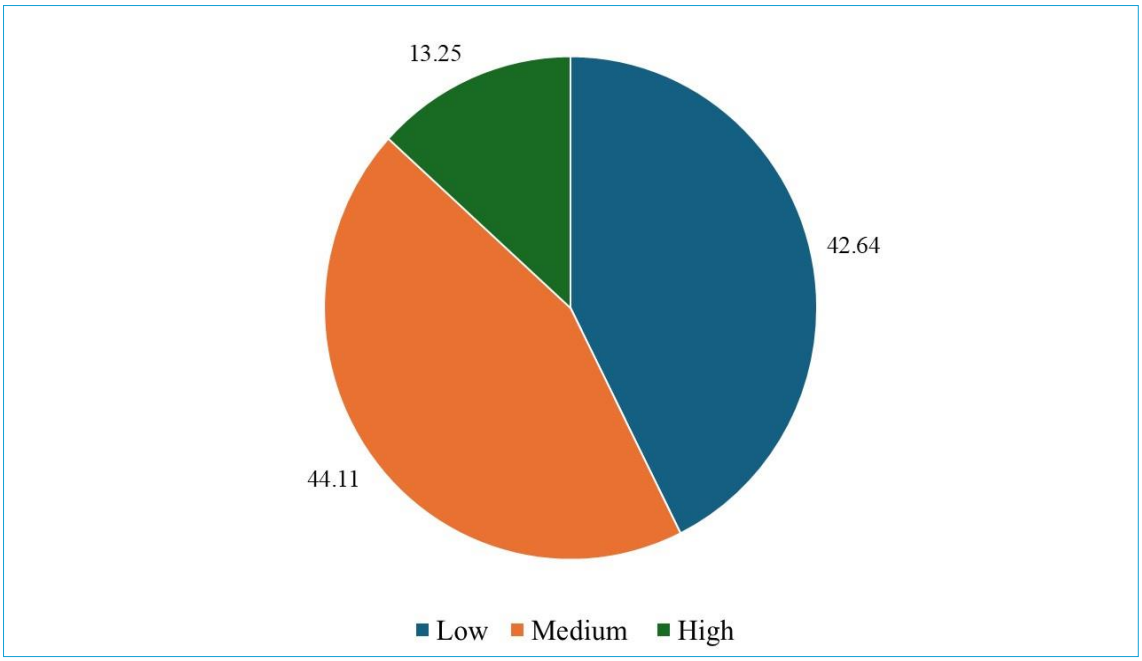

Fig. 4. *Proportional distribution of water consumption of plant species detected in the study areas (%)*

When the water consumption of woody ornamental plants identified in the areas is evaluated, the density of species with low water consumption shows that these areas are also suitable for arid landscape approaches [25]. The plant species identified in the areas

were also listed according to their light requirements. Accordingly, light requirements of plant species were classified in three groups as shadow, semi-shadow, semi-shadow/sunny conditions and sunny conditions (Table 2). The proportional distribution of the identified plant species according to their light requirements is given in Fig. 5.

Table 2. *Classification of woody ornamental plants identified in the study areas according to their light requirements [21, 26, 27].*

Light Request	Plant Species
SHADOW	*Ruscus aculeatus*
SEMI-SHADOW	*Cotoneaster franchetii*
	Cotoneaster horizontalis
	Hedera helix
	Juniperus sabina
	Pyracantha coccinea
SEMI-SHADOW/SUNNY CONDITIONS	*Acer platanoides*
	Agave americana
	Ailanthus altissima
	Archontophoenix cunninghamiana
	Berberis thunbergii
	Chamaerops excelsa
	Cycas revoluta
	Euonymus japonicus
	Ficus carica
	Fraxinus excelsior
	Ligustrum ovalifolium
	Ligustrum vulgare
	Lonicera japonica
	Magnolia grandiflora
	Melia azederach
	Morus nigra var. pendula
	Nandina domestica
	Parthenocissus quinquefolia
	Photinia x fraserii
	Pistacia lentiscus
	Pittosporum tobira
	Platanus orientalis
	Populus alba
	Quercus cerris
	Robinia pseudoacacia
	Schinus molle
	Viburnum opulus
	Viburnum tinus

