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INTERNATIONAL COMPILATIONS, RESEARCH AND STUDIES IN THE FIELD OF LANDSCAPE ARCHITECTURE

Editor

Prof. Dr. SERTAÇ GÜNGÖR

CONTENTS

Chapter 1

REDEFINING PUBLIC SPACE UNDER PANDEMIC CONDITIONS

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1. Introduction

Throughout history, humanity has faced not only natural disasters, wars, and political crises, but also the widespread devastation caused by infectious diseases. Epidemics have remained a persistent phenomenon in world history, creating critical turning points that have profoundly affected both individual and collective life. According to Akın and Gözel (2020), periods characterized by intensified human interaction—such as those driven by war, migration, and trade—have also facilitated the rapid spread of epidemics, leading to disruptive transformations in social structures, economic balances, and cultural patterns.

Unlike the immediate and visible destruction caused by natural disasters or armed conflicts, COVID-19 affected urban life in a more subtle yet pervasive manner, functioning as a "slow poison" that disrupted cities over an extended and fluctuating period (Liu et al., 2024). The most recent outbreak, Coronavirus Disease (COVID-19), was officially declared a global pandemic by the World Health Organization (WHO). While globalization and rapid communication networks have accelerated the spread of infections during modern pandemics such as COVID-19, these same dynamics have simultaneously enabled the rapid exchange of information, knowledge, and experience (Noszczyk et al., 2022). The emergence of COVID-19 once again revealed the extensive impact of epidemics on societies, influencing nearly all domains of life—from public health to social relations, and from economic systems to education. With the global spread of COVID-19, a disease caused by a type of coronavirus, the concept of the "pandemic," which had largely faded from collective memory, re-entered everyday life.

The emergence of COVID-19 once again revealed the extensive impact of epidemics on societies, influencing nearly all domains of life—from public health to social relations, and from economic systems to education. With the global spread of COVID-19, a disease caused by a type of coronavirus, the concept of the "pandemic," which had largely faded from collective memory, re-entered everyday life. Beyond its effects on healthcare systems, COVID-19 deeply disrupted social and economic structures. The sudden transformation of familiar daily routines into an "abnormal" state, combined with compulsory measures such as quarantine, produced significant changes across all spheres of life. In response to the pandemic's far-reaching consequences, countries rapidly implemented lockdowns and quarantine policies (Başar, 2021). Tekçe (2021) emphasizes that the confinement of daily life to the domestic sphere during the pandemic resulted in two contrasting yet simultaneous outcomes: while the notion of public space was reproduced within the

home, the use of streets—previously on the verge of being marginalized—experienced a renewed significance.

Furthermore, the implementation of multifaceted measures, including social distancing regulations, quarantine practices, curfews, travel restrictions, the closure of public institutions and private enterprises, flexible working arrangements, distance education, and remote work (Noszczyk et al., 2022), led to the substantial suspension of routines associated with public life. Consequently, this process affected not only the rhythm of everyday activities but also directly transformed the public spaces in which social life is enacted (Figure 1).

Figure 1. *Figure 1. Examples illustrating social distancing practices as part of the "new normal" (URL1, URL2)*

2. Public Space

Public space, one of the fundamental concepts of everyday human life, traces its historical origins back to Antiquity. In Ancient Greece, public space was defined as a domain in which individuals could exercise their freedoms and political rights (Arendt, 2013: 68). Throughout history, public space has occupied a central position in social life, referring to shared environments that are accessible to all and enable collective experiences (Düzenli & Alpak, 2021; Kurak & Yılmaz, 2024). Within public spaces, individuals share ideas, thereby shaping and strengthening these environments. Accordingly, public space represents not only a physical setting but also a social structure that comes to life through citizen participation and serves as an indicator of a society's democratic vitality.

Since ancient Greek societies, the term public—derived from Greek politikos, Latin republices, and Ottoman Turkish amme—has generally referred to spaces that lie outside the private and political realms and are shared by all (Aydın, 2002: 77). The earliest known usage of the term public in English (in the 1470s) associated it with the common interest of

society. Later, in 1542, an additional meaning was attributed to the term, defining it as "open to general observation and visible to all" (Budak, 2016). From the seventeenth century onward, the distinction between public and private space became more clearly defined: while the concept of "public" referred to a broad domain open to collective oversight, the concept of "private" denoted the individual's intimate sphere. Over time, the notions of public and public space have evolved, acquiring diverse meanings across different social and cultural contexts (Sennett, 1996: 31).

Public spaces are the environments—both open and enclosed—where urban residents communicate, engage in various events and activities, and collectively shape the city and society (Yılmaz & Kurak, 2022; Yılmaz & Kurak, 2024; Düzenli & Alpak, 2019; Düzenli et al., 2020; Parlakkkalay, 2020). Roads, squares, parks, religious sites, and hospitals—all open to public use—constitute public spaces accessible to every individual's daily life. Public spaces can thus be defined as shared-use environments in which individuals establish reciprocal interactions with one another (Parlakkkalay, 2020). Within this framework, public spaces may be understood as social arenas where ideas, modes of expression, and experiences are formed, shared, and debated within social life.

Theoretical approaches to public space conceptualize it as a setting in which physical encounters, social negotiation, and collective experience take place. The pandemic process questioned these fundamental characteristics of public space, as the risks associated with physical proximity challenged the spatial and social boundaries of "publicness." In this context, the pandemic reintroduced public space as a multilayered urban phenomenon, evaluated not merely as a spatial entity but also through the lenses of social resilience, spatial justice, accessibility, and sustainability. Consequently, redefining public space under pandemic conditions has become a critical field of inquiry within urban studies, architecture, landscape architecture, and the social sciences.

3. The Renewed Concept of Public Space During the Pandemic

Public space motivates individuals by offering opportunities to escape the cycles and obligations of private life, while simultaneously providing a setting in which people can test themselves and reflect upon the social consequences of their actions (Budak, 2016). In this context, the social distancing policies, curfews, bans on public gatherings, and hygiene-oriented spatial arrangements implemented during the COVID-19 pandemic questioned the functions, modes of use, user behaviors, and social meanings of public space (Ferenčuhová et al., 2025). This transformation necessitated a reconsideration of established assumptions

regarding what constitutes "public space," both in physical and sociocultural dimensions. Öztas (2021) argues that, during the pandemic, the strengthening of perceptions related to privacy, social distance, and security brought approaches such as "livable neighborhoods" and the "15-minute city" to the forefront. Accordingly, urban public space design must be rethought in relation to behavioral patterns, environmental psychology, and principles of flexibility.

The mandatory implementation of social isolation and physical distancing rules disrupted individuals' bodily and socio-emotional interactions with public space (Noszczyk et al., 2022). During this period, public space ceased to function solely as a physical gathering place and was redefined as a structure transformed by new social norms, anxieties, and boundaries, acquiring altered representational and functional dimensions (Figure 2). The pandemic thus emerged as a critical rupture that reconfigured the experience of public space not only spatially but also in terms of cultural codes, social belonging, and individual emotional states. This transformation profoundly influenced the rhythm of urban life, modes of social interaction, and senses of spatial belonging, leaving lasting imprints on the conceptual framework of public space.

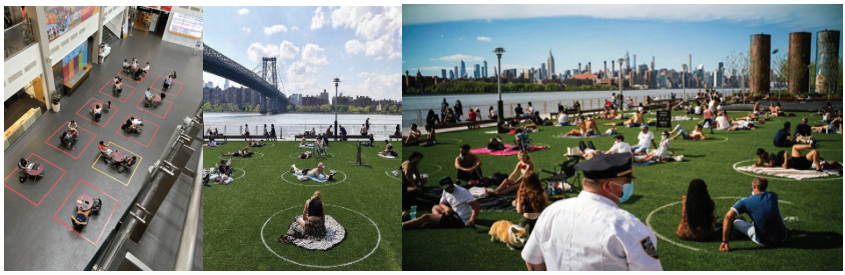

Figure 2. *Examples of safe social distancing practices (URL1, URL3, URL4)*

On the other hand, the temporal and spatial restrictions imposed by pandemic regulations transformed urban public spaces into lifeless and depopulated voids, reshaping the definition of these spaces around the notion of "emptiness" (Güneyemen, 2021). During the pandemic, public space was redefined on the one hand through concepts such as "contactlessness," "emptiness," and "restricted circulation" due to health risks, while on the other hand, the strengthening of outdoor-oriented social life brought the importance of flexible, permeable, and health-oriented spatial design to the forefront. Parks, squares, pedestrian corridors, waterfronts, and semi-public transitional spaces became more visible as vital urban elements that support individuals' physical and psychological well-being. This process particularly paved the way for

the reinterpretation of public space within the contexts of health, safety, social interaction, and digitalization.

In this period, commercial spaces primarily attracted users through functionality and service efficiency, whereas parks were increasingly preferred to fulfill emotional satisfaction and ecological needs (Cai et al., 2025). With the pandemic, public space acquired a dual conceptual character, being perceived simultaneously as a space of risk (due to the threat of contagion) and as a space of essential need (providing access to open air, nature, and psychological relief). Accordingly, the use of public space was transformed into areas of psychological support governed by criteria such as physical distancing, contactless circulation, and limited gathering (Noszczyk et al., 2022). This shift prompted public spaces to be reconsidered particularly in relation to flexibility, accessibility, safety, and resilience (Table 1).

Table 1. Factors Determining the Quality of Public Space During the Pandemic

FFactor	**Description**
Accessibility	Proximity and accessibility to urban open spaces
Open Space Size	Capacity required for crowding and social distancing
Flexibility	Adaptability of space to changing purposes
Green Infrastructure	Park, tree, canopy
Security	Hygiene
Digital Support	QR codes, density monitoring
Equality	Suitable for all age groups

During the pandemic, publicness was reproduced through regulated forms of encounter; that is, interaction within public spaces did not disappear entirely but became conditioned by regimes of hygiene, distance, surveillance, and spatial regulation (Güneyemen, 2021). In this context, public space evolved into a complex ground where not only physical encounters but also risk management, behavioral guidance, and new forms of sociality were produced. Similarly, studies conducted in developing cities emphasize that urban open spaces during the pandemic gained importance as "safe breathing spaces" that both reduced the risk of contagion and supported physical and psychological well-being (Ibrahim, Farrag & Khalil, 2022; Noszczyk et al., 2022).

Sepe's (2021) study, based on the Italian case, examines the effects of COVID-19 on the quality, flexible use, and "community space" function of public open spaces, highlighting that the pandemic brought forward

not only recreational aspects but also health, safety, and resilience dimensions of public space.

Several studies indicate that inadequately flexible urban public spaces turned into insufficient and fragile environments during crisis periods, whereas well-designed public spaces played a critical role in mitigating social and psychological problems (Kokarca & Batuhan, 2023). During the pandemic, certain squares, parks, pedestrianized streets, and transitional spaces transformed into highly functional, temporary, and adaptable environments. The principle of "flexibility" thus emerged as a fundamental concept for both pandemic management and spatial design practices. As the risk of indoor transmission increased, social needs were reoriented toward open-air-focused environments; parks, waterfronts, green areas, and semi-open spaces became strong centers of social life. The pandemic also made spatial justice—namely, the spatial dimensions of inequality in urban environments—more visible. Consequently, the equitable distribution, accessibility, and inclusiveness of public spaces moved to the center of urban discourse.

Research conducted in Jakarta demonstrates that public space was redefined as an adaptive form of public life responding to pandemic conditions, revealing that users made more pragmatic and needs-oriented choices due to heightened health awareness, while simultaneously gravitating toward flexible, multifunctional, and accessible spaces (Hartanti & Prabowo, 2023). Other studies argue that during the pandemic, the perception of public space evolved toward the concept of public environments that generate well-being; multifunctional, adaptable, and user-centered spatial design became a critical tool for sustainable urban welfare (El Khateeb & Shawket, 2022). A study examining visitor patterns in Las Vegas between 2019 and 2023 indicates that before the pandemic, parks were primarily valued for entertainment activities, whereas after the pandemic, natural elements and infrastructural qualities gained increased importance. These findings emphasize the necessity of urban design that integrates green spaces offering opportunities for physical activity, social interaction, and mental restoration (Cai et al., 2025).

Overall, these studies demonstrate that COVID-19 repositioned public space not merely as a "space of risk," but also as an infrastructure through which health, psychological resilience, and social bonds are reproduced. Accordingly, the functional and conceptual framework of public space has been fundamentally redrawn. Public space is now recognized as significant not only in terms of social interaction but also with respect to public health and spatial resilience. Resilience refers to the capacity of public spaces to adapt, remain flexible, and sustain functionality in

the face of unexpected crises. The recent pandemic has underscored the necessity for public spaces to operate as resilient infrastructures capable of supporting social life under crisis conditions. A comparative overview of public space use before, during, and after the pandemic is summarized in Table 2.

Table 2. *Comparison of Public Space Use Before, During, and After the Pandemic*

Criteria	Pre-Pandemic	Pandemic Period	Post-Pandemic
Intensity of Use	High social interaction, crowded spaces	Low intensity due to social distancing	Controlled but increasing use
Spatial Configuration	Fixed seating arrangements, dense circulation	Distance markings, directional guidance	Flexible, modular, and transformable layouts
Role of Open Space	Recreation- and socialization-oriented	Centered on health and safety	Focused on well-being, health, and resilience
Digitalization	Predominantly physical use	Virtual events and digital publicness	Hybrid (physical + digital) public space
Art and Culture	High level of physical participation	Digital exhibitions, outdoor art interventions	Hybrid artistic practices
User Behavior	Voluntary use	Mandatory, guided use	More conscious, health-sensitive use

Healthy urban planning, ecological design, and biophilic design principles have become fundamental components of public spaces in the post-pandemic period. Social media, online meetings, and digital events have strengthened the virtual dimension of public space, giving rise to the phenomenon of the "Digital Public Space." Moreover, at the intersection of physical and digital public spaces, new forms of use have emerged, such as virtual museums, digital art exhibitions, QR-coded park routes, and remotely interactive installations. Based on the literature review, four main findings regarding the transformation of public space under pandemic conditions have been identified:

a) Public space use has shifted toward open and green spaces

During the pandemic, due to physical distancing requirements and the risks associated with enclosed environments, individuals increasingly gravitated toward open spaces where they felt safer, such as parks, waterfronts, recreational areas, and pedestrian corridors. Open-air environments became critical in terms of psychological relief, social interaction, and physical activity. Supporting this trend, studies have

demonstrated that parks, coastal zones, and pedestrianized streets became indispensable for physical and mental well-being during the pandemic. However, the quantity, spatial distribution, and accessibility of these spaces emerged as key issues within ongoing debates on spatial justice (Barrantes-Chaves et al., 2025).

b) Public space has evolved into a flexible and multifunctional structure

The pandemic period revealed that public spaces must be rapidly reprogrammable, adaptable to temporary uses, and multifunctional under crisis conditions. Open-air cafés, temporary bicycle lanes, pop-up parks, and transformable seating arrangements served as prominent examples of spatial flexibility (Holub-Moorman, 2025). Consequently, public space transformed into a flexible spatial typology capable of being swiftly reconfigured according to changing needs.

c) A new health- and safety-oriented spatial language has emerged

Parameters such as social distancing, hygiene, air quality, walking distances, and user density became integral components of public space design, strengthening the concept of "safe public space" (Sepe, 2021). Spatial solutions including distancing markings, wayfinding signage, hygiene stations, controlled entrances, and low-density seating arrangements contributed to the development of a pandemic-specific spatial language, establishing health and safety as new core components of public space.

d) Digital and hybrid forms of publicness have been strengthened

Artistic events, cultural programs, and social gatherings were transferred to digital platforms, while augmented reality applications, QR-coded park routes, and digital participation tools provided a new conceptual foundation for public space design. These hybrid practices expanded the boundaries of public space beyond its physical dimensions, integrating digital participation into everyday public life.

4. Conclusions

Pandemics should be understood not only as crises confined to the field of public health but also as historical rupture points that trigger profound social and cultural transformations. As a result of pandemics, collective memory is reshaped, interpersonal relationships and everyday practices are reconfigured, and perceptions of space undergo significant change. This multidimensional transformation has also been reflected in artistic forms of expression and public representations, allowing

pandemics to transcend their biological nature and become cultural and aesthetic phenomena.

This study examined the use of public space during the pandemic within the context of urban parks, open squares, recreational areas, and various public-use environments, focusing on emerging life practices, the formation of social sensitivities, and the potential of public spaces to foster dialogue and awareness. The findings reveal a new urban paradigm that necessitates the design of healthy, safe, accessible, and resilient public spaces in post-pandemic cities.

Beyond its impact on physical health, the COVID-19 pandemic has had profound effects on public space, one of the fundamental components of social life. Physical and social restrictions imposed on public space use significantly limited individuals' opportunities for public expression and interaction.

In conclusion, COVID-19 should be recorded not merely as a health crisis but as a historical phenomenon that has fundamentally transformed societies. The pandemic process marks the beginning of a new era that will shape future social, cultural, and economic structures.

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Chapter 2

LANDSCAPE POTENTIAL OF SOME FOREST TREES IN THE EASTERN BLACK SEA REGION

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Introduction

Plants are natural elements that directly influence the biological, psychological, and cultural dimensions of human life. With their many characteristics, plants are used as fundamental components in creating outdoor spaces that enhance human-nature interaction (Sarı & Karaşah, 2018). In landscape architecture, the process of creating spaces by bringing plants together is carried out during the planting design phase. This process involves planning plant species according to their size, form, color, texture, and line characteristics in a way that meets the aesthetic, functional, and ecological requirements of the spaces. Among these characteristics, size is one of the most important design parameters that directly shapes the spatial concept (Karaşah & Var, 2012). Because the plant's height, crown width, and overall mass play a decisive role in defining the boundaries of the space, determining its volumetric structure, and how it is perceived by the user (Kahveci, 2021).

In landscaping design, trees are chosen for urban design not only based on physical criteria such as height, crown width, and spatial scale, but also for their aesthetic values derived from leaf, flower, and fruit characteristics, as well as their ecological functions. The form, texture, and seasonal color changes of leaves, the timing and visual impact of flowering, and the color, size, and persistence characteristics of fruits are important design elements that enhance the perceptual quality of urban spaces (Dirik et al., 2014). However, the ecological contributions of trees, such as providing shade, creating noise and wind barriers, regulating microclimate, reducing air pollution, carbon sequestration capacity, and supporting urban biodiversity, play a decisive role in sustainable urban design (Sarı, et al., 2020). These multifaceted characteristics necessitate that trees be considered not merely as structural elements, but as fundamental components that ensure the ecological, aesthetic, and functional integrity of the urban environment. Consequently, forest trees are indispensable landscape elements that are critical for ecosystem sustainability and that lend a strong identity, scale, and function to planting designs.

Türkiye is one of the world's richest countries in terms of plant diversity and, thanks to its location at the intersection of three different phytogeographic regions, possesses a wide range of flora (Terzioğlu, et al., 2012). One of the most important components of this diversity is the forest ecosystems that cover a large part of the country. According to findings from 2020, forested areas cover 29.4% of the country's land area. When examining the distribution of these forested areas according to their mixture types, the proportion of pure forests is 59%, while the proportion of mixed forests is 41%. When evaluating the ratio of tree species

groups to the total forested area, it is seen that 48% are coniferous, 32% are deciduous, and 20% are both coniferous and deciduous forests. When evaluating Türkiye's forest resources in 2020 by geographical region, the Black Sea Region had the highest share at 24.4%; followed by the Mediterranean Region (19.6%), the Aegean Region (15.9%), the Central Anatolia Region (13.8%), the Marmara Region (12.8%), the Eastern Anatolia Region (8.3%), and the Southeastern Anatolia Region (5.8%) (TOV, 2020). Türkiye, with its climate, topography, and soil characteristics, provides suitable conditions for the growth of many plants and is home to numerous species (Öztürk, 2016). Turkish forests contain many tall tree species such as fir, spruce, pine, oak, juniper, cedar, beech, and hornbeam, offering a unique natural heritage from both an ecological and cultural perspective.

The Eastern Black Sea Region is one of Türkiye's most striking areas due to its unique topographical features. Unlike its western parts, the region has mountain ranges that run parallel to the coastline and rise rapidly over a very short horizontal distance, reaching approximately 3,400 meters (Terzioğlu, et al., 2012). These distinct elevation differences allow various ecosystems to develop sequentially over short distances. The geographical location and topographical structure also determine the region's climatic characteristics. In particular, the high humidity and intense rainfall spread throughout the year are significantly above the national average. The balanced seasonal distribution of rainfall directly affects the structural and floristic composition of forest ecosystems. Consequently, there is an increase in plant species diversity and high endemism rates (Yazar & Terzioğlu, 2019).

Türkiye offers significant natural potential for landscape architecture with its rich forest ecosystems and high endemism rates. However, it is observed that this natural species richness is not sufficiently reflected in urban landscape designs, the use of native species is limited, and exotic species are mostly preferred (Kaya Şahin, et al., 2020; Güneroğlu & Pektaş, 2022). This situation leads to a weakening of the ecological functions of urban ecosystems and an increasing homogenization of the local landscape identity (Bekci, et al., 2013). The main reasons for the decline of native species in urban areas include the rapid visual impact of exotic species, their familiarity and acceptance as standard in implementation processes, the limited diversity of native species in nursery production, and the prioritization of aesthetic concerns over ecological criteria in the design process.

In this context, the study aims to evaluate the potential use of certain forest tree taxa in landscape design by examining their aesthetic, ecological, and functional characteristics. It emphasizes that the use of forest

trees in landscape design is not merely a botanical preference, but also a strategic design element that defines, directs, and characterizes the spatial scale. In line with these objectives, a total of 19 tree taxa belonging to 8 families naturally occurring in the Eastern Black Sea region of Türkiye were examined. Of these, Fagaceae, Betulaceae, Sapindaceae, Malvaceae, Salicaceae, Platanaceae, and Rosaceae belong to the Angiosperm class, while Pinaceae belongs to the Gymnosperm class.

Abies nordmanniana* (Stev.) Spach. subsp. *nordmanniana

Its natural range is Türkiye, Georgia, and the mountainous regions of the Caucasus. In Türkiye, this taxon is concentrated in the cool, humid, and high-altitude sections of the Eastern Black Sea mountain ranges, showing optimal development in deep valleys, steep north-facing slopes, and forest interior glades with high moisture retention capacity. The typical Black Sea climate is largely compatible with the taxon's natural ecology. It is not overly selective in terms of soil requirements, but it thrives in moist soils (Zincirkıran, 2013). This taxon, belonging to the Pinaceae family, is an evergreen tree that can reach 40–50 meters in height, with a broad conical–pyramidal crown. The needle-like leaves are 20–35 mm long, blunt at the tips, glossy dark green on the upper surface, and have two distinct stomatal bands on the lower surface. The cones are 15–20 cm long, cylindrical in shape, and develop vertically on the upper parts of the tree. Its high resistance to urban climates and various diseases, as well as its relatively slow growth rate, make it suitable for long-term urban landscaping applications. In landscape architecture, solitary or group plantings are a frequently preferred taxon for designs requiring background creation, screening of unwanted views, spatial orientation, and high vertical emphasis (Sarı & Öztürk, 2023). They offer aesthetic and functional contributions to city parks, squares, residential gardens, and large-scale recreational areas (Karaşah, 2021). In addition, thanks to their deep and strong root structure, they play an important role in ecosystem services such as erosion control and stabilization of slopes at risk of landslides.

***Acer campestre* L.**

The natural range of the species extends to Europe, Thrace and Northern Anatolia, the Caucasus, Northern Iran, and Northwest Africa. In Türkiye, it is mainly found in Thrace, the Marmara Region, and Northern Anatolia. Acer campestre is a species that has adapted to temperate climatic conditions, loves warmth but is also resistant to frost. It thrives in sunny and semi-shaded areas. The species can grow in clayey and loamy soils and is resistant to lime. Belonging to the Sapindaceae family, it is a deciduous tree that can reach 15-20 m in height, with a rounded form,

straight trunk, and dense branches (Utorova, et al., 2014). The leaves are opposite, 3–5 lobed, and 5–10 cm in size, turning yellow in autumn. Its high tolerance to air pollution, wind, and pruning makes it particularly suitable for use in urban and semi-urban areas. Thanks to these characteristics, it is reliably preferred for street and roadside tree planting, as well as for linear arrangements along pedestrian and vehicle paths. Due to its strong root system, it functions as a soil stabilizer in windbreaks and sloped areas. When used as a solitary tree or in groups in parks and gardens, its rounded and dense crown creates a strong mass effect (Zecchin, et al., 2016). Furthermore, its dense branching structure provides shelter and protection for birds, contributing to biodiversity in urban ecosystems.

***Acer cappadocicum* Gleditsch**

The natural range of the species encompasses the Eastern Black Sea, the Caucasus, and Northern Iran, exhibiting a wide geographical distribution extending as far as Western Asia and the Himalayas (Erdoğan Genç, 2010). In Türkiye, it is particularly widespread in the provinces of Giresun, Trabzon, Rize, Gümüşhane, and Artvin. *Acer cappadocicum* is a species that thrives in temperate and humid maritime climates. While generally resistant to frost, it is sensitive to prolonged drought conditions. Therefore, high air humidity and regular rainfall patterns are noteworthy in its natural range. It prefers deep, moist, well-drained, and organic-rich soils. However, it also grows in shallow and calcareous soils. It is a deciduous tree belonging to the Sapindaceae family, reaching 20–25 m in height, with a straight trunk, dense branches, and a rounded crown (Öztürk, 2016). The leaves are opposite, 5–7-lobed, wider than they are long, and the lobes are pointed. In autumn, the leaves turn yellow. Its tolerance to areas with high air pollution allows the species to be used successfully in urban environments. Its strong root system ensures good soil retention and increases wind resistance. Its round and broad crown structure creates a powerful spatial effect in parks and gardens when planted as a solitary tree or in groups. Furthermore, its use in natural habitats contributes to the creation of sustainable landscape designs that are compatible with local ecosystems.

***Acer platanoides* L.**

Its natural range covers a large part of Europe, the Caucasus, northern Iran, and Anatolia. In Türkiye, it occurs naturally in the Thrace, Marmara, Aegean, and Black Sea regions at elevations of 500–1,900 m, occasionally reaching up to 2,400 m. This wide distribution area demonstrates the species' high adaptability to climate and soil conditions. Belonging to the Sapindaceae family, the species is a broad-leaved, deciduous tree

that can reach 20–30 m in height (Öztürk, 2016). While exhibiting high resistance to frost, it does not prefer very hot and extremely dry climates, but it can adapt to these conditions to a certain extent. In terms of light requirements, it thrives in sunny and semi-shaded areas. It shows optimal growth in deep, well-drained soils. However, it can also adapt to poor, heavy clay soils and soils with different textures. *Acer platanoides* is a tree with a full and straight trunk, dense branches, and a rounded crown. The leaves are opposite, 5-lobed, and 6–18 cm in size. The leaves turn yellow in autumn. Its spreading and strong root system increases its resistance to wind and stability in urban areas. These characteristics make the species suitable for urban areas, street and road tree planting, and alley landscaping (Kunakh & Zhukov, 2025). Its resistance to air pollution is also an important advantage for urban use. Its rounded and dense crown structure makes it suitable for solitary or group planting in parks and gardens.

***Acer trautvetteri* Medv.**

It is an important forest tree native to the Caucasus and northern parts of Türkiye. In Türkiye, it exhibits a continuous distribution along the northern Anatolian region, stretching from the Istranca Mountains in the west to the Artvin forests in the east (Korkut, et al., 2008). It can grow from approximately 100 m above sea level up to 2100 m. Acer trautvetteri is a species that prefers humid and cool climatic conditions and is quite shade-tolerant. It avoids arid and semi-arid climatic conditions; it does not occur naturally in areas where summer drought is pronounced. Its resistance to cold allows it to thrive even at high altitudes. It prefers deep, fresh, humus-rich, and well-drained soils. Riverbeds, foothills, and moist valley interiors are habitats where the species is commonly found. Belonging to the Sapindaceae family, the species is a tree that can reach 15–25 m in height, with a straight trunk and broad crown (Erdoğan Genç, 2010). The trunk bark is light gray in color and remains smooth without cracking even in old age. Young shoots are thick and bare, initially dark green, turning reddish-brown over time. The leaf blade is 5-lobed, 9–14 cm long, and the leaf stalks are 4.5–17 cm long. The species has high visual value in landscape architecture due to its straight trunk, broad and aesthetic crown shape, and smooth, light-colored bark. Its shade tolerance and successful growth in moist areas make it particularly suitable for use in natural and semi-natural landscape designs. It can be used as a solitary tree or in small groups in parks, large-scale green areas, forest recreation areas, and streamside landscaping.

***Betula pendula* Roth**

It is a species that occurs naturally in most of Europe and Asia, as well as in the northeastern and eastern parts of Türkiye. Adapted to temperate and cool climates, the species is resistant to cold and frost but sensitive to high temperatures; therefore, it does not thrive under hot climate conditions. Its sensitivity to salinity is another factor that limits its use in coastal areas. It grows better in shallow but humus-rich, well-drained soils. Belonging to the Betulaceae family, *Betula pendula* is a deciduous tree that can reach 20 m in height, with thin shoots, semi-pendulous branches, and deciduous leaves. The trunk is snow-white, covered with a thin, shiny bark, and the shoots are reddish. The coarse, three-lobed, pointed leaves, 3-7 cm long, show a distinct yellowing in autumn. Due to its aesthetic bark structure, reddish shoots, seasonal color changes, and form flexibility, *Betula pendula* is among the indispensable decorative tree species in landscape designs, especially those with a natural and semi-natural character. In landscape applications, this species can be preferred as an avenue tree along roadsides, in small groups or as copses in large lawn areas, and in groups of 3–5 in parks, residential gardens, and children's playgrounds (Güçlü & Yılmaz, 1990). It can also be used in groups along highways for boundary planting.

***Castanea sativa* Mill.**

The natural distribution of the species covers Southern Europe, Türkiye, and the Caucasus, and in Türkiye, it is widely distributed, particularly in Northern Anatolia, Western Anatolia, and partially in Southern Anatolia. Adapted to humid and temperate climates, chestnut trees thrive in areas with regular rainfall and exhibit a certain resistance to winter cold. Being a taproot species, it prefers deep, loose, and well-drained soils; it has high soil requirements and shows vigorous growth in fertile habitats (Conedera, et al., 2004). *Castanea sativa*, belonging to the Fagaceae family, is a large deciduous forest tree that can grow to 30–35 m in height, with a broad and rounded form. The leaves are lanceolate–narrow elliptical in shape, 16–30 cm long, pointed at the tip, and serrated at the edges. The fruits develop inside spherical cups covered with dense, prickly spines. Its flowers are an important source of nectar and are highly valued for beekeeping. In landscape design, it stands out for its form aesthetics, autumn coloration, broad crown structure, and rich flower and fruit production. Thanks to its dense branching structure and leaf density, it is an effective species for sound, dust, and wind barriers. The root system contributes to soil stabilization, erosion control, and water infiltration. It also demonstrates high compatibility with thematic design concepts such as pollina-

tion gardens rich in pollen and nectar, theme gardens containing edible species, bird gardens, and fragrance gardens (Abdelwahab, et al., 2024).

***Carpinus betulus* L.**

This species, native to Europe and Western Asia, is naturally distributed in Türkiye, particularly in the Aegean, Marmara, and Black Sea regions (Varol, et al., 2022). It thrives in temperate climates but has low drought tolerance. As a shade tree, it exhibits optimal growth in moist, deep, well-drained soils. It belongs to the Betulaceae family and is a deciduous tree species that can reach 20–25 meters in height, with a broad crown and medium texture. The leaves are 7–14 cm long, alternately arranged, with a wedge-shaped base and sharp, double-rowed serrated edges. The species is aesthetically significant due to its leaves, which turn yellow in autumn, its smooth bark texture, and its crown form, which has high landscape value. *Carpinus betulus* has versatile potential for use in landscape architecture (Zhou, et al., 2018). Its dense and bushy structure gives it a high capacity to block wind and absorb noise; therefore, it is preferred as a wind and noise barrier on highways, streets, and urban corridors. Its strong root structure, which firmly anchors the soil, plays an important role in erosion control, particularly on slopes and road embankments. It can be used as a border plant and privacy screen in parks and gardens; when planted in groups, it creates effective volumetric arrangements. Due to its strong landscape form, it can be used as a solitary plant in large lawn areas to create a focal point. Its high shade-producing capacity makes it suitable for children's play areas and parking lot landscaping.

***Fagus orientalis* Lipsky**

Its natural range is Europe, the Balkans, and Türkiye. In Türkiye, it has its widest distribution and best development in the mountainous slopes parallel to the Black Sea coast, outside the Aegean and Marmara regions (Ayan, et al., 2022). It exhibits optimal development in nutrient-rich, well-drained, deep, and cool soils. However, it can also adapt to sandy and calcareous soils. It tolerates sunny or semi-shaded environments and thrives in maritime climates. *Fagus orientalis*, belonging to the Fagaceae family, is a tall, broad-crowned, deciduous forest tree that can reach 30–40 meters in height, with a straight, single trunk and spreading crown. Its oval-shaped leaves, measuring 7–15 cm in size, gain high aesthetic value with their autumn coloration, turning from yellow to brown. The trunk bark is smooth, light gray in color, even, and crack-free. Its resistance to frost and urban air makes *Fagus orientalis* a reliable species for urban landscapes, but its sensitivity to salt requires careful use in coastal areas. Its broad crown structure provides effective shade, this feature makes it

a preferred choice for large park areas, recreation and picnic areas. In roadside tree planting, especially on boulevards and wide avenues, it is an ideal species due to its tolerance to urban air and its regular crown shape. Its dense branch and leaf structure allows it to be used as a background and screen plant. Highly adaptable to industrial areas and urban environments with polluted air conditions, this species also serves as a strong focal element when planted as a solitary specimen on large lawn surfaces (Aytaş & Tuttu, 2015).

***Picea orientalis* L.**

This species is distributed between the Caucasus Mountains and Türkiye 's Eastern Black Sea Region. It thrives naturally on cold, humid mountain slopes facing the sea, exhibiting optimal growth performance in humus-rich, well-drained soils with high aeration capacity (Güney, et al., 2019). *Picea orientalis* belongs to the Pinaceae family and is an evergreen forest tree that typically grows to a height of 30–40 meters, with a pyramidal and pointed crown. Its trunk branches densely from the base and is smooth and light-colored when young, becoming dark and cracked with age. The species' bright dark green needles are 3–11 mm long. Oval-cylindrical cones, 3–9 cm long, are inverted egg-shaped. Due to its form, the species stands out as an impressive focal element in both solitary and group plantings. Thanks to its dense branch and leaf structure, it can be used effectively in plant screens that reduce wind, dust, and noise, while also masking unsightly views to enhance spatial comfort (Karaşah, 2021; Sarı & Öztürk, 2023). Its resistance to air pollution increases its usability in urban open and green spaces, offering both aesthetic and functional contributions in parks, gardens, and recreational areas (Çetin, 2024). It also plays an important role as a component in plant compositions created with natural species in ecological landscape designs, demonstrating high compatibility in habitat creation and nature-based design applications.

***Pinus pinea* L.**

Pinus pinea, one of the characteristic species of the Mediterranean region, is found in Türkiye, particularly in Southern and Western Anatolia and the Marmara Region, as well as around Artvin in the Eastern Black Sea region. This species, which is a tree of the hot and dry Mediterranean climate, has high light requirements and limited shade tolerance. It grows best in loamy-sandy soils and generally has low soil requirements and is tolerant to salinity. Belonging to the Pinaceae family, the species generally reaches a height of 25–30 m. The crown shape, which appears spherical in young individuals, transforms into a distinct umbrella shape

with age (Viñas, et al., 2016). Needle-like leaves are 8–20 cm long, bright light green in color, and prickly. One of the most striking features of the species is its woody, large-scaled cones, which are about the size of an orange. Thanks to its broad and dense crown structure, it is preferred as a strong shade tree in parks, coastal landscaping, and large gardens. It is also an important species for holding and afforesting coastal dunes due to its windbreak and erosion control function, thanks to its taproot system (Öner, et al., 2015). Its large and eye-catching cones also enhance its aesthetic value. It can be used in roadside landscaping, but due to its spreading crown structure, it must be positioned at a suitable distance from the roadside. It is suitable for use in very wide medians and also creates an effective accent element when planted as a solitary specimen. Furthermore, its rounded-umbrella shape contributes to the creation of decorative silhouettes.

***Pinus sylvestris* L.**

This pine species, which has the widest distribution area in the world, is found naturally in Türkiye in the western and eastern Black Sea regions, particularly on south-facing slopes, as well as in the eastern Anatolia and southern Marmara regions. The yellow pine is undemanding in terms of soil requirements and grows well in loose, deep, moist sandy soils. It is resistant to frost and drought. Belonging to the Pinaceae family, this species can typically reach heights of 20–40 meters. Depending on its growing environment, it can exhibit a slender trunk, pointed crown, and thin branches, or, in favorable habitats, it can develop a full and straight trunk, a broad crown, and thick branches (Brichta, et al., 2023). The trunk bark is reddish-brown in color and peels off in thin layers like onion skin (Durrant, et al., 2016). The needle-like leaves are blue-green in color and prickly. The 3–6 cm long cones are stalked, sometimes displaying a twisted structure at the base. Widely used in parks, urban forests, and green belt projects, this species creates an aesthetic vertical accent and, thanks to its strong root system and dense structure, can serve as an effective windbreakDue to its light-bearing nature, yellow pine is highly successful in open areas. With its broad crown structure, durability, and long-lived form characteristics, it is an ideal species for recreational areas and large-scale landscape designs.