SUNNY CONDITIONS	*Abelia grandiflora*
	Acacia dealbata
	Albizia julibrissin
	Atriplex halimus
	Bougainvillea spectabilis
	Buxus sempervirens
	Casuarina equisetifolia
	Cedrus deodara
	Cercis siliquastrum
	Cineraria maritima
	Citrus limon
	Cortaderia selloana
	Cupressocyparis leylandi
	Cupressus arizonica
	Cupressus macrocarpa
	Euryops pectinatus
	Juglans regia
	Juniperus horizontalis
	Lavandula angustifolia
	Liquidambar orientalis
	Malus floribunda
	Morus alba
	Nerium oleander
	Olea europaea
	Phoenix canariensis
	Pinus brutia
	Pinus pinea
	Rosa semperflorens
	Sophora japonica
	Thuja orientalis
	Washingtonia filifera
	Washingtonia robutsa
	Yucca filamentosa

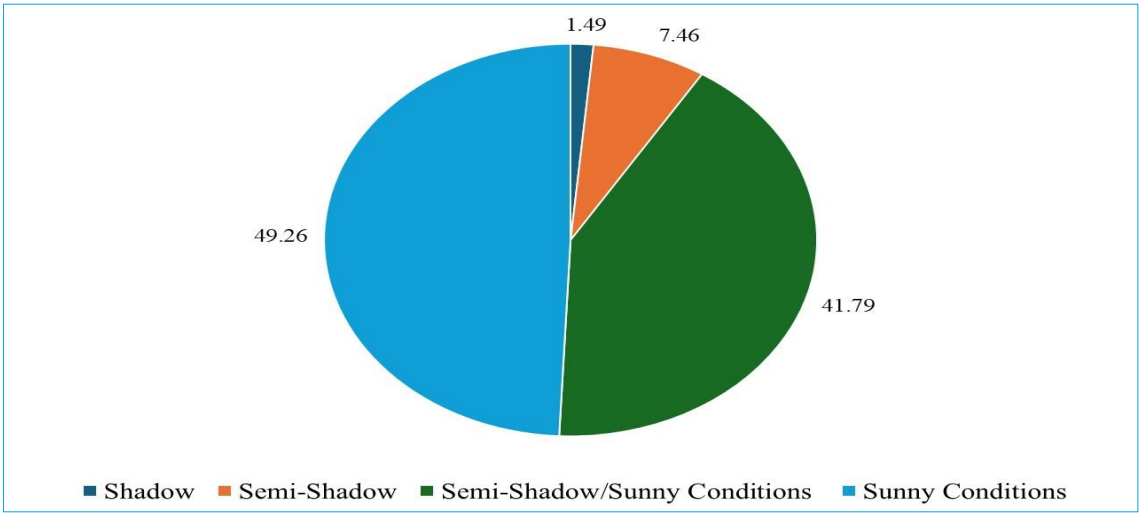

Fig. 5. *Proportional distribution of light requirements of plant species identified in the study areas (%)*

According to their ecological tolerances; it was determined that 55.23% of the plant species were tolerant to frosts and 44.77% were not tolerant. 73.13% of the plants were tolerant to temperature, 26.87% were not tolerant. To salinity, 67.16% of the plants were tolerant, 32.84% were not tolerant. As for wind, 85.07% of the plants were tolerant and 14.93% were not tolerant (Fig. 6) [28, 29, 30, 3].