***Platanus orientalis* L.**

The natural distribution of the species extends from Southeast Europe and Western Asia to the Himalayas, and in Türkiye it is widely distributed in an area ranging from sea level to 1100 m elevation (Kösa & Atik, 2013). Stream banks, river edges, deltas, and gravelly slopes are habitats

where the species shows optimal development. It exhibits rapid growth in sunny conditions in deep, fertile, well-drained soils rich in organic matter. Belonging to the Platanaceae family, the species is a long-lived, broad-topped, deciduous tree that can reach heights of 30–40 m. The trunk is light gray or greenish gray in color. The light green leaves are 10-18 cm long, with 3-7 lobes, and the indentations between the lobes are deep and narrow. The spherical fruits, measuring 2-2.5 cm, are arranged in clusters of 2-6 on a long stem. Due to its aesthetic bark texture, broad form, and leaves that turn bright yellow in autumn, it can be used as a solitary or accent tree in parks. *Platanus orientalis* can create large shaded areas with its broad crown (Tığlı Kaytanlıoğlu, et al., 2022). Its tolerance to saline soils, drought, urban air pollution, and compacted soils makes it important for urban landscaping (Aslan, 2017). It is frequently preferred, especially in boulevard arrangements. Its dense and thick branches provide effectiveness in wind and noise barriers. In addition, its dense branches serve as a shelter for birds and other fauna, adding value to ecological corridors and natural life arrangements.

***Populus tremula* L.**

Europe, Africa, Asia, and parts of China, the Caucasus, and Siberia are also areas of distribution. *Populus tremula*, a natural element of the Turkish flora, shows particularly strong growth in the moist and cool ecosystems of Thrace, Western Anatolia, and the Black Sea Region (Turna & Atar, 2024). In terms of ecological requirements, *Populus tremula* prefers moist, cool, and well-drained soils. However, it also has the ability to grow easily on disturbed land, along riverbanks, or on slopes. Belonging to the Salicaceae family, this species is a deciduous tree with dense branches, a broad conical crown, and can reach heights of up to 30 meters. The leaves are 3–7 cm long, heart-shaped, and have thin stems (Eminağaoğlu, et al., 2018). The yellow–orange color change observed in the leaves during the fall season enhances the species' seasonal aesthetic value. In terms of landscape design, *Populus tremula* is a valuable species in both natural and semi-natural landscapes. Due to its rapid growth, ability to quickly cover large areas, and support for natural regeneration in post-fire areas, it is widely used in ecological restoration projects, erosion control, and rehabilitation projects. Additionally, its yellow-orange autumn coloration creates visual richness in natural and rural landscape designs. It is suitable for planting in groups or groves along stream banks, forest clearings, and large recreational areas. However, due to its tendency to spread very rapidly, its use in controlled areas is recommended.

***Quercus hartwissiana* Steven**

The natural distribution of the species extends from southern Bulgaria through northern Anatolia to western Caucasus. In Türkiye, it is particularly widespread in the coastal belt of the Black Sea Region and in inland areas close to the coast (Akkuş, et al., 2018). It can be found up to an altitude of 1200 m in Black Sea forest ecosystems. This oak is a species that has adapted to the humid and temperate Black Sea climate conditions. It prefers deep, well-drained, humus-rich, and fresh soils. Its rapid growth characteristic increases its competitive power, especially under suitable ecological conditions. It is a deciduous forest tree belonging to the Fagaceae family, capable of reaching up to 35 m in height. Its trunk is straight, and its crown is narrow and cylindrical (Dündar, 2001). The leaves are generally obovate, 8.5–15 cm long, with regularly spaced shallow lobes, 7–10 lobes, and blunt tips. The fruits are 8–20 mm in size and occur in clusters of 1–4 on fruit stalks that are 2–7 cm long. This species has significant potential in natural and semi-natural landscape designs due to its uniform trunk structure and narrow, aesthetically pleasing crown. It is particularly suitable for large-scale parks, recreational areas, forest rest areas, and green belt applications near the coast. Its shade tolerance and rapid growth make it advantageous for use in ecological restoration projects and afforestation efforts.

***Quercus petraea* (Mattuschka) Lieb.**

It is an important oak species naturally distributed across most of Europe outside its northern regions, including the Balkans, Anatolia, the Caucasus, and northern Iran (Viciani, et al., 2016). In Türkiye, it has a wide distribution across the Thrace, Marmara, Black Sea, Central Anatolia, and Southern Anatolia regions and is one of the oak species with the widest distribution in our country. This oak is adapted to temperate climatic conditions and thrives in semi-humid to semi-arid areas. It prefers moderately deep, acidic, well-drained, permeable soils that are either nutrient-rich or nutrient-poor. Its ability to thrive in stony, clayey, and moderately dry soils demonstrates the species' broad ecological tolerance. It is a deciduous forest tree belonging to the Fagaceae family, capable of reaching heights of 30–40 m. Its trunk is straight, cylindrical, and branching begins relatively high up (Eyüboğlu, 2010). The leaves are 6–17 cm long, elliptical or obovate, tapering to a wedge shape at the base. The leaf margins have 5–9 shallow or deep lobes. The fruits are 3–4 cm long, cylindrical, and pointed, and are covered up to half their length by a hemispherical or pear-shaped cupule. This species is extremely valuable in landscape architecture due to its straight, long trunk structure and narrow, symmetrical crown shape. It can be used in parks and gardens as

a solitary tree or in groups, as a mass tree in large green areas, and as a windbreak and boundary element. Its resilience to urban climates, ability to thrive in partial shade conditions, and robust root system offer significant potential for sustainable urban green space design.

***Sorbus aucuparia* L.**

This species, which is naturally distributed in the temperate zones of Europe and Asia, is commonly found in Türkiye, particularly in the forests of Central and Northern Anatolia. Able to adapt to both maritime influences and high temperatures, this species can thrive in varying elevations and soil conditions throughout its natural range. *Sorbus aucuparia*, belonging to the Rosaceae family, is a deciduous tree that can grow to a height of 10–15 meters, with a rounded and loose crown. Its single compound leaves, 10–30 cm long, consist of 7–17 serrated leaflets and are elliptical in shape. The yellow-orange coloration of the leaves in autumn enhances the seasonal visual appeal of the species. Its small, fragrant, white flowers are found in upright, umbrella-shaped clusters. The ripe orange-red fruits, 5–8 mm in diameter with soft pits, form broad clusters, enhancing the species' aesthetic and ecological value (Suhonen & Jokimäki, 2015). From a landscape design perspective, *Sorbus aucuparia* is a suitable species for both solitary and group plantings. It is a plant commonly used in urban roadside plantings, parks, and gardens. Its fruits serve as a food source for numerous bird and small mammal species, making it a preferred choice in landscapes designed to support wildlife. The aesthetic appeal of its flowers, fruits, and autumn coloration renders the species an attractive landscape element throughout all four seasons. Its adaptive characteristics, which enable it to be used in drought-tolerant landscape designs, make the species resistant to various environmental stresses. Furthermore, its status as a pioneer species allows it to be used in the ecological restoration of degraded areas.

***Sorbus torminalis* (L.) Crantz**

This species, which naturally has a wide distribution across Europe, North Africa, Türkiye, and the Caucasus, is found in Türkiye in the Black Sea and Marmara regions, as well as in the Mediterranean region in Adana and Hatay. *Sorbus torminalis*, which naturally develops in the temperate climate zone, is resistant to harsh winters and frost. The species, belonging to the Rosaceae family, generally prefers moist, deep, permeable, nutrient-rich, calcareous-clay soils. The lobed leaves, approximately 10 cm long, turn red, orange, and light brown in autumn. The flower clusters, consisting of 20-50 white flowers, are 8-12 cm long. The fruits are simple pseudo-fruits, 8–10 mm long, 5–6 mm in diameter, cylindrical in shape,

and light brown when ripe. Due to its tolerance to air pollution, it can be safely used in city centers, medians, and industrial areas for windbreaks, erosion control, and restoration of degraded areas thanks to its deep root system. Because its fruits are consumed by numerous birds and mammals, it can be used in ecological landscapes that support wildlife (Var, et al., 2010). It is preferred for creating visual diversity throughout the four seasons in parks and gardens due to its autumn coloration, flowers, and fruit clusters.

***Tilia rubra* DC. subsp. *caucasica* (V.Engler)**

The natural range of the taxon, synonymous with *Tilia dasystyla* Steven subsp. *caucasica*, is Crimea, the Caucasus, Northern Iran, and Türkiye. The taxon is particularly widespread in northeastern Anatolia, southern Marmara, the Aegean, the Black Sea region, and around Erzurum–Kars in Türkiye. Although it prefers temperate climates, its hardy nature allows it to adapt to high altitudes with harsh winters. It prefers deep, moist, well-drained, nutrient-rich soils. This taxon, belonging to the Malvaceae family, is a deciduous tree with a broad crown that can grow up to 35–40 meters tall. The leaves are oval and pointed, 10–12 cm long. The leaf stalk is 2.5–5 cm long and usually hairless. Flower clusters consisting of 3–7 yellow flowers bloom in July (Oral, 2018). It has a high shading capacity due to its broad crown. Its flowers, which bloom in mid-summer, emit a pleasant fragrance, enhancing the environmental quality of recreational areas. The leaves turning yellow in autumn create a decorative seasonal attraction. It is one of the most preferred taxa in urban-rural green space arrangements that carry aesthetic and ecological value, such as city parks, boulevards, street and avenue tree plantings, highway plantings and median strip arrangements, border plantings, and with its rich flowering, in honey forest facilities.

Conclusions and Evaluation

Türkiye possesses a significant advantage in landscape architecture due to its high plant species diversity and extensive natural flora potential. The Eastern Black Sea Region, in particular, hosts numerous native and endemic tree species thanks to its humid climate conditions, distinct topography, and rich forest ecosystems. Considering the plants examined, it has been determined that the measurement characteristics of these taxa, such as height, crown width, and volumetric mass, are noteworthy in urban landscape applications. It is suggested that the vertical dimensions of these tree taxa can give direction and boundaries to spaces, their crown widths can determine the spatial openness-closure relationship, and their mass effects can directly influence the perceived scale of the spa-

ce. Additionally, it has been determined that the leaf form, texture, and seasonal color changes of these taxa; their flowering time and visual impact; and the color, size, and persistence characteristics of their fruits are important design elements that enhance the perceived quality of urban spaces. In addition to their aesthetic value, the ecological value of these taxa is also noteworthy. Their wide ecological tolerance ranges, developed in response to different climatic, topographic, and edaphic conditions, make these taxa important biological tools in urban landscape design and the rehabilitation of problematic areas. These taxons, which can adapt to stress factors such as drought, excessive rainfall, soil compaction, and air pollution, contribute to the restoration of vegetation cover in degraded areas while supporting fundamental ecosystem functions such as reducing erosion, increasing soil stability, and improving hydrological balance through their root systems. In addition to all these characteristics, these natural plant taxa have the potential to stand out with their capacity to produce ecosystem services, reduce the urban heat island effect, their carbon sequestration potential, and their role in supporting biodiversity. For this reason, in urban landscape design, it is essential to take a holistic approach to the aesthetic, ecological, and functional characteristics of natural tree species, as well as their dimensional qualities, in order to create sustainable, climate-adaptive, and spatially qualified urban environments.

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Chapter 3

POSSIBILITIES OF USE IN LANDSCAPE DESIGN OF SOME FRAGRANT WOODY PLANT TAXA

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1. Introduction

Plant landscapes, which constitute an essential component of urban parks and green spaces, can contribute to human physical health by increasing the concentration of negative air ions and oxygen release, as well as by reducing harmful particulate matter and noise levels. They provide free and easily accessible spaces for physical activity. Physical activity conducted in natural environments has a synergistically beneficial effect compared to that performed in artificial settings (Liu et al., 2017). Numerous studies have demonstrated that different activities undertaken in parks (such as physical exercise, walking, social interaction, outdoor presence, and experiencing nature) have varying effects on health and well-being outcomes (Church et al., 2014; Wolf & Wohlfart, 2014; Liu et al., 2017).

Plants stimulate the sense of sight through their diverse forms and colors; the sense of touch through contact with their leaves; the sense of smell through the fragrances of flowers and fruits; the sense of taste through edible fruits; and the sense of hearing through the sounds produced by moving leaves (Hussein, 2012). From birth onward, humans receive various sensory stimuli from the environment through their sensory organs, which contribute to the development of physical senses (Francis-West et al., 2002).

The five senses vision, hearing, touch, smell, and taste are the most direct means by which humans perceive external information and evaluate experiences. Sensory organs transmit information to the brain to help individuals understand and perceive the external environment. Moreover, the five senses are essential channels for communication with the outside world (He et al., 2022). Odors in nature generally occur as mixtures (e.g., plant scents and spring fragrance blends) (Krishnamurthy et al., 2017).

Plants are known to stimulate the senses of sight, touch, smell, and taste. Additionally, through their diverse shapes and colors, plants activate visual perception; through leaf contact, tactile perception; through the scents of flowers and fruits, olfactory perception; through fruits, gustatory perception; and through the sounds of leaves, auditory perception. Plants that activate all five senses can provide an environment of multisensory stimulation, which may enhance emotional stability and sensitivity in humans (Öner & Pouya, 2024).

Unique experiences perceived by individuals in urban parks such as feelings of "tranquility" and "refuge" have been shown to significantly enhance mental restoration. Furthermore, many studies suggest that, in contrast to artificial environments, natural environments can help restore physical capacities. Numerous studies have also demonstrated that

natural areas, particularly vegetation, play an effective role in human sensory development (Kaplan, 1973; Minter, 1995).

In urban areas, plants an important component of green infrastructure systems provide numerous ecosystem services to cities and urban residents. Through their characteristics such as fragrance, color, and texture, plants appeal to human senses, reduce stress, and improve mental health. Scent is a characteristic capable of eliciting strong sensory responses and can occupy a more prominent and lasting place in human memory than visual images. Medicinal and aromatic plants are used at various scales in landscape design for aesthetic, functional, ecological, and economic purposes (Karaşah, 2025).

In this study, certain woody taxa with fragrance effects derived from their leaves, flowers and other plant parts, which can be used to create effective ecological landscapes through their aesthetic and functional qualities, are examined. Their morphological and ecological characteristics, which directly influence planting design decisions, were analyzed, and their potential uses in landscape applications were investigated. The study aims to encourage the use of these fragrant taxa in landscape planting designs in terms of effective and sustainable applications.

2. Materials and Methods

In this study, several woody fragrant plants commonly preferred in landscape architecture planting designs constitute the research material. In addition to their fragrance effects, their aesthetic and functional characteristics were examined, and their areas of use in landscape architecture were evaluated. The taxa that can be used in fragrance gardens and are evaluated in this study are presented below:

- *Daphne glomerata Lam.*
- *Datura stramonium L.*
- *Gardenia jasminoides* Ellis
- *Jasminum officinale* L.
- *Laurus nobilis* L.
- *Lavandula angustifolia* Mill.
- *Lonicera caprifolium L.*
- *Magnolia grandiflora* L.

- *Osmanthus heterophyllus* (G.Don) PS Green
- *Philadelphus coronarius* L.
- *Pittosporum tobira* (Thunb.) Ait.
- *Rhododendron luteum* Sweet
- *Rhododendron ponticum* L.
- *Trachelospermum jasminoides*
  (syn: *Rhyncospermum* jasminoides)
- *Robinia pseudoacacia* L.
- *Rosa* sp.
- *Rosmarinus officinalis* L.
- *Santolina chamaecyparissus* L.
- *Syringa vulgaris*. L.
- *Tilia tomentosa Moench*
- *Wisteria sinensis* (Sims) Sweet

The form, leaf, flower and fruit characteristics of these fragrant woody plant taxa are explained in detail below:

***Daphne glomerata** Lam.*

Form: An evergreen, dwarf shrub that can grow up to 40 cm tall and either vertically or horizontally.

Leaf: Leaves, approximately 45 x 11 mm at the ends of the branches, are elliptic or obovate, glabrous.

Flower: Pink or slightly reddish-yellowish, waxy white within, blooming between May and July, are arranged in clusters of 2-10 and fragrant.

Fruit: Fruits are red and ovoid (Davis, 1982).

***Gardenia jasminoides* Ellis**

Form: An evergreen shrub that can grow up to 120-180 cm tall.

Leaf: It has thick, glossy, dark green leaves to 10 cm long.

Flower: Extremely fragrant white flowers often double-flowered to 7cm diameter (Pamay, 1993).

***Jasminum officinale* L.**

Form:A deciduous or semi-evergreen shrubs that can grow up to 1-1.5 meters tall.

Leaf: The dark green leaves, arranged oppositely on the shoots, have 7-9 leaflets.

Flower:Their star-like white flowers, which bloom from summer to autumn, are strongly fragrant (Koçer, 2018a)

***Laurus nobilis* L.**

Form: An evergreen shrub or tree that can 2-15 m.

Leaf: Fragrant leaves 3-10 x 2-4 cm, narrowly oblong-lanceolate to broadly ovate, acute or acuminate,

somewhat wavy-margined, coriaceous.

Flower: Pink or slightly reddish-yellowish, waxy white within, blooming between May and July, are arranged in clusters of 2-10 and fragrant.

Fruit: Black and 10-12 mm, globular to ellipsoid (Davis, 1982).

***Lavandula angustifolia* Mill.**

Form: An evergreen aromatic shrub that grows to about 1m though usually lower.

Leaf: Furry gray leaves are lanceolate, elliptical-narrow and 14-40 x 1-5 mm.

Flower: The purplish-red flowers are pedunculate spikes and each spike having 6-10 flowers. They bloom from March to June. (Davis, 1982; Burnie et al. 2004; Öztekin, 2018).

Lonicera caprifolium* *L.

Form: A deciduous, woody climbing plant. Young branches are hollow and glabrous.

Leaf: Leaves are elliptic, 2-10 x 1-5 cm, obtuse, sessile, subglabrous, dark green above, glaucous beneath.

Flower: Inflorescence are terminal, 4-10-flowered, sessile and yeilowis-h-white, sometimes tinged with purple, appear spring.

Fruit: Berries are red or orange-red and clustered (Davis, 1972).

***Magnolia grandiflora* L.**

Form: An evergreen trees that can grow to 20-30 m in height, with a pyramidal and a broad crown.

Leaf: Leathery leaves are12-20 cm obovate-oblong to elliptic, glossy above, rust colored-pubescent beneath.

Flower: Flowers that bloom at the tip of the shoot in early summer are fragrant, white, cup-shaped, 15-20 cm diam.

Fruit: Fruits are ovoid, 7-10 cm, rusty-tomentose. The bright red seeds, similar to bean seeds, fall in October-November (Pamay, 1993; Burnie et al. 2004; Mamıkoğlu, 2007).

***Osmanthus heterophyllus* (G.Don) PS Green**

Form: An evergreen densely branched tall shrub or small tree to 5-6 m.

Leaf: Leaves are 2-6 cm. coriaceous, shiny, ovate-lanceolate, dark gre-en above, paler below.

Flower: Clustered flowers white, fragrant and bloom in autumn.

Fruit: Drupe ellipsoid, 1-1.5 cm and deep blue-purple (Pamay, 1993; Mamıkoğlu, 2007; Eminağaoğlu, Ö. 2018a).

***Philadelphus coronarius* L.**

Form: A deciduous shrub that can grow up to 3 m tall, with dense branches and a rounded crown.

Leaf: Leaves are ovate or elliptic, 4.5-9 x 2-4.5 cm. and bright green.

Flower: Very fragrant White flowers are in racemes of 5-9 flowers and bloom in May and June (Burnie et al. 2004; Eminağaoğlu, Ö. 2018b).

***Pittosporum tobira* (Thunb.) Ait.**

Form: An evergreen, densely branched, grows to a height of 5-6 m and a rounded crown.

Leaf: Leaves are oval to oblong, 5x3 cm, shiny dark green and generally slightly curved downwards.

Flower: Star shaped cream flowers with and orange blossom scent appear in late spring and summer. Forms umbrella-shaped clusters at the tips of shoots.

Fruit: Capsule-shaped fruit 8-10 mm and contains a sticky liquid and many red seeds (Pamay, 1993; Burnie et al. 2004).

***Rhododendron luteum* Sweet**

Form: A deciduous shrub that sheds its leaves in winter, can grow up to 3-4m tall, and generally forms a broad form.

Leaf: The leaves are mostly broad, spear-like, with finely toothed edges and covered with fine hairs on both sides. Autumn coloration is very decorative. In autumn, leaf coloration is observed, which is yellow, orange and eventually red and sometimes burgundy.

Flower: It has bright yellow and pungently scented flowers, which usually start before the leaves in April and are very densely located on the plant. Its flowers are poisonous, and their scent is intoxicating. (Davis, 1978; Clark, 1982; Kayacık, 1982; Pulatkan & Oğuztürk, 2024)

***Rhododendron ponticum* L.**

Form: An evergreen shrub or tree, 3-5 m tall, with a round and irregular form.

Leaf: It has leaves that are hard like leather, full-edged, 8-12cm long, 2.5-4cm wide, shiny dark green on the upper surface, hairless on the upper and lower surfaces.

Flower: The fragrant flowers, which appear in the form of compound clusters, have long stems, hairy tops, colors in purple and shades of purple, and are very decorative.Flower buds begin to burst in the second half of April (Davis, 1978; Clark, 1982; Kayacık, 1982; Pulatkan and Oğuztürk, 2024).

***Trachelospermum jasminoides* (syn: *Rhyncospermum* jasminoides)**

Form: An evergreen twiner, growing 3 or 4 m high.

Leaf: Leaves oval-lanceolate, 4 to 9 cm long, 1 to 2,5 cm wide, downy beneath when young, becoming glabrous, dark glossy green above.

Flower: Flowers very fragrant, pure white, star shaped, scarcely 2,5 cm across blossom in July and August on glabrous, slender-stalked cymes, 4-5 cm long, usually on short lateral twigs (Burnie et al. 2004)

***Robinia pseudoacacia* L.**

Form: A deciduous tree that can grow up to 25 m tall.

Leaf: Leaflets are 25-45 x 12-25 mm, elliptical in shape, and number 3-10 pairs. They turn yellow and fall in autumn.

Flower: The flower clusters are numerous, fragrant white flowers, and droop. Flowers appear from April to June.

Fruit: The fruit is a bean-shaped 5-10 x 1 cm. (Davis, 1970).

***Rosa* sp.**

Form: Roses are almost decidious, woody stemmed shrubs or scrambling clibers.

Leaf: Roses have trifoliate or pinnate leaves with finely toothed leaflets. The foliage may be bright green, very deep lustrous, almost black green or distinctly blue-tinted.

Flower: They often have semi-double to very full double flowers. Flower color among the modern hybrids now covers everything except a true natural blue (Burnie et al. 2004).

***Rosmarinus officinalis* L.**

Form: An evergreen shrub that can grow up to 50 cm tall, with dense branches and growing upright branches.

Leaf: Leaves 10-25 x 1-4 mm, dark green, slightly rough on the upper surface and covered with long, soft hairs, the lower surface is covered with white, mixed, short, dense hairs.

Flower: Flowers that bloom between May and July are 8-12 mm, blue-white (Davis, 1982; Pamay, 1993).

***Santolina chamaecyparissus* L.**

Form: The low-spreading, aromatic shrub, grows to a height of 45cm and spread of 1 m.

Leaf: Grayish green leaves 1.5-3 cm, narrowly linear or oblanceolate in outline

Flower: It bears bright yellow, rounded flower on long stalks in summer (Davis, 1975; Burnie et al. 2004).

***Syringa vulgaris*. L.**

Form: A deciduous, upright shrub or sometimes a small tree that can reach up to 7 m in height.

Leaf: The dark green leaves are arranged oppositely on the shoots, oval or broadly egg-shaped, 5-12 cm long, pointed at the tip, and glabrous.

Flower: The fragrant pink flowers form a terminal cluster 10-20 cm long (Koçer, 2018b)

Tilia tomentosa *Moench*

Form: A deciduous tree that grows up to 35-40 m in height.

Leaf: Leaves broadly ovate, 7-13 x 5.5-10 cm with serrated edges; the upper surface is dark green; the lower surface is densely covered with silvery hairs.

Flower: The flowers, which has cymes with 4-10 flowers bloom in late June-early July, hang downwards.

Fruit: The fruit is 9.3-10.5 mm long, ellipsoid or slightly ovate, brownish-grey, soft, covered with stellate hairs; it has a thick bark (Oral, 2018a).

***Wisteria sinensis* (Sims) Sweet**

Form: A climbing, deciduous, woody plant that can reach a height of 4-10 m.

Leaf: Its single pinnate leaves, which are dark green, are 25-30 cm long; they are long, ovate or lanceolate, and consist of 7-13 leaflets.

Flower: Slightly fragrant, lavander or violet-blue many flowers, 2.5 cm long, are clustered together to form racemose inflorescences 15-30 cm long that hang downwards in early summer, in April-May.

Fruit: The bean-like fruit, 10-15 cm long, bearing 1-3 seeds, leathery and covered with velvety soft hairs (Burnie et al. 2004; Oral, 2018b)

3. Results

In the study, the forms, leaf, flower and fruit states, visual effects, fragrant parts and areas of use in landscape architecture of the some selected

fragrant woody plant taxa.are presented in Table 1. The table also includes photographs of the plants, their families, and their natural/exotic status.

Table 1. Characteristics of some fragrant woody plant taxa and their areas of use in landscape architecture

Plant photo	Scientific name	Family	Exotic/ Natural	Form	Foliation feature	Visual effect	Fragrant parts	Area of use
	*Daphne glomerata* (URL 1)	Thymelaeaceae	Natural		Evergreen			In urban green areas, scent gardens, residential gardens, children's playgrounds and rock gardens it can be used solitary specimen or accent and in groups border plant.
	*Gardenia jasminoides* (URL 2)	Rubiaceae	Egzotic		Evergreen			In scent gardens, residential gardens, urban parks, It can be used shrub border, formal or informal hedge. It can be planted near entrance areas and pathways to enhance the scent.
	*Jasminum officinale* (URL 3)	Oleaceae	Egzotic		Half Evergreen			With its long blooming time, it is a nice addition to an indoor garden, can be used as a container plant on a patio and a climbing in entrance area to add fragrance to your outdoor living areas.
	*Laurus nobilis*	Lauraceae	Natural		Evergreen			It can be used in scent gardens, in urban park, in residential gardens as a hedge plant, border plant and be grown as a screen and background plant. The leaves are highly aromatic and the dried leaves protect stored dry food.
	*Lavandula angustifolia* (URL 4)	Lamiaceae	Natural		Evergreen			In scent gardens, urban park, and residential gardens, it can be can be used as a low hedge, responding well to trimming. It is considered to be the finest quality lavender essential oil, impart a sweet smell to rooms and to deter insects with the aromatic leaves and flowers. A good bee and butterflies plant.
	*Lonicera caprifolium* L.	Caprifoliaceae	Natural		Deciduous			It can be used on pergolas, trellises and fences to add a vertical dimension with the perennial flowers in a pollinator garden, children's garden, winter garden or shade garden. Also can be effective as a groundcover. A good bee plant.
	*Magnolia grandiflora* L.	Magnoliaceae	Egzotic		Evergreen			With its dark green leaves and aesthetically and very strongly fragrant flowers, it can be used solitarily or in groups in urban parks and scent gardens, for shade or accent purposes, can be grouped to form an evergreen screen.
	*Osmanthus heterophyllus* (G.D on) PS (URL 5)	Oleaceae	Egzotic		Evergreen			Where winter hardy, it can be pruning and used an excellent screen, hedge and border shrub or as a specimen plant in scent gardens, urban park, residential gardens and rock gardens. The flowers are deliciously scented.
	*Philadelphus coronarius* L.	Hydrangeaceae	Natural		Deciduous			With scented flowers in scent gardens, can be used a hedge, border or low screens shrub in urban parks, residential gardens and fragrant gardens. An essential from its flowers is used as a cosmetic preparations.
	*Pittosporum tobira* (Thunb.) Ait.	Pittosporaceae	Egzotic		Evergreen			It can be providing dense evergreen color to the landscape, trimmed and trained as a small tree. It used a specimen plant or mass plant it as a screen, barrier, hedge and wind-resistant hedge. It is highly resistant to marine influences.

	*Rhododendron luteum* Sweet	Ericaceae	Natural		Deciduous		It can be used as a medium-sized hedge and border plant in scent gardens, urban and rural park, residential gardens and open shade gardens as group or specimen. Flowers are scented with a honey-like fragrance but contain of the toxic compound andromedotoxin.
	*Rhododendro ponticum* L.	Ericaceae	Natural		Evergreen		In scent gardens, urban and rural parks, residential gardens, it can be used a specimen or group as a border, hedge plant. It is effective with its fragrant purple flowers and dark green leaves.
	*Robinia pseudoacacia* L. (URL 6)	Fabaceae	Egzotic		Deciduous		It is used as a shade plant in scent gardens, urban and rural parks. It is also used to rehabilitate contaminated soils, depleted soils, gravel pits, stabilize highway edges and for erosion control.
	*Rosa* sp.	Rosaceae	Egzotic		Deciduous		It can be used as a solitary specimen or accent plant, and in groups as a border plant along pedestrian walkways in residential gardens, scent gardens, and city parks. With its fragrant flowers in various colors, it is quite effective in landscape.
	*Rosmarinus officinalis* L.	Lamiaceae	Egzotic		Evergreen		It can be grown in herbal gardens, rock gardens, seaside gardens, borders or foundations and use an ornamental specimen or low hedge. Leaves provide flavor to meats, fish and vegetables. Oil from the leaves and flowering stems is used in some cosmetics
	*Santolina chamaecyparissus* L. (URL 7)	Asteraceae	Egzotic		Evergreen		It can be used a ground cover in massing, in herb gardens, rock gardens, foundations, terraces, border fronts and dwarf hedge along walkways. Dried leaves can be used as a fragrance in sachets.
	*Syringa vulgaris*. L.	Oleaceae	Egzotic		Deciduous		It can used as a specimen and accent or in small groups, an informal hedges, borders and screens plant in residential gardens, scent gardens and urban parks. An essential oil is obtained from the flowers and the flowers attract butterflies and moths.
	*Tilia tomentosa* Moench (URL 8)	Malvaceae	Natural		Deciduous		In residential gardens and urban parks, it can be used individually or in groups to provide shade, and as avenue plants along streets. It is quite effective with the fragrance of its flowers and the autumn coloration of its leaves.
	*Trachelospermum Jasminoides* (URL 9)	Apocynaceae	Egzotic		Evergreen		In scent garden, urban parks and residential garden, it can be used on pergolas, trellises and fences as a climbing plant, planted in a patio container or near a walkway. An essential oil is obtained from the flowers. Also grown and clipped as a hedge or ground cover.
	*Wisteria sinensis* (Sims) Sweet	Fabaceae	Egzotic		Deciduous		It can be use a vine for large, sturdy, freestanding arbors, pergolas, fences and walls, and can be particularly effective when grown near or above patios. It can also be trained as a specimen shrub or tree. An extract of flower is used as a skin conditioner in cosmetic preparations.

: Tree : Shrub : Groundcover : Climber : Leaf, flower and fruit

4. Conclusion

The senses constitute fundamental channels through which individuals perceive the external environment, interpret space, and interact with their surroundings, and they play a decisive role in shaping landscape experience. In this context, the sensory landscape approach, which has gained increasing prominence in landscape architecture literature in recent years, focuses not only on the visual qualities of spaces but also on the holistic experience perceived through all senses, including smell, touch, hearing, and taste. Sensory landscapes represent design approaches that prioritize multisensory perception processes and support the establishment of emotional and cognitive connections between users and space.

Among the senses, smell is not merely a form of physical perception but rather a multilayered experience with strong cognitive and emotional dimensions. It is well established that olfactory stimuli leave more powerful and enduring impressions in human memory compared to visual images. Owing to this characteristic, scent is regarded as a significant design component in the creation of sensory landscapes, as it strengthens spatial identity and deepens user experience. Plants serve as the fundamental building blocks of sensory landscapes by enhancing the perceptual quality of space through their fragrance, color, texture, form, and seasonal dynamics.

In planting design, the conscious and appropriate selection and spatial arrangement of fragrant plants play a critical role in the formation of sensory landscapes. Fragrant plants perform various functions within a space, such as providing orientation, creating focal points, ensuring seasonal continuity, and enriching user experience. In this respect, the use of fragrant plants is not limited to enhancing aesthetic value; it also offers functional and ecological contributions by supporting psychological well-being, reducing stress, and strengthening a sense of place and spatial belonging.

In this study, fragrant plants that can be evaluated within planting designs in line with the sensory landscape approach were examined in terms of their exotic or native status, size and form characteristics, leaf, flower, and fruit attributes, flowering periods, and the plant organs responsible for visual and olfactory effects. Based on the findings obtained, the potential applications of these plants in landscape areas of different scales and functions were evaluated. It is anticipated that integrating fragrant plants into planting design will contribute to the creation of user-oriented, sustainable landscape spaces that enhance sensory diversity.

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Chapter 4

WATER MANAGEMENT WITH PROJECT EXAMPLES FROM THE WORLD

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1.Introduction

Found almost everywhere on Earth, water is the source of life and all living things. This life source covers approximately two-thirds of the Earth's surface. Of this area,97.5% consists of saltwater in the oceans, while 2.5% consists of freshwater. The general distribution of water across the Earth's surface is illustrated in percentage terms in Figure 1 (OpenWASH, 2016).

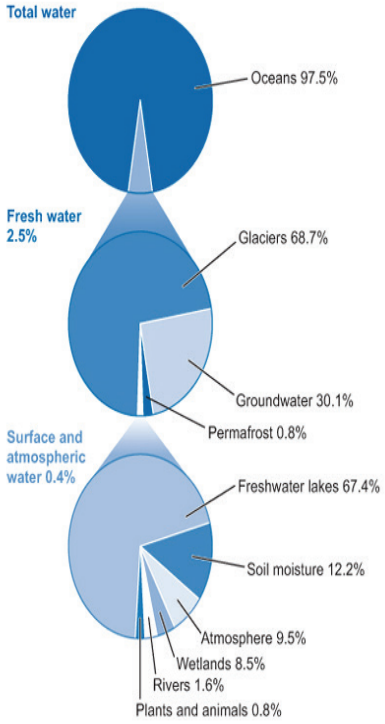

Figure 1. Percentage Distribution of Water Resources in the World (OpenWASH, 2016)

When the world's water resources are classified by country, the annual per capita and usable water amount is 7,600 m3 worldwide. By country and continent, South America has an average of 23,000 m^3, Africa an average of 7,000 m^3, Western Europe an average of 5,000 m^3, and Asia an average of 3,000 m^3 of usable water per capita. Countries with an annual per capita water amount of less than 1,000 m3 are considered water-poor, those with less than 2,000 m3 are considered water-scarce, and those with more than 8,000-10,000 m3 are considered water-rich. Türkiye has a total usable water amount of 112 billion m3. Considering the approximately 1,566 m^3 of usable fresh water per capita per year, Türkiye is neither

a water-rich nor a water-poor country (Republic of Türkiye Ministry of Environment, Urbanization, and Climate Change, 2018).

Today, water resources in urban areas, where the majority of people reside can be impacted by factors such as population growth, per capita water consumption, climate change, and inadequate water conservation allocations (Düzenli et al., 2019). This impact can be individual but also interactive. From a population perspective, as urban populations increase, they become areas with concentrated water demands. Furthermore, the negative consequences of climate change on a global and regional scale are causing changes in the total amount of water worldwide (Jenerette & Larsen, 2006). The decrease in green spaces due to urbanization, combined with the increase in construction and impervious surfaces, and the impact of climate change, disrupts the water cycle and limits water availability. This complicates water management in urban areas (Fletcher et al., 2015). Therefore, ensuring the sustainability of water resources in urban areas can be achieved through water management. Water management involves the development, distribution, and utilization of water resources in accordance with a specific plan (Özkan et al., 2013). Traditional water management approaches adopted in urban areas focus on supply-side water control, which is unsustainable in the long term (Brown & Farrelly, 2009). Today, integrated urban water management is being adopted, an approach that is compatible with urban infrastructure and ensures the natural water cycle (Mitchell, 2006). This approach ensures integration into the urban scale through the recycling of graywater, harvesting of rainwater, adoption of nature-based solutions, and development of green infrastructure practices (Short et al., 2012). Thus, urban areas enhance environmental sustainability, economic resilience, and social resilience by effectively managing water (Alpak et al., 2021). Water contributes to urban ecosystem services, including microclimate regulation, ecological diversity, and the creation of recreational value.

This study examines project examples from various implementation scales, explaining the project objectives, methods adopted for water management, and approaches employed. The study was conducted using randomly selected project examples from around the world. This effort aims to highlight the importance of water and the approaches of planners, managers, and designers in this area through the examples presented.

2. Water Management - Project Examples from Around the World

This section of the study presents three project examples from around the world, implemented at different scales. A randomly selected example addresses water management.

2.1. Madrid Río Project-Spain

The Madrid Rio project (Figure 2) was initiated in 2008 by the Urban Planning Department of the Madrid City Council to rehabilitate the Manzanares River and create a natural habitat around it. The project aimed to restore the river and its surrounding banks as public green spaces for residents. Its objectives are:

- To create new open green spaces for users along the banks of the Manzanares River.
- To encourage public participation in the creation of new public spaces and provide information on how the projects relate.
- To strengthen and improve the relationship between the city center and the districts to the south and west of the city to increase urban integration.
- To improve the river's water conditions and implement measures to control pollutants.
- To decongest the city center, increase mobility, and reduce travel times and accident rates within the city (NYC Global Partners Innovation Exchange, 2012).

Figure 2. Madrid Rio Project (Url-1)

The project includes approaches that include both residents and visitors. In this regard, new green areas, bicycle paths, pedestrian paths, and recreational areas are planned that will improve the quality of life. The project prioritizes improvements, such as planting numerous trees and establishing sustainable drainage systems, which will enhance green infrastructure, biodiversity, and the environment (Polo-Martín, 2025). As part of the project, work was carried out to improve water quality in the Manzanares River. A 13-kilometer (8-mile) new pipeline, 27 rainwater tanks, and improvements to the sewerage facilities surrounding the river were made. The project also created a beach near Matadero, an 11,280-meter (37,000-foot) renovated water network, and five tanks with a daily capacity of 5,200 m^3 of recovered and recycled water (NYC Global Partners Innovation Exchange, 2012). The project;

Strategies for water management include:

1. Creating an ecological corridor by ensuring continuity in greenery and water along the river.

2. Improving water quality by cleaning the river and ensuring its recycled use.

3. Reducing flooding by controlling water flow in the riverbed.

Additionally, the water cycle from the city's booster stations and the drainage systems of its metro lines was maintained within the park system (Url-2). The project physically rehabilitated the rive banks. Efforts were made to increase biodiversity by fostering interaction between land and the river, while also mitigating excessive river flow (Holgado et al., 2023). Environmental issues were also addressed to enhance urban resilience. Sustainable design elements were incorporated through the creation of permeable surfaces, water filtration systems, and green spaces. Green and blue infrastructure elements were integrated into the project to improve the ecological health of the city and the well-being of its users (Polo-Martín, 2025).

2.2. The Murray–Darling Basin

Located in southeastern Australia, the Murray-Darling Basin is a system of interconnected rivers and lakes. Australia's most extensive river system is home to 16 internationally important wetlands, 35 endangered species, and 120 native and migratory bird species. The primary objective of the Murray-Darling Basin project is to sustainably manage water resources and maintain ecological balance (Murray-Darling Basin Authority, 2025a).

The Murray-Darling Basin is Australia's nutrient reservoir and home to numerous rivers, lakes, and wetlands. Some areas of the basin are subject to prolonged droughts, and water is not always sufficient. The basin's water is used for agriculture, drinking, washing, and many other needs. It also requires water for the survival of its diverse flora and fauna. In this regard, partners have been collaborated to ensure that water remains safe and accessible to those who need it. The Murray-Darling Basin Authority strives to fulfill the water management tasks outlined in Figure 3 (Murray-Darling Basin Authority, 2025b).

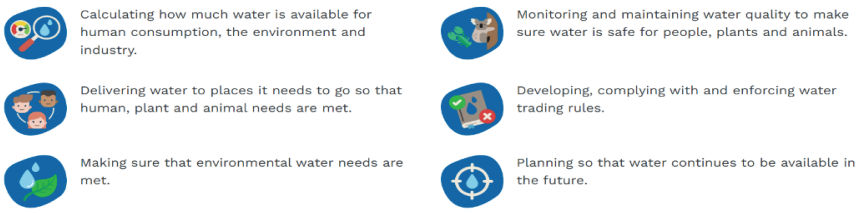

Figure 3. The Duties Adopted by the Murray-Darling Basin Authority within the Scope of Water Management (Murray-Darling Basin Authority, 2025b)

The Murray-Darling Basin Authority collaborates with state basin governments to ensure that water resource plans comply with the requirements of the basin plan and local water resource management needs. State basin governments are responsible for complying with the water resource plans and accounting for water withdrawals from the river system. Each water resource plan also establishes local and basin-level regulations for water use. These regulations address:

- Limitations on the amount of water that can be withdrawn from the system,
- How much water will be released to the environment,
- How water quality standards will be met.

Water resources plans outline how each region aims to achieve economic, social, environmental, and cultural outcomes, ensuring that water management policies align with the objectives of the Basin Plan. The plans reflect existing and effective regulations, as well as new regulations aimed at strengthening local water management (Water Resource Plan, 2025)(Figure 4).

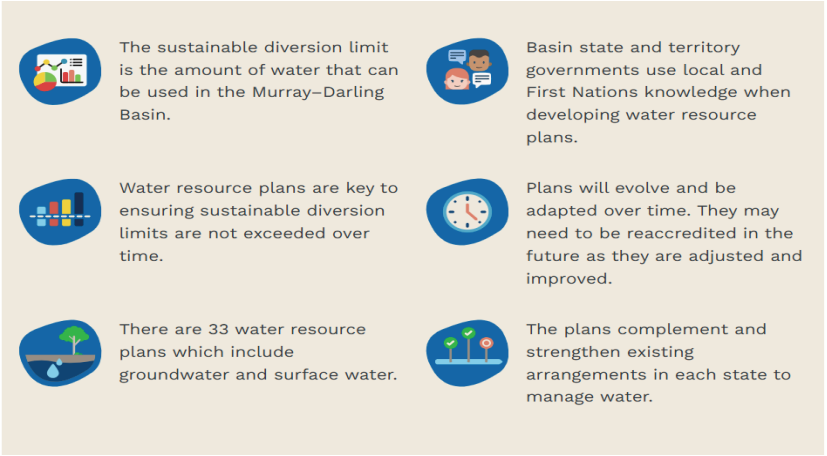

Figure 4. Basic Information in the Water Resources Plan (Water Resource Plan, 2025).

Water resource plans cover a wide range of water management topics. These are briefly explained in Figure 5.

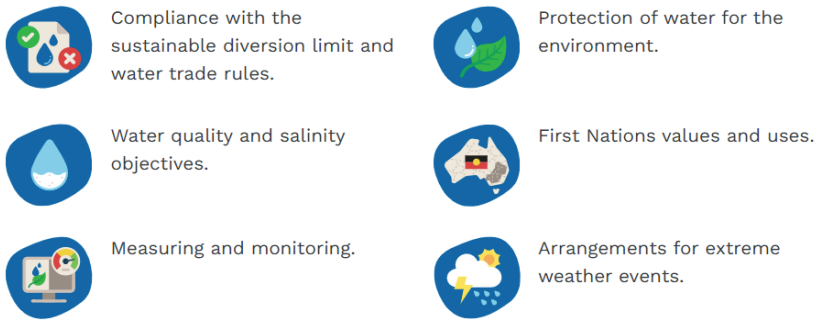

Figure 5. Water Management Topics Covered by the Water Resources Plan (Water Resource Plan,2025)

2.3. Watersquare Benthemplein

Designed between 2011 and 2012, the project was completed in 2013. The Benthemplein Water Square project, which has a two-pronged strategy, combines public space and rainwater storage into a single site. It also strives to increase climate resilience through adaptive measures. The Water Square project combines water storage with improving the quality of urban public spaces. It provides an opportunity to enhance the identity of the public space along with environmental quality. Rainwater is collected in three basins within the project. Rainwater falling onto the square is collected through large stainless-steel gutters (Url-3). This community water

park, fed entirely by rainwater, is designed to make water the primary element, rather than storing it in underground pipes and reservoirs (Url-4).

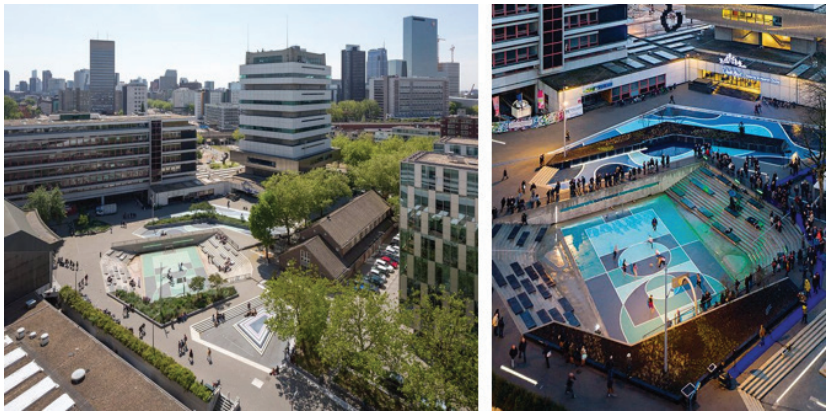

Figure 6. Watersquare Benthemplein (Url-5; Url-6)

This square, which has a water-holding capacity of approximately 2 million liters, hosts various activities, including sports, recreation, and theater (Figure 5). Because the area where the square is located is at high risk of flooding, the solutions implemented within the square have helped prevent floods in the city (Url-7).

Conclusion

The study examined the approaches, objectives, and methods employed in water management projects implemented at various scales. The results indicate that projects are designed with ecological remediation in mind when managing water, replanning a process that closely approximates the natural water cycle without disrupting it, linking water to recreational and social purposes alongside technical infrastructure, and considering its long-term contribution to resource productivity and sustainability, adaptation to climate change, and urban resilience. While water is an element that needs to be controlled in planning and design processes, it should also be considered as a value that generates ecosystem services. In conclusion, water management projects at various scales worldwide, considered a key component of sustainable urbanization and climate adaptation policies, demonstrate that holistic, multifunctional, and nature-based methods are the most effective strategies for managing water in strengthening the green-blue infrastructure approach. These findings clearly demonstrate the need for integrated planning approaches that incorporate ecological, social, and technical components in future water management projects.

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Chapter 5

COASTAL CITIES AND CLIMATE RESILIENT DISASTER MANAGEMENT

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Introduction

More than half of the population in coastal countries lives within 100 km of the coastline. Settlements in coastal regions are concentrated in the first 5 km and at altitudes lower than 20 m (Omori, 2021; Cengiz et al., 2022). In coastal regions, negative impacts resulting from human activities, as well as natural disasters and their effects caused by climate change, pose a threat to life, infrastructure, and ecosystems in coastal cities (WMO, United in Science 2023 Report; Sümer, 2021; Nichols et al., 2019). According to the International Disaster Database (EMDAT), the number of disasters that occurred in Turkey after the 2000s was examined, and it was stated that the most frequent type of disaster was floods (EMDAT, 2025). Inventory and documentation studies are important for disaster management practices to be implemented in coastal cities. It is necessary to plan measures to address the existing risks that will be identified later (Taştan, 2015). Identifying risks specific to coastal cities, determining data on vulnerable cultural assets, conducting risk analyses by evaluating all these components, and producing sustainable solutions in harmony with nature are among the priority issues in terms of developing heritage management and protection policies in coastal cities. The Presidency of the Republic of Turkey's Strategy and Budget Directorate (2023), in its Twelfth Development Plan, has given priority to ensuring the healthy and reliable transmission and protection of our cultural heritage to future generations.

Disasters affect the environment and society in various ways. These effects include loss of life and property, economic, sociological, and psychological problems, and pose significant threats to cultural heritage. Globally, cultural heritage is under considerable risk from natural risks (disasters), human-induced risks, and technical risks. Potential disasters affecting cultural heritage include earthquakes, floods, fires, landslides, tsunamis, etc. Site-specific disaster management is of particular importance in mitigating and eliminating these threats (Oktay et al. 2020).

The destruction and loss of cultural heritage sites as a result of disasters has drawn attention worldwide to the risks to heritage sites. Following these events, institutions and organizations such as UNESCO, ICORP, ICOMOS, UNDRR, and ICCROM have prepared global conventions, organized conferences, and published declarations to reduce potential threats to cultural heritage in historical environments, minimize damage and losses resulting from disasters, and protect cultural heritage (Oktay et al., 2020).

Climate change-related disaster risks in coastal cities

The concept of resilience in disasters is defined as the ability to overcome potential damages with minimal losses and in a timely manner, return to normalcy, and recover, including the protection of living beings, heritage values, and important structures, the repair of damages, and the reconstruction processes in the event of a hazard (UNISDR, 2009).

Alongside these definitions, another important concept is urban resilience, focusing on both increasing disaster risks and the areas where people live. Particularly since the Industrial Revolution, the most significant event affecting urban resilience and increasing disaster risks is global climate change. In this context, climate resilience can be defined as developing the capacity to anticipate global climate change and related disasters, conduct preparatory work, and respond to potential damages (Iavarone and Kaya, 2021).

A city's resilience to disasters depends on the capacity of its constituent elements to withstand, adapt to, and recover from disaster risks (Istanbul Governorship, Istanbul AFAD, Istanbul Project Coordination Unit; 2014; Iavarone and Kaya, 2021). In a high-emission scenario where the global average temperature could reach +5°C, sea level rise could reach 178 cm. Considering the contribution of thermal expansion and large ice sheets, sea level could even exceed 2 m by 2100 (Bamber et al., 2019; Iavarone and Kaya, 2021). Given these increases, it is particularly important to note that every 1-meter increase in sea level likely to occur means the sea will encroach 100 meters inland from the coast (Kurnaz, 2019; Iavarone and Kaya, 2021).

Coastal disaster risk reduction/prevention

To counter the risk of sea level rise due to climate change, existing coastal protection systems in coastal cities need to be adapted to climate change (21. Republic of Türkiye Ministry of Agriculture and Forestry, 2020). Due to climate change, sea levels are rising globally along almost all coasts. Coastal communities need plans to maintain ecology, economy, and social activities and to ensure community continuity (Burger et al., 2017; Cengiz et al., 2022). Many plans are being implemented to help coastal regions adapt to the effects of sea level rise (Pranzini et al., 2018; Contestabile et al., 2020; Cengiz et al., 2022). The resilience of built and unbuilt environmental morphology in urban and rural areas to climate change depends on the adaptation decisions and practices created and implemented in these areas. In this context, coastal infrastructure applications focusing on increasing the resilience and adaptation of coastal settlements are becoming increasingly important. According to the

Republic of Türkiye Ministry of Agriculture and Forestry (2020); in this context, it is important to develop alternative adaptation models for different climatic conditions and to evaluate the risk of rising sea level together with the Coastal Risk Prevention Plan.

Present and projected climate-driven impacts on coastal areas highlight the need for a revised approach to the design, implementation, and governance of coastal infrastructure. In this regard, nature-based and non-structural hybrid interventions offer a more effective framework for addressing multiple objectives, such as ecosystem restoration, long-term climate adaptation, and the provision of social benefits. Enhancing multifunctionality is closely linked to greater resilience, as systems with diverse functions are better equipped to withstand disturbances while continuing to perform their primary roles (Khew et al., 2015; Brand et al., 2007; Cengiz et al., 2022). At this point, landscape design approaches that contribute to coastal resilience through multifunctionality gain importance.

Identifying risks and vulnerable areas

Coastal cities face multiple disaster risks. Increased extreme weather events due to climate change, rising sea levels, and ecosystem loss weaken the resilience of these cities to disasters. Coastal reclamation, pressure from construction, and the destruction of natural buffer zones (sand dunes, wetlands, mangroves, etc.) eliminate natural defense mechanisms.

Sea level rise

One of the disasters directly affected by global climate change is sea level rise. As a direct consequence of global climate change, sea level rise stands out as one of the most significant risks, particularly for coastal cities, in terms of both governance and the creation of resilient urban areas (Iavarone and Kaya, 2021). Climate change is not experienced uniformly in all regions of the world. Even sea level rise is predicted to vary geographically; therefore, creating disaster-resilient plans according to the dynamics of each area is a necessity (Iavarone and Kaya, 2021; Çetin and Cengiz, 2024).

The threat of rising sea levels causes negative consequences in coastal cities, including economic risks related to climate change, as well as depletion of freshwater due to saltwater mixing, destruction of coastal vegetation, damage to agricultural areas, coastal erosion and soil subsidence, increased costs in coastal protection and land use planning, damage to infrastructure systems, salinization of river ecosystems, destruction of marine barriers, and flooding of settlements and coastal uses located below sea level (Talu, 2019; Iavarone and Kaya, 2021). Damage to historical

and cultural heritage sites due to flooding, deterioration in the functions of ports, rehabilitation needs, and increased costs are among the disaster risks that may be faced with rising sea levels.

Temperature increase

Due to rising temperatures and drought during the climate crisis, groundwater use, particularly in agriculture, has increased, leading to the drying up of some lakes and streams. To mitigate the risks posed by climate change through drought, it is necessary to reduce greenhouse gas emissions, increase permeable and semi-permeable surfaces, protect groundwater, reduce water waste and greenhouse gas emissions in industry, reduce water losses through rainwater management, expand green spaces, and develop extreme drought prediction systems. Simultaneously, it is possible to reduce vulnerability by developing early warning systems, protecting and expanding forests, incorporating drought-resistant species (xeriscape) into urban landscape applications, promoting sustainable transportation systems (public transport, cycling, pedestrian-prioritized transportation systems, etc.), preventing the misuse of agricultural land, facilitating the transition to automated irrigation systems in agriculture, and conducting awareness and education programs to mitigate/adapt to disaster risks caused by temperature increase.

Determining risk reduction and adaptation strategies

One of the most important aspects of managing the risks created by global climate change is risk reduction and adaptation efforts (Iavarone and Kaya, 2021). Adaptation efforts focus not on eliminating risks, but on reducing the severity of the devastating effects of potential threats.

While the probability of climatic events occurring cannot be controlled, the extent of the damage they cause can be reduced. In other words, it aims to reduce the damage that the inevitable effects of climate change will cause to the fragile infrastructure of the city. Adaptation approaches include elements such as improving existing infrastructure investments, planning new land uses in a way that is suitable for the changing climate, and making institutions and the city's population more aware and prepared (URL-1, 2025). Unique solutions proposed within the scope of adaptation efforts at the local level have a higher probability of being effective. The primary aim of global climate change adaptation policies is; Being resilient to impacts such as rising sea levels, floods, droughts, extreme weather events, heat waves, storms, and heat islands (European Environment Agency, 2016; Peker and Aydın, 2019; Iavarone and Kaya, 2021) means preparing cities for adverse impacts through engineering solutions such

as early warning systems, as well as landscape-focused applications. Developing proactive planning approaches based on planning recreational areas for day trips outside of residential areas in riverbeds and sea-level areas should be among the priority approaches in creating healthy and resilient cities.

Landscape-based approaches to disaster management in coastal cities

Coastal cities have historically been centers of attraction in terms of economic, cultural, and ecological aspects; However, today, due to climate change, rapid urbanization, and ecosystem destruction, coastal cities have become more vulnerable to disaster risks (Disasters such as rising sea levels, coastal erosion, storm surges, floods, and tsunamis seriously threaten life and infrastructure in coastal cities (European Environment Agency, 2016; Kabisch et al., 2017). In this context, it is observed that nature-based and landscape-oriented approaches are gaining increasing importance in disaster management, alongside traditional engineering solutions. Holistic and multidisciplinary approaches are needed for disaster risk management in coastal cities.

Landscape-based solutions stand out as an important component of this holistic approach, and are used as an active tool in risk reduction/damage limitation (natural buffer zones, green infrastructure systems, etc.), intervention (use of open and green spaces as emergency gathering and temporary shelter areas), and recovery processes (ecosystem restoration and social recovery processes). Landscape-oriented approaches aim to reduce the impact of disasters by supporting natural processes and, in this respect, are "nature-based". These are evaluated within the scope of "Nature-Based Solutions" (European Environment Agency, 2016; Cohen-Shacham et al., 2016; Guguk, 2024).

In projects proposed and implemented by developed countries for coastal cities, solutions such as systems where sea level is controlled and transported to the city via canals, replanning of the coastal area according to the projected water level, adaptation of infrastructure systems (Urban Lab Institute, 2014), coastal applications on elevated platforms, and boardwalk designs (Cengiz et al., 2022) stand out. Within this framework, walkways represent a form of infrastructure whose physical characteristics generate economic and/or social value and are therefore widely implemented as part of resilience-building strategies. Well-designed walkway systems can play an active role in mitigating the impacts of climate change, while simultaneously enhancing coastal accessibility for tourism and recreational activities (Khew et al., 2015; Cengiz et al.,

2022). Moreover, walkways contribute to the protection of shorelines by reducing the effects of marine erosion (Charbonneau et al., 2019; Prisco et al., 2021; Cengiz et al., 2022). In this context, landscape-focused solutions for disaster management in coastal cities can be addressed under the following headings (Table 1);

Table 1. *Nature-based solutions for disaster management in coastal cities*

Nature-based solutions for disaster management in coastal cities	Description
Conservation and restoration of natural coastal ecosystems	Sand dunes, mangrove forests, salt marshes, and wetlands are natural defense systems that reduce wave energy, slow flooding, and prevent coastal erosion. Protecting these ecosystems and restoring degraded areas significantly reduces the risk of disasters in coastal cities.
Green Infrastructure and Blue-Green Systems	Rain gardens, bioswales, permeable and semi-permeable surfaces, and green corridors reduce flood risk by controlling surface runoff caused by excessive rainfall. In coastal cities, blue-green infrastructure systems enhance ecological resilience by providing continuity between marine and terrestrial ecosystems.
Planning of multifunctional coastal parks	Coastal parks and recreation areas, with their permeable surface properties, fulfill social and ecological functions in normal times, while in times of disaster they can be used as emergency assembly points or temporary shelter areas. This multifunctional approach increases spatial efficiency and supports the post-disaster recovery process.
Landscape design practices for coastal resilience	Landscape design, through topography, planting, open space organization, and boardwalk designs, not only enables the creation of disaster-resilient spaces but also offers functionality as climate-adaptive arrangements.

Conclusion

Landscape-focused solutions offer an effective and sustainable approach to disaster risk reduction by integrating ecological, social, and spatial dimensions. Protecting natural ecosystems, developing green infrastructure systems, and planning multifunctional open spaces are important tools in increasing the resilience of coastal cities to disasters. In this context, considering landscape as a strategic planning tool in disaster management emerges as a fundamental requirement in creating sustainable and resilient coastal cities.

Coastal cities are more exposed to climate change-related disasters (sea level rise, storms, floods, coastal erosion, etc.). These disasters and their effects pose significant risks to the sustainability of cultural heritage sites located in coastal cities. Within current disaster management practices, landscape-focused approaches provide highly feasible opportunities that

protect the unique values of heritage sites through on-site assessment, site-specific nature-based preventative measures, and short-term intervention proposals. This study highlights the importance of developing a multifaceted perspective on climate-adaptive approaches to disaster management, considering the threats that climate change-related disasters will pose to heritage sites in the long term through various dynamics. The risk of rising sea levels is pushing major coastal cities around the world to take steps towards becoming "resilient cities," and the approaches, proposals, and preventative and adaptation efforts developed for these cities are among the priority issues.

Combining landscape architecture practices with disaster risk reduction/prevention principles to develop a nature-based, holistic, and implementable disaster management model for coastal cities is of great importance for local governments and practitioners. Furthermore, identifying potential site-specific disaster risks and vulnerable areas within coastal cities is crucial for the sustainability of these areas, and for developing landscape-focused risk reduction, adaptation strategies, and integrated conservation approaches.

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Chapter 6

CONCEPTUAL PROCESS IN LANDSCAPE DESIGN: THE EXAMPLE OF RESIDENTIAL ENVIRONMENTAL DESIGN PROJECT

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1. Introduction

Landscape design is not merely a technical field of application aimed at shaping the physical environment; it is an interdisciplinary design practice that aims at the spatial reproduction of natural, cultural, and social components. In this context, landscape design represents a multi-layered production process encompassing not only the visible physical qualities of space but also its perceived, experienced, and interpreted dimensions (Mumcu and Kuyumcuoğlu,2023). This multi-dimensional nature of the design process necessitates that conceptual thinking plays a central role in landscape architecture practice. Theoretical approaches to the production of space reveal that design is not merely an objective organizing activity; rather, it is a field of production shaped by intellectual, social, and cultural processes. Henri Lefebvre, by considering space in its perceived, conceived, and lived dimensions, emphasizes that spatial production is shaped through the relationships between abstract thought and everyday experience (Lefebvre, 1991).

This approach demonstrates that in landscape design, the concept is not merely a starting idea, but a fundamental building block that guides the entire production process of the space. In the discipline of landscape architecture, the conceptual process refers to the reinterpretation of environmental data, user needs, and spatial potentials by the designer within a specific intellectual framework. Ian McHarg's approach to environmental planning revealed that design decisions should be developed within an analytical and conceptual whole, rather than through random aesthetic preferences (McHarg, 1969). In this context, the concept is considered a guiding tool that enables environmental analyses and spatial decisions to meet on a common logical ground in the design process. The importance of the conceptual process in landscape design is particularly evident in the transition from the abstract thought stage to concrete spatial arrangements. In this process, the designer defines and prioritizes spatial relationships through the concept and establishes the fundamental principles of spatial organization. James Corner emphasizes that conceptual thinking not only produces narratives in the design process but also serves as a critical tool that tests and guides spatial decisions (Corner, 1999; 2006). This approach demonstrates that the concept is not a static definition in the design process, but rather a dynamic structure that is constantly reproduced. The single-dwelling scale considered in this study offers a significant design area where the spatial counterparts of the conceptual process can be clearly observed. Compared to large-scale urban projects, in single-dwelling projects, the designer can more directly reflect the concept in the spatial organization; they can address the use of open spaces, circulation arrangement, degrees

of privacy, and the building-landscape relationship in a more controlled manner. This situation makes the decisive role of the conceptual approach in the design process visible and allows for a clearer evaluation of the concept-space consistency. For the concept to find a spatial counterpart in landscape design, it needs to be readable not only at the plan level but also through user experience.

The perceptibility and readability of the space show the extent to which conceptual decisions are consistently transferred to the spatial organization. At this point, Kevin Lynch's concept of spatial readability offers an important theoretical framework for evaluating the concept-space relationship (Lynch, 1960). In landscape design, supporting the concept with spatial continuities and thresholds stands out as one of the fundamental elements that enhance user experience.

This study aims to examine the production method of the conceptual process in landscape design, extending from abstract to concrete, through the scale of a single dwelling. Within the scope of the study, the role of the conceptual approach in the design process is addressed in terms of schematic representation, spatial organization, and concept-space consistency. In this respect, the study aims to contribute to the theoretical and methodological importance of the concept-based design approach in the discipline of landscape architecture.

2. Conceptual Approach and the Production of Space

Space has long been considered a physical output in design disciplines; it has been defined through form, function, and aesthetic relationships. However, contemporary theories of space reveal that space is not merely a constructed object, but a product of intellectual, social, and environmental processes. In this context, the production of space is a process directly related to the designer's conceptual approach. In landscape design, the concept provides a fundamental framework for how space is to be read, which relationships are to be prioritized, and how environmental data is transformed into spatial decisions. Henri Lefebvre, one of the fundamental references in theoretical discussions on the production of space, argues that space emerges as a result of a social production process. According to Lefebvre, space exhibits a three-dimensional structure consisting of perceived space (spatial practice), designed space (representations of space), and lived space (representational spaces) (Lefebvre, 1991). This approach shows that the conceptual process in landscape design is not limited only to plans and projects; This reveals that user experience and daily practices should be considered together. The conceptual approach is one of the fundamental tools that determine

the direction and quality of the relationship established between these three dimensions. In landscape design, the concept functions not only as a conceptual tool specific to the initial stage in the production of space, but also as a frame of reference that shows continuity throughout the design process. The natural characteristics of the area, user needs, and contextual data are abstracted and transformed into spatial organization through the conceptual approach. This shows that the concept is more than just an aesthetic theme; it is a productive tool that guides spatial decisions (Corner, 1999).

The conceptual approach transforms the production of space in landscape design into a relational and multi-layered process. Open space organization, circulation systems, degrees of privacy, and threshold spaces are reinterpreted in line with the conceptual framework (Mumcu and Düzenli, 2018). Especially at the residential scale, the fact that these relationships are more legible and traceable clearly reveals the impact of the conceptual process on spatial production. Edward W. Soja's approach, which considers the social and perceptual dimensions of space together, supports the idea that conceptual thinking in design is an element that shapes spatial experience (Soja, 1996). Another important dimension of the conceptual approach in the production of space is the interpretive relationship the designer establishes with the area. In this process, the area is not merely a physical ground that is manipulated; it is treated as a dynamic context that needs to be read, analyzed, and reinterpreted. The concept forms the basis of spatial organization by concretizing the interpretation developed by the designer towards this context. In this respect, the conceptual approach stands out as a critical and creative tool that determines the production of space in landscape design (Corner, 2006).

In conclusion, the production of space in landscape design is a multi-dimensional process that cannot be addressed without a conceptual approach. The concept guides the design process by making visible the connections established between environmental analyses, spatial relationships, and user experience. The fact that this process can be observed more clearly at the scale of a single dwelling reveals the decisive role of the conceptual approach in spatial production and strengthens the methodological importance of conceptual thinking in landscape design.

3. Conceptual Process: From Abstract to Concrete

In landscape design, the conceptual process refers to a multi-layered and dynamic production process where the designer's abstract intellectual framework is transformed into spatial decisions. This process ensures

that the concept moves beyond being merely an idea defined at the initial stage of design and becomes a continuous structure that guides all stages of the design (Treib ,2011).This transformation, defined as "from abstract to concrete," allows design decisions to be produced within a conceptual whole, rather than through accidental or intuitive interventions. The first stage of the conceptual process is based on abstracting and reinterpreting the physical and environmental data of the area, rather than directly transforming this data into formal decisions. Components such as topography, climatic conditions, vegetation, existing usage patterns, and user profile are given meaning through a conceptual filter. At this stage, the designer focuses on the question of "what is important?" rather than "what exists?". Thus, environmental data ceases to be a quantitative inventory and transforms into a qualitative framework that guides spatial decision-making. As Ian McHarg emphasizes in his approach to environmental planning, the analysis of environmental layers in the design process can only find spatial representation through such a process of abstraction and prioritization. Schematic representations play a central role in transforming the abstract conceptual framework into concrete spatial decisions. Schemas prevent the direct transformation of the concept into form, allowing for the discussion of relationships in the design process. These representations, stripped of scale, material, and detail, make visible fundamental design components such as orientation, movement, spatial hierarchy, thresholds, and voids. In this respect, the schema functions as an interface between abstract conceptual thought and concrete spatial organization, increasing the experimental nature of the design process. In the later stages of the conceptual process, the relationships established at the schematic level begin to transform into spatial organization decisions. The positioning of open spaces, the design of circulation systems, the building-landscape relationship, and the definition of spatial boundaries are shaped by this transformation process guided by the conceptual framework. Especially at the scale of a single dwelling, this transition process becomes more explicit and observable. The impact of the concept on the organization of open spaces becomes legible in plans, sections, and perspectives; The continuity established between different stages of the design process becomes visible. The transition from abstract to concrete is not limited solely to the shaping of physical space; it also includes the structuring of the user experience. The way the user enters the space, the route they follow, the thresholds they encounter, and the open spaces they experience are concrete manifestations of conceptual decisions. Henri Lefebvre's approach to the perceived, designed, and experienced dimensions of space reveals that this process is not limited only to the designed space; the experienced space is also an integral part of conceptual production. In this context, the concept can be considered

a fundamental tool guiding the spatial structuring of the user experience. The concretization of the conceptual process aims to provide consistency and readability in design, rather than producing definitive and immutable solutions. The concept allows for the evaluation of spatial decisions within a holistic framework by adapting to varying scales and levels of detail at different stages of the design process. This ensures that the design process progresses in both a flexible and controlled manner. As James Corner points out, conceptual representations open up areas of possibility in the design process, allowing the space to be tested through different scenarios. In conclusion, the conceptual process in landscape design is a productive transitional space where abstract thought is transformed into spatial decisions. The fact that this transformation can be more clearly observed at the scale of a single dwelling highlights the decisive role of the conceptual approach in the design process. This process, extending from the abstract to the concrete, is fundamentally important for ensuring conceptual integrity, enhancing spatial readability, and strengthening user experience in landscape design (Düzenli and Alpak, 2023).

4. Environmental Design Project Process

In the KTU Landscape Architecture Environmental Design Project 2 course, students are given a single residential area and its immediate surroundings as their project area. First, scaled maps containing the existing physical elements in the project area were obtained and used in all subsequent stages of the design (Yılmaz et al. 2020). Then, missing data was transferred to the basic map through on-site observations and examinations. Information and documents related to the field were collected through research. The next step is space analysis. Key strategies and clues have been identified on how the design solution can be tailored to the specific conditions of the project area. Analysis in landscape design depends on a thorough examination of the circulation, landscape, characteristics, problems, and potentials of the project area. The expressions in the field analysis are aimed to emphasize decision and action (Düzenli et al.2023).

In the next stage, the profile of the residents of the house is determined by the students. Their professions, hobbies, the ages, education, and hobbies of the children who will live in the house are also determined by the students, and they prepare scenarios about how they spend their day in the open space of the house. Here, the aim is to instill in students the relationship between needs, activities, and space. Students identify the needs of the family living in the house, list related activities, and design spaces suitable for these activities. While creating scenarios for

the residents, students determine a concept and visually represent it. This visual tool leads them to the design of the space.

5. Consistency Between Concept and Space

This clearly demonstrates the importance of concept-space consistency. Henri Lefebvre emphasizes that space should be considered in its perceived, designed, and experienced dimensions, stating that the conceptual framework produced in the design process should find a counterpart in all three planes (Lefebvre, 1991). This approach points to the necessity of the concept showing continuity not only in plans and diagrams but also in user experience in landscape design.

Consistency between concept and space is primarily achieved by shaping design decisions around a common intellectual axis. Basic design components such as open space organization, circulation system, spatial hierarchy, degrees of privacy, and threshold spaces are expected to support the chosen conceptual approach (Spirn, 1998). For example, a concept based on movement and flow produces continuities that strengthen orientation in space; while a privacy-focused concept should be concretized through spatial separation and filtering strategies. At this point, consistency means the reproduction of the concept at every scale. In landscape design, schematic representation serves as an important intermediary mechanism in ensuring concept-space consistency (Eisenman, 2004). Schemas allow for testing the spatial equivalents of a concept and monitoring the continuity of these equivalents at different stages of the design process. As James Corner points out, conceptual representations offer not only a means of expression but also a basis for critical evaluation in the design process (Corner, 1999; 2006). In this context, the harmony between the schema and the final spatial arrangement can be considered a concrete indicator of concept-space consistency. The consistent readability of the concept in space is also crucial for user experience. The route the user follows from the moment of entry into the space, the thresholds they encounter, the open spaces they experience, and their spatial orientation reveal how conceptual decisions are translated into the lived space. Kevin Lynch's concept of spatial readability offers an important theoretical framework in this context. According to Lynch, the user's comprehensibility of space is directly related to the consistency of the spatial arrangement (Lynch, 1960). In landscape design, the perceptibility of the concept in space is one of the fundamental elements that strengthens this readability.

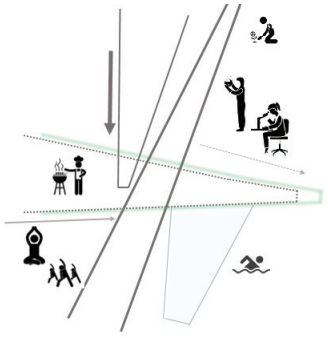
The consistency between concept and space can be observed more clearly at the scale of a single dwelling. At this scale, the designer can address the ways in which open spaces are used, the relationships between

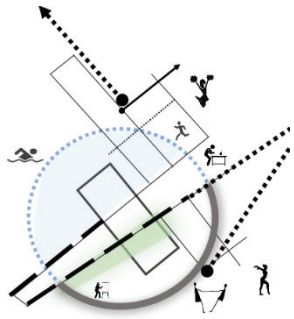
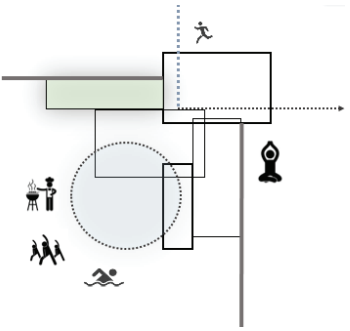
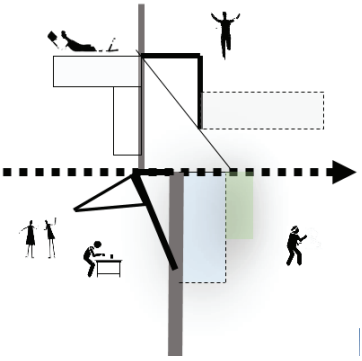
the building and the landscape, and user movement within a more controlled framework. The impact of the concept on the organization of open spaces finds its direct spatial counterpart through garden layout, semi-open spaces, boundaries, and transitions. This situation makes the decisive role of the conceptual approach in the design process visible (Table 1).

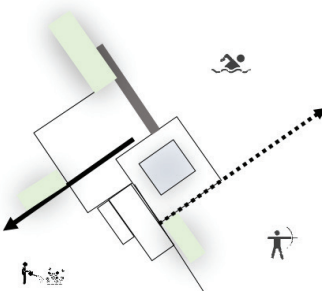
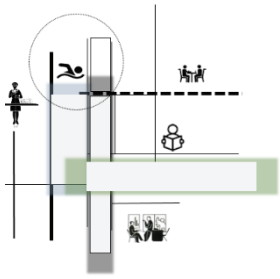
Concept-space consistency does not mean certainty and uniformity in design. On the contrary, consistency is related to the concept's ability to adapt to different spatial situations and to be reproduced at different scales. In this context, the concept should be considered not as a rigid framework that limits the design process, but as a flexible point of reference that guides spatial decisions. Christian Norberg-Schulz's emphasis on the meaning and experiential dimension of space shows that the concept can maintain its consistency within spatial diversity (Norberg-Schulz, 1980).

In conclusion, consistency between concept and space in landscape design is a fundamental criterion that determines both the conceptual and spatial integrity of the design. The continuity of the concept throughout the entire design process, from schematic representations to spatial organization, user experience, and environmental relationships, enhances the readability and meaningfulness of the design. The fact that this consistency can be observed more clearly at the scale of a single dwelling strengthens the methodological and theoretical importance of the conceptual approach in landscape design.

Table 1: *Scenario And Conceptual Approaches Studied İn Projects Obtained Within The Scope Of The Course*

SCENARIO	CONCEPTUAL APPROACH
SYMPHONY OF LITTLE ARCHITECTS Our residence is home to the renowned entomologist Ali Demirsoy and his family. Ali Demirsoy conducts research on endangered insect species in the Eastern Black Sea region. His wife, Funda Hanım, is a retired biologist and also practices yoga and terrariums. Their daughter, Aliye Doğa, is interested in dance and teaches dance to a group of students. Our youngest child, Ali Evren, is a first-year high school student and is developing his wall-climbing skills.	

INCLUSIVE STAGE Our residence is also home to the theater and film actor Mehmet Bey and his wife İmra Hanım. Mehmet Bey is a well-known Turkish operetta, theater, and film actor, and a comedian and vaudeville performer who practiced ballet in her childhood. They have a son and a daughter. Their son is interested in music, and their daughter is interested in photography.	
NATURE HOUSE Recai Bey is a 49-year-old veterinarian, and Elif Hanım is a 42-year-old agricultural engineer. Besides working at his private clinic, Mr. Recai has a dedicated area in his garden where he can train pets, and he spends his free time training both his clients' and his own animals there. Ms. Elif's main job is as a soilless farming trainer. She has a greenhouse in her garden where she can train her guests and clients, and she grows strawberries for herself. She also uses rainwater to meet the water needs of the greenhouse, garden, and pool.	
YOGA, ART, AND NATURE The family members are Aylin and Emre. Their closest friend, Deniz, comes to visit them one morning. Aylin starts practicing yoga early in the morning on the terrace overlooking the sea in their garden. Emre, meanwhile, is working on a new painting with natural dyes he made from leaves, flowers, and soil he collected from the garden's natural beauty. Deniz is greeted by this peaceful scene as he enters through the garden gate. He greets Aylin and Emre. Aylin invites Deniz to do yoga, while Emre shows Deniz his latest work made with natural dyes. After Aylin finishes her yoga session, she, Deniz, and Emre go down to the pool in the garden.	