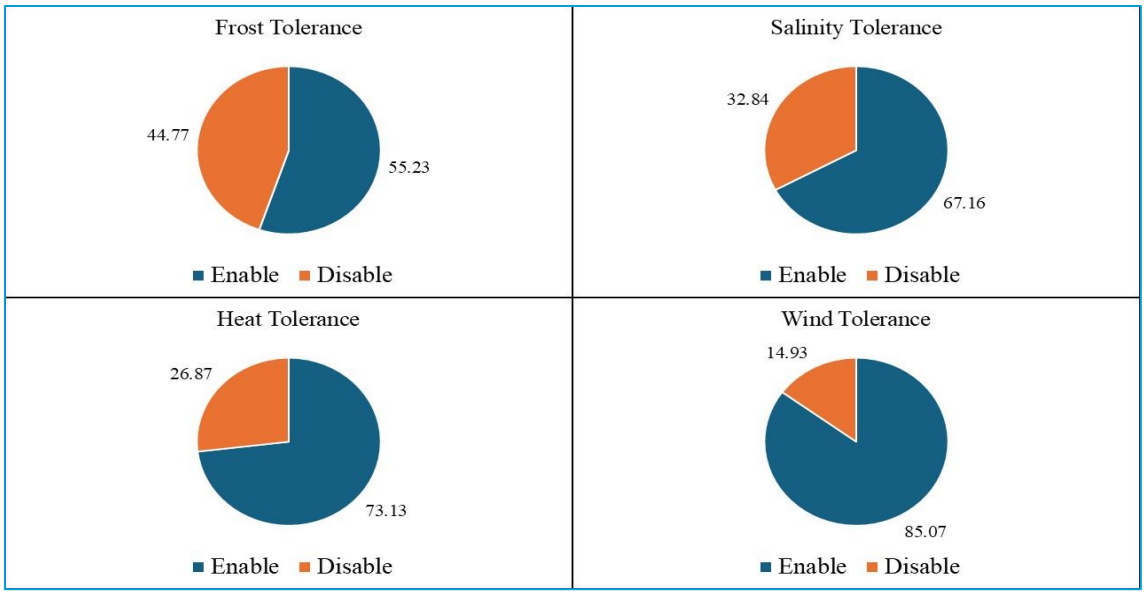

Fig. 6. *Proportional distribution of plant species identified in the study areas according to their ecological tolerance (%)*

The ecological tolerance criterion that should be evaluated separately from all these is the tolerance of plants to air pollution. Because Aliağa is an industrial city [32, 33]. Therefore, plant species in the recreation areas of the city should be tolerant to air pollution. Accordingly, it was determined that 91.05% of the woody ornamental plant species detected in all areas were tolerant to air pollution, while 8.95% were not tolerant [30, 31] (Fig. 7).

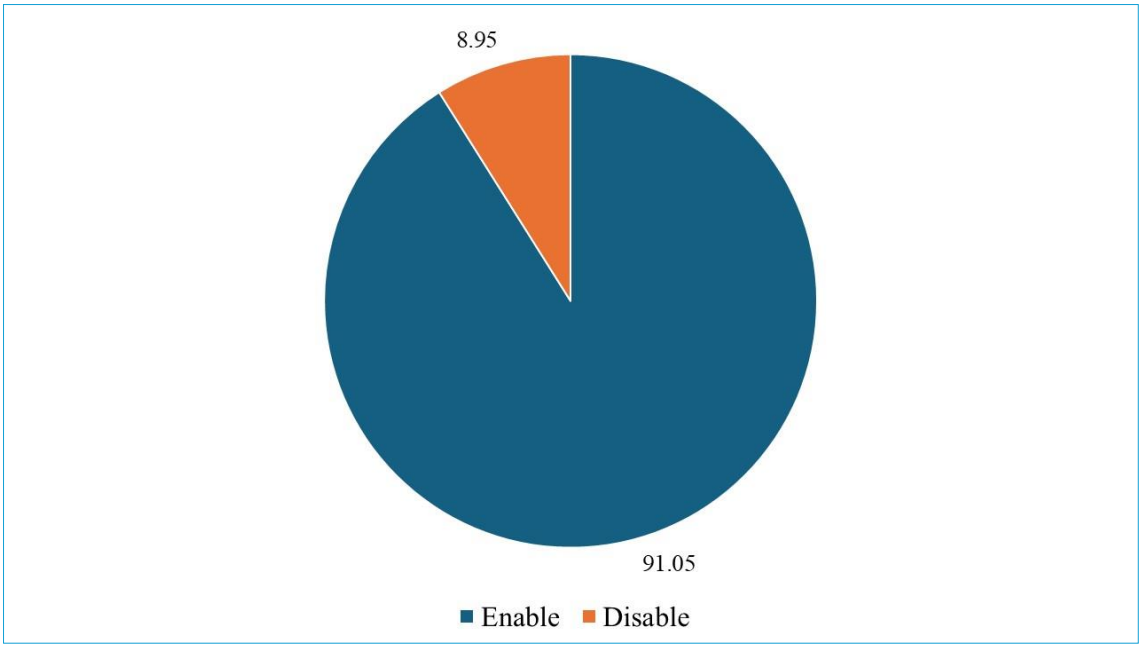

Fig. 7. *Proportional distribution of tolerances of plant species identified in the study areas to air pollution (%)*

Ekren et al. [34] evaluated ornamental plants used in urban open-green areas of Rize in terms of ecological tolerance criteria. Within the scope of the study, they determined the plant species used in 11 urban parks and evaluated these plant species in terms of ecological tolerance criteria. As a result of the analyses they performed, they determined that the plant species used in urban parks were in accordance with the ecological tolerance criteria they examined. This study is similar to the study of Ekren et al. [34] in terms of method and evaluation criteria, but this study differs in that the city examined is different and recreational areas with different usage qualities are examined.

CONCLUSION AND RECOMMENDATIONS

As a result of this study, the ecological tolerance criteria of 67 woody ornamental plant species identified for use in recreational areas with different usage types in the city center of Aliağa, an industrial city, were evaluated and their light requirements and water consumption were emphasized. It was determined that the water consumption of woody ornamental plant species was 44.11% medium and 13.25% high. This situation reveals that the plant species used in the areas are not suitable for arid conditions. Considering that the annual temperature change in Aliağa varies between 7 ºC and 37 ºC, it is necessary that the plants should be suitable for drought conditions. It was determined that the light requirements of the plants identified in the areas were mostly sunny conditions and semi-shadow/sunny conditions. Considering that the average annual sunshine duration of Aliağa and İzmir is 8.1 hours, it is seen that the plants in the areas are used in accordance with their light requirements [35]. Although Aliağa's annual temperature values are rarely reported to fall below 0 ºC during cold periods, frost is generally not observed. Therefore, whether the plants are tolerant to frost was not considered as an important factor in the landscaping works to be carried out in Aliağa region. However, it was determined that 55.23% of the plants detected in the areas had frost tolerance. Since

Aliağa city has coastal areas, the plants used in landscape design and planning in this region must be tolerant to salinity due to salt transport. It was determined that 67.16% of the woody ornamental plants identified in the areas were tolerant to salinity. This rate is quite high, and the ecological tolerance of the plants used is compatible with the field conditions. Considering that the annual temperature values reach up to 37 ^{o}C, the plants in the areas should be tolerant to temperature. The fact that 73.13% of the plants in the area are tolerant to temperature indicates that these plants are compatible with the field conditions in terms of temperature. Since the prevailing wind of the district is a strong wind, the plants in the region should be tolerant and resistant to wind. It was determined that 85.07% of the woody plant species identified in the areas were wind tolerant. Therefore, it was seen that the plant species used in the areas are compatible with the ecological conditions of the region. Aliağa is an industrial city. Therefore, the plants used in the areas should be especially air pollution tolerant species. It was observed that 91.05% of the woody ornamental plants identified in the areas were tolerant to air pollution. From this point of view, it was determined that the plants used in the areas were compatible with air pollution in industrial conditions and the ecological conditions of the region. In the general evaluation, only the incompatibility of water consumption of plant species in the areas examined in the city center with arid conditions was seen as a problem. Selecting the plant species to be used in the future landscaping works from the natural plant species of the region will both increase the resistance to arid conditions and ensure that the biodiversity of the city is more sustainable. *Arbutus unedo, Asparagus acutifolius, Berberis crataegina, Calicotome villosa* and *Lavandula stoechas* can be given as examples of natural plant species that can be used [36]. Similarly, conducting such a study on landscape arrangements of specific areas such as coastal areas and historical areas will contribute to the literature.

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