THE AROMA OF ART	
Our residence is also home to the famous chef Somer Sivri's son, his wife, and their only child. Somer Sivri's son is a Turkish chef, restaurant owner, and presenter. Our chef reflects his career in his home life; having achieved great things in the field of gastronomy, he shares the new flavors he creates at home with his fans on various platforms by filming them, and he also gives private lessons in gastronomy. Our chef has a greenhouse in his garden where he grows and cultivates some special vegetables and spices himself. He frequently organizes tasting events with his friends and acquaintances on the specially designed viewing terrace in his garden, where he shares his newly discovered flavors.	
BOOKSHOP HOUSE	
Ms. Bilge is a primary school teacher. Her husband, Mr. Ozan, is also a literature teacher. Besides this, Mr. Ozan has a small soda production workshop in his garden, which is his hobby. There, he produces and tries to make different soda flavors. He is a person who loves children very much. He has dedicated the rest of his life to children. His entire effort is essentially focused on instilling a love of reading in them and making them develop a habit of reading.	

6. Conclusion

This study aimed to demonstrate that the conceptual process in landscape design is not merely a discourse at the initial stage of design; it is a fundamental building block that guides all phases of spatial production. The evaluation, conducted on a single-dwelling scale, provided an important reading area in terms of making visible how the conceptual approach transforms from an abstract level of thought into concrete spatial decisions.

The findings discussed in the study show that when the concept is addressed consistently in the design process, spatial organization gains a more readable, holistic, and meaningful structure. Relating the conceptual framework to open space organization, circulation layout, spatial hierarchy, and user experience ensures that design decisions are produced within a continuous intellectual process rather than being

accidental. In this context, the concept is considered not as an aesthetic narrative of design, but as a methodological tool that guides spatial decision-making.

The transition process from abstract to concrete is considered in the study not only as a formal transformation but also as a multi-layered production area in which the designer reinterprets environmental, social, and perceptual data. The transfer of spatial relationships developed through conceptual diagrams to plan and open space arrangements allows for monitoring the continuity of the concept in the design process. This reveals that the conceptual approach functions as a critical control mechanism in the design process.

Another important result of the study is that the consistency between the concept and the space has a decisive effect on user experience. The readability of the concept in spatial organization directly affects how the user perceives, orients themselves towards, and experiences the space. This aligns with theoretical approaches that emphasize that space is not merely a designed product, but a lived and experienced process (Lefebvre, 1991). Therefore, the fact that the spatial counterparts of the conceptual approach are perceptible at the user scale can be considered one of the fundamental criteria for the success of the design.

This discussion, conducted at the scale of a single dwelling, shows that the conceptual process can also offer a methodological framework for larger-scale landscape and urban design projects. The ability of the concept to be reproduced at different scales and to maintain its consistency within spatial diversity reveals that a flexible but guiding design approach is possible in landscape design. In this respect, the study argues that the conceptual design process can be considered not only a pedagogical tool but also a fundamental method in professional design practice. Consequently, the conceptual process in landscape design is a dynamic relationship between abstract thought and concrete spatial production. Ensuring consistency between concept and space enhances both the intellectual depth and spatial quality of the design. This study, by revealing the decisive role of the conceptual approach in the design process through the scale of a single dwelling, offers a theoretical and methodological contribution to the importance of concept-based production in landscape design.

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Chapter 7

PUBLIC ART IN THE SHADOW OF COVID-19

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1. Introduction

Throughout history, pandemics have emerged not only as medical phenomena but also as moments of rupture that profoundly impact social structures, spatial practices, and forms of cultural production. In this context, the COVID-19 pandemic has triggered a multi-layered transformation process extending from individual life to the public sphere, and from daily routines to collective representations. In particular, the physical and social restrictions imposed on the use of public spaces have reopened the debate on the meaning, function, and perception of public space.

Public spaces are social areas within social life where thoughts, forms of expression, and experiences are formed, shared, and discussed (Düzenli and Alpak, 2021; Kurak and Yılmaz, 2024; Yılmaz and Kurak, 2022). As a result of the cultural, artistic, and social experiences that arise, public art emerges. (Kühnapfel et al., 2025). This street art can be defined as an artistic form of production that establishes a direct relationship with society and carries the potential for social communication in areas shaped by the urban context, such as streets, parks, squares, building facades, open landscape areas, and shared spaces (Mcewan et al., 2022).

During the pandemic, public space has been restricted by health and safety regulations on the one hand, while on the other hand, it has become an arena for expression where social sensitivities, concerns, and forms of solidarity are visible. In this transformation process, public art has gone beyond being merely an aesthetic element in urban spaces (Figure 1); it has become an important tool that records social memory, makes collective experience visible, and reestablishes public dialogue. Murals, temporary installations, graphic interventions, and digital art applications have enabled individuals to maintain their presence in public spaces and express their emotional responses during the pandemic.

Figure 1. A woman walks past a mural in Manchester, England (URL 1), Indonesian local artists; a mural in Depok city informing the public about the fight against the COVID-19 pandemic (URL 2)

The pandemic has left individuals facing significant psychological stress, anxiety, and traumatic experiences at both the individual and societal levels. The fear of contracting a deadly disease and social isolation have seriously challenged individuals' psychological resilience; however, this process has also provided an opportunity for many people to reflect on the problems they have experienced and transform these experiences into a common ground for developing creativity, awareness, and resilience (Gerber et al., 2024). Public art practices produced in the shadow of COVID-19 reflect the social atmosphere shaped by emotions such as fear, uncertainty, and isolation; at the same time, they have brought discourses of hope, solidarity, and collective healing into the public space. In this sense, public art can be seen not only as a means of representation during the pandemic but also as a spatial expression of social resilience and healing processes. As Yılmaz et al. (2021) also state, artists have created their works in nature with a more libertarian understanding of art, transcending all boundaries of art and imbuing it with new meanings. This transformative role of art in the public sphere raises new questions about how public space should be designed, used, and interpreted in post-pandemic cities.

Figure 2. A doctor collects a sample from a man for a coronavirus test outside Clinic Ajwa in Malaysia; A woman wearing a protective mask; A woman walks past a coronavirus-themed mural in Indonesia (URL 1)

This study examines the relationship between public art and public space during the COVID-19 pandemic; it evaluates the effects of artistic interventions on social awareness, public dialogue, and spatial experience. In this context, it aims to reveal the transformative effect of pandemic conditions on public art practices and to provide a theoretical basis for designing more resilient, inclusive, and meaningful public spaces in the future.

2. Public Art

Publicness is related not only to the physical accessibility of the artwork, but also to the transparency, participation, and social representation of

the production process (Şanlı, G. and Kurtaslan, B., 2022). Public art is an artistic expression that is part of social life and appeals to a wide audience. Unlike any previous artistic formation, it is an artistic production field that changes the perspective on space, the artist-audience relationship, and, consequently, the formation process of the artwork.

This form of art, performed in public spaces, goes beyond the traditional boundaries of galleries and museums, enabling art to interact more directly with the public (Sharp et al., 2020). Simply put, it refers to art created in spaces such as streets, parks, squares, building facades, and common areas of public buildings, meaning art that goes out into the streets and engages with the audience.

Public art serves as a means of self-expression for artists. In particular, genres such as street art and graffiti enable the direct sharing of individual views or social messages with the public. Public art, which appears in various forms such as graffiti, street art, sculptures, installations, murals, and interactive projects, takes art beyond being merely an aesthetic experience; it also becomes an important means of communication in a social and cultural context (Macaya and Valero, 2019).

In addition, public art also serves a broader social function. It enriches public spaces, reshapes the visual environment, and involves citizens in the visual perception of their surroundings. This process can increase social participation, enable individuals to take ownership of the places they live in, and create social awareness. In this sense, public art creates a powerful interaction at both the individual and social levels (Wang, 2024). As Ercan (2013) emphasizes, for public art to be "public," it must be directly related to its ability to reach a wide audience. This is not only about physical access but also about the production process of the artwork being transparent and socially conducted.

The participatory nature of the artistic production process is important in terms of reflecting social diversity and bringing together different voices. This approach allows art to go beyond being merely a form of individual expression and become part of society (Şanlı, G. and Kurtaslan, B., 2022). Designing public art with an understanding of social inclusion and pluralism also ensures that art is embraced and understood by a wider audience.

Figure 3. Graffiti on a road in India, a Covid-19 artwork raising awareness (URL 3)

When evaluated in terms of space usage, the artist–audience relationship, and the production process of the artwork, participatory art practices in public spaces enable art to take place within everyday life, in areas accessible to everyone, rather than in closed spaces such as museums and galleries. This approach allows the viewer to move from a passive position to becoming an active part of the process, transforming the art experience into a participatory action (Kühnapfel et al., 2025). Adapting art to such a social or communal space is based on the desire to create site-specific aesthetic representations, essentially escaping museums, galleries, and other institutions in search of art spaces more intertwined with life (Selvi, 2017).

The places where public art is realized are common areas for city dwellers; events held in public open spaces, in particular, are more accessible, observable, and easy to participate in. It is an expanding practice that continues to combine every environment and discipline, from painting to new media, sculpture to design, architecture to performance (Zebracki et al., 2010, p.789). It encompasses all artworks integrated into buildings, such as freestanding sculptures, monuments, street furniture designed by artists, murals, architectural details, and digital screens.

We encounter public art projects where the space itself is an element of the artwork. Another concept that emerges at this point is 'Installation or Site-Specific Art'.

2.1. Art Installation

Installation art is one of today's most effective and eye-catching forms of expression, especially in public spaces and large venues. This art form draws viewers in both physically and intellectually, as the works are often designed specifically for the space and presented on a large scale. At prestigious events such as international biennials, installations provide artists with an opportunity to present their ideas and social critiques to a wide audience (Toluyağ, 2020).

An installation can be considered not only as a work of art, but also as a form of placement and arrangement. In this sense, ordinary objects are brought together to create a new field of meaning, thereby questioning the viewer's familiar structures of meaning. Artists transform these objects into artistic production by abstracting them from their functions, offering the viewer an opportunity to experience the objects in a way that differs from their usual meanings.

Lisa Moran's definition of installation as an art practice in which one or more objects are arranged in a specific space according to the artist's concerns aptly summarizes the dynamic nature of installation (Moran, 2003). Here, the connection between object and space creates a relationship that enriches the meaning of the work and prompts the viewer to think deeply. The placement of objects not only as physical entities but also as "signifiers" that carry meaning transforms installations into an abstract experience (Öçalan, 2007).

In addition, installations are works that allow the viewer to interact not only with their eyes but with all their sensory perceptions. This enables art to become a more layered and dynamic experience. The viewer becomes part of the work; the work goes beyond being merely an object to be viewed and offers an emotional, physical, and mental experience. In the words of Pooke and Whitham, installations now "draw in" the viewer and transform them into an action, which increases art's power to offer the viewer a direct experience (Pooke and Whitham, 2013:175).

As Danto also points out, the boundaries of installation art are quite broad. Artists constantly explore new materials and spaces, aiming to create a different experience for both themselves and their audience. Installations do not merely offer a visual experience; they also invite sensory and intellectual exploration (Danto, 2010: 240). In this sense, installation art becomes an interactive and participatory art form that draws on different disciplines.

The creative processes of installation artists are also quite different and interesting. While some artists explore historical or cultural contexts, bringing together piles of materials and transforming them into an artistic language, others focus more on the physical properties of objects (such as mass, density, scale). Installation artists use everyday objects, detaching them from their usual meanings and offering the viewer a new conceptual perspective. This process allows objects to be perceived in a new context and in a different way.

Installations made using recycled materials, in particular, draw attention to consumer culture and environmental issues. The use of

objects considered "worthless" in everyday life, such as plastic bags, toys, and scrap items, as tools for artistic production highlights the social and environmental meanings these objects carry. A simple plastic bottle or an old car wheel gains meaning when removed from its usual purpose and placed in a different context (Toluyağ, 2020). These objects can convey powerful messages about global consumption, environmental issues, or social values, going beyond being merely aesthetic objects.

Such works take the viewer on an intellectual journey, creating a new awareness about objects they frequently encounter in daily life but rarely reflect upon. The reshaping of objects' meanings and values through art is one of the elements that enhances the power and impact of installation art.

In summary, the encounter between installations and the audience in public spaces allows art to reach a wider audience. One of the most important features of public art is that it is usually presented outside art galleries, in a context accessible to everyone and that forces them to think about it. In this way, art is experienced not only by an elite group but also by a broader social audience. Furthermore, the impact of installation art in public spaces encourages the audience to create change not only aesthetically but also socially and environmentally.

2.2. Street Art: Murals, Graffiti

Street art is not only a visual form of expression in public spaces today, but also a means of creating a social language and sharing cultural messages. Implemented in various forms and methods, street art is one of the powerful ways to reach society and engage in social criticism.

Graffiti is one of the most well-known and controversial types of street art. Although graffiti is generally perceived as an "illegal" act among the public, it is also seen as an important form of expression for artists. Tag, one of the types of graffiti, consists of simple, quick drawings made to show the artist's identity or signature and often aims only to announce the artist's presence. Types such as mosaic and poster are works that contain more detail and aesthetic concerns, often reflecting social events, criticism, or humorous elements. A piece (masterpiece) is a more complex work, both aesthetically and technically, requiring high skill and long-term effort. Graffiti art can sometimes be applied even in "legal" areas, especially in temporary and non-permanent forms such as light graffiti. Faster and easier methods such as stencils and stickers aim to quickly attract the viewer's attention and convey a message (Toy and Görgülü, 2018).

Street art can also be considered a form of reclaiming public space. The use of public space by artists allows the audience to question and reflect on the environment they encounter every day through art (Evcil and Usal, 2020). Here, art interacts with a city, a street, a neighborhood, or a cultural context.

Figure 4. A mural in Manchester, UK (URL 1), a mural depicting a healthcare worker wearing a mask covering their mouth and nose, boxing gloves, and angel-like wings on their back, (URL 4)

A mural generally refers to paintings made on empty wall surfaces. The wall is actually an unusual surface that the artist chooses as their canvas. For this reason, murals are usually large-scale paintings. They can be seen both on interior walls and on blank walls on the exterior facades of buildings. Since most are created with the permission of the building or space owner, they are legal, eye-catching works with a strong artistic aspect. The English equivalent of wall painting is the word mural, and although it does not exist in Turkish, some of our municipalities organize festivals on this subject that are referred to as "murals."

Although wall painting and graffiti may seem different, they share many similarities as two important types of street art. Wall paintings are generally authorized and large-scale works, which allows them to be accepted as a more artistic form (Erdoğan, 2009). Graffiti, on the other hand, is mostly done without permission and is usually smaller in scale, sometimes lacking artistic concern, but still offering a powerful form of expression.

3. Public Art in a Pandemic World

Such pandemics are considered not only health crises but also historical thresholds that trigger processes of social and cultural change. The collective memory of societies has been rebuilt under the influence of epidemics; interpersonal relationships, life practices, and spatial perceptions have undergone transformation. All these transformations have also been reflected in the forms of expression and

public representations of art, making epidemics not only a biological but also a cultural and aesthetic issue. Moreover, street art is argued to have significant potential in addressing the challenges posed by the pandemic, as it operates through close spatial proximity to public spaces and fosters direct interaction between creative practices and everyday urban life (McEwan et al., 2022).

With physical distancing minimized under the name of social distancing, people began to maintain their socialization and communication through the internet. Mandatory social distancing also came between galleries, museums, and all kinds of cultural activities where audiences gather, and the artists themselves. This situation affected many sectors, including art. As people encountered new conditions such as social distancing, quarantine, and isolation, they had to make sense of this extraordinary situation and adapt. As in previous periods, each new extraordinary situation has led to the creation of its own solutions. This process also showed how art and cultural production have entered a process of change. Artists reflected the spirit of the era by conveying social uncertainties, isolation, and emotional responses to the pandemic in their works.

Extraordinary events around the world, social changes, and the process of adapting to new conditions are important factors that shape art. This situation shows that art is not only an aesthetic means of expression but also a social reflection. Similar to other extraordinary situations in the past, the pandemic produced new solutions in the ways art is produced and shared. This process led to art transcending its traditional boundaries and developing a different form of interaction. Although pandemic conditions limited physical access to public spaces, artists sought ways to redefine these spaces by intervening in public areas; through murals, installations, posters, and digital designs, they made visible the inclusive and transformative potential of public art. As Mcewan et al. (2022) also stated, street art, which is based on physical spaces and tangible relationships, is an environment where this expression takes place and has become an important form of media shaping public space in the context of COVID-19. In this context, public art has been evaluated as a platform for expression that both fills the temporary voids in public space and contributes to the redefinition of public space.

The emptiness experienced throughout the pandemic did not limit the creative expression of street artists; on the contrary, urban landscape areas, wall surfaces, and public spaces have become narrative surfaces through which social sensitivities, mental states, and calls for collective awareness are expressed through art. During COVID-19, many artists

have used street art to reinforce a sense of social unity, encourage solidarity in the face of the pandemic, draw attention to individuals' psychological states, raise global awareness, or criticize national policies. These artistic practices, implemented in different parts of the world, demonstrate that public space has been redefined as both a medium of expression and a critical surface.

During the pandemic, many artists made visible the social mood and the messages they wanted to convey through their individual and collective experiences by means of public art and installation works in public spaces (Figure 5). The pandemic process has transformed art from being merely an aesthetic form of expression into a powerful tool that keeps collective memory alive in times of crisis, translates shared emotions, and offers alternative forms of communication. During this period, art has emerged as the visual embodiment of public sensitivity and resistance on the walls of silent cities, in empty squares, and in abandoned landscapes.

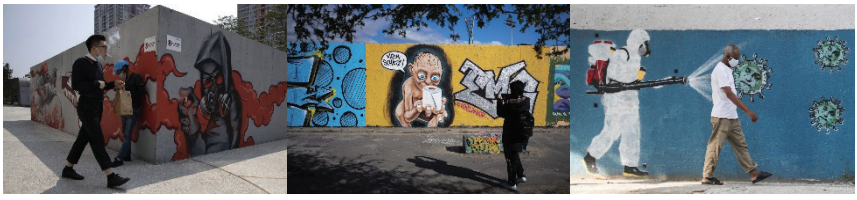

Figure 5. Graffiti on a wall in Beijing; graffiti depicting the character Gollum from the movie "The Lord of the Rings" in Mauerpark public park in Berlin; in Brazil, a man walks past graffiti showing a cleaning worker wearing protective clothing spraying Brazilian President Jair Bolsonaro's face with viruses during the coronavirus pandemic (URL 5)

This article develops a theoretical framework focusing on concepts such as public space, public art, and social distancing, and includes public art practices that emerged during the COVID-19 pandemic. Examples are given of the forms of expression developed by artists under pandemic conditions, and the relationships established between artworks produced in public spaces and individuals and society are discussed. It conveys how art functions as a means of communication, particularly in times of crisis, what themes it uses to generate social awareness, and how it intervenes in public space. In this context, public art is evaluated both as a narrative surface and as a spatial reflection of collective emotion. In this century, life in cities has driven people into loneliness and distanced them from nature and social communication. It is only through the integration of art and artistic production into daily life and living spaces that individuals, especially those living in metropolitan areas, can regain their sensitivity and awareness and become more attentive to social issues.

Artistic events in public spaces or urban open areas bring nature and the external environment closer to people through art, making individuals more sensitive to what is happening in this environment. They create points of mental relaxation for people, different from the daily flow of city life, offering individuals the opportunity to encounter surprising, intriguing surprises through contrasts and perceptual illusions. Today, art practices in public spaces allow people to encounter fantastic, fairy-tale-like expressions, enabling those with no interest in art to interact with art and artworks in their daily lives. Alternatively, they draw attention to social issues and raise awareness within society. From another perspective, art is given the opportunity to leave museums and galleries and communicate with people in urban open spaces.

Socially focused art events highlight the accessibility of public spaces while also ensuring the participation of individuals in the creation process of the artwork. Public art supports people in gaining different life experiences and presents itself as an important dynamic in the cultural life of society. In addition, during the COVID-19 pandemic, street art has been an important tool for reaching large audiences and communicating the conditions of the pandemic, restrictions, and quarantine processes to society. With its functions of combating disinformation, raising awareness about public health, and encouraging social responsibility, street art has contributed to the creation of socially sensitive and interactive public spaces through its relationship with society.

The collective and collaborative nature of street art and artists' proximity to communities have been central to efforts to create informed publics and shape responses to the pandemic. And public artworks have emerged, decorating streets, city squares, and building facades in many parts of the world.

4. Conclusions

The COVID-19 pandemic has shaped not only individuals' health but also public spaces, one of the fundamental areas of social life. Physical and social restrictions on the use of public spaces have limited individuals' opportunities for public expression; this situation has particularly prompted a rethinking of the role of art in public spaces.

The COVID-19 outbreak has provided an important platform for public art to emerge by moving into the streets. As seen in the examples, artists have both evaluated the voids in public spaces and made concepts such as social solidarity, hope, criticism, and questioning visible through spatial interventions.

Art practices of this period have, on the one hand, produced the symbolic language of the crisis period and, on the other hand, actively participated in spatial transformation processes. These artistic interventions, which have left their mark on the collective memory of society, have contributed to the redefinition of public space not only as a physical space but also as a discursive and emotional space.

In urban open spaces, at all visible points of the city, on building facades, in squares, parks, and everywhere accessible to the public, creative practices and public art have been placed in the social spaces of cities and in the daily experiences of the pandemic.

With the works they left in open spaces, artists conveyed pandemic intervention measures to the public, intertwining them with messages of harmony, supervision, and security from the World Health Organization, health institutions, and even governments. During the pandemic, murals depicting scenes from daily life, often large-scale, proliferated in public spaces. At this point, public artworks became an important means of communication during the pandemic.

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Chapter 8

RETHINKING PUBLIC OPEN SPACES WITH FEMINIST SPATIAL THEORY: A CONCEPTUAL FRAMEWORK FOR LANDSCAPE ARCHITECTURE

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1.Introductıon

Public open spaces are one of the fundamental components that ensure the continuity of cities. Parks, squares and green spaces are also defined as places where users engage in activities such as relaxation and socialising within the dynamics of their daily lives. These spaces are more than just physical spaces; they are areas that facilitate social interaction and shape the dynamics of communal life (Carmona, 2021). The role attributed to public open spaces in design disciplines also leads to the evaluation of these spaces based on criteria such as accessibility, suitability for different activities, and aesthetics. This approach to public open spaces is based on the assumption that space is an area that is equally accessible to everyone, regardless of social differences. (Yavuz,2025). However, the physical accessibility of these spaces does not mean that they are equal and fair for everyone. It is often overlooked that the spatial experience is not limited to physical access (Düzenli and Alpak, 2024a).

The concept of spatial experience is considered a multidimensional process that encompasses not only the physical dimension of an individual's relationship with a space, but also its perceptual and social layers. In this context, the concept of space is not merely a ground where physical functions are performed, but also a phenomenon that is constantly re-experienced through everyday life practices. The same spaces are perceived differently by different individuals, different relationships are established, and they are used and experienced in different ways. In this context, it demonstrates that spatial experience is shaped more by the social and cultural relationships that the user establishes with the space than by the characteristics of the space itself. (Lefebvre and Donald, 1991; Massey, 2013). Users' practices of experiencing spaces are directly related to concepts such as age, gender, and social roles. For example, while children and individuals experiencing public spaces may perceive these areas as requiring care and supervision, older users may view them as spaces for rest, socialising, and mobility (Düzenli et al.,2018a). Similarly, people with physical disabilities, who have different physical characteristics, often encounter barriers that hinder their access and participation, and therefore experience public spaces as frustrating rather than enjoyable places. These characteristics are also closely related to the legibility, wayfinding, and spatial comfort offered by the space (Imrie, 2000; Madanipour, 2021). This inequality highlights the need for inclusive design practices that ensure public spaces are not only accessible but also welcoming and functional for everyone, taking into account the different physical and social needs of all users. For women, children, older people, and individuals with different physical capacities, these spaces are often experienced at specific times, under specific conditions, and frequently

with caution, rather than being places that can always be used freely and safely (Pain, 2001). In particular, women users' use of public open spaces is shaped by factors such as the distinction between day and night, being accompanied or alone, care responsibilities, and perceived safety; this situation can affect the continuity and depth of spatial belonging (Koskela, 1997; Kern, 2020). These examples also emphasise that public spaces are not singular and homogeneous in structure and, accordingly, do not produce a uniform user experience (Yavuz et al., 2019).

The ways in which public open spaces are used differ not only based on the physical characteristics of the space, but also on factors such as the length of time users spend in the space and the time periods during which they choose to use it. The conditions that spaces offer at different times of the day directly affect users' duration of stay and their relationship with the space (Pashaei Kamali & Yilmaz, 2018). While some users consider these spaces to be part of their daily lives, others can only use them under certain conditions (Gehl, 2011). This situation leads to these areas being considered not only as "used" spaces, but also as preferred spaces or, in some cases, spaces to be avoided (Alpak et al., 2018b). This differentiation shows that, despite the universal emphasis on equal use of urban open spaces, they are not equally inclusive for everyone (Düzenli and Alpak, 2024b).

The same spaces can generate a sense of belonging, continuity, and well-being for some users, while for others, they can create conditions of conditional use or insecurity. Therefore, urban open spaces should be evaluated based on the relationships users can establish with the space (Relph, 1976; Massey, 2013).

It is observed that the varying nature of spatial experience is not sufficiently taken into account in planning and design approaches to urban open spaces (Ståhle, 2010). The assumption that space is neutral ignores the differences in experience among users and negatively affects the questioning of spatial inequalities. In this context, critical spatial theories emphasise that space is not a passive ground but an active space where social relations are produced. They point to new approaches that question who can access open spaces and under what conditions (Lefebvre, 1991; Madanipour, 2021).

2. Feminist Spatial Theory: Evaluating Spatial Experience in the Context of Gender

Feminist spatial theory offers a critical approach to the assumption that space is independent of social relations and neutral. The theory argues

that space is not defined solely by physical boundaries but is instead shaped by gender relations and everyday life practices (Lefebvre, 1991; Massey, 2013). Feminist theory aims to reveal inequalities in the context of spatial experience by focusing on which users have access to space and which are excluded. The theory's starting point is that space is historically constructed on norms centred on male experience. Historically, public spaces have mostly been associated with concepts such as productivity and visibility, while private spaces have been associated with care and everyday life practices. This distinction has paved the way for the concept of space to be constructed from a gender perspective and has ensured that public spaces have acquired a structure centred on the experience of male users (Grundström & Molina, 2012). Theorists emphasise that this distinction is not natural and is based on gender roles (Hayden, 2005). One of the fundamental contributions of the theory is to reveal that space is not merely a phenomenon perceived by the eye, but rather something felt and experienced by the body. What female users do in space, how long they stay there, and under what conditions they manifest their spatial presence clearly demonstrate how space is shaped by gender (Koskela, 1997; Young, 2005). The theory also places the emotional and perceptual dimensions of the concept of spatial experience at the centre of this analysis. Concepts such as security concerns, fear, and belonging are addressed socially rather than as individual perceptions within the context of feminist theory. In particular, the feelings of insecurity and unease experienced by female users in public spaces are linked to elements such as the field of vision, lighting, and the distribution of user profiles within the space (Valentine, 1989; Pain, 2001). This approach also reveals that the spatial experience is shaped not only by physical access but also by feelings of safety and comfort. In this context, feminist spatial theory also questions the dimensions of representation and visibility of space. From a feminist perspective, it is argued that spatial discourses produced based on the assumption of the "average user" relegate women's experiences to the background (Massey, 1994; Kern, 2020).

In conclusion, feminist theory argues that space is not a fixed and neutral phenomenon, but rather a dynamic process that is constantly reproduced through social relations. Feminist theory provides a powerful analytical philosophy to reveal how different user groups experience space, thereby enabling the questioning of spatial inequalities. In this respect, the theory also ensures that public spaces can be approached in a more inclusive and equitable manner.

2.1. Rethinking Public Spaces through Feminist Spatial Theory

Spatial readings conducted through a feminist lens also reveal how women assert their presence and agency in spaces traditionally defined as male-dominated. This action often takes place not in overt and confrontational forms, but through everyday practices, spatial choices, and silent negotiations (Madge et al., 1997). The feminist theory of space discussed in previous sections demonstrates that space cannot be considered independently of social relations and is not neutral. (Lefebvre, 1991; Massey, 1994). This approach also demonstrates that space cannot be evaluated solely in terms of physical access and functionality, but is also shaped by gender. At this point, it is clear that public spaces must be considered "plural" for different experiences and different users (Massey, 2013).

Feminist spatial theory enables us to re-examine public spaces, questioning not so much how these spaces are designed, but rather how they are experienced, to what extent they are accessible to whom, and under what conditions they can generate a sense of belonging. This approach challenges the assumption that public spaces are experienced equally by everyone, arguing that publicness is variable and conditional in practice (Valentine, 1989; Pain, 2001).

Within this framework, re-evaluating public spaces from a gender perspective requires focusing on how dimensions such as security, visibility, and everyday life practices shape the spatial experience. In the following sections, the experiential dimensions of public open spaces will be evaluated in line with the analytical possibilities offered by feminist spatial theory (Koskela, 1997; Kern, 2020).

2.2. Security and Spatial Experience

Feminist theory evaluates the experience of public spaces from a body-centred perspective, revealing that the concept of spatial experience is not merely a visual and abstract process. This approach emphasises that the concept of space is a phenomenon that is felt, discussed and reinterpreted through bodies (Kallus, 2003). The physical behaviours exhibited by users in public spaces, their duration of stay in the space, and their spatial preferences reveal how the concept of experience is shaped by the gender perspective (Young, 2005; Koskela, 1997).

From a gender perspective, the concept of safety in public spaces cannot be assessed solely based on the presence or absence of physical dangers. Within the framework of feminist spatial theory, safety must also be considered in terms of the perceptual, social, and emotional

dimensions of space (Hyndman, 2001). Determinants such as sightlines, lighting elements, and user density affect the body's movement within public space and its preference for remaining in that space (Pain, 2001). In this context, feminist theory argues that users exist in space in a state of constant awareness and caution. For female users, the spatial experience is mostly a constant negotiation with the space rather than simply being present in the area. The perception of safety in a space is shaped by where to stand in the space, how long to stay in the space, and which routes to choose for transportation. This situation also reveals that public spaces do not produce equal conditions for everyone (Koskela, 1997).

The theory also argues that spatial experience should be evaluated not only through movement and access, but also through emotional experiences. Feelings such as alienation, belonging, and unease are related not only to the physical characteristics of the space but also to its social norms. These elements are among the factors that determine the extent to which users remain in public spaces and the relationship they establish with the space (Kern, 2020).

In this context, the relationship between the body, security, and experience requires questioning not only the accessibility of public spaces but also their inclusiveness. Feminist spatial theory points to the need for spatial design approaches to consider the experiential dimension by making visible the different experiences produced for different user groups in public spaces. This approach highlights the necessity for public spaces to be inclusive not only physically but also perceptually and emotionally (Khalid et al., 2020).

2.3. Visibility and Representation

Feminist theory focuses not only on the physical organisation of public spaces, but also on how they are represented and how user profiles are centralised in spatial discourse. The way in which space is presented through design narratives provides clues as to who the public space is designed for. In this context, spatial representations are considered not only as means of communication but also as discursive tools that produce natural or normative ways of using space (Rose, 1993; Massey, 1994).

In the disciplines of landscape architecture and urban design, public spaces are designed based on the assumption of an average user. This assumption typically relies on a user profile that can freely use the space and whose presence in the space is not questioned. Feminist theory, however, emphasises that this average user assumption produces unequal experiences in public spaces, revealing that the spatial experiences

of certain user groups are invisible (Massey, 2013; Kern, 2020). This invisibility is particularly evident in spatial representations. Studies on the design phase of space present it as an equally accessible area. However, these representations often overlook the conflicts and limitations of how public space is experienced in everyday life. The feminist perspective argues that these representations mask the gender-based inequalities of public space, making it impossible to question whose experience the space is produced for (Rose, 1993).

From the perspective of feminist spatial theory, the concept of visibility is not limited to merely being physically present in a space. It reveals which user groups are accepted in public spaces, which experiences are normalised, and how publicness is socially produced. While women's presence in public spaces often involves constant awareness, adaptation and caution, this experience is rarely reflected in spatial representations. This reveals that, despite appearing inclusive at the representational level, public spaces can produce unequal spaces at the experiential level (Kern, 2020).

In this context, feminist spatial theory evaluates public open spaces not only as designed and presented spaces, but also as spatial constructs that are narrated, visualised, and normalised. This approach provides an important tool for re-evaluating public spaces from a gender perspective.

3. Evaluation of Selected Examples in the Context of Feminist Spatial Theory

This section re-evaluates the feminist spatial theory and experiences of public space discussed in previous sections through selected examples of public open spaces. The aim is not to assess these spaces as 'good' or 'successful' designs, but to demonstrate how the experience of public space differs when viewed through the conceptual tools offered by feminist spatial theory. In this context, the examples will be evaluated not through quantitative data or detailed design analyses, but within the framework of concepts such as spatial experience, visibility, safety, and belonging. The selected examples aim to discuss the explanatory power of feminist spatial theory in readings of public space by revealing how publicness can be produced in conditional, variable, and plural forms in different contexts.

3.1. Evaluation of High Line Park in the Context of Feminist Theory

High Line Park is an area in New York City that emerged from the conversion of an old railway line and is now heavily used. The area is an

important example for discussing the experiential nature of the concept of publicness within the context of feminist spatial theory.

Figure 1. *High Line Park*

From the perspective of feminist spatial theory, the High Line park is shaped primarily through the concepts of visibility and crowd density. The linear structure of the space encourages constant movement. It restricts actions such as stopping, waiting, and lingering. This transforms the use of public space into a transit-oriented experience and weakens spatial belonging (Gehl, 2011). For women, this experience is often associated with a form of spatial existence that requires controlled movement, limited stopping, and constant awareness (Koskela, 1997).

Visibility in High Line Park shapes the public space experience not merely as an aesthetic presentation, but as an element that influences the relationship between the body and the space. Feminist approaches reveal that visibility does not always have an empowering quality in every context; in some situations, bodily existence requires greater awareness (Rose, 1993; Kern, 2020). In this context, being in High Line Park is an experience that requires constant awareness and a cautious relationship with the environment, especially for women. This example demonstrates that publicness cannot be measured by quantitative intensity of use or physical access; rather, the experience of public space is shaped through the body, movement, visibility, and perceived safety (Valentine, 1989; Pain, 2001). Within the framework of feminist spatial theory, the High Line indicates that public spaces are not equally 'public' for everyone.

3.2. Evaluation of Einsiedlerpark in the Context of Feminist Theory

Einsiedlerpark, a public open space in Vienna redesigned in line with the gender mainstreaming approach, concretely demonstrates the fundamental assertion of feminist spatial theory that space is not neutral and impartial (Massey, 1994). Women's experiences of public spaces were taken into account in the park's design process; safety was assessed not only through surveillance and control but also through experiential elements such as visibility, lighting, and spatial continuity (Valentine, 1989; Pain, 2001). In this respect, the park creates a public space that allows women to stay longer and establish a daily relationship with the space. As emphasised by feminist spatial theory, the inclusiveness of public space goes beyond physical access and offers the opportunity to exist comfortably in the space and develop a sense of belonging.

Figure 2. *Einsiedlerpark*

In this context, Einsiedlerpark can be considered one of the examples designed within the framework of feminist spatial theory, which demonstrates that public spaces can be conceived in a way that does not reproduce gender-based inequalities, rather than creating a space exclusively for women.

4. Sonuç

High Line Park and Einsiedlerpark, evaluated within the framework of feminist spatial theory, demonstrate that public open spaces are not experienced in the same way by everyone and that publicness can produce different meanings through different spatial configurations. While High Line Park exhibits a conditional and cautious spatial existence, Einsiedlerpark, in contrast, produces a publicness that supports everyday

use and long-term spatial presence. Taken together, these two examples clearly show that the physical accessibility of public spaces does not mean they are inclusive at the experiential level. Feminist spatial theory provides a powerful theoretical framework for producing more inclusive and equitable public spaces by emphasising that visibility, safety, the body, and everyday life practices must be considered together in the design and evaluation processes of public open spaces.

Experiential dimensions such as being able to be present in a space, remain in it, develop a sense of belonging, and establish connections with everyday practices, as posited by feminist spatial theory, emerge as fundamental elements determining the inclusivity of public space. This approach demonstrates that while public spaces produce an empowering and comforting experience for some users, they offer a cautious, limited, and conditional existence for others.

In this context, feminist spatial theory argues that the gender perspective must be central to the design and evaluation processes of public open spaces. The possibility of reconfiguring public spaces in a more equitable and inclusive manner necessitates moving beyond approaches focused solely on access and intensity of use; it requires the simultaneous evaluation of the perceptual, emotional, and everyday dimensions of spatial experience. Consequently, feminist spatial theory provides a robust theoretical and critical foundation for rethinking and transforming public open spaces.

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Chapter 9

THE NEW SCALE OF URBAN DECARBONIZATION: CARBON-NEUTRAL NEIGHBORHOODS

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1. Introduction

United Nations (2019) data shows that a large portion of the world's population is concentrated in cities due to the economic, educational, and health opportunities they offer, and that the urban population ratio is expected to reach 68% by 2050. The concentration of a large portion of the world's population in urban areas accounts for more than 60% of global energy consumption and approximately 70% of greenhouse gas emissions and waste production (UN, 2017; Huovila, 2024). Urbanization and increased economic activity are leading to significant ecological impacts, making climate change the most important global issue. International climate governance efforts aimed at addressing the global problems caused by climate change are based on limiting the rise in temperature. Within this framework, the goal defined by the Paris Agreement to keep the global temperature increase well below 2°C and limit it to 1.5°C (UNFCCC, 2015) has been concretized at the European Union level through the European Climate Law; and within this framework, the goal of achieving net-zero greenhouse gas emissions by 2050 has been made legally binding (European Union, 2021). Although certain agreements have been adopted at the international level to combat climate change, the United Nations Environment Programme (2025) reports that global greenhouse gas emissions showed an approximate 53% increase between 1990 and 2024, excluding a short-term temporary decline around 2020 due to the pandemic. The report states that the most dominant CO_2 emissions originate from fossil fuels, and therefore industry, transportation, and energy production are still largely dependent on fossil fuels. CO_2 is emitted from agriculture, waste management, and fossil fuel production/transportation, and CH_4 (methane), which has a much stronger warming effect than CO_2; N_2O (Nitrous oxide), which has a relatively smaller effect but creates persistent climate impacts due to its long atmospheric lifetime; and F-gases, which are associated with refrigeration systems and industrial processes and are the fastest-growing group of gases. It is stated that CO_2 emissions resulting from land use change due to deforestation, land conversion, and the weakening of natural carbon sinks exert significant pressure on total emissions (Figure 1).

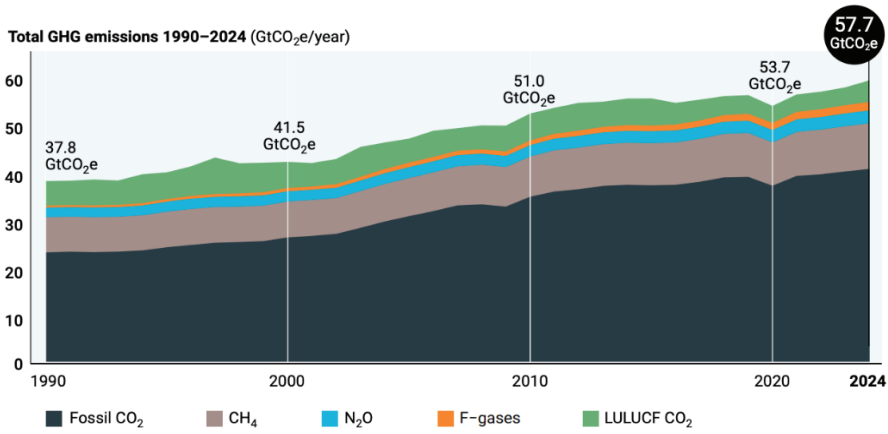

Figure 1. *Distribution of global greenhouse gas emissions between 1990 and 2024 (United Nations Environment Programme (2025)*

This report reveals that there is a structural incompatibility with the Paris Agreement's goal of staying below 2°C and that a systemic transition to decarbonization on a global scale has not been fully achieved. Therefore, the transformation of fossil fuel-based systems, particularly in energy, transportation, and industry, along with the development of comprehensive reduction strategies related to agriculture, land use, and industrial processes on a global scale, necessitates the integration of these strategies into urban planning, design, and governance processes. In this context, urban planning, design, and management processes aim to address the reduction of energy demand, the integration of renewable energy sources, the limitation of greenhouse gas emissions, and the improvement of quality of life within a comprehensive spatial framework.

In line with these objectives, various methods and techniques have been developed to achieve climate neutrality (Rosales, 2011). Initially, demand increased particularly for the sustainability of buildings, but over time it became clear that focusing solely on the building scale would not be sufficient (Kyrkou & Karthaus, 201; Haapio, 2012). it has been recognized that a more comprehensive assessment approach at a higher level, taking into account all components of the urban area, such as the interaction of social, environmental, and spatial dynamics, including transportation, infrastructure services, and the built environment, is necessary (Berardi, 2013; Sharifi & Murayama, 2013; Venou, 2014). Efforts to enhance urban sustainability can be developed at various scales, from individual buildings to blocks, neighborhoods, cities, and urban regions, but the neighborhood scale has been a particular focus of attention (He et al., 2018). The reason for this is that neighborhoods are sufficiently

small to enable effective and efficient experiments, sufficiently large to assess the complex interactions between different urban components, and the most suitable urban units for strengthening social interaction and involving local stakeholders in sustainability processes (Sparshott et al., 2019; Sala Benites et al., 2020; Sharifi et al., 2021a; Sharifi et al., 2021b). The development of new urban approaches such as carbon-neutral neighborhoods and net-zero energy neighborhoods has been supported by the applicability of carbon reduction strategies and innovative energy concepts at the neighborhood and regional levels (Annunziata et al., 2013; Ayyoob, 2013).

2. Carbon Neutral Neighbourhoods

A carbon-neutral neighborhood is defined as a comprehensive urban approach that first minimizes greenhouse gas emissions from all activities within the neighborhood boundaries through reduction strategies and aims to offset the remaining emissions to zero through renewable energy sources, energy efficiency measures, and balancing mechanisms (Annunziata et al., 2013; Janssens et al., 2017; Wu et al., 2023). The carbon-neutral neighborhood approach offers a multidimensional carbon management framework that encompasses not only the energy consumption of buildings but also transportation, land use, infrastructure systems, open green spaces, and user behavior (Komeily & Srinivasan, 2015). The carbon-neutral neighborhood approach, which aims to reduce fossil fuel dependency and support low-carbon lifestyles by achieving energy consumption balance at the local level, positions the neighborhood scale as a strategic intermediate scale in the fight against climate change. In this context, the concept of carbon-neutral neighborhoods has been operationalized through certification systems that aim to measure, monitor, and guide sustainability at the neighborhood level, going beyond a theoretical goal (Tam et al., 2018). In particular, neighborhood-focused assessment tools such as LEED for Neighborhood Development, BREEAM Communities, CASBEE for Urban Development, and DGNB for Urban Districts address energy efficiency, renewable energy use, transportation, land use, infrastructure, and social sustainability criteria within a comprehensive framework to promote low-carbon urban development. These systems, which do not directly focus on the carbon neutrality target, support the feasibility of the carbon neutral neighborhood approach through performance criteria and indicators. Therefore, these certification systems serve as an intermediary mechanism between conceptual goals and practical applications. The performance and governance-based fundamental characteristics of carbon-neutral neighborhoods, which demonstrate a holistic approach by

addressing the dimensions of energy, space, ecosystem, and governance together, are as follows:

- Energy efficiency and renovation are achieved by improving building facades, systems, and infrastructure to reduce energy consumption (Janssens et al., 2017; Cheng et al., 2022; Krarti, 2024).
- Renewable energy production such as solar panels, wind turbines, and geothermal energy is used at the local or community level to meet energy needs (Janssens et al., 2017; Nematchoua et al., 2021; Krarti, 2024).
- Urban green spaces, green roofs, and nature-based solutions support the offsetting of carbon emissions and the improvement of air quality (Orozco-Messana et al., 2022; Cong et al., 2023). Investing in local food systems, such as community gardens and farmers' markets, promotes neighborhood food self-sufficiency.
- To minimize resource consumption, waste management systems and recycling are encouraged, while rainwater management and gray water recycling are implemented for water management.
- Integration of smart transportation and technologies for emission reduction (Orozco-Messana et al., 2022).
- Regular assessment of energy use and emissions to ensure targets are met (Laine et al. 2020; Huovila et al., 2022).
- Including stakeholder participation in planning and implementation processes to develop solutions tailored to local needs (Ahlers et al., 2019; Pulselli et al., 2021).

The characteristics outlined above reveal which components will be evaluated in carbon-neutral neighborhoods, while the design principles presented below focus on how these goals will be implemented spatially and technically.

- Design approaches that utilize daylight and incorporate active and passive solar energy strategies, such as solar panels, should be considered in order to optimize building orientation (Krarti & Aldubyan, 2021; Manni et al., 2023).
- Smart grid technologies for energy sharing should be promoted by supporting on-site renewable energy production and storage solutions to meet local energy needs (He et al., 2021; Zhou, 2022).

- Nature-based solutions such as green roofs, green walls, and rain gardens should be integrated to sequester carbon, improve microclimates, and increase biodiversity. Sustainable materials and circular economy practices should be encouraged during the construction phase (Nematchoua et al., 2025; Min, 2025).
- While promoting mixed-use urban settlement patterns that support public transportation, cycling, and walking to reduce travel demand, electric transportation systems and the associated charging infrastructure should be widely adopted to reduce transportation-related emissions (He et al., 2021; Chen et al., 2022).
- The use of digital tools such as urban digital twins and carbon calculation methods should be promoted to enable strategies to be adapted over time by monitoring developments (Wu et al., 2023).

3. Malmö – Västra Hamnen (Western Harbor) Example: The Evolution of Carbon-Neutral Neighborhoods Within Planning, Design, and Governance Integrity

For much of the 20th century, the Västra Hamnen (Western Harbor) area of Malmö, a city with an economy based on shipbuilding, was the spatial focus of this production. By the 1970s, the global oil crisis and structural transformations in the maritime sector led to the gradual cessation of shipyard activities, causing the region to lose its function and become an idle industrial area. The abandonment of this area, which was transformed into a built environment by filling in the sea and the shoreline, has become an urban problem area from both an ecological and socio-economic perspective (Reepalu, 2013). Since the mid-1990s, Malmö Municipality has approached the area not only as a physical redevelopment site but also as a strategic opportunity to support the city's economic, environmental, and social transformation. In 1996, the municipality purchased the 175-hectare artificial island section of Western Harbor, and the transformation process was formally initiated. Parallel to the municipality's acquisition of this area, the completion of the Öresund Bridge strengthened Malmö's integration with Copenhagen and other European cities, laying the foundations for the transformation process with a knowledge economy, university investments, and a sustainable city vision (Anderberg, 2015).

Figure 2. *Old and new images of Western Harbor (URL1, 2025; URL2, 2025)*

The Bo01-City of Tomorrow Housing Fair held in 2001 was the first concrete application area of the transformation. This housing fair is not merely a temporary event space showcasing new housing typologies; it is designed as an experimental urban laboratory where the carbon-neutral neighborhood approach will be tested across its dimensions of energy, transportation, water, waste, landscape, and social life. The goal is to develop a neighborhood model based on 100% renewable energy, minimizing environmental impacts and aiming to provide a high quality of life. The planning approach, based on structural and green space balance, prioritizes diversity in architecture and landscaping, public spaces that encourage social interaction, and an urban fabric on a human scale. The guide developed by Klas Tham emphasizes that sustainability should be considered in conjunction with technical performance criteria, as well as aesthetics, quality, and life satisfaction. The Bo01 process, which goes beyond the traditional implementation of zoning plans, is an innovative governance model that holds the municipality responsible for public spaces and infrastructure while holding private developers accountable for development on their own plots. It manages developers through a flexible yet binding Quality Program. The quality program has defined targets in areas such as energy performance, renewable energy use, water and waste management, architectural quality, landscape design, and social spaces, and developers involved in the process have been asked to commit to meeting these targets. The Green Space Factor, an important element of the quality program, indicates that developers participating in the housing fair commit to creating a certain amount of green space in their projects. Different weight scores were assigned to each parameter, such as trees, shrubs, grass, native/foreign species selection, and green roofs, encouraging developers to invest in green spaces. This creates a balancing mechanism between carbon-neutral neighborhood goals and market dynamics.

Figure 3. *Western Harbor: An example of the relationship between housing and green spaces (URL2, 2025)*

The focus has been on developing renewable energy production rather than high energy efficiency buildings. Wind turbines, solar collectors, photovoltaic panels, geothermal heat pumps, and waste-to-energy systems are used together to meet the neighborhood's entire annual energy needs from renewable sources. Geothermal storage systems based on seawater and aquifers provide heating and cooling regionally, with warm seawater in summer being stored for heating in winter, and cold seawater in winter being stored for cooling in summer (MacLauchlan, 2021). Despite all these efforts, it is noted that many buildings have not fully achieved the

specified energy efficiency targets, and there are inconsistencies between technical performance and architectural diversity.

Figure 4. *Examples of Western Harbor's renewable energy and nature-based solutions (MacLauchlan, 2021)*

Rainwater management, considered not only as an engineering infrastructure solution but also as a component of landscape design and public space planning, has been evaluated in terms of water quantity control, water quality improvement, and key indicators of sustainable development. In addition to limited problems such as canal flooding and downstream erosion in the region located on the coast of the Öresund Strait, the quality of water reaching the strait has become a critical issue due to the removal of rainwater from structures. The area between the strait and the saltwater channel has been raised by approximately 1.8-2.7 meters using a gravity-fed surface drainage system. Green roofs, courtyard water retention ponds, rain gardens, and permeable surfaces slow down surface runoff, supporting natural filtration processes. While ensuring complete surface drainage of rainwater, careful grading, high construction quality, and innovative landscape infrastructure solutions have been taken into consideration. Thus, it has been demonstrated that nature-based solutions are multifunctional tools that enhance both ecological and spatial quality in carbon-neutral neighborhoods (Anderberg, 2015). Seawater from the Öresund is pumped up from the canal embankment on the pedestrian bridge leading to Bo01 and conveyed to Ankarparken on the other side of the bridge. Rainwater is directed to the artworks at Scaniaplatsen through this complex canal system, which includes canals running alongside buildings, ponds covered with vegetation, and underground channels. The water is then conveyed to the elevated water features that form the

focal point of the square, serving as a unique element in the area's urban planning (MacLauchlan, 2021).

Figure 5. *Visuals of Western Harbor structures and waterways (Anderberg, 2015)*

Waste management, approached in line with circular economy principles, has been resolved by grinding organic waste in homes, collecting it in underground storage facilities, and converting it into biogas in anaerobic digestion plants. The biogas obtained here has been used as fuel in public transport vehicles or for heat and electricity production. Inorganic waste, on the other hand, is transported to central facilities via vacuum pipe systems and either recycled or utilized to contribute to the district heating system (Anderberg, 2015; MacLauchlan, 2021).

In the region where a pedestrian and bicycle-priority transportation strategy aimed at reducing car dependency was implemented, 470 km of extensive bicycle networks were created, and access to public transportation stops within walking distance of residences was ensured (Reepalu, 2013). Despite all these efforts, the higher-than-expected level of car ownership has revealed that spatial design alone is insufficient for transforming transportation behavior. Public open spaces are designed to encourage social interaction, taking into account aesthetic quality and user satisfaction through the use of water features and landscaping. Although the high cost of housing has been criticized for limiting the area's social diversity and inclusiveness to a narrow social profile, the completion of the area and its integration into the city has changed this situation, ensuring its intensive use by different segments of society.

4. Conclusion

The limited impact of sustainability approaches implemented through individual structures has brought about a growing awareness of the need to address multidimensional environmental issues such as green spaces, water management, transportation, and energy at the neighborhood level. In this context, the carbon-neutral neighborhood approach is increasingly gaining a central position in the literature as a scale at which sustainable development goals can be implemented in a spatially holistic, feasible, and measurable manner.

The example of Malmö Västra Hamnen (Western Harbor) clearly demonstrates that carbon-neutral neighborhoods should not be viewed as static, flawless models, but rather as learning urban systems that evolve through processes of experimentation, feedback, and adaptation. The experimental process initiated with Bo01 with high environmental goals has evolved into more realistic, performance-based approaches supported by governance tools due to the technical, economic, and social limitations encountered in practice. This evolution demonstrates that carbon neutrality goals can only become permanent through the coordination of planning, design, and governance mechanisms.

On the other hand, today's expectations for improving quality of life go beyond technological innovations that enrich individual experiences, making it imperative to create healthy, environmentally compatible, and resilient living environments on an urban scale. Carbon-neutral neighborhoods contribute to reducing environmental impacts and enhancing social and economic well-being by comprehensively addressing walkability, green infrastructure continuity, renewable energy use, and low-carbon transportation systems.

In this respect, carbon-neutral neighborhoods should be considered not only as technical solutions to combat climate change, but also as strategic planning models that address urban transformation, quality of life, and urban resilience goals simultaneously. The Malmö example is an important reference point in that it demonstrates how this approach can inspire global policy and planning practices through innovative tools developed at the local level.

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Chapter 10

THE ROLE OF ENDEMIC PLANTS IN LANDSCAPE DESIGN

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1. INTRODUCTION

Landscape design is an interdisciplinary process that is not limited to visual arrangements but includes ecological, cultural and socio-economic dimensions. In this context, endemic plant species that grow naturally only in a particular geography and are unique to that region play a critical role in landscape architecture for sustainability. Endemic species stand out with their high adaptation to the climatic and edaphic (soil-related) conditions of their habitat, reducing water consumption, lowering maintenance costs and strengthening ecosystem services (Kahvecioğlu and Sağlık, 2025; Sandal Erzurumlu & Savran, 2019).

Endemic plants provide ecosystem services such as erosion control, microclimate regulation, habitat creation and aesthetic value. Their roots bind the soil and prevent erosion. They contribute to the local climate's mildness and support life by providing food and shelter. Their unique appearance adds diversity and richness to landscapes.

Türkiye is an important center of endemism worldwide thanks to its different climate zones and geological diversity. Türkiye's flora contains approximately 12,000 plant species, more than 3,000 of which are endemic. This richness contributes to the preservation of biodiversity and enables the spatial representation of cultural identity using local species in landscape design. For example, the Taurus cedar (*Cedrus libani*) and the sweetgum tree (*Liquidambar orientalis*) are endemic species that stand out in landscape projects with their ecological adaptability and cultural values (Eroğlu et al., 2025).

The use of endemic plants in the landscape is not only an aesthetic choice but also related to functional contributions such as continuity of ecosystem services, water and soil management, microclimate regulation and habitat creation. These species also offer social benefits such as environmental education, ecotourism and strengthening the local economy (Eroğlu et al., 2025).

Davis et al.'s (2025) study reveals that urban biodiversity can be increased, the heat island effect can be reduced, and urban well-being can be strengthened by using endemic species in urban vertical gardens (Davis, et al. 2025). A similar study indicates that native and endemic species contribute to ecosystem services such as soil protection, habitat creation and cultural value generation, whereas exotic species may pose ecological risks in the long term (Figure 1).

In this study, the role of endemic plants in landscape design will be discussed in terms of ecological, aesthetic and functional dimensions;

application strategies will be evaluated through sample species from Turkey and recommendations will be presented in line with sustainable design principles.

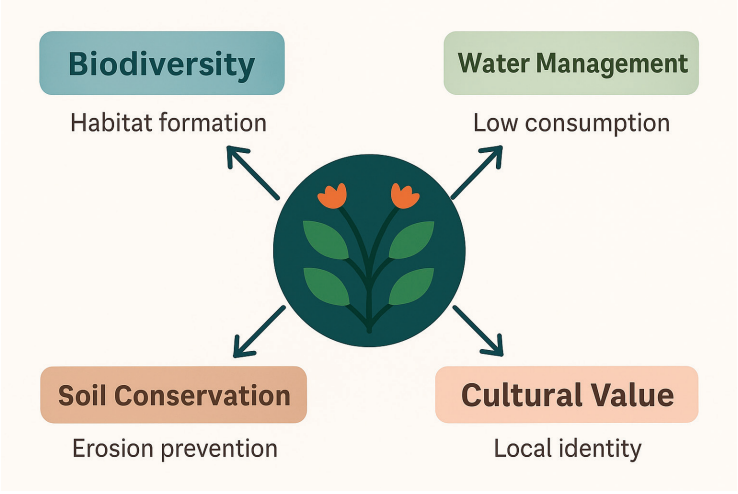

Figure 1. Landscape Contributions of Endemic Plants

2. Ecological and Cultural Value

2.1. The Role of Endemic Species in Biodiversity Conservation

Endemic plants play a critical role in maintaining biodiversity by creating habitats and providing food and shelter for local fauna. Ethnobotanical studies, especially in urban parks, show that woody endemic species provide both ecosystem services and cultural value (Seyidoğlu Akdeniz, & Yener, 2024).

2.2. Adaptation Advantages to Local Ecosystems

Endemic species provide low maintenance costs and long-term sustainability thanks to their adaptation to climate and soil conditions. A SWOT analysis conducted at Tokat Gaziosmanpaşa University revealed the ecological and economic advantages of natural plants in landscaping. These findings support the idea that endemic species increase the resilience capacity of landscapes to climate change (Avşar, & Çelik, 2024).

Endemic plants are species that have adapted to the climatic, edaphic and biotic conditions of their geography because of long-term evolutionary processes. This adaptation offers significant advantages in terms of sustainability in landscape design. First, the resistance of endemic species to local climatic conditions saves water and energy by reducing irrigation

and maintenance requirements. This increases the ecological resilience of landscape practices, especially in regions where the effects of drought and climate change are felt intensely (Özman, 2025).

In terms of integration with the soil, endemic plants support both the nutrient cycle and play a critical role in erosion control thanks to their root systems compatible with the local soil structure. This feature ensures the continuity of ecosystem services by preventing soil loss, especially in sloping lands and sensitive ecosystems (Erken, etc., 2022). Additionally, endemic plants support essential ecological processes such as pollination, nutrition and shelter by establishing symbiotic relationships with local fauna. This contributes to the preservation of biodiversity and the strengthening of ecological balance (Akyıldırım, et al., 2011).

Finally, the use of endemic plants in landscape design carries not only an ecological but also a cultural dimension. These species, which reflect local identity with their region-specific appearance, increase the aesthetic value of the landscape while also reinforcing the sense of cultural belonging. Therefore, the choice of endemic plants in landscape design can be considered as a strategic approach in terms of both ecological sustainability and preservation of cultural landscape identity (Figure 2).

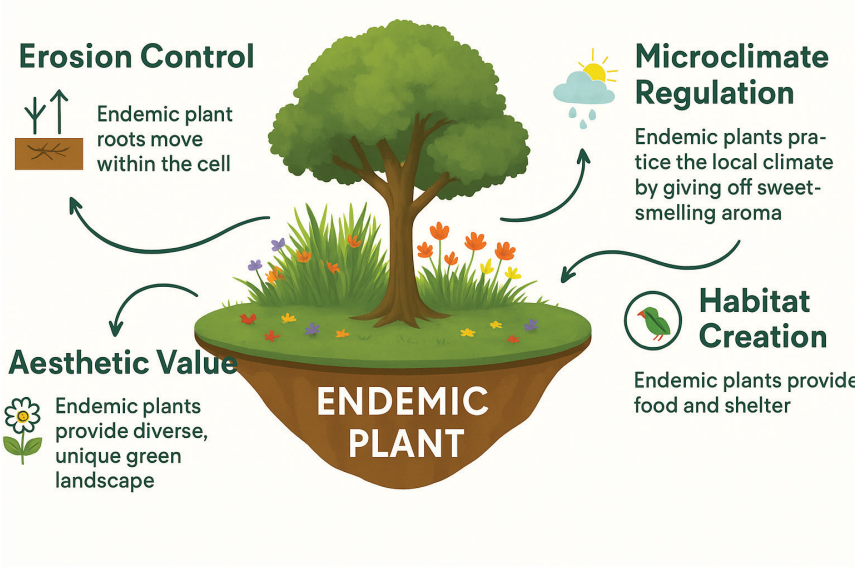

Figure 2. Ecosystem Services of Endemic Plants in Landscape Design (Image creation supported by Artificial Intelligence)

2.3. Contributions to Cultural Heritage and Identity Formation

Endemic plants strengthen spatial memory with their cultural and symbolic values. For example, the sweetgum tree has been a cultural symbol in Anatolia throughout history with its aromatic resin. In international literature, studies conducted at the Pisa Botanical Garden highlight the role of endemic species in popularizing them and creating cultural identity (D'Antraccoli, Carta, Astuti, et al. 2025). Additionally, research on landscape architecture in the United States shows that native plant gardens increase biodiversity in cities while also serving as cultural education (Park, Zhang, & Ali, 2020).

3. Principles of Use in Landscape Design

Endemic plants play a critical role in landscape design in terms of ecological sustainability, local identity and climate adaptation. These plants have both environmental and cultural value because they are indigenous to the region where they are found.

Fundamental Contributions of Endemic Plants to Landscape Design

- Ecological Adaptation and Resilience
- Endemic plants require less maintenance and watering because they naturally adapt to local climate and soil conditions.
- They form symbiotic relationships with local fauna, supporting biodiversity.
- Sustainability and Water Management
- They save water when used with automatic irrigation systems.
- They increase the resilience of the landscape against climate change.
- Cultural and Aesthetic Value
- They contribute to the preservation of local culture by reflecting regional identity.
- They offer unique aesthetic values in terms of color, texture and form.
- Economic and Educational Benefits
- When supported by local production, it stimulates the local economy.

- They create living laboratories for environmental awareness and education in natural areas (Erken, et al., 2022; Karaşah, 2021).

3.1. Ecological Adaptation

The most important advantage of using endemic plants in landscape design is their natural adaptation to local ecosystem conditions. Because these species are adapted to the climate, soil structure and water regime of the region they are in:

- Reduces water consumption and minimizes the need for irrigation.
- It protects the soil structure and prevents erosion with its root systems.
- It is resistant to climatic conditions and creates long-lasting and sustainable landscape elements (Öztürk & Gücel, 2016).

3.2. Aesthetic Value

Endemic species strengthen the identity of the place by increasing the visual diversity of the landscape.

- Colour diversity: Provides a dynamic aesthetic with seasonal flowering and leaf changes.
- Texture and form: The natural texture of native plants enhances the harmony of the landscape with the surrounding environment.
- Seasonal change: Maintains the liveliness of the landscape by creating different visual effects throughout the year (Yıldız & Aksoy, 2018).

3.3. Functional Additives

Endemic plants are not only aesthetic but also functional in terms of ecosystem services:

- Erosion control: It holds the soil with its root systems, providing protection especially in sloping areas (Hobbs & Norton, 1996).
- Microclimate regulation: Softens the local climate through shading and humidity balance.
- Creating habitat: Provides habitat for birds, insects and other creatures, supports biodiversity (Table 1) (Park, Zhang & Ali, 2020).

Criterion	Ecological Contribution	Aesthetic Contribution	Functional Additive
Water consumption	Low, climate-adapted	Arid landscape aesthetics	Sustainable care
Soil compatibility	Adaptation to local soil structure	Natural tissue compatibility	Erosion control
Seasonal change	Contribution to the ecosystem cycle	Variety of colors and forms	Microclimate regulation

Table 1. Contributions of Endemic Plants to Landscape Design

4. Application Examples

4.1. Examples from Turkey

- Taurus Cedar (*Cedrus libani*)

Taurus cedar is an endemic species that naturally spreads in the high mountain ecosystems of Anatolia. Studies on afforestation sites compatible with the climate type reveal this species' drought resistance and long-term potential for use in landscapes (Ayan et al., 2017). Additionally, studies examining the effects of cultivation density on seedling morphology highlight the importance of correct cultivation techniques in landscape applications (Albayrak, 2002).

- Sweetgum Tree (*Liquidambar orientalis*)

The sweetgum tree, which naturally spreads in Muğla and its surroundings, is an endemic species that is valuable both ecologically and culturally. Quantitative character studies on seedlings support the genetic diversity and conservation strategies of this species. In addition, research on "rebirth" in the context of cultural heritage reveals the historical and symbolic value of sweetgum (Figure 3) (Alan et al., 2018; Bolat, 2024).

Figure 3. Sections of Cedrus libani and Liquidambar orientalis from the campus

- Munzur Valley Plants

Munzur Valley National Park is one of the largest and most biodiverse national parks in Turkey. There are many endemic plant species in the 420 km² area, and these species are considered as both ecological and cultural identity-forming elements in landscape design (Table 2) (Figure 4) (T.C. Kültür ve Turizm Bakanlığı, 2025).

Species Name	**Area**	**Ecological Feature**	**Landscape Use**
Taurus Cedar *Cedrus libani*	Taurus Mountains	Drought-resistant, long-lasting	Monumental tree, shade
Sweetgum Tree *Liquidambar orientalis*	Muğla	Compatible with humid areas	Aromatic value, cultural identity
Munzur Flowers	Tunceli	High altitude adaptation	Natural meadow aesthetics

Table 2. Example Endemic Species from Turkey

Figure 4. A view from Munzur Valley National Park (URL-1)

4.2. Endemic Plant Density Regions in Turkey

The distribution of endemic plants is concentrated in three major flora regions:

- İran-Turan Region (%64,7)
- Akdeniz Region (%26,4)
- Euro-Siberian Region (%12,2)

The provinces with the most endemic species are: Antalya (862 species), Mersin (462 species), Konya (458 species), Sivas (413 species), Kayseri (313 species). The most intense endemism regions are: Western and Central Taurus Mountains, Anatolian Diagonal, Kaz Mountains and Munzur Valley (Figure 5) (Şenkul, & Kaya, 2017).

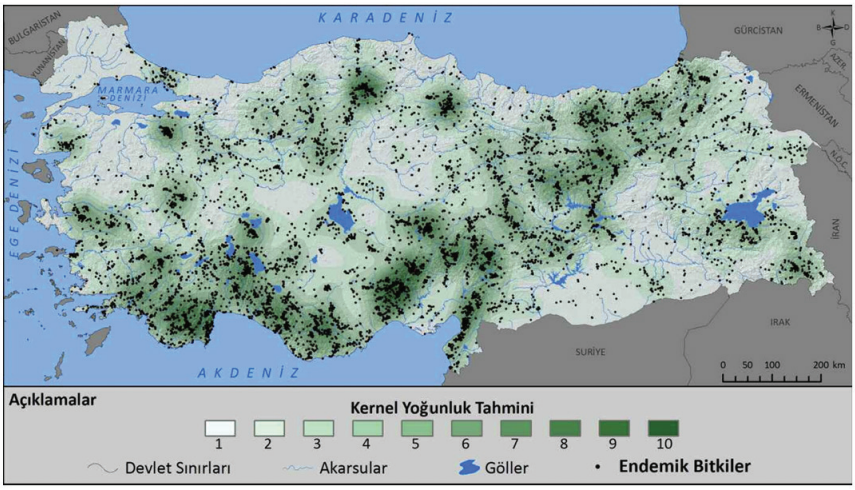

Figure 5. Kernel density analysis of Türkiye endemic plants (Şenkul, & Kaya, 2017).

4.3. Examples from the World

- California Redwoods (*Sequoia sempervirens*)

Native to the west coast of the United States, redwoods are among the world's longest-lived and tallest trees. In landscape architecture, their use as shading, carbon storage and ecological symbols is prominent (Oregon State University, 2025).

- Australian Banksias (Banksia spp.)

Native to Australia, banksias offer both aesthetic and ecological value in landscape design with their drought tolerance and unique flower forms. It supports biodiversity by providing a food source for local fauna. Studies by the Australian Native Plants Society highlight the cultural and ecological importance of banksia in landscape design (Table 3) (Australian Native Plants Society, 2025).

Species Name	Region	Ecological Features	Landscape Use
Californian Redwood *Sequoia sempervirens*	US West Coast	The world's longest-lived and tallest trees; High carbon storage capacity.	Shading, Carbon Sequestration, Ecological Symbol
Australian Banksia (Banksia spp.)	Australia	High drought tolerance; Food source for local fauna and biodiversity support.	Aesthetic Value (Unique Flower Form), Ecological and Cultural Significance

Table 3. Example Endemic Species from the World

5. Main Issues and Proposed Approaches

5.1. Main Issues

- Habitat Loss: Urbanization, expansion of agricultural areas and infrastructure projects are shrinking the natural habitats of endemic species. This is one of the biggest threats limiting the use of the species in landscape design (Öztürk & Gücel, 2016).
- Incorrect Use: Using endemic plants in the wrong areas, ignoring their ecological needs, negatively affects both the health of the plant and the sustainability of the landscape.
- Climate Change: Rising temperatures, changing precipitation patterns and extreme weather events are challenging the adaptation capacity of endemic species and increasing the risk of extinction for some species (Hobbs & Norton, 1996).
- Decreasing Genetic Diversity: Uncontrolled breeding and limited gene pools can undermine the long-term resilience of endemic species.

5.2. Proposed Approaches

- Sustainable Design Trends: Nowadays, ecological sustainability comes to the fore in landscape architecture. The use of endemic species offers an approach compatible with this trend (Park, Zhang & Ali, 2020).
- Ecotourism Potential: Highlighting endemic plants in landscape projects supports ecotourism activities and contributes to the local

economy. Regions such as Munzur Valley serve as an example in this regard.

- Participation of Local Communities: The use of endemic species in landscape design encourages local people to protect their cultural heritage. This participation is an important opportunity for both protection and awareness (D'Antraccoli et al., 2025).
- Scientific Research and Education: The use of endemic plants in landscape projects creates practical training and scientific research opportunities for universities and research institutions (Kaya Şahin et al., 2017).

6. Conclusion and Recommendations

Conclusion

Endemic plants are not only an aesthetic element in landscape design; they are also carriers of ecological sustainability, cultural identity and social awareness. In countries with high endemism rates, such as Türkiye, integrating these species into landscape projects contributes to both the conservation of biodiversity and the spatial representation of local culture. On a global scale, endemic species such as redwood and banksia stand out in terms of ecological resilience and symbolic value in landscape architecture. However, threats such as habitat loss, climate change and misuse make the sustainable use of these species in the landscape difficult.

Recommendations

- Type Selection: Endemic species to be used in landscape design should be selected by taking into account ecological adaptation criteria (water consumption, soil structure, climatic conditions) (Öztürk & Gücel, 2016).
- Maintenance Strategies: Low-maintenance landscape systems should be designed by taking into account the natural adaptation advantages of endemic species (Yıldız & Aksoy, 2018).
- Social Awareness: Projects that encourage local people to protect their cultural heritage should be developed. Education and ecotourism activities can be effective in conveying the value of endemic species to society (D'Antraccoli et al., 2025).
- Research and Education: Universities and research institutions should conduct applied studies examining the role of endemic plants in landscape design and develop new methods for the use

of these species in urban and rural landscapes (Park, Zhang & Ali, 2020).

- Policy and Planning: Local governments should develop strategies that encourage the use of endemic species in landscape projects and support conservation and production policies (Hobbs & Norton, 1996).

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Chapter 11

SPATIAL ANALYSIS OF URBAN CLIMATE AND THERMAL COMFORT USING LAND SURFACE TEMPERATURE DATA

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INTRODUCTION

Urban climate has become an increasingly important field of research as cities continue to expand and intensify under the combined pressures of rapid urbanization and global climate change (Oke, 1982; Weng, 2009). Rising temperatures, more frequent heat waves, and prolonged periods of thermal stress have placed urban populations at heightened risk, particularly in densely built environments (Peng et al., 2012; Zhou et al., 2014). As a result, there is growing demand for robust, spatially explicit indicators that can effectively represent urban thermal conditions and support climate-sensitive planning and management strategies.

Traditionally, urban climate assessments have relied on near-surface air temperature measurements obtained from meteorological stations (Oke, 1982). While air temperature remains a fundamental variable for describing atmospheric conditions and human thermal comfort, its application in urban environments is constrained by limited spatial coverage. Urban areas exhibit strong spatial heterogeneity driven by variations in land cover, surface materials, vegetation density, and urban form (Voogt & Oke, 2003; Weng, 2009). A small number of point-based air temperature measurements are often insufficient to capture this complexity, particularly at neighborhood and street scales where thermal conditions can vary substantially over short distances.

In response to these limitations, satellite remote sensing has emerged as a powerful tool for urban climate research (Voogt & Oke, 2003; Weng, 2009). Among the various remotely sensed parameters, Land Surface Temperature (LST) has gained prominence as a spatial indicator for urban thermal environments. Derived from thermal infrared satellite observations, LST represents the radiative temperature of the Earth's surface and provides spatially continuous information on surface heating patterns (Li et al., 2013). Its ability to reveal fine-scale thermal variability has made LST a central variable in studies of urban heat islands, land cover temperature relationships, and climate-sensitive urban design (Weng et al., 2004; Peng et al., 2012).

The increasing use of LST as an indicator for urban climate raises important conceptual questions regarding what LST actually represents and how it should be interpreted (Voogt & Oke, 2003). Unlike air temperature, which describes atmospheric conditions at a specific height above ground, LST reflects the thermal state of surface materials such as asphalt, concrete, soil, vegetation, and water (Oke, 1982; Li et al., 2013). These surfaces respond directly to solar radiation and surface energy exchange processes, often exhibiting temperature extremes that differ

substantially from ambient air temperature. Consequently, LST should not be viewed as a direct substitute for air temperature, but rather as a complementary indicator that captures the surface-driven component of urban climate (Voogt & Oke, 2003; Weng, 2009).

Despite this distinction, numerous studies have demonstrated strong relationships between LST patterns and key urban climate phenomena. Elevated surface temperatures contribute to increased sensible heat fluxes, which in turn influence near-surface air temperatures within the urban canopy layer (Oke, 1982; Voogt & Oke, 2003). In this sense, LST plays an indirect but critical role in shaping atmospheric thermal conditions experienced by urban residents. This relationship is particularly pronounced during daytime, when surface heating reaches its maximum and land cover contrasts play a dominant role on thermal behavior (Weng et al., 2004).

Daytime LST has therefore become a focal point in urban climate research. Satellite observations acquired during daytime overpasses capture the cumulative effects of land cover, surface moisture, and material properties on surface heating (Sobrino et al., 2004; Jiménez-Muñoz & Sobrino, 2003). These observations provide valuable insights into where and why urban areas accumulate heat, enabling the identification of thermal hotspots and vulnerable neighborhoods (Oguz, 2017; Zhou et al., 2014). In hot climate cities, daytime surface temperatures are closely linked to heat exposure risks and energy demand, further underscoring the relevance of LST-based analysis (Peng et al., 2012).

Another key reason for the widespread adoption of LST as an indicator for urban climate is its strong association with the Urban Heat Island (UHI) phenomenon. Surface-based UHI analysis, commonly referred to as the Surface Urban Heat Island (SUHI), relies almost exclusively on LST to characterize temperature contrasts between urban and non-urban areas (Weng, 2009; Zhou et al., 2014). SUHI studies have revealed that land cover composition particularly the balance between impervious surfaces and vegetation is a primary determinant of urban thermal intensity (Weng et al., 2004; Bowler et al., 2010). These findings reinforce the value of LST as an indicator of urban climate modification resulting from human activities.

Beyond its application in UHI studies, LST is increasingly used to explore the relationship between urban form and thermal comfort. Although LST does not directly measure human thermal sensation, it provides critical information on surface conditions that influence radiant heat load and near-surface air temperatures (Voogt & Oke, 2003). Areas

with persistently high LST values often correspond to environments with increased thermal discomfort, particularly under conditions of low wind speed and high solar radiation (Weng, 2009). As such, LST has emerged as a practical and accessible indicator for assessing spatial patterns of thermal stress in cities.

The objective of this chapter is to critically examine the use of Land Surface Temperature as an indicator for urban climate and thermal comfort. By synthesizing conceptual foundations and empirical evidence, the chapter aims to clarify what LST can and cannot represent in the context of urban climate analysis (Li et al., 2013; Weng, 2009). Particular attention is given to the role of daytime LST, its relationship with air temperature and urban heat island dynamics, and its potential for informing assessments of urban thermal comfort. Through this focused examination, the chapter seeks to contribute to a scientifically grounded use of LST in urban climate research and planning.

CONCEPTUAL FRAMEWORK

Land Surface Temperature (LST) is a physically grounded variable that reflects the thermal state of the Earth's surface as observed by thermal infrared sensors (Li et al., 2013). In the context of urban climate studies, LST represents the radiative temperature of surface materials such as asphalt, concrete, rooftops, soil, vegetation, and water bodies (Voogt & Oke, 2003). These materials differ substantially in their thermal properties, including albedo, heat capacity, emissivity, and moisture availability, which collectively control how surfaces absorb, store, and release heat (Oke, 1982; Weng, 2009).

At its core, LST is governed by the surface energy balance. Incoming shortwave solar radiation, outgoing longwave radiation, sensible heat flux, latent heat flux, and ground heat flux interact to determine surface temperature at any given moment (Oke, 1982). In urban environments, this balance is strongly modified by anthropogenic surfaces that typically exhibit low albedo, high heat storage capacity, and limited evaporative cooling (Voogt & Oke, 2003; Weng, 2009). As a result, urban surfaces often attain significantly higher daytime LST values compared to surrounding rural or vegetated areas (Weng et al., 2004; Zhou et al., 2014).

What LST represents most effectively is the spatial heterogeneity of surface heating. Unlike point-based meteorological measurements, satellite-derived LST provides spatially continuous information that captures fine-scale thermal contrasts across an entire city (Voogt & Oke, 2003). These contrasts reflect differences in land cover, surface materials,

vegetation density, and surface moisture conditions (Weng et al., 2004). Consequently, LST is particularly well suited for identifying thermal hotspots, mapping surface urban heat island intensity, and examining the cooling effects of green and blue infrastructure (Bowler et al., 2010; Weng, 2009).

However, it is equally important to clarify what LST does not represent. Most notably, LST is not a direct measure of near-surface air temperature. Air temperature is an atmospheric variable typically measured at a height of approximately 2 meters above ground level, whereas LST describes the temperature of the surface itself (Voogt & Oke, 2003). Under strong solar radiation, surface temperatures can exceed air temperatures by several degrees, particularly over impervious materials (Oke, 1982). This divergence is especially pronounced during daytime in summer, when urban surfaces may reach extreme temperatures while air temperature remains comparatively lower (Weng et al., 2004).

The distinction between LST and air temperature has important implications for interpretation. While high LST values indicate intense surface heating, they do not necessarily translate into equivalent air temperature conditions at pedestrian level (Voogt & Oke, 2003). The degree to which surface heat influences air temperature depends on factors such as wind speed, atmospheric stability, urban morphology, and the efficiency of heat transfer from the surface to the atmosphere (Oke, 1982). Therefore, LST should be viewed as an indicator of surface thermal forcing rather than a direct indicator for atmospheric thermal conditions (Weng, 2009).

Another common misconception is the assumption that LST directly represents human thermal comfort. Thermal comfort is a multidimensional concept influenced by air temperature, humidity, wind speed, radiation, clothing, and metabolic activity (Voogt & Oke, 2003). LST captures only one component of this system: the thermal state of surrounding surfaces. Nevertheless, surfaces with high LST contribute to increased radiant heat exposure and sensible heat flux, which can indirectly exacerbate thermal discomfort, particularly in outdoor environments with limited shading and airflow (Weng, 2009). Thus, LST provides valuable contextual information for thermal comfort assessments but cannot replace comprehensive biometeorological indices.

LST is also temporally specific. Satellite observations capture surface temperature at the moment of overpass, typically during mid-morning or early afternoon for sun-synchronous satellites such as Landsat (Sobrino et al., 2004; Jiménez-Muñoz & Sobrino, 2003). These snapshots do not

represent diurnal temperature dynamics and may overlook important nighttime processes, including heat release from urban materials (Oke, 1982). Consequently, LST-based studies must carefully consider acquisition time and avoid overgeneralizing single-date observations (Li et al., 2013).

Despite these limitations, LST remains a powerful and widely used variable in urban climate research when its physical meaning is correctly understood (Li et al., 2013; Weng, 2009). Its strength lies in its ability to reveal how land cover and surface properties structure urban thermal environments. By explicitly acknowledging what LST represents and what it does not, researchers can avoid misinterpretation and use LST more effectively as a proxy for surface-driven components of urban climate.

In this conceptual framework, LST is best interpreted as a bridge between land surface characteristics and urban atmospheric processes. It captures the immediate thermal response of urban surfaces to solar forcing and provides insights into the mechanisms that drive urban heat accumulation (Oke, 1982; Voogt & Oke, 2003). When integrated with complementary data or interpreted within a well-defined theoretical context, LST serves as a robust and scientifically defensible indicator for urban climate analysis (Weng, 2009; Li et al., 2013).

RELATIONSHIP BETWEEN LAND SURFACE TEMPERATURE AND NEAR-SURFACE AIR TEMPERATURE

The relationship between Land Surface Temperature (LST) and near-surface air temperature is central to the interpretation of satellite-based urban climate studies (Voogt & Oke, 2003; Weng, 2009). Although these two variables are often discussed together, they represent fundamentally different components of the urban thermal environment. Understanding their interaction is essential for the appropriate use of LST as an indicator for urban climate conditions (Li et al., 2013).

Near-surface air temperature describes the thermal state of the atmosphere, typically measured at a height of approximately 2 meters above the ground in standardized meteorological conditions (Oke, 1982). In contrast, LST represents the radiative temperature of the Earth's surface, as sensed by thermal infrared satellite instruments (Voogt & Oke, 2003; Sobrino et al., 2004). This distinction implies that LST responds directly to surface energy balance processes, while air temperature reflects the integrated effects of surface heating, atmospheric mixing, and advective processes (Oke, 1982).

During daytime, especially under clear-sky summer conditions, surface materials in urban areas absorb large amounts of solar radiation. Impervious surfaces such as asphalt, concrete, and rooftops typically exhibit low albedo and high heat storage capacity, leading to rapid increases in LST (Weng et al., 2004; Zhou et al., 2014). As a result, daytime LST values in urban environments often exceed near-surface air temperatures by several degrees (Oke, 1982; Voogt & Oke, 2003). This divergence is particularly pronounced in dense urban cores, industrial zones, and transportation corridors where vegetation and surface moisture are limited (Peng et al., 2012).

Despite this difference, numerous studies have demonstrated statistically significant correlations between LST and air temperature, particularly when analyses are conducted across spatial gradients rather than at individual point locations (Voogt & Oke, 2003; Weng, 2009). High-LST zones often correspond to areas with elevated air temperatures, reflecting the influence of surface sensible heat flux on the urban boundary layer (Oke, 1982). However, the strength of this relationship varies depending on land cover type, time of day, and prevailing meteorological conditions (Weng et al., 2004; Li et al., 2013).

The coupling between LST and air temperature is generally stronger during periods of low wind speed and stable atmospheric conditions, when heat exchange between the surface and the overlying air is less disrupted (Oke, 1982). In such cases, intense surface heating contributes to localized warming of the near-surface air, particularly within the urban canopy layer (Voogt & Oke, 2003). Conversely, under windy or unstable conditions, enhanced mixing can weaken the spatial correspondence between surface and air temperatures, reducing the explanatory power of LST for atmospheric conditions (Weng, 2009).

Vegetation plays a critical role in mediating the LST-air temperature relationship. Vegetated surfaces typically exhibit lower LST due to shading and evaporative cooling, which reduces sensible heat flux and limits surface to air heat transfer (Weng et al., 2004; Bowler et al., 2010). As a result, areas with dense vegetation often display both lower LST and lower near-surface air temperatures (Zhou et al., 2014). This shared response strengthens the observed correlation between the two variables in green spaces and agricultural areas. In contrast, impervious surfaces amplify surface–air temperature decoupling by intensifying radiative heating without corresponding atmospheric moderation (Voogt & Oke, 2003).

Temporal scale also influences the relationship between LST and air temperature. Satellite-derived LST represents an instantaneous

observation tied to the satellite overpass time, whereas air temperature is commonly averaged over longer intervals (Sobrino et al., 2004; Jiménez-Muñoz & Sobrino, 2003). Consequently, comparisons between the two must account for temporal mismatches (Li et al., 2013). Studies that aggregate LST across multiple dates or seasons often report stronger and more consistent relationships with air temperature than single date analyses, underscoring the importance of multi-temporal approaches (Weng, 2009).

It is also important to recognize that nighttime conditions exhibit different dynamics. While this chapter focuses primarily on daytime LST, nighttime air temperatures are often more closely linked to the release of stored heat from urban materials (Oke, 1982). Nighttime LST, when available, may therefore show a different and sometimes stronger relationship with air temperature (Voogt & Oke, 2003). However, limitations in nighttime satellite data availability often restrict such analyses (Li et al., 2013).

Overall, the relationship between LST and near-surface air temperature is complex and context-dependent. LST should not be interpreted as a direct substitute for air temperature, but rather as an indicator of surface thermal forcing that contributes to atmospheric heating under specific conditions (Voogt & Oke, 2003; Weng, 2009). When used with an understanding of its physical meaning and limitations, LST provides valuable insights into the spatial structure of urban thermal environments and complements traditional air temperature measurements in urban climate research (Li et al., 2013).

ROLE OF DAYTIME LAND SURFACE TEMPERATURE IN URBAN CLIMATE ANALYSIS

Daytime Land Surface Temperature plays a central role in urban climate analysis because it captures the maximum thermal response of urban surfaces to solar forcing (Voogt & Oke, 2003; Weng, 2009). During daytime, particularly in summer under clear-sky conditions, the contrast between different land cover types is most pronounced. Impervious urban materials absorb and store large amounts of solar radiation, while vegetated and moist surfaces dissipate energy through evapotranspiration (Oke, 1982; Weng et al., 2004). As a result, daytime LST provides a sensitive indicator of how urban structure and land cover regulate surface heating (Li et al., 2013).

Sun-synchronous satellites such as Landsat acquire thermal observations during late morning or early afternoon, a period when

incoming solar radiation is strong and surface energy exchanges are highly active (Sobrino et al., 2004; Jiménez-Muñoz & Sobrino, 2003). This acquisition timing is advantageous for urban climate studies because it coincides with the development phase of daytime heat stress (Voogt & Oke, 2003). Although peak air temperatures may occur later in the afternoon, daytime LST captures the onset and spatial distribution of surface heating that contributes to subsequent atmospheric warming (Oke, 1982).

One of the primary strengths of daytime LST is its ability to amplify spatial thermal contrasts within cities. Built-up areas, industrial zones, transportation corridors, and densely populated neighborhoods often exhibit much higher LST values compared to parks, agricultural lands, and water bodies (Weng et al., 2004; Zhou et al., 2014). These contrasts are essential for identifying surface urban heat island patterns and for distinguishing thermally vulnerable areas at fine spatial scales (Peng et al., 2012).

Daytime LST is particularly effective for evaluating the thermal impact of land cover and land use changes. Urban expansion, vegetation removal, and surface sealing are directly reflected in increased surface temperatures during daylight hours (Weng et al., 2004; Oguz, 2017). By analyzing daytime LST across multiple dates, researchers can assess how urban growth trajectories influence surface heating and identify areas where mitigation strategies may be most urgently needed (Li et al., 2013). This makes daytime LST a valuable tool for monitoring the thermal consequences of urbanization (Weng, 2009).

Another important advantage of daytime LST is its relevance to human heat exposure. Outdoor thermal discomfort during summer is strongly influenced by surface radiation and sensible heat flux from surrounding materials (Oke, 1982; Voogt & Oke, 2003). High LST surfaces contribute to increased radiant heat load, which can exacerbate heat stress even when air temperature differences are modest (Weng, 2009). Consequently, daytime LST maps provide indirect but meaningful information on spatial patterns of thermal stress within urban environments (Peng et al., 2012).

Despite these strengths, the use of daytime LST also requires careful interpretation. Surface temperatures respond rapidly to short term changes in solar radiation, shading, and surface moisture (Li et al., 2013). Ephemeral factors such as cloud cover, irrigation, or recent rainfall can influence LST patterns and may not reflect long-term thermal characteristics (Sobrino et al., 2004). Therefore, robust urban climate

analyses typically rely on multi-temporal daytime observations rather than single-date imagery to ensure representativeness (Weng, 2009).

Furthermore, daytime LST does not capture nighttime heat retention processes that are critical to understanding nocturnal urban heat island effects. Urban materials release stored heat after sunset, influencing nighttime air temperatures and human comfort during sleeping hours (Oke, 1982). While nighttime thermal data are valuable for comprehensive urban climate assessments, limitations in spatial resolution and data availability often constrain their use (Voogt & Oke, 2003; Li et al., 2013). In this context, daytime LST remains the most accessible and widely used indicator for surface-based urban climate analysis (Weng, 2009).

In summary, daytime Land Surface Temperature serves as a powerful lens through which the thermal structure of cities can be examined. Its sensitivity to land cover, surface properties, and solar forcing makes it particularly suited for identifying heat hotspots, evaluating urban heat island intensity, and assessing the thermal implications of urban design (Weng et al., 2004; Zhou et al., 2014). When interpreted within its temporal and physical context, daytime LST provides essential insights into the mechanisms driving urban thermal environments (Voogt & Oke, 2003; Li et al., 2013).

URBAN HEAT ISLAND CONCEPT FROM A LAND SURFACE TEMPERATURE PERSPECTIVE

The Urban Heat Island (UHI) phenomenon describes the temperature difference between urban areas and their surrounding rural environments, traditionally based on near-surface air temperature measurements (Oke, 1982). While atmospheric UHI studies have provided valuable insights into urban climate dynamics, the advent of thermal remote sensing has introduced a complementary and increasingly influential perspective: the Surface Urban Heat Island (SUHI) (Voogt & Oke, 2003; Weng, 2009). From this perspective, Land Surface Temperature serves as the primary variable for characterizing urban-rural thermal contrasts (Peng et al., 2012; Zhou et al., 2014).

LST-based SUHI analysis focuses on the thermal behavior of urban surfaces rather than the atmosphere. This distinction is critical, as surface materials are the initial recipients of solar radiation and play a fundamental role in shaping urban thermal environments (Oke, 1982; Voogt & Oke, 2003). Impervious materials commonly found in cities such as asphalt, concrete, and rooftops exhibit thermal properties that promote heat accumulation during daytime (Weng et al., 2004). In contrast,

vegetated and moist surfaces dissipate energy more efficiently through evapotranspiration, resulting in lower surface temperatures (Bowler et al., 2010). These differences create distinct spatial patterns that are clearly captured by LST (Weng, 2009).

One of the major advantages of using LST to analyze urban heat islands is its capacity to reveal fine-scale spatial heterogeneity. Traditional air temperature measurements, limited to discrete monitoring stations, often fail to represent the complex thermal mosaic of urban landscapes (Voogt & Oke, 2003). LST maps, by contrast, provide wall-to-wall coverage that highlights intra-urban temperature gradients and identifies localized heat hotspots (Weng et al., 2004; Oguz, 2017). These hotspots frequently coincide with densely built-up districts, industrial zones, and transportation infrastructure, making SUHI analysis particularly relevant for urban planning and risk assessment (Peng et al., 2012).

From an LST perspective, the intensity of the urban heat island is strongly controlled by land cover composition. Numerous studies have demonstrated that areas with high proportions of impervious surfaces consistently exhibit elevated LST values, while green spaces, water bodies, and agricultural lands function as surface cool islands (Weng et al., 2004; Zhou et al., 2014). The spatial comparison of these contrasting surfaces generates sharp thermal gradients that define the structure of the SUHI (Weng, 2009). As a result, SUHI intensity is not uniform across a city but varies according to land use patterns and urban morphology (Peng et al., 2012).

LST-based SUHI analysis also enables the classification of urban areas into thermal intensity zones. By categorizing surface temperatures into relative classes, researchers can delineate zones of low, moderate, and high thermal stress (Weng, 2009). These zones provide a practical framework for assessing urban vulnerability and for targeting mitigation strategies (Bowler et al., 2010). In hot-climate cities, high-intensity SUHI zones often overlap with socioeconomically vulnerable neighborhoods, underscoring the importance of integrating thermal data into urban equity and resilience planning (Peng et al., 2012).

Temporal analysis further enhances the understanding of SUHI dynamics. Multi-date LST observations reveal how SUHI intensity fluctuates across seasons and under different meteorological conditions (Li et al., 2013). Daytime SUHI patterns are typically more pronounced during summer, when solar forcing is strongest and vegetation stress may reduce cooling efficiency (Weng et al., 2004; Zhou et al., 2014). By contrast, cooler seasons often exhibit weaker surface temperature contrasts. This

temporal variability highlights the need for multi-temporal approaches when assessing urban heat islands using LST (Weng, 2009).

While LST-based SUHI provides valuable insights, it is important to distinguish it from atmospheric UHI. Surface temperature differences do not directly equate to air temperature differences, particularly during daytime (Voogt & Oke, 2003). Nevertheless, SUHI analysis captures the surface processes that drive urban heating and contribute to atmospheric warming (Oke, 1982). In this sense, LST-based approaches offer a complementary perspective that enriches the broader understanding of urban heat island mechanisms (Weng, 2009; Li et al., 2013).

In conclusion, the urban heat island concept viewed through the lens of Land Surface Temperature emphasizes the role of surface properties and land cover in shaping urban thermal environments. By revealing spatial patterns of surface heating and identifying thermally critical zones, LST-based SUHI analysis provides a robust foundation for evaluating urban heat risks and informing climate-sensitive urban planning strategies (Peng et al., 2012; Zhou et al., 2014).

POTENTIALS AND CONSTRAINTS OF LAND SURFACE TEMPERATURE AND URBAN THERMAL COMFORT

Urban thermal comfort refers to the degree to which outdoor environmental conditions are perceived as comfortable by humans. It is influenced by a complex interaction of meteorological, physical, and physiological factors, including air temperature, humidity, wind speed, solar and terrestrial radiation, clothing insulation, and metabolic activity (Oke, 1982; Voogt & Oke, 2003). Within this multifaceted framework, Land Surface Temperature occupies a distinctive position as an indicator of surface thermal conditions rather than a direct measure of human thermal sensation (Weng, 2009).

The primary contribution of LST to urban thermal comfort assessment lies in its ability to characterize the thermal behavior of surfaces that shape the radiative environment (Voogt & Oke, 2003). Surfaces with high LST emit greater amounts of longwave radiation and contribute to increased radiant heat load experienced by pedestrians (Oke, 1982). In outdoor urban spaces with limited shading and low wind speeds, this additional radiative burden can significantly intensify thermal stress, even when near-surface air temperatures are moderate (Weng, 2009). As such, areas exhibiting persistently high LST values are often associated with heightened levels of thermal discomfort (Peng et al., 2012).

Daytime LST is particularly relevant for assessing heat exposure in cities during summer conditions. High solar radiation and elevated surface temperatures coincide with periods when outdoor activities are most common and heat-related health risks are elevated (Peng et al., 2012; Zhou et al., 2014). LST maps derived from satellite imagery provide spatially explicit insights into where surface-driven heat stress is likely to be most severe (Weng, 2009). This information is valuable for identifying thermally vulnerable neighborhoods, evaluating the cooling performance of green spaces, and prioritizing heat mitigation interventions (Bowler et al., 2010).

Vegetation plays a central role in mediating the relationship between LST and thermal comfort. Shaded and vegetated surfaces typically exhibit lower LST due to reduced solar absorption and enhanced evapotranspiration (Weng et al., 2004). These processes not only lower surface temperatures but also reduce radiant heat load and, in some cases, improve local microclimatic conditions (Oke, 1982). Consequently, urban areas with extensive tree canopy cover and green infrastructure tend to offer more thermally comfortable outdoor environments, a pattern that is consistently reflected in LST observations (Bowler et al., 2010; Zhou et al., 2014).

Despite these strengths, LST has important limitations as a proxy for thermal comfort. Most critically, LST does not account for atmospheric variables such as humidity and wind speed, which strongly influence human thermal perception (Voogt & Oke, 2003). High humidity can increase heat stress even in areas with relatively moderate surface temperatures, while strong airflow can alleviate discomfort in high-LST environments by enhancing convective heat loss (Oke, 1982). Therefore, LST alone cannot capture the full spectrum of factors that determine thermal comfort (Weng, 2009).

Another limitation relates to the vertical and spatial scale of LST observations. Satellite-derived LST represents the temperature of the surface viewed from above, which may differ from the thermal conditions experienced at pedestrian height within urban canyons (Voogt & Oke, 2003). Urban morphology, including building height, street orientation, and shading patterns, can significantly modify radiant and convective heat exchange at the human level (Oke, 1982). These micro-scale processes are not directly resolved by satellite LST data, particularly at moderate spatial resolutions (Li et al., 2013).

Furthermore, the instantaneous nature of satellite LST observations constrains their representation of temporal variability in thermal comfort.

Thermal discomfort evolves throughout the day in response to changing solar angles, surface heating, and atmospheric conditions (Weng, 2009). A single LST snapshot captures only one moment within this dynamic process. Consequently, robust assessments of thermal comfort based on LST typically require multi-temporal observations or integration with complementary datasets (Sobrino et al., 2004; Li et al., 2013).

In light of these considerations, LST should be regarded as an indicator of urban thermal comfort rather than a direct measure. Its greatest value lies in revealing spatial patterns of surface heat that contribute to thermal stress and in highlighting the role of land cover in shaping urban microclimates (Voogt & Oke, 2003; Weng, 2009). When interpreted within its physical and methodological constraints, LST provides meaningful insights that can support broader assessments of urban heat exposure and guide climate-sensitive urban design (Bowler et al., 2010; Peng et al., 2012).

MULTI-TEMPORAL LAND SURFACE TEMPERATURE ANALYSIS

Multi-temporal analysis of Land Surface Temperature provides a robust framework for examining the spatial and temporal dynamics of urban thermal environments (Weng, 2009; Li et al., 2013; Oguz, 2020). Rather than relying on a single-date snapshot, multi-temporal LST analysis captures variations in surface heating across different periods, allowing for a more representative assessment of urban thermal behavior. This approach is particularly important in urban climate studies, where surface temperatures are influenced by seasonal conditions, land cover dynamics, and short-term meteorological variability (Voogt & Oke, 2003).

The general methodology for multi-temporal LST analysis involves the selection of cloud-free satellite images acquired during comparable seasonal and atmospheric conditions (Sobrino et al., 2004; Oguz, 2017). Daytime thermal infrared data from sensors such as Landsat are commonly used due to their moderate spatial resolution and long-term data continuity (Jiménez-Muñoz & Sobrino, 2003; Li et al., 2013). By processing multiple images using consistent retrieval algorithms, it becomes possible to compare LST patterns across time and to identify persistent thermal structures within the urban landscape (Oguz, 2022).

Once LST maps are generated, spatial distribution analysis forms the foundation of interpretation. LST values are typically classified into relative temperature categories, such as low, moderate, and high temperature zones, based on statistical thresholds or quantile-based

approaches (Weng, 2009). These classifications allow for the identification of surface heat concentration areas and facilitate comparison between different time periods (Weng et al., 2004). Areas that consistently fall within the highest temperature classes can be interpreted as stable surface heat hotspots, while areas with lower LST values often correspond to vegetated or moisture-rich environments (Bowler et al., 2010).

An important analytical step in multi-temporal studies is the delineation of surface urban heat island intensity zones. By comparing LST values between urban and non-urban reference areas, relative thermal anomalies can be quantified (Voogt & Oke, 2003). This approach highlights the spatial structure of the surface urban heat island and reveals how its intensity varies across the city (Weng, 2009; Zhou et al., 2014). In many cases, the strongest thermal anomalies are observed in densely built-up districts, industrial zones, and areas with extensive impervious surfaces (Peng et al., 2012).

The relationship between LST and urban green spaces is another key focus of multi-temporal analysis. Vegetated areas such as parks, urban forests, agricultural lands, and river corridors consistently exhibit lower LST values compared to surrounding built-up areas (Weng et al., 2004; Bowler et al., 2010). By analyzing LST patterns across multiple dates, the persistence and stability of these cooling effects can be evaluated (Zhou et al., 2014). Larger and more contiguous green spaces typically generate stronger and more spatially extensive cooling effects, while smaller or fragmented green areas may provide localized but limited thermal relief (Bowler et al., 2010; Weng, 2009).

IMPLICATIONS FOR URBAN CLIMATE ASSESSMENT AND PLANNING

The use of Land Surface Temperature as a proxy for urban climate has important implications for urban climate assessment and spatial planning (Weng, 2009; Li et al., 2013). LST-based analysis offers a spatially explicit and operationally accessible approach to identifying thermal patterns within cities, enabling planners and decision-makers to better understand how land cover, urban form, and surface materials influence urban heat distribution (Voogt & Oke, 2003). When appropriately interpreted, LST provides a valuable evidence base for climate-sensitive urban development (Oke, 1982).

One of the primary planning applications of LST analysis lies in the identification of urban heat hotspots. High-LST zones often correspond to densely built-up areas with extensive impervious surfaces and limited

vegetation (Weng et al., 2004; Zhou et al., 2014). These areas are typically more vulnerable to heat stress and may coincide with populations at increased risk, such as the elderly or low-income communities (Peng et al., 2012). By mapping these hotspots, urban planners can prioritize interventions and allocate resources more effectively to reduce heat exposure and improve thermal resilience (Weng, 2009).

LST-based assessments also highlight the critical role of green and blue infrastructure in regulating urban thermal environments. Parks, urban forests, agricultural lands, and water bodies consistently exhibit lower surface temperatures and function as cooling elements within the urban fabric (Weng et al., 2004; Bowler et al., 2010). Planning strategies that preserve existing green spaces and promote the creation of new vegetated areas can significantly enhance urban thermal comfort (Bowler et al., 2010). Importantly, LST analysis demonstrates that the spatial configuration, size, and connectivity of green spaces influence their cooling effectiveness, suggesting that strategic placement is as important as overall green space coverage (Weng, 2009; Zhou et al., 2014).

Another key implication concerns land use planning and zoning. LST maps reveal how different land use categories contribute to surface heating, providing empirical support for climate-responsive zoning regulations (Weng et al., 2004; Li et al., 2013). For example, industrial and commercial zones characterized by high surface temperatures may benefit from targeted mitigation measures such as increased tree canopy cover, reflective materials, or permeable surfaces (Oke, 1982; Bowler et al., 2010). Integrating LST data into zoning decisions allows planners to evaluate the thermal consequences of alternative land use scenarios and to design urban layouts that minimize heat accumulation (Weng, 2009).

LST analysis also supports the evaluation of urban design and redevelopment projects. By comparing LST patterns before and after land cover changes, planners can assess the thermal impacts of urban expansion or regeneration initiatives (Oguz, 2017; Li et al., 2013). This capability is particularly valuable in rapidly growing cities, where development decisions made today will shape thermal conditions for decades (Peng et al., 2012). LST-derived indicators can serve as benchmarks for assessing the effectiveness of heat mitigation strategies and for monitoring progress toward climate adaptation goals (Weng, 2009).

Despite its strengths, the integration of LST into urban planning requires careful consideration of its limitations. LST should not be interpreted as a direct measure of human thermal comfort or air temperature, and planning decisions should be informed by complementary climatic and

socio-environmental data where possible (Voogt & Oke, 2003; Li et al., 2013). Nevertheless, when used as part of a multi-indicator framework, LST provides a robust and scalable foundation for urban climate assessment (Weng, 2009).

In summary, LST-based analysis offers a practical and scientifically grounded tool for supporting urban climate assessment and planning. By revealing spatial patterns of surface heating and highlighting the cooling role of green infrastructure, LST contributes to evidence-based planning strategies aimed at reducing heat vulnerability and enhancing the thermal resilience of urban environments (Bowler et al., 2010; Zhou et al., 2014).

CONCLUSIONS

LST provides a unique perspective on urban climate by capturing the immediate thermal response of surface materials to solar forcing (Oke, 1982). Unlike traditional point-based air temperature measurements, satellite-derived LST offers spatially continuous information that reveals fine-scale thermal heterogeneity across cities (Voogt & Oke, 2003; Weng, 2009). This capability makes LST particularly valuable for identifying surface urban heat island patterns, mapping heat hotspots, and evaluating the cooling effects of vegetation and water bodies (Weng et al., 2004; Zhou et al., 2014).

At the same time, the chapter has underscored that LST is not a direct substitute for near-surface air temperature or human thermal comfort (Voogt & Oke, 2003). The relationship between surface temperature and atmospheric conditions is complex and influenced by factors such as wind, urban morphology, and atmospheric stability (Oke, 1982). Consequently, LST should be interpreted as an indicator of surface thermal forcing rather than a comprehensive measure of urban thermal experience (Weng, 2009). Recognizing this distinction is essential for avoiding misinterpretation and for ensuring scientifically sound applications (Li et al., 2013).

The emphasis on daytime LST reflects its particular relevance for urban climate analysis. Daytime observations capture the period of maximum surface heating and strongest land cover contrasts, providing critical insights into the processes that drive urban heat accumulation (Voogt & Oke, 2003; Weng et al., 2004). When analyzed across multiple dates, daytime LST reveals persistent thermal structures that are closely linked to urban form and land use patterns (Weng, 2009; Zhou et al., 2014).

The general case study framework presented in this chapter illustrates how multi-temporal LST analysis can be applied to cities in hot climates to assess urban heat distribution and green space cooling effects (Oguz,

2017; Li et al., 2013). By combining general methodological principles, the chapter demonstrates the transferability and scalability of LST-based approaches for urban climate assessment (Weng, 2009).

From a planning and policy perspective, LST-based analysis offers a practical and evidence-based foundation for climate-sensitive urban development (Bowler et al., 2010; Peng et al., 2012). By identifying thermally vulnerable areas and highlighting the cooling role of green infrastructure, LST supports targeted heat mitigation strategies and informed land use decisions (Zhou et al., 2014). While complementary data are needed for comprehensive thermal comfort assessments, LST remains a powerful and accessible indicator for urban heat analysis (Voogt & Oke, 2003; Weng, 2009).

In conclusion, Land Surface Temperature serves as a robust proxy for surface-driven components of urban climate. When used with a clear understanding of its physical meaning and limitations, LST contributes valuable insights into urban heat dynamics and supports the development of more resilient and thermally sustainable cities (Oke, 1982; Li et al., 2013).

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Chapter 12

THE IMPACTS OF CLIMATE CHANGE ON BIOCLIMATIC COMFORT: CONCEPTUAL FRAMEWORK, INDICES, AND ADAPTATION STRATEGIES

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1. Introduction

Climate change is becoming an urgent global problem affecting various aspects of social life, and its impacts on the physical environment and socio-economic structures pose a significant threat to human health (Chiabai et al., 2018; Das et al., 2024; Karaelmas et al., 2025; Bera and Nag, 2026). Rising global temperatures, changes in precipitation regimes, and an increase in extreme weather events are among the main consequences of climate change; this process leads to a gradual increase in environmental stress factors (Ndetto and Matzarakis, 2015; Yahia et al., 2018; Windarto et al., 2024). With changing climate conditions, the increasing frequency of extreme weather events such as storms, extreme temperatures, floods, droughts, and wildfires is having a decisive impact on human life, health, and daily activities, leading to increased mortality rates, spread of diseases, and deepening health crises (Das et al., 2024; Bera and Nag, 2026).

Climate change is causing many problems in urban environments (Cengiz, 2013; Karakounos et al., 2018). Climate change exposes urban areas to multifaceted climatic pressures, creating varying effects depending on the geographical location of cities (Opoku-Boateng et al., 2024; Bera and Nag, 2025). Climate change vulnerability varies by sector and region, reflecting differing levels of exposure, sensitivity, and capacity for adaptation (Windarto et al., 2024). The accelerated urbanization and increasing population density that accompany this process significantly affect bioclimatic comfort conditions, which are determined by the interaction of temperature, relative humidity, wind speed, and solar radiation (Cengiz and Boz, 2020; Çelekli et al., 2023). In particular, dense construction and the destruction of natural vegetation are causing heat or cold stress in some urban areas, negatively altering bioclimatic comfort conditions (Bera and Nag, 2025). In this context, rapid urbanization processes stand out as one of the main factors that make the sustainability of urban bioclimatic comfort increasingly difficult in different climate types (Çelekli et al., 2023; Bera and Nag, 2025). Through altering the urban thermal balance, urbanization exerts negative effects on environmental quality, aesthetics, energy efficiency, human health, and residents' quality of life (Çelekli et al., 2023).

In the context of urbanization, comfort zones refer to geographical, social, and cultural settings in which individuals feel comfortable, safe, and secure (Çelekli et al., 2023). As one moves from rural areas towards the city center, afternoon temperatures rise due to increased land use density, while green spaces have a mitigating effect on temperature. Urbanization can significantly impact meteorological conditions by altering regional

air circulation and energy balance (Li et al., 2019). Due to the resulting urban heat island effect, air temperatures observed in urban areas are generally higher compared to surrounding rural areas, and this spatial temperature differentiation is schematically shown in Figure 1 (Jha et al., 2011, Li et al., 2019; Çelekli et al., 2023).

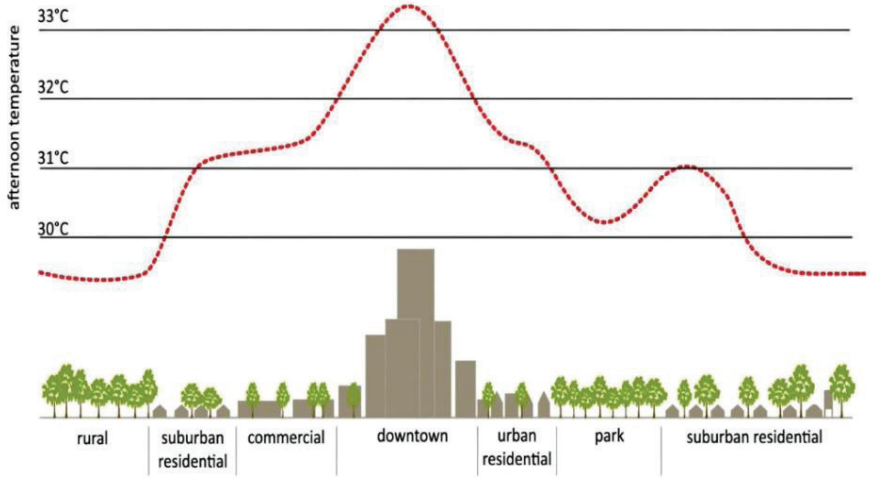

Figure 1. *The impact of urbanization on air temperature (Jha vd., 2011; Çelekli vd., 2023)*

Bioclimatic comfort refers to the optimal climate conditions in which an individual adapts to environmental conditions with minimum energy consumption and feels healthy, comfortable, and dynamic (Mazhar et al., 2015). Urbanization dynamics significantly affect bioclimatic comfort levels in urban areas (Çelekli et al., 2023). Today, especially in densely built-up cities, the creation of unsuitable bioclimatic conditions can lead to negative effects on people's physical and psychological health, as well as their work productivity (Metin, 2023). The growing occurrence of heat waves in urban areas intensifies the urban heat island effect and poses greater risks to human health and thermal comfort (He et al. 2022; Bera and Nag, 2025). The continuous development of cities and insufficient attention to urban planning profoundly affect the urban microclimate; the urban heat island effect, driven by intense anthropogenic modification of the environment, results in elevated air temperatures, thereby affecting human comfort and health (Mazhar et al., 2015; Salata et al., 2016).

Urbanization has significant effects on bioclimatic comfort conditions, defined by the interaction of temperature, relative humidity, wind speed, and solar radiation, which determine the heat balance of the human body. The close relationship between these conditions and human

health, meteorological processes, energy consumption, and urban quality of life has led to bioclimatic comfort becoming an increasingly important focus worldwide (Çelekli et al., 2023). To create suitable living spaces for human health, planned urbanization approaches are necessary, and bioclimatic comfort stands out as one of the fundamental and determining parameters in this process (Mirza, 2014; He et al., 2022). In this context, considering the effects of climate change and urbanization on urban bioclimatic comfort is a critical requirement for planning healthy, livable, and sustainable cities.

This study examines the effects of increasing thermal stress conditions due to climate change on bioclimatic comfort in urban areas within the context of conceptual frameworks, bioclimatic indices, and adaptation strategies. By highlighting the importance of bioclimatic comfort for human health and urban sustainability, the study aims to provide assessments for developing climate-sensitive urban planning and design approaches.

2. Conceptual Framework of Bioclimatic Comfort

Bioclimatic comfort is defined as the state in which environmental parameters coexist in an environment where humans can adapt to climatic conditions with minimal energy expenditure and without disrupting metabolic balance (Olgyay, 1973; Çınar, 2004; Çağlak, 2021; Sancar, 2022). This approach is based on the thermo-physiological effects of climatic elements on the human body (Mirza, 2014). It evaluates comfort conditions through the individual or combined effects of parameters such as temperature, relative humidity, wind, and solar radiation (Çınar, 2004; Lim et al., 2008; Mirza, 2014).

The bioclimatic comfort approach was first defined in the modern research literature by Victor and Aladar Olgyay in their book "Design with Climate: A Bioclimatic Approach to Architectural Regionalism," published in 1973 (Olgyay, 1973; Attia, 2021; Beqqal et al., 2021). Bioclimatic comfort developed alongside thermal comfort studies; the first comprehensive bioclimatic maps and comfort graphs were also proposed by Olgyay (1973). These graphs defined comfort ranges depending on the combination of climatic parameters such as temperature, humidity, wind, and radiation (Olgyay, 1973; Özdeniz, 1991). By systematically addressing the effects of climatic parameters on human thermal comfort and spatial design, it formed the basis of the bioclimatic design discipline.

Bioclimatic comfort is shaped by the combined effect of environmental and personal factors. Environmental factors include air temperature,

relative humidity, wind, radiation, and topography and surface characteristics (Mirza, 2014; Ülker, 2025). These parameters play a fundamental role in determining microclimatic conditions in urban spaces. Personal factors consist of elements such as an individual's metabolic thermoregulation capacity, activity level, and clothing insulation (Olgyay, 1973; Mirza, 2014; Ülker, 2025). Environmental conditions directly affect the perceived level of comfort by humans.

Bioclimatic comfort is defined by a combination of air temperature of 21-27.5 °C, relative humidity of 30-65%, and wind speed up to 5 m/s in open spaces, and these ranges are commonly used in bioclimatic assessments (Olgyay, 1973; Çınar, 2004; Mirza, 2014). Human-perceived temperature is not a single atmospheric variable but rather the result of the combined effect of climatic elements such as humidity, wind, cloud cover, and sunshine. Therefore, it is considered a fundamental indicator in the assessment of bioclimatic comfort in urban spaces (Toy, 2010; Mirza, 2014). The bioclimatic comfort approach is based on an individual's capacity to maintain body heat balance by adapting to environmental conditions.

In the context of bioclimatic comfort, adaptation encompasses all processes aimed at reducing the mismatch between environmental conditions and physiological and psychological needs. Nikolopoulou and Steemers (2003) address adaptation under three main headings: behavioral/physical adaptation, which individuals achieve through behavioral and environmental adjustments; physiological adaptation, which refers to changes in thermophysiological responses as a result of repeated exposures; and psychological adaptation, which includes knowledge, experience, expectations, and cultural factors that influence the perception of the environment. This approach suggests that thermal comfort should be evaluated not only in terms of physical environmental conditions but also in conjunction with individual perceptions and contextual factors (Antonini et al., 2020). Bioclimatic comfort has been proven to be a fundamental component of a vital and functional external environment. Ensuring bioclimatic comfort in built environments is essential to safeguard user well-being and productivity (Achouri et al., 2024).

Assessing human thermal perception requires a holistic approach that takes into account the dynamic and subjective nature of environmental stimuli. The perception of thermal comfort is shaped not only by objective biometeorological parameters but also by individuals' physiological, psychological, and behavioral adaptation processes. Therefore, a multidimensional framework encompassing physical, physiological, psychological, and social/behavioral dimensions is necessary for a realistic assess-

ment of outdoor bioclimatic comfort in particular. This approach allows for a more accurate understanding of the relationship between microclimatic conditions and user perception through measurement, modeling, and field data (Antonini et al., 2020; Matzarakis, 2021).

Over the past two decades, numerous studies, encompassing both controlled experiments in climate chambers and direct field research, have aimed to incorporate the human dimension into bioclimatic comfort assessments. While some of these studies address potential adaptation processes from a thermophysiological perspective (Ketterer and Matzarakis, 2014), others focus on psychological and behavioral parameters that determine the perception of thermal comfort (Antonini et al., 2020). This literature clearly demonstrates the necessity of a holistic approach to human-climate-space interaction in the assessment of bioclimatic comfort.

3. Determinants of Climate Change on Bioclimatic Comfort

3.1. Increased Air Temperature and Heat Stress

Increased air temperature is a direct factor affecting bioclimatic comfort. High temperatures negatively impact human health and thermal satisfaction by increasing heat stress levels (Su et al., 2025). Rising global average temperatures and more frequent and intense heat waves increase human thermal stress and have negative consequences for quality of life and health in outdoor environments (Antoniou et al., 2024). High air temperatures strain the body's thermoregulation ability and make it difficult to maintain heat balance (Antoniou et al., 2024; Su et al., 2025). This leads to increased heat stress levels and a narrowing of thermal comfort limits (Antoniou et al., 2024).

Rising temperatures due to climate change, especially when combined with the urban heat island effect, further intensify the pressure on thermal comfort (Ullah et al., 2024). Increased average temperatures and extreme heat events correspond to high thermal stress categories in indices such as Physiological Equivalent Temperature (PET) and Universal Thermal Climate Index (UTCI) (Antoniou et al., 2024; Ullah et al., 2024; Su et al., 2025). Consequently, many studies have shown that as temperatures rise, PET and UTCI values increase, leading to increased thermal stress and narrower comfort ranges for people.

3.2. Changes in Relative Humidity and Wind Regimes

Climate change significantly affects atmospheric water vapor dynamics and air currents, leading to changes in relative humidity and wind

regimes. Observational and model-based analyses show both increasing and decreasing trends in relative humidity in some regional areas, and these trends are linked to changes in moisture sources and thermodynamic processes in broader climate systems (Jones and Ricketts, 2022). These changes directly affect thermal comfort conditions.

Atmospheric parameters such as relative humidity and wind speed are factors that directly play a role in determining human thermal comfort (Mendes et al., 2025). Wind regimes are also a determining factor on thermal comfort. In outdoor thermal comfort studies, wind speed alters perceived temperature by increasing heat transfer in the environment or reducing the effects of solar radiation; high wind speeds improve comfort, especially in hot and humid conditions, while low speeds may negatively affect comfort (Achouri et al., 2024). Therefore, modern bioclimatic comfort indices (UTCI-PET, etc.) evaluate parameters such as temperature, relative humidity, and wind together in measurements and classify the microclimatic conditions created by these factors as suitable or uncomfortable for humans (Mendes et al., 2025). In this context, changes in relative humidity and wind regimes are important not alone, but interactively with temperature in determining bioclimatic comfort. Changes in these two parameters are of strategic importance for understanding the spatial and temporal effects of climate change, environmental risk management, and bioclimatic comfort analysis.

3.3. Solar Radiation and Average Radiant Temperature

While some of the radiation originating from the sun enters the atmosphere, some of the radiation entering the atmosphere is reflected back from the Earth's surface, and some is absorbed and retained by the atmosphere and the Earth's surface (Mirza, 2014). There is always a balance between incoming and outgoing radiation from the sun (Figure 2). The energy coming from the sun via short-wave radiation primarily heats the Earth's surface, and these heated surfaces, in turn, heat the atmosphere from below upwards through convection. In addition, the radiation reflected from the surfaces contributes to the heating of the atmosphere, and these processes are defined as direct radiation and reflected/diffuse radiation effects, respectively (Toy, 2010). All of these radiation parameters have a significant impact on bioclimatic comfort.

Solar radiation is a strong factor influencing the thermal load experienced by humans, and the effect of emitted radiation is measured by mean radiant temperature (MRT) (Toy, 2010; Jing et al., 2024; Mandic et al., 2024). MRT represents the total radiant energy emitted from all surrounding surfaces, more accurately expressing the temperature perce-

ived by humans (Mandic et al., 2024). Therefore, solar radiation and the resulting MRT values are critically important in assessing thermal stress, especially in open areas exposed to prolonged sunlight.

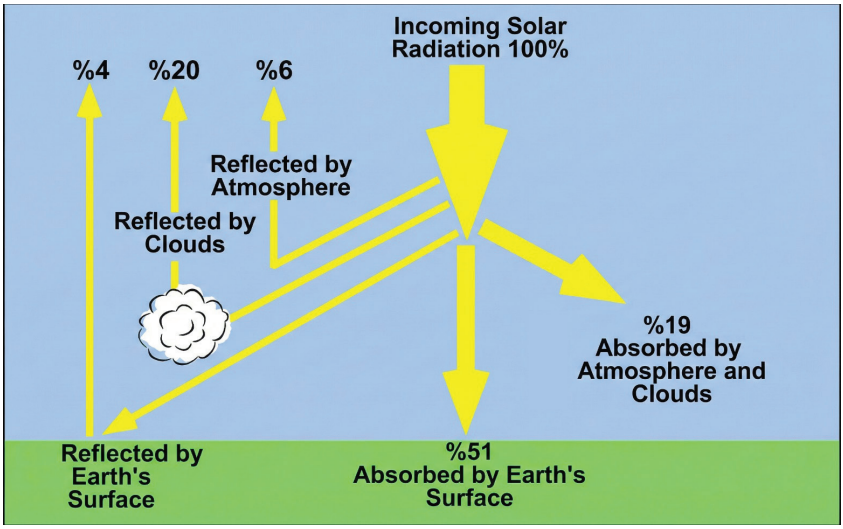

Figure 2. *Interaction of Solar Radiation with the Atmosphere and Earth's Surface (URL-1, 2025)*

3.4. Personal Factors

Physiological characteristics and behaviors of individuals also play an important role in determining bioclimatic comfort. Personal factors consist of variables such as metabolic heat production, skin temperature and moisture content, and the thermal insulation effect of clothing, and directly affect the responses of the human body to environmental conditions (Toy, 2010; Mirza, 2014; Ülker, 2025). Metabolic heat is one of the fundamental components of the human body's heat balance model and refers to the amount of heat produced as a result of the body's physiological activities. This heat production consists of heat generated during the involuntary activities of internal organs and muscle movement. Some studies indicate that metabolic heat can also be indirectly affected by factors such as an individual's nutritional status and the food and beverages they consume (Toy, 2010; Ülker, 2025). Skin temperature and skin moisture are physiological parameters that apply to parts of the human body not covered by clothing and directly affect thermal perception. These variables are particularly important in some bioclimatic comfort calculations because they reflect heat loss, especially through sweating and evaporation. The temperature and moisture levels at the skin surface are among

the key factors determining how an individual perceives environmental conditions (Toftum et al., 1998; Toy, 2010).

Clothing is a key personal factor that regulates heat exchange between the human body and its surrounding environment. The enveloping or insulating effect of clothing plays a decisive role in thermal comfort by controlling heat loss from the body (Toy, 2010). In heat balance models, this effect is considered as a numerical variable and expressed in the unit "clo". The clo value represents the permeability resistance of the clothing to heat, and this value increases as the thickness of the clothing increases (Toy, 2010; Mirza, 2014; Ülker, 2025). The human body constantly exchanges heat with its environment to maintain energy balance. This process is shaped by the combined effect of metabolic activity, physical activity level, and environmental conditions. During activities such as walking, running, or strenuous physical work, the metabolic rate increases, and consequently, energy consumption rises. This directly affects an individual's capacity to adapt to environmental conditions and their perception of thermal comfort. Therefore, considering the activity level in bioclimatic comfort assessments is of great importance for the accurate analysis of human-environment interaction (Ülker, 2025).

4. Bioclimatic Comfort Indices and Evaluation Methods

Bioclimatic indices are models developed based on experimental findings to reveal the effects of atmospheric conditions on the human organism (Mirza, 2014). The number of indices aimed at determining comfort conditions has increased since the 1960s due to technological advancements, and numerous bioclimatic indices have been developed taking into account the climatic characteristics of different geographical regions. Commonly used thermal indices include: PET, UTCI, Estimated Mean Vote (PMV), Effective Temperature (ET), Standard Effective Temperature (SET) or Outdoor Standard Effective Temperature (Out SET), and Perceived Temperature (PT) are all examples of temperature parameters (Gagge, 1986; Mayer, 1987; Höppe, 1999; Matzarakis, 1999; Spagnolo, 2003; Jendritzky et al., 2012; Mirza, 2014; Matzarakis, 2021). The most commonly used indices in the literature for bioclimatic comfort assessments are PET and bioclimatic comfort indices, which are frequently used in studies and are presented in Table 1 (Antoniou et al., 2024; Achouri et al., 2024). Furthermore, bioclimatic comfort indices can be categorized according to the factors they take into account, such as physiological, environmental, or adaptive responses (Achouri et al., 2024).

Table 1. *Most commonly used bioclimatic comfort indices (Achouri et al., 2024)*

Indexes	Definition	Integrated parameters
PET	It is suitable for evaluating thermal comfort in urban microclimates. It considers the intricate relationships between climatic conditions and human responses, incorporating both meteorological and thermophysical parameters. It provides an equivalent temperature at which a person would feel comfortable under specific outdoor conditions. It represents the perceived temperature in a standard indoor environment.	• Air temperature • Average radiation temperature • Relative humidity • Wind speed • Activity level • Clothing insulation • Heat exchange mechanisms in other factors
UTCI	It is regarded as the most advanced thermoregulation model, as it incorporates a comprehensive set of parameters to deliver a holistic evaluation of thermal conditions. It reflects how the human body reacts to different climatic conditions. It is used in all climates, from cold to hot.	• Air temperature • Average radiation temperature • Wind speed • Relative humidity • Physical activity and clothing insulation
PMV	Developed by Fanger, this method assesses thermal comfort by considering a combination of environmental and human factors and estimates the average thermal perception of a large group on a 7-point scale.	• Air temperature • Average radiation temperature • Wind speed • Relative humidity • Metabolism rate and clothing insulation
ET	is a thermal comfort index that integrates air temperature and humidity to represent the temperature perceived by the human body. The new ET* offers a more comprehensive method for assessing thermal comfort in both outdoor and indoor environments, taking air velocity into account.	• Air temperature • Average radiation temperature • Wind speed (in ET* units) • Relative humidity
SET	This is a comprehensive measure used in thermal comfort studies, representing both the human thermal experience and the temperature of a hypothetical, isothermal indoor environment. It is used particularly in studies evaluating the effects of thermal stress on humans in various climates, both indoors and outdoors.	• Air temperature • Moisture • Clothing insulation • Metabolic rate

Outdoor thermal comfort, as a mental state expressing satisfaction with the environmental context, is a multifaceted construct encompassing psychological and behavioral processes beyond physical variables. The hierarchical model presented in Figure 2, centering on the principle of "subjective assessment" emphasized in ASHRAE standards, categorizes elements affecting comfort into two main classes: "Environment-Based" and "Human-Based". Environmentally focused parameters include physical variables such as meteorological data and climatic conditions,

as well as urban geometry, material selection, and blue-green planning strategies. Human-focused parameters consist of social and individual layers that shape the mental dimension of comfort. In this context, physiological characteristics such as metabolic rate, clothing insulation, age, and gender, along with psychological state, social and cultural dynamics, are defined as the main components determining the outdoor thermal experience (Achouri et al., 2024).

Figure 3: *Schematic diagram of factors affecting bioclimatic comfort (Achouri et al., 2024)*

5. The Impacts of Climate Change on Bioclimatic Comfort

5.1. Deterioration of Outdoor Thermal Comfort

Given that people spend a significant amount of time outdoors, focusing on bioclimatic comfort is considered one of the most important issues for improving people's health and satisfaction (Karakuş and Selim, 2022). Increased air temperatures and more frequent extreme heat events as a result of climate change are leading to significant deteriorations in outdoor thermal comfort conditions (Huang, 2023). The increase in climatic heat load in urban areas shortens the comfortable time people can spend outdoors and raises thermal stress levels (Karakuş and Selim, 2022; Huang, 2023). This effect causes a deterioration in outdoor bioclimatic

comfort, with thermal comfort indicators such as bioclimatic comfort indices showing increasing temperature and stress values.

5.2. Urban Heat Island Effect and Thermal Stress

Rising temperatures due to climate change are reinforcing the urban heat island (UHI) effect, significantly negatively impacting bioclimatic comfort conditions in urban areas (Watkins et al., 2007). Due to dense construction, limited green spaces, low-reflectivity surfaces, and anthropogenic heat emissions, air temperatures in cities tend to be higher than their surroundings; this leads to increased outdoor thermal stress, especially during the summer months (Liu et al., 2023). The literature shows that UHI causes higher heat stress levels in outdoor thermal comfort indices such as PET, UTCI, and WBGT, and when combined with low wind speed and high radiation load, it significantly increases perceived temperature (Ren et al., 2023).

Measurements at the microclimate scale show that thermal comfort conditions are more unfavorable in urban centers compared to rural areas, and that the urban heat island effect (UHI) has become one of the main environmental stressors limiting open space use (Qaid et al., 2016). In this context, the urban heat island effect is considered a critical mechanism that deepens the effects of climate change on bioclimatic comfort.

5.3. Temporal and Spatial Variation of Comfort Conditions

Developing effective and consistent adaptation strategies to enhance bioclimatic comfort zones requires a deeper understanding of the spatial and temporal variability of the local climate, as well as the influence of urban characteristics (Van Hove et al., 2015). Climate change affects bioclimatic comfort conditions not only through increasing air temperatures but also through changes in these conditions over time and in different locations. Studies show that thermal comfort exhibits significant temporal differences on intraday and seasonal scales, and a heterogeneous distribution in different areas within the city spatially (Koç and Koç, 2024). Bioclimatic comfort, which depends on environmental and physical factors, is a subjective value that varies according to location, time, and individual (Koç and Koç, 2024). All these differentiations and changes become even more pronounced with the influence of local factors such as extreme temperatures, shading conditions, surface characteristics, and the presence of green areas. In this case, temporal and spatial variations must be considered together in order to properly evaluate bioclimatic comfort.

6. Adaptation Strategies for Bioclimatic Comfort

To accurately define the natural landscape and ecological structure, climate should be considered as one of the fundamental factors reflecting the power of nature; climate analyses carried out within a measurable system enable the development of bioclimatically efficient planning and design models (Yahia and Johansson, 2014; Yang et al., 2018; Cengiz et al., 2020). In this context, landscape architecture and landscape design, which holistically address meteorological parameters, are important tools guiding urban planning. In particular, bioclimatic components such as temperature, relative humidity, and wind speed stand out as key determinants in evaluating bioclimatic comfort and designing user-oriented open spaces during the planning process (Yahia and Johansson, 2014; Yang et al., 2018).

Climate-sensitive landscape design contributes to the creation of a more livable urban microclimate by providing adequate levels of human comfort (Yang et al., 2018). Urban design decisions directly affect microclimate conditions and thus outdoor thermal comfort through components such as building layout, open space organization, and green infrastructure (Yahia et al., 2018). However, in existing built environments, urban areas are often characterized by inadequate microclimate conditions and low levels of thermal comfort. The literature emphasizes that microclimate and outdoor thermal comfort are generally considered a secondary element and are not given sufficient consideration in urban design and planning processes (Yahia and Johansson, 2014).

Considering the complex nature of the built environment, it is observed that design models developed for different urban morphologies have significant effects on microclimate conditions and outdoor thermal comfort. Therefore, evaluating the climatic effects of the formal and spatial components of urban design with a holistic approach is of great importance in creating climate-sensitive and comfort-oriented urban spaces (Yahia et al., 2018). Accordingly, adaptation strategies based on the findings of empirical and modeling-based studies revealing the effects of green and blue infrastructure applications, urban morphology and shading arrangements, and nature-based solutions on microclimate and thermal perception in urban areas are presented in Table 2 (Nikolopoulou and Steemers, 2003; Bowler et al., 2010; Gill et al., 2007; Ketterer and Matzarakis, 2014; Raymond, 2017; Demir and Cengiz, 2021).

Table 2. *Adaptation Strategies for Enhancing Bioclimatic Comfort in Urban Areas*

Strategy Level	Adaptation Approach	Bioclimatic Impact on Comfort
Urban Design and Planning Approaches	Green and blue infrastructure applications (Parks, green roofs, water surfaces)	It lowers air temperature through evaporation and shading, contributing to the reduction of thermal stress.
	Shading elements (Trees, pergolas, eaves)	Reduces the mean radiant temperature, thereby improving outdoor thermal comfort.
	Urban morphology (Building density, street orientation)	It controls the microclimate by regulating wind flow and sunlight.
	Surface and building material selection (High albedo, permeable surfaces)	It limits the urban heat island effect by reducing heat storage.
Architectural and Passive Design Strategies	Natural ventilation	It supports thermal balance by reducing heat accumulation both indoors and outdoors.
	Passive cooling solutions (Courtyards, cross ventilation)	It reduces energy consumption, providing comfortable indoor environments.
	Solar control and building orientation	It improves thermal comfort by limiting excessive solar exposure.
Nature-Based Solutions and Ecosystem Services	Strengthening urban ecosystems (Afforestation, green corridors)	It regulates the microclimate, reduces heat stress, and enhances bioclimatic comfort.
	Integration of ecosystem services	It provides thermal regulation, air quality, and psychological comfort.

7. Conclusions and Recommendations

This study examines the effects of climate change on bioclimatic comfort through a holistic approach, encompassing the conceptual framework, determining climatic factors, bioclimatic comfort indices, and adaptation strategies. Bioclimatic comfort, while an outcome of physical environmental conditions, is also a fundamental indicator of human health, quality of life, and urban sustainability. Temperature increases, changes in relative humidity and wind regimes, and the intensification of the urban heat island effect due to climate change lead to increased thermal stress, particularly in urban areas. This situation limits the use of open spaces and directly affects the physical and psychological well-being of urban residents.

The findings show that bioclimatic comfort is determined by meteorological parameters such as air temperature, relative humidity, wind speed, and solar radiation, as well as urban morphology and land-use characteristics, and that this interaction leads to spatial and temporal differentiation of comfort conditions. Bioclimatic comfort indices such as PET, UTCI, and others offer effective tools in evaluating this multidimensional structure and reveal that comfort conditions show significant differences between seasonal cycles, local climate zones, and urban fabrics.

The findings obtained within the scope of this study indicate the effects of climate change on bioclimatic comfort are becoming more pronounced, particularly in urban areas. The urban heat island effect, increased thermal stress levels, and a decrease in the number of comfortable days are among the main consequences of climate change at the city scale. These effects constitute a multi-dimensional risk area that should be evaluated not only as an environmental problem but also in terms of health, social equity, and urban resilience. In this context, adaptation strategies developed for bioclimatic comfort are considered as fundamental components of climate-sensitive urban planning and landscape design.

Strengthening green and blue infrastructure, urban form decisions that support natural ventilation, and microclimate-focused open space designs stand out as key strategies for reducing thermal stress. Integrating these strategies into planning and design processes, in line with scientific analyses supported by bioclimatic comfort indices, is of great importance in creating climate-resilient and livable cities. In this context, systematically integrating bioclimatic comfort assessments into planning and design processes is necessary for creating climate-resilient and livable cities. It is recommended that future studies focus on local context-specific and multi-scale analyses that relate bioclimatic comfort to climate projections.

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Chapter 13

DETERMINING USER OPINIONS OF URBAN AGRICULTURE POTENTIAL IN PARKS: THE CASE OF KONYAALTI, ANTALYA

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1. INTRODUCTION

Increasing urbanization on a global scale has led to various problems, such as the gradual loss of natural areas, disruption of ecological balance, and deterioration of food systems (Olgun & Karakuş, 2024; Olgun et al., 2024). According to United Nations data, more than 55% of the world's population currently lives in cities, and this percentage is expected to continue to increase (UN, 2018; Durukan et al., 2025). It is thought that the rate of urban population growth will be higher in developing countries such as Türkiye (City Farmer, 2011; FAO-FCIT, 2011; Kutsal & Polatoğlu, 2023). This rapid transformation is leading to changes in the spatial structures of cities, not only as areas for work, housing, and economic activity, but also as areas that encompass natural spaces. The urbanization process leads to a decrease in productive agricultural land and forest areas, an increase in air and water pollution, microclimatic changes, and the emergence of various socio-economic constraints (Orsini et al., 2013; Ranagalage et al., 2020; Olgun et al., 2025). Therefore, it is necessary to develop comprehensive planning strategies that target transforming cities into spaces that offer social, cultural, and healthy living environments (Erdoğan et al., 2016; Elmas, 2022). Urban green spaces are among the fundamental components of cities due to the ecosystem services they provide and the opportunities for social use they offer (Selim et al., 2023; Olgun et al., 2024). In addition, the planning of spaces that can contribute to ensuring food security for the growing and densifying population is an important issue that needs to be reconsidered by decision-makers and planners (Morgan & Sonnino, 2010; FAO, 2025; Tabrez, 2025).

Urban agriculture is one of the prominent strategies in the planning of sustainable cities. Urban agriculture is defined as a holistic system that encompasses plant and animal production activities carried out within cities or on their peripheries, including production, processing, and distribution processes (Artmann & Sartison, 2018; Türker & Anaç, 2022; Mwetulundila & Indongo, 2025). In addition to contributing to safe food production, urban agriculture offers significant gains in terms of environmental sustainability, social integrity, and economic benefits (Lovell, 2010; Ackerman et al., 2014). It also provides various ecosystem services such as reducing the urban heat island effect, carbon sequestration, stormwater management, and increasing urban biodiversity (Artmann & Sartison, 2018; Mwetulundila & Indongo, 2025). It is noted that urban agriculture practices are particularly effective in regulating the microclimate in areas with dense urban settlements (Artmann & Sartison, 2018; Yaman & Yenigül, 2022; USDA, 2025). At the social and individual scale, various studies have demonstrated that urban agriculture practices promote physical activity, reduce individual stress levels, support mental

well-being, and increase interaction with nature (Yaman & Yenigül, 2022; Soga et al., 2017).

Urban agriculture practices can be spatially integrated into areas such as parks, public open spaces, vacant lots, residential gardens, and rooftops and terraces (Orsini et al., 2013; Taylor & Lovell, 2014). Among these areas, urban parks are considered important spaces for implementing urban agriculture in a multifunctional manner due to their large areas, high accessibility, and intensive public use (Yaman & Yenigül, 2022). Urban agriculture practices in parks can offer production, education, and environmental awareness, alongside recreational functions.

The integration of urban agriculture into park areas is not merely a process limited to spatial suitability or ecological capacity. Users' perceptions, expectations, willingness to participate, and potential concerns are among the decisive factors for the success and sustainability of such applications (Nadal et al., 2018). Planning and design approaches that do not take user opinions into account face difficulties in gaining social acceptance in public spaces and ensuring long-term sustainability. While the topic of urban agriculture in Türkiye has increasingly come to the fore in academic and practical areas in recent years, it is observed that a great deal of the existing studies focus on conceptual discussions, spatial suitability analyses, or policy recommendations, while user-based empirical studies remain limited (Yurday et al., 2024; Türker & Akten, 2023). It is particularly noteworthy that there is a lack of studies addressing urban agriculture at the scale of urban parks from the user's perspective.

Antalya, located in the Mediterranean climate zone, has favorable climatic conditions for agricultural activities throughout the year. The spaciousness and intensive use of parks in the city indicate that these areas have significant potential for urban agriculture practices. The study aims to evaluate the potential for urban agriculture in parks based on user opinions, using the example of the 23 April National Sovereignty Park located in the Konyaaltı district of Antalya province. In the study, park users' usage habits, existing agricultural activities, perceptions and attitudes towards urban agriculture, and preferences for different urban agriculture scenarios developed at the park scale were analyzed. It is expected that this study will contribute to the landscape planning and urban design literature by presenting a user-based approach to the integration of urban agriculture into public open areas.

2. MATERIALS AND METHODS

2.1. Study Area

Antalya is located in the Mediterranean region in southern Türkiye and is one of the country's leading tourism and agricultural cities. With its Mediterranean climate prevailing throughout the year, long coastline, and intensive urban development, Antalya offers significant potential for the sustainable use of urban open green spaces. The park determined as the study area is located in the Konyaaltı district, west of Antalya city center. Konyaaltı, one of the five central districts, is bordered by the Mediterranean Sea to the south and the Beydağları Mountains, the western extension of the Taurus Mountains, to the north. The district, which has a coastline approximately 7.5 km long, encompasses both coastal areas and mountainous and forested ecosystems. Important natural and structural components within the district boundaries, such as the Olimpos–Beydağları Coastal National Park, Boğaçay Stream, Antalya Port, and Akdeniz University's main campus, enhance Konyaaltı's ecological, recreational, and socio-cultural importance. The district has a total area of approximately 546 km² (Manavoğlu & Ortaçeşme, 2007; Erdoğan et al., 2011; Dipova, 2016; Olgun, 2020) (Figure 1).

The 23 April National Sovereignty Park is an urban park area located within the boundaries of the Konyaaltı district and surrounded by a dense urban pattern. Due to its location, the park serves as an area that offers both active and passive recreational activities between residential areas, transportation axes, and public uses. The 23 April National Sovereignty Park, with its existing vegetation, pedestrian circulation networks, and open green spaces, makes a significant contribution to the urban ecosystem services of the region. The park's existing green space quality, user diversity, and accessible location provide opportunities for testing different urban agriculture scenarios.

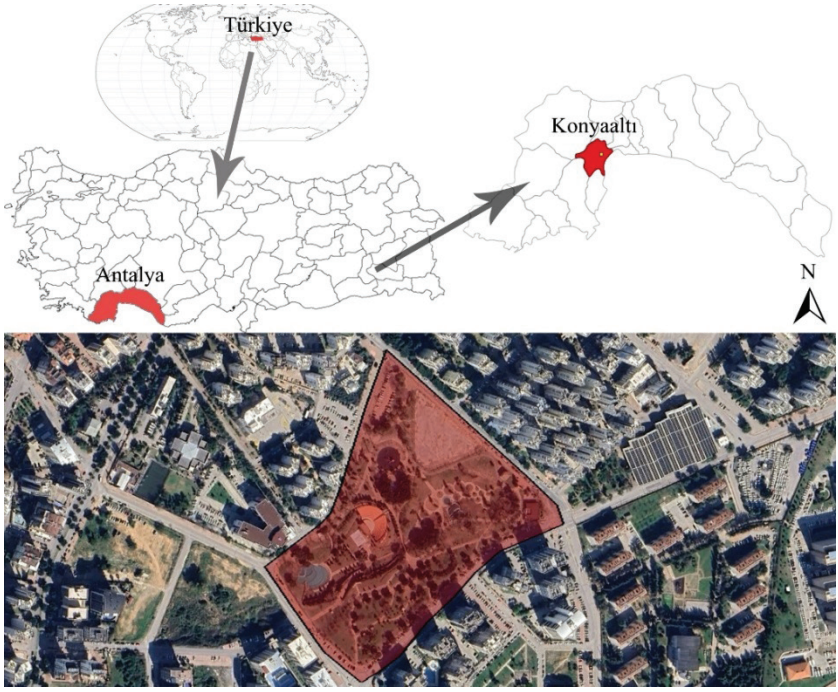

Figure 1. Map of the study area boundary of Konyaaltı, Antalya

2.2. Method

The study, which aims to evaluate the urban agriculture potential of parks based on user opinions, was conducted in three stages. In the first stage, the national and international literature related to the study topic was reviewed, and projects, articles, books, and thesis studies on the topics of urban areas, open green spaces, urban green spaces, parks, and urban agriculture were examined. In the second stage, a survey form consisting of four sections and 37 questions was prepared to evaluate user opinions. The first section of the survey form contained questions about participants' park usage habits, the second section about their current agricultural activities, the third section about their opinions on urban agriculture and their level of participation in proposals, and the final section contained questions to evaluate the socio-demographic structure of the participants. In addition, five different spatial scenarios for urban agriculture activities within the park boundaries were developed and visualized using Adobe Photoshop software. In the images produced, alternative plans were created by considering different types of agricultural uses, such as greenhouse areas, orchards, and open field plant cultivation plots, both separately and together. During the development of the scenarios, the area's existing green pattern, pedestrian circulation

network, recreational uses, and environmental context were taken into consideration.

In this context, face-to-face and online surveys were conducted with 310 park users who had previously used the study area on different days and times of the week. The surveys were conducted on a voluntary basis, and simple random sampling was used for sample selection. In the final stage of the study, the data obtained from the surveys were digitized using SPSS software, and descriptive statistical analyses were performed. The analysis results obtained were evaluated together with field observations to assess the potential for urban agriculture in the parks.

3. FINDINGS

3.1. Socio-Demographic Structure of Participants

The study conducted at 23 April National Sovereignty Park in Konyaaltı district consists of 57.1% women and 42.9% men. When the age distribution of participants is examined, 14.2% of them are aged 18-30, 34.8% are aged 31-50, 31.9% are aged 51-65, and 19.1% are aged 65 and above. In terms of educational level, 15.2% of participants have primary education, 23.9% have high school education, 25.4% have associate's degrees, 31.6% have bachelor's degrees, and 3.9% have postgraduate degrees. When examining the professional status of participants, 11.3% of them are students, 39.7% are employed in any profession, 6.1% are unemployed, 29.7% are retired, and 13.2% are housewives. In terms of housing type, 34.2% of the participants reside in an apartment, 15.8% in a detached house, 48.1% in an apartment within a housing complex, and 1.9% in shantytown-type housing.

3.2. Park Usage Habits of Participants

The majority of participants (98.1%) stated that they regularly use the parks in the Konyaaltı district. When examining the frequency of park use, it was found that 44.2% of participants use the parks once a week, 27.1% use them once a month, and 21.0% use them almost every day. A significant portion of park users visit parks with their families (39.7%) or friends (36.8%). The purpose of visiting the parks was stated as relaxing and resting by 39.7% of the participants. In addition to this purpose, the use of parks is diversified with various activities such as exercising (running and walking), social meetings, playing with children, having a picnic, walking pets, reading books, passing the time, and being together with other individuals. When the time of park use was evaluated, it was determined that 56.3% of participants visit parks on weekends, 32.4%

visit both weekdays and weekends, and 11.3% visit only on weekdays. The majority of participants (53.7%) use parks in spring and summer, especially between 4:00 p.m. and 8:00 p.m. In terms of time spent in the park, 46.3% of participants spend an average of 1–3 hours in the park, while 30.7% spend 3-5 hours.

3.3. Current Agricultural Practices of Participants

It was determined that 34.2% of participants have a residential garden, while 23.9% currently engage in some form of agricultural activity at their residence. Of the participants engaged in agricultural activities, 47.3% carry out these activities in their residential gardens, 22.9% on their balconies, 17.6% on their terraces, and 12.2% on the roofs of their residences. When the types of products grown were examined, it was found that 39.2% of participants grow vegetables, 25.7% grow fruit, 18.9% grow ornamental plants, and 16.2% grow medicinal and aromatic plants.

When evaluating participants' purposes for engaging in agricultural production in their residences, the most important reason was found to be obtaining healthier products (54.1%). This was followed by hobby-based production (24.3%), the need for physical activity (12.2%), and contributing to the budget (9.4%). On the other hand, the majority (78.4%) of participants who did not engage in any plant and/or animal production in their residences explained this situation by citing insufficient or no space suitable for growing products.

3.4. Opinions of Participants Regarding Urban Agriculture

While 52.3% of participants stated that they knew about urban agriculture, 25.1% stated that they knew about it partially, and 22.6% stated that they had never heard of the term urban agriculture before. Participants indicated parks (39.7%), vacant lots (25.5%), residential gardens (21.9%), public open spaces within the city (11.3%), and rooftops/terraces (1.6%) as the most suitable areas for urban agriculture activities. However, the majority of participants (89.2%) stated that they would like to see agricultural areas in the parks in their neighborhood. When examining opinions on the types of agricultural activities that can be carried out in urban areas, it is seen that 48.7% of participants find vegetable cultivation more suitable, while 38.4% find fruit cultivation more suitable. Other participants stated that medicinal and aromatic plants, ornamental plants, and grain types can also be cultivated within the scope of urban agriculture.

When urban agricultural activities are carried out in parks, 86.1% of participants stated that they would like to actively participate in these

activities. Moreover, 82.6% of participants indicated that it is important for urban agricultural areas to be located within a 0–0.5 km walking distance. Regarding the amount of time that could be spent in these areas, 42.7% of participants stated that they could spend 0–2 hours, 30.9% stated that they could spend 2–4 hours, while the remaining participants stated that they could spend more than 4 hours. 58.3% of participants believe that urban agriculture areas in parks should be 2000–5000 m^2 in size. Furthermore, 76.4% of participants stated that these areas should be the responsibility of municipalities, while 14.4% said they should be the responsibility of the Provincial Directorate of Agriculture and Forestry, and 9.2% said they should be the responsibility of the private sector.

The urban agriculture scenarios developed for the 23 April National Sovereignty Park in Konyaaltı district aim to spatially integrate different production types while preserving the park's existing recreational character and green texture continuity. In this context, the visuals prepared depict agricultural areas designed with different production types, such as greenhouse structures, orchards, and open field plant cultivation plots. While greenhouse areas representing controlled production are highlighted in some scenarios, community-based production areas are proposed in some arrangements through semi-natural garden textures created with fruit trees or modular plot systems. Furthermore, hybrid planning approaches that combine these uses have been adopted in some designs, increasing both production diversity and spatial flexibility. In all scenarios, agricultural areas are positioned in harmony with the park's pedestrian circulation, existing tree cover, and recreational areas. Participants were asked to rate the images related to these scenarios. Accordingly, 46.8% of participants preferred Photo 2, 21.3% preferred Photo 5, 18.1% preferred Photo 1, 8.4% preferred Photo 4, and 5.4% preferred Photo 3. Photo 2, which received the highest score, reflects a hybrid agricultural production approach, presenting fruit orchards, modular plant beds, and greenhouse areas suitable for protected cultivation in this scenario (Figure 2).

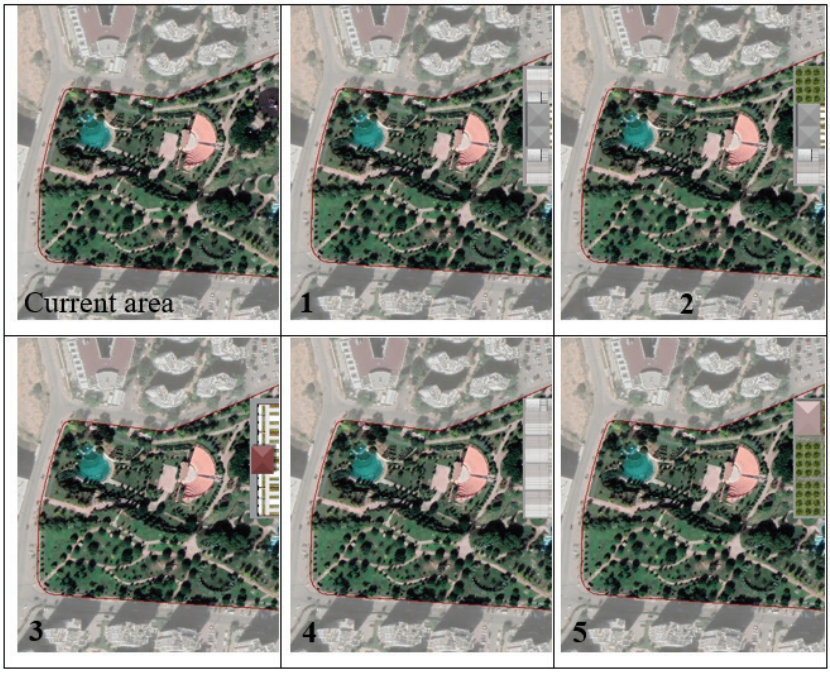

Figure 2. Proposed urban agriculture scenarios within the study area.

To evaluate participants' opinions on urban agriculture, 25 proposals were presented using a 5-point Likert scale. Participants showed a high level of agreement with the statements "contributes to reducing individual stress" ($\bar{X}$: 4.70), "provides opportunities for physical activity" ($\bar{X}$: 4.63), and "increases people's interest in agriculture" ($\bar{X}$: 4.58) (Table 1).

Table 1. Participants' level of agreement with statements regarding urban agriculture.

Proposal	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	$\bar{X}$	sd
	%	%	%	%	%		
Contributes to the urban ecosystem	1.0	4.2	20.6	41.3	32.9	4.01	0.890
Contributes to the social structure of the urban	0.6	12.9	3.9	16.5	66.1	4.35	1.076
Contributes to the urban economy	1.9	8.1	8.4	21.3	60.3	4.30	1.048
Contributes to the health of individuals living in urban areas	1.0	5.2	11.6	31.3	51.0	4.26	0.924
Urban agriculture improves the urban climate	3.9	11.6	9.0	45.8	29.7	3.86	1.088
Urban agriculture promotes social integrity	0.6	8.7	12.3	50.6	27.7	3.96	0.899
It increases social interaction among people.	1.3	6.8	3.2	39.4	49.4	4.29	0.913
Urban agriculture improves individuals' quality of life.	0.6	4.8	7.4	40.3	46.8	4.28	0.848
Urban agriculture is beneficial in providing aid to the poor.	1.6	4.8	11.6	41.9	40.0	4.14	0.916
It offers a recreational activity.	1.0	10.3	7.1	30.6	51.0	4.20	1.021
It benefits the local food supply.	3.9	8.7	11.0	51.6	24.8	3.85	1.017
It provides local job opportunities.	15.5	31.0	9.4	21.0	23.2	3.05	1.439
Provides access to fresh food	1.9	4.8	6.8	19.4	67.1	4.45	0.953
Contributes to reducing individual stress	0.0	3.2	1.9	16.8	78.1	**4.70**	0.667
Provides opportunities for physical activity	0.0	0.6	2.9	29.7	66.8	**4.6**3	0.576

Provides psychological benefits	8.4	16.1	15.2	41.0	19.4	3.47	1.211
Provides opportunities to learn about agricultural activities	0.0	5.8	7.7	33.5	52.9	4.34	0.854
Increases people's interest in agriculture	0.3	2.6	1.0	31.3	64.8	**4.58**	0.677
Increases knowledge and skills related to agriculture	1.9	5.5	6.1	39.4	47.1	4.24	0.932
Provides green space for the area	4.5	19.7	8.4	42.6	24.8	3.64	1.182
Facilitates urban-rural integration	1.6	6.5	3.9	58.7	29.4	4.08	0.855
Promotes inter-generational cultural integration	1.3	5.5	14.5	52.6	26.1	3.97	0.862
Increases urban biodiversity	1.6	6.8	5.5	51.6	34.5	4.11	0.896
Mitigates the urban heat island effect	0.6	6.5	9.4	46.5	37.1	4.13	0.875
Reduces vandalism in parks	0.6	6.8	5.5	46.1	41.0	4.20	0.869

Additionally, participants are presented with 8 statements using a 5-point likert scale to assess negative user opinions regarding potential issues arising from urban agriculture. Participants mostly agree with the statement that urban agriculture pollutes the soil due to excessive use of chemicals and fertilizers. This statement is followed by the statements "it causes a decrease in water resources" and "it pollutes groundwater." (Table 2).

Table 2. Participants' level of agreement with statements regarding urban agriculture.

Proposal	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	$\bar{X}$	sd
	%	%	%	%	%		
Increases the amount of waste produced in the park	41.9	31.9	6.8	15.8	3.5	2.07	1.199
Destroys the natural beauty of the park and its surroundings	49.7	34.2	3.5	11.9	0.6	1.80	1.015
Increases air pollution	33.5	47.4	8.4	10.0	0.6	1.97	0.938
Pollutes groundwater	31.0	49.7	3.2	10.3	5.8	**2.10**	1.127
Pollutes the soil due to excessive use of chemicals and fertilizers	7.1	34.2	11.0	35.5	12.3	**3.12**	1.209
Leads to a decrease in water resources	6.8	44.5	4.5	30.0	14.2	**3.00**	1.261
Increases the risk of soil erosion	34.8	46.1	10.6	7.4	1.0	1.94	0.915
Reduces the use of park areas	57.4	32.6	3.5	5.5	1.0	1.60	0.871

4. DISCUSSION AND CONCLUSION

Today, urban agriculture accounts for between 15% and 20% of the global food supply. This percentage is insufficient to meet the food needs of city residents. Studies show that 30% of urban land would need to be converted to agricultural land to meet the food demand in cities. In this context, urban agriculture is expected to support existing food sources (USDA, 2025). This study, conducted on the example of 23 April National

Sovereignty Park in the Konyaaltı district of Antalya, contributes significantly to the literature by examining the suitability of parks in cities for urban agriculture based on user opinions. The findings reveal that the integration of urban agriculture into park areas is not limited to environmental and spatial dimensions; it also provides meaningful contributions to social interaction and individual health.

The findings of the study show that the majority of park users regularly use parks and spend long periods of time in these areas. This situation reveals that parks play an important role in individuals' daily lives. The positive effects of parks on physical and psychological well-being are frequently emphasized in the literature (Sturm & Cohen, 2014; Soga et al., 2017). The findings of this study also show that parks can be re-examined not only as passive recreation areas but also as productive spaces that encourage active participation by users. The fact that 23.9% of participants are currently engaged in agricultural activities in their own residences, while many individuals are unable to continue these activities due to insufficient space, clearly demonstrates the necessity of addressing urban agriculture at the park scale. This situation aligns with the views emphasized by Orsini et al. (2013) and Taylor and Lovell (2014) that urban agriculture must move beyond the spatial limitations of the residential scale and into public spaces.

When perceptions and attitudes towards urban agriculture are evaluated, it is seen that the majority of participants adopt urban agriculture as a positive practice and want such activities to take place in neighborhood parks. In particular, the high level of agreement with the statements "it contributes to reducing individual stress," "it provides opportunities for physical activity," and "it increases people's interest in agriculture" reveals that users strongly perceive the social and psychological dimensions of urban agriculture. These findings are consistent with previous studies showing that urban agriculture and gardening activities contribute to individuals' mental well-being (Soga et al., 2017; Gunapala et al., 2025).

The participants' generally high level of agreement with statements regarding environmental contributions indicates that urban agriculture has created significant awareness in the context of ecosystem services. Findings on improving the urban climate, reducing the urban heat island effect, and increasing biodiversity are consistent with the environmental benefits of urban agriculture identified by Artmann and Sartison (2018) and Pradhan et al. (2023). This shows that participants view urban agriculture not only as a recreational element, but also as a planning tool with ecological functions. Moreover, findings regarding the potential

negative impacts of urban agriculture also reveal noteworthy results. Participants' emphasis on risks of soil and water pollution associated with chemical fertilizer and pesticide use highlights the importance of oversight, education, and sustainable production techniques in the planning and management processes of urban agriculture practices. These findings indicate that urban agriculture can pose environmental risks when not properly managed.

The study results reveal that park users do not view urban agriculture as an activity limited solely to food production; rather, they evaluate it through its multidimensional contributions, such as social interaction, physical activity, psychological well-being, and environmental awareness. The fact that the majority of users want to participate in urban agriculture activities in parks and demand that these areas be within walking distance clearly demonstrates the importance of planning urban agriculture at the neighborhood level. It is a noteworthy finding that the hybrid production approach is preferred more by participants among the different urban agriculture area scenarios developed for the study area. This approach, which combines orchards, modular plant beds, and greenhouse areas, reveals that participants have adopted balanced solutions in terms of both visual landscape quality and production diversity.

Overall, this study demonstrates that urban agriculture practices in city parks should be considered not only based on physical spatial suitability but also in line with user expectations and preferences. Urban agriculture areas with high user participation, accessibility, medium scale, and managed by public authorities will be more sustainable and socially acceptable practices within park systems. This approach, based on user opinions, is expected to significantly guide future urban agriculture and park planning studies. In future studies, it is recommended to conduct comparative analyses across different cities and park types, examine long-term user behavior, and carry out comprehensive assessments supported by ecological indicators.

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Chapter 14

SPATIAL JUSTICE IN URBAN LANDSCAPE DESIGN: THEORETICAL APPROACHES AND APPLICATION REFLECTIONS

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1.Introductıon

In today's world, where the dynamics of urbanisation are changing on a global scale, the concept of space is no longer merely a physical structure but also an area shaped by social relations (Lefebvre, 1991). In this context, 21st-century urbanisation is defined not only by concepts such as physical density, rapid construction and population growth, but also by social inequality, exclusion and environmental fragility. The urbanisation process is shaped by policies that prioritise economic growth, but studies have shown that this growth is not based on an egalitarian approach and causes social and spatial fractures (Harvey, 2010; Soja, 2013). Public spaces and urban open spaces – parks, squares, and recreational areas – can be said to be the most visible sites of this social fracture and inequality. Increasing inequalities in urban areas, the privatisation of public spaces, and the spatial effects of the climate crisis have made the concept of "justice" a necessity within the design disciplines (Alpak et al., 2019).

The concept of spatial justice is a multidimensional concept that is not limited to determinants such as physical access or service distribution, but is shaped by questions such as which users are visible in space and for whom and how public spaces are produced (Fainstein, 2014; Young, 1990). Spatial justice, in its simplest definition, argues that individuals should have equal participation and access rights in their relationships with their environment (Soja, 2013). The concept of spatial justice, shaped by Henri Lefebvre's (1968) pioneering idea of the right to the city, argues that space is not merely a physical structure but also an arena where social relations are established and the struggle for existence takes place. The concept of spatial justice seeks answers not only to the question of "who lives where" but also to questions such as "who is present in the space, who is represented, and who is excluded" (Fainstein, 2014). Although the discipline of landscape architecture has traditionally been characterised by concepts such as ecology and aesthetic design principles, today it must be reconceptualised in terms of concepts such as spatial equality and justice, taking into account issues such as the inclusiveness, functionality, and accessibility of the field (Anguelovski et al., 2016).

With the rise of the spatial justice movement (Bullard, 2000), the climate crisis has disproportionately affected vulnerable groups in cities (Anguelovski et al., 2016). In this context, landscape architecture is undergoing a transformation that encompasses not only natural features but also the definition of justice in access rights and spatial use (Alpak et al.,2015).

Although urban landscape areas appear to be open to everyone, issues such as access, exclusion, and representation remain relevant. A fair landscape design should not only ensure physical equality but also incorporate an approach that considers social differences (Low et al., 2005). Current urban landscape projects are shaped more by an aesthetic understanding, which leaves the concept of spatial justice behind. For example, environmental investments and landscape improvements made during the process of "green gentrification" can displace low-income groups through rent increases (Checker, 2011). This example demonstrates that the concept of spatial justice is a principle that must be considered at every stage of the design process. In this context, the remainder of this study will examine the definition and theoretical framework of the concept of spatial justice (Alpak ve Yılmaz, 2021).

2. Spatial Justice

To understand the concept of spatial justice, it is important to examine approaches to how space is defined and produced. Henri Lefebvre considers space not only as a physical entity but also as an area where social relations are produced. According to Lefebvre, space should be considered in three dimensions. These spaces are: perceived space, designed/representational space, and lived space. In this context, the production of spaces is not only the product of architects and planners but also of users. The structure of space reveals that the concept of justice must focus not only on outcomes but also on processes. In this context, a just city is defined by equal access to resources and fair participation (Purcell, 2002).

One of the first theorists to address the concept of spatial justice is Edward Soja. Soja (2013) argues that the concept of justice is directly related to space. According to Soja, "Spatial inequality produces injustice because space determines not only the distribution of power and resources but also identity, visibility, and participation" (Soja, 2013). Soja emphasises that justice is not a static state but a relational state that is reproduced. This understanding suggests that it is directly related to the discipline of urban design and landscape architecture and the production of space.

In her work The Just City, Susan S. Fainstein defines justice in urban planning and design and proposes three fundamental principles in this context. These principles are equality, diversity and participation. These principles can have significant effects in terms of including marginalised groups in spatial production processes, reducing social vulnerabilities and improving quality of life. These principles can be reflected in both the design process and the post-design evaluation process. The principle of equality seeks to answer the question of who has access to urban green

spaces and who is excluded. In many cities, park projects are often located in areas where high-income groups live. This situation creates spatial injustice as well as inequalities in access to environmental resources. In this context, Fainstein's concept of equality requires urban open spaces to be accessible in both social and physical terms (Fainstein, 2014).

The principle of diversity argues that different lifestyles and cultural values should be made visible. In this context, design processes must be sensitive to the cultural needs of communities. These designs should enable individuals of different ages, genders, and cultural norms to exist in the space, rather than treating all users as the same type of user. The principle of participation argues that landscape design is not a process reserved solely for experts, but rather an action that requires the participation of communities (Fainstein, 2014). The principles of equality, diversity, and participation proposed by Fainstein demonstrate that the concept of spatial justice offers not only a principle but also a guiding framework. Fainstein presents these three principles as a benchmark system for urban planning and design practice. Particularly in a discipline such as landscape architecture, where social and physical dimensions are intertwined, these principles can be used not only theoretically but also as a design guide. In this context, it is important to evaluate how the principles are reflected in the design. The discipline of landscape architecture presents itself as areas where spatial justice is embodied and reproduced.

Principle	**Theoretical Connection**	**Meaning in Design**
Equality	Distributive Justice	Fair access to spaces
Diversity	Recognition / Representation	Representation of cultural and social differences
Participation	Processual / Democratic Justice	Effective and meaningful user participation

Table 1. *Fainstein's principles of justice and their spatial meanings*

3. Spatial Design of Social Equality and Representation in Landscape Architecture

Social inequalities manifest themselves in space not only physically, but also in cultural and representational dimensions. In this context, landscape architecture should be considered not only as a technical discipline that makes aesthetic and ecological arrangements, but also as a tool that shapes and reproduces social relations. Particularly through public spaces, the ways in which communities express themselves

inevitably raise questions about for whom and how these spaces are produced (Mitchell, 2003; Lefebvre, 1991).

Spatial justice is not a concept limited to the right of equal access to resources and services. It also encompasses the visibility of identity and experience in space. According to Young (1990), justice requires the specific experiences of different groups to be present in public life and space. Landscape design is a powerful tool that can enable this kind of recognition, but for this potential to be realised, representation must find a place in space. Sculptures, plant selection, seating arrangements, colour usage, or spatial orientation elements in public landscape areas are directly related to which aspects of social memory we highlight (Harvey, 2008). For example, a square design that reflects only national narratives may lead to the exclusion and othering of local or marginalised communities. Therefore, representation is not merely a 'visual' element; it is also a political concept.

The principle of social equality in spatial planning is not only about fair physical distribution. It also concerns the rights to use space and its functional diversity. Spatial equality cannot be achieved simply by ensuring that everyone has access to the same amount of green space, because it is also about who uses these spaces, to what extent, how they exist there, and the sense of belonging they experience (Fainstein, 2010). For example, the fact that a city park is open to everyone does not mean that it is socially inclusive. Design decisions that do not cater to certain age groups, genders, or cultural groups can render these spaces dysfunctional or exclusionary for some users. In this context, the question of "who the space is designed for" is as important as the question of "who is being overlooked". (Mitchell, 2003). In this context, the remainder of this study will evaluate international landscape practices from the perspective of spatial justice.

4. International Landscape Practices from a Spatial Justice Perspective

The conceptual framework of spatial justice must encompass a multidimensional understanding that includes not only the physical distribution of resources but also the representation of different social groups and their participation in decision-making processes. This multi-layered structure is concretised around three fundamental principles in Susan Fainstein's (2010) approach to the just city: equality, diversity, and participation. This section will examine two international park projects with different socio-cultural contexts in line with these principles: Superkilen Park (Copenhagen) and Medellín Library Parks (Colombia).

4.1 Superkilen Park (Copenhagen): A Critical Assessment Based on the Three Principles of Spatial Justice

Superkilen Park, located in the Nørrebro district of Copenhagen, Denmark, stands out as one of the most experimental projects in contemporary landscape architecture. Developed in collaboration between BIG Architects, Topotek1 and the art collective Superflex, the project was designed with the aim of promoting cultural representation in an area with a high concentration of immigrants (BIG et al., 2012). The park is physically divided into three main areas: the red zone (sports and activities), the black zone (urban furniture and social seating areas), and the green zone (natural landscape).

Figure 1. *Map of Superkilen Park (URL 1)*

The visual in Figure 1 is a map showing the spatial organisation and representation of Superkilen Park. The map shows the park's three main areas: Red Square, Black Market and Green.

- **Red Area:** Represents the social gathering area; a zone actively used by young people, cyclists and sports enthusiasts.
- **Black Area:** Represents the relaxation, seating and daily interaction area; a zone featuring urban furniture, fountains and benches.
- **Green Area:** A zone with lawns and park areas set aside for nature-related activities.

The flags indicate that each flag represents an object, work of art, play equipment, structural element or symbol belonging to that country within the park. For example: Turkey: Located in the red zone, it indicates the presence of an object belonging to Turkish culture (e.g. seating element or sign). Representations of numerous different countries, such as Japan, the USA, Morocco, Lebanon, China, Russia, etc., are scattered throughout various areas of the park.

This map concretely demonstrates that Superkilen Park was designed according to the principles of multiculturalism and spatial diversity. It can also serve as visual evidence in the context of representational justice within the space.

Figure 2. Superkilen Park Images (URL 1)

Spatial justice is a multidimensional concept that prioritises equality in individuals' access to the physical environment, social inclusion, and participation processes (Soja, 2010). Superkilen Park stands out as an exemplary urban public space practice that can be evaluated through the principles of spatial justice: equality, diversity, and participation.

When evaluated in the context of equality, Superkilen Park's design serves all user profiles by taking into account variables such as age, gender, and physical ability. Play areas, sports fields, skateboard ramps, and rest areas are located together in the space, suitable for use by different age

groups. This coexistence strengthens physical accessibility and functional equality. The fact that all paths are designed to be barrier-free for cyclists and pedestrians demonstrates that the park design complies with the principle of universal design (Gehl, 2022).

When evaluated in the context of diversity, the park design incorporates symbolic urban furniture and regional icons from over 60 countries. The flag map seen in one of the images reveals that the park was designed to make the identities of users from different ethnic backgrounds visible in the public space. This multicultural form of representation enables users to create their own areas of belonging within the framework of Henri Lefebvre's "right to the city" approach (Lefebvre, 1991).

When evaluated in the context of participation, one of the most distinctive features of Superkilen Park is the involvement of the local community in the design process. Thanks to the "participatory design workshops" implemented by the designer, the local community has had the right to choose elements representing their cultural heritage in the park.

In conclusion, Superkilen Park is one of the rare urban examples that transforms the theoretical principles of spatial justice into a concrete space through a user-centred, pluralistic and participatory design approach. The principles of equality, diversity and participation are effective not only in the physical elements of the design, but also in the process itself. However, whether this example creates lasting social change should be assessed not only in terms of the design of the space, but also in conjunction with local government policies and social integration dynamics.

4.2. Tempelhofer Feld (Berlin): A Critical Assessment Based on the Three Principles of Spatial Justice

Located in the heart of Berlin, the site of the former Tempelhof Airport, which was closed to civilian use in 2008, is now known as Tempelhofer Feld, one of Europe's largest public open spaces. Covering a total area of 355 hectares, it attracts attention with its diversity of uses and planning approach based on principles of spatial justice. This transformation process is considered a powerful case study for discussion on the democratisation of urban areas, rights-based planning and collective ownership.

Figure 3. *Images of Tempelhofer Feld*

When evaluated in the context of participation, the planning process for Tempelhofer Feld saw plans to open the area for development rejected by a public vote in a referendum held in 2014. This demonstrates that participation in decision-making processes, one of the fundamental principles of spatial justice, has found its counterpart in the field. The community gardens, landscape maintenance activities carried out by voluntary organisations, and social interaction areas seen in the images, when evaluated in the context of Lefebvre's (1991) concept of "right to place," show that users have become individuals with rights over the area.

When evaluated in the context of equality, the diversity of user groups in the photographs proves that the area is equally embraced by individuals of different ages and social classes. Tempelhofer Feld does not have any paid entry system, restrictive security barriers, or overly regulated themes, making it accessible to all users. Users can walk, cycle, picnic or engage in urban farming. This flexibility evokes the concept of "loose space" defined by Franck and Stevens (2006); that is, the space can be rebuilt again and again by users rather than being defined by fixed rules.

When assessed in the context of diversity, as seen in Figure 3, Tempelhofer Feld simultaneously accommodates numerous public functions. These include extensive green spaces, open-air sporting events,

social gathering areas, etc. Furthermore, various collective structures established by the local community enable individual creativity to be incorporated into the space. This diversity aligns with Harvey's (2012) concept of "spatial democracy"; for the area is not merely a recreational space but also a collective space open to social, cultural, and political interactions. In this context, Tempelhofer Feld should not be considered solely as a physical redevelopment project. It also presents itself as a model of public space that requires reflection on social equality, collective rights and the right to the city. In this context, the area provides a powerful example in line with the three fundamental principles of spatial justice: participation, equality and diversity.

5. Conclusion

Today, public spaces are designed not merely as physical voids but as strategic spaces where social justice, representation, and collective rights are embodied. In this context, spatial justice is expressed as a multi-layered concept that goes beyond the principle of equal distribution to encompass the spatial representation of different communities, their right to participation, and their access to opportunities for free use. (Soja, 2013). Superkilen and Tempelhofer Feld are pioneering examples that apply these principles through different design strategies, but both strive to establish justice in public space. Superkilen Park has developed a spatial justice approach based on representation and cultural diversity by incorporating symbolic and physical elements that bring the daily life practices of immigrant communities into the space, located in a multicultural neighbourhood.

Participatory workshops conducted during the design process have ensured that community memory is reflected in the public sphere and strengthened the relationship between users and the space, thereby increasing individuals' sense of belonging to the space. On the other hand, Tempelhofer Feld is an important example that highlights the role of participatory planning processes and civil will in the production of space. The collective response of the public against development in the 2014 referendum symbolises resistance to the commodification of public space; it can also be seen as evidence in the field of Harvey's emphasis on the "collective right to the production of space" (Harvey, 2012). The flexible structure of the area, free from planned interventions, aligns with Franck and Stevens' (2007) concept of "loose space"; it supports individuals' potential to experience, transform, and appropriate the space. Here, a wide range of activities can take place, from recreational activities to community gardening, political rallies to artistic performances,

demonstrating the possibilities of a multifunctional, open and inclusive public space.

Both examples demonstrate that the design and management of urban spaces must take into account not only aesthetics or functionality, but also principles such as socio-political equality, cultural representation and rights-based participation. At this point, the discipline of landscape architecture has become not only one that designs the environment, but also one that acts as the bearer and interpreter of spatial justice. The future of public landscapes will rise on this bridge between technical expertise and social sensitivity. Therefore, design strategies that focus on spatial justice, respect cultural diversity, and encourage participation and access not only create more liveable cities but also build the physical foundation of urban democracy (Lefebvre, 1991; Mitchell, 2003).

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Chapter 15

URBAN ACUPUNCTURE: THE TRANSFORMATIVE ROLE OF MICRO-SCALE INTERVENTIONS IN URBAN PLANNING AND DESIGN

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1. INTRODUCTION

Rapidly expanding cities globally are facing increasingly complex urban challenges due to growing population pressure and limited land resources. This process profoundly affects not only spatial expansion but also the social, environmental, and economic functioning of cities, thus necessitating sustainable, inclusive, and innovative urban planning approaches. In response to these multifaceted challenges faced by growing cities worldwide, the strategic importance of urban planning and design is increasing day by day. In this context, the need for more flexible, place-oriented, and community-participatory methods compared to traditional large-scale and hierarchical planning approaches is becoming evident. The development of tools that involve local people in urban renewal processes is a fundamental reflection of this need.

One of the tools developed within this framework, urban acupuncture (UA), is gaining importance as an innovative approach that develops small-scale but strategically impactful interventions for the improvement and sustainable transformation of urban areas (Casprini et al., 2026) . At the heart of the UA approach lies the strategic identification of small intervention areas, much like "acupuncture points," to enhance urban functionality. This method encompasses interventions at different scales, from the revitalization of the socio-cultural fabric to environmental improvement (Tousi et al., 2022). The main objective of this approach is to trigger large-scale positive change processes by targeting critical points in the urban environment, revitalizing the urban fabric, and improving sustainable quality of life (Wang et al., 2024) . This concept, increasingly accepted in the field of urban design and development today, offers a unique intervention framework that holistically addresses different components such as socio-cultural context, environmental improvement, public space quality, and community interaction (Al-Hinkawi & Al-Saadi, 2020; Salman & Hussein, 2021; Tousi et al., 2022).

UA emerged in 1982 through the work of Manuel de Solà-Morales, a Barcelona-based architect and urban planner who linked the urban renewal process to the healing process of the human body (Hemingway & De Castro Mazarro, 2022). Morales's approach of UA, implemented in Barcelona, involved micro-spatial interventions demonstrating that small design moves could create chain reactions across the entire city in a short time (Hemingway & De Castro Mazarro, 2022; Raoufi & Shieh, 2023). Another name that made significant contributions to the development of the concept is Jaime Lerner, on the other hand, has advocated for the selection of strategic points, taking into account the constantly changing dynamics of cities, and initiating transformation processes with rapid and low-cost interventions. According to Lerner, even a single small intervention at the

right point can create a "catalytic effect" that will revitalize the social and spatial integrity of the city (Lerner, 2014). UA derives its basic philosophy from the acupuncture technique in Chinese medicine: to reorganize urban functionality and open urban "meridians" by identifying points that block the "energy flow" in the urban fabric. Therefore, the approach aims to reveal the potential of neighborhoods, streets, and public spaces through micro-scale design applications (Guan, 2024; Wang et al., 2024). Salman and Hussein (2021) defined this approach as small but strategic spatial interventions that improve the quality of life of urban dwellers through the analysis of the social, cultural, and economic dynamics of the urban environment. Prabowo et al. (2024) emphasize that urban acupuncture, unlike large-scale master plans, is a place-oriented intervention method that optimizes existing potential, strengthens social cohesion, and develops sustainable urban fabric.

Current literature demonstrates that UA creates "micro-intervention networks" that challenge traditional infrastructure planning, and reveals the impact of small-scale, contextually sensitive applications on transforming the urban environment (Apostolou, 2015). Studies support the idea that small-scale improvements, particularly in older residential areas, dilapidated areas, and urban neighborhoods with weak social interaction, strengthen community spatial belonging and enhance urban well-being (Bandeira et al., 2021). This approach also plays a significant role in promoting ecological and cultural sustainability, as it addresses both the restoration of the natural environment and the preservation of historical fabric (Yu, 2021; Raoufi & Shieh, 2023). Many successful examples of this approach exist worldwide: the San Francisco Cannery district, the Park Güell regeneration areas, and the Centre Pompidou, Guggenheim Bilbao Museum, New York Grand Central Station restoration, Paley Park, Puerto Rico Interventions such as the Madero revitalization project, the Pampulha architectural complex, the Ópera de Arame, and the redesigns of the Paris and Bilbao metro systems offer powerful examples of the capacity of small touches to create major transformations. These projects demonstrate that UA is not only a spatial design tool but also a holistic strategy that activates processes of social interaction, cultural vitality, and economic revitalization.

In general, UA is an alternative urban planning paradigm that aims to develop small-scale but impactful sustainable interventions, taking into account the unique cultural, historical, and spatial context of each city (Yang et al., 2021; Tousi et al., 2022). Considering that successful planning often begins with small touches that create a spark before large-scale projects, the urban acupuncture approach has become a strategic component of renewal processes in modern cities. This study aims to comprehensively examine the theoretical foundations, historical development, application principles,

and micro-spatial intervention types of the UA approach, supported by examples from around the world. It also reveals the approach's contributions to creating sustainable, healthy, and resilient cities, and evaluates different applications in Türkiye and internationally from a comparative perspective. This comprehensive framework aims to explain how urban acupuncture shapes contemporary planning and design practices and its potential role in future urban transformation strategies.

2. CONCEPTUAL DEVELOPMENT: THEORETICAL FOUNDATIONS OF THE CONCEPT OF URBAN ACUPUNCTURE

2.1. Conceptual development of urban acupuncture

Urban acupuncture (UA) is an innovative urban design approach developed to counter the limitations of large-scale and hierarchical planning models. It is based on site-focused, small-scale interventions with a wide-ranging impact. The concept is metaphorically inspired by the practice of acupuncture in Chinese medicine; the idea that stimulating specific points on the human body can improve the entire system is transformed into the assumption that holistic improvement can be achieved by targeting critical "pressure points" where spatial problems are concentrated in an urban context (Salman & Hussein, 2021; Wang et al., 2024). UA's flexible, rapidly implementable, and low-cost nature offers an effective transformation mechanism that enhances both social and environmental vitality (Raoufi & Shieh, 2023). Therefore, the approach is built on the idea that small but focused interventions can trigger significant changes on an urban scale.

UA involves the implementation of micro-scale projects that can create meaningful impacts on the social, cultural, and economic fabric of a city. These interventions, which "penetrate" the city's structure, aim to stimulate strategic points by analyzing local characteristics and to initiate a ripple effect across the city, thus starting a remedial process. Contextual awareness, community participation, cultural sensitivity, and sustainable practices are among the core principles of UA. Therefore, UA is a multi-dimensional intervention approach that combines urban design principles with contemporary technologies such as digital social networks (Salman & Hussein, 2021).

The theoretical basis of the concept has been developed from different perspectives by many pioneers. Manuel de Solà-Morales, one of the first to integrate urban acupuncture into planning practice, defines the approach as a set of small-scale interventions that can be implemented with a limited budget and create a local and catalytic effect, as an alternative to large and costly transformation projects (Morales, 2004). According to Morales, these interventions increase environmental comfort through the ripple effect they initiate at specific points and improve the quality of life of city dwellers

in a short time (Hemingway & De Castro Mazarro, 2022). Morales, who considers cities as living organisms, emphasizes that small interventions have the power to restructure the urban fabric. Another name that made the concept visible on a global scale is Jaime Lerner. Lerner defines urban acupuncture as "the revitalization of a worn-out area with a single simple touch, and this interaction initiating a chain of positive reactions in the urban system" (Lerner, 2015). According to him, every good plan can only be realized with the right intervention. Therefore, UA is a low-cost, easy-to-implement strategy with rapidly spreading effects. Lerner identified four key urban components -transportation, affordable housing, parks, and recycling- as acupuncture points, arguing that micro-interventions at these points could benefit the entire city (Lerner, 2016). UA's metaphor of creating a "positive energy flow" points to the potential of small-scale interventions to trigger urban-level renewal by transcending the local level (Lerner, 2015). Thus, UA represents a holistic and strategic approach to revitalizing neighborhoods and/or cities; it is integrated into long-term urban visions and aims to unlock hidden urban potential (Casprini et al., 2026).

Marco Casagrande, who added an ecological dimension to the concept, argues that UA views the city as a "multidimensional, delicate energy organism," and that stressed areas of this organism can be healed through bio-urban interventions (Casagrande, 2012; Hemingway & De Castro Mazarro, 2022). Casagrande's approach transforms UA from merely a physical design strategy into a holistic healing method that strengthens human-nature relationships and promotes ecological sustainability. According to him, interventions function like "healing needles" in the urban fabric; improving strategic areas balances the city's energy flows and initiates an ecosocial healing process. In this way, a holistic approach restores cities to their original essence by harmonizing with nature (Casagrande, 2020).

In the literature, different researchers have added various dimensions to the concept. Marshall (2004) defines UA as "metastatic and strategic micro-interventions aimed at restructuring public spaces" while David West (2011) emphasizes that UA initiates social transformation to solve urban problems through low-cost micro-actions that mobilize community energy. Foth (2008) argues that urban acupuncture provides large-scale spatial relief by targeting social and environmental stress points. Yu (2021) considers urban acupuncture as an approach that triggers small but visible changes by creating a catalytic effect in specific focus areas. Casanova and Hernandez (2015) offer a framework that aims to revitalize urban life through time-based strategies, citizen participation, and temporary uses by adapting acupuncture principles to public spaces. These different definitions and the intended effects they emphasize are summarized in Table 1.

Table 1. Definitions and intended effects of the concept of urban acupuncture.

Reference	Concept definition	The intended effect of the concept
Solà-Morales (2004)	"A set of local and small-scale interventions with a catalytic effect, applicable with limited resources, as an alternative to large-scale planning."	It describes how a healing effect at a small point spread to the surrounding area through a domino effect, rapidly improving the quality of urban life.
Lerner (2015)	"An improvement approach that initiates positive chain reactions throughout the entire system with a simple but strategic touch to a worn or problematic point in the urban fabric."	It triggers revitalization, social mobility, and sustainable transformation throughout the city by improving pressure points.
Casagrande (2012)	"A method that treats the city as a multi-layered energy organism, healing stressed areas of this organism through bio-urban healing interventions."	It aims to achieve ecosocial improvement by strengthening the human-nature relationship, repairing ecological cycles, and balancing energy flow in the urban fabric.
Hemingway & De Castro Mazarro (2022)	"A multidimensional intervention approach that addresses social and ecological layers together and supports sustainability transitions."	Creating healthy environments, increasing social resilience, and guiding ecological transformation starting from the local level; and simultaneously creating cities in harmony with nature.
David West (2011)	"A strategy that mobilizes community energy and provides solutions to urban problems through light, subtle, and low-cost micro-interventions."	Strengthening local participation, rapidly improving public spaces, and initiating community-based transformation processes.
Marshall (2004)	"A set of metastatic and strategic small-scale urban interventions aimed at restructuring public space."	Creating new energy flows in the urban fabric by improving strategic points and initiating long-term spatial transformation.
Foth (2008)	"Local interventions that create a remedial effect in the built environment by targeting social and environmental stress points in the urban fabric."	This aims to provide large-scale spatial relief by resolving stress-accumulating areas and accelerate the healing of the city as an "organism."
Yu (2021)	"Small-scale interventions that create visible change in specific focus areas by creating a catalytic effect on the urban environment."	This encourages small-scale, cost-effective interventions that aim to create noticeable effects in specific areas.
Casanova & Hernandez, (2015)	"A whole set of acupuncture-based interventions that revitalize public space through time-based strategies, citizen participation, and temporary uses."	This involves increasing citizen participation, transforming public spaces with flexible and permeable uses, and gradually revitalizing urban life.

In recent years, the UA approach has expanded further, evolving into sub-concepts such as urban environmental acupuncture (Starzewska-Sikorska et al., 2022), biophilic urban acupuncture (Reinhold, 2018), and urban blue acupuncture (Bell et al., 2020). These new approaches focus, respectively, on improving non-green spaces with nature-based solutions, redesigning everyday spaces with biophilic elements, and strengthening the role of water spaces in urban renewal processes. While biophilic interventions aim at stress reduction and increased well-being, urban blue acupuncture positions intra-city water resources among the important components of UA. Key features of UA include participatory processes, micro-scale interventions, contextual sensitivity, flexibility, integration of digital technologies, low-cost applications, and catalytic effects that trigger development. In this sense, UA is not merely a series of small interventions; It is a multidimensional urban improvement paradigm that takes into account the original context of a place, its social fabric, ecological processes, and user experiences. Its capacity to trigger large-scale transformation processes by targeting critical tension points in the urban fabric places UA in a significant position in contemporary sustainable urban planning and design literature. In this respect, UA offers a strong theoretical and practical framework for healthy cities, sustainable urban transformation, and community-based spatial interventions.

2.2 Basic Principles of Urban Acupuncture

Urban acupuncture is an innovative approach that differs from traditional large-scale urban renewal initiatives, relying on community-based and low-cost interventions sensitive to local conditions (Balicka et al., 2021). Lerner argues that small but effective interventions at strategic points in cities, along the axes of sustainability, mobility, and social inclusion, can rapidly improve the quality of urban life. Accordingly, interaction, participation, and awareness-raising processes are seen as integral components of UA (Lerner, 2014). As Apostolou (2015) states, UA is a system of micro-interventions that prepare the ground for large-scale transformations by creating gradual but cumulative effects. The principles of "simplicity, immediate impact, and reasonable cost" emphasized by Lerner (2016) are the fundamental dimensions that define both the applicability and success potential of UA.

The principles of the urban acupuncture approach are briefly summarized below (Hoogduyn, 2014; Moussavi A et al., 2024; Nassar, 2021; Raoufi & Shieh, 2023):

- **Identifying strategic and sensitive points:** The first and most critical step in UA is correctly identifying the focal points to be intervened. Morales defines these points as the "starting energy" of urban

acupuncture, while Lerner states that problematic or "diseased" urban areas should be the priority targets. According to Casagrande, these areas are hidden but potentially catalytic energy nodes that, when revealed, can produce a positive energy effect. The aim of UA applications is to revitalize the energy flow by treating these nodal points and create a domino effect in the surrounding area.

- **Scenario production:** Scenarios developed with the participation of different actors are critical for the successful implementation of UA. Scenarios strengthen consensus among decision-makers and ensure that project processes proceed in a transparent and predictable manner. Especially in top-down projects, scenarios encourage local participation and create a common ground of commitment in the process.

- **Rapid action:** Lerner argues that long-term and complex planning processes weaken social motivation, emphasizing the necessity of "rapid action" in UA. He states that cities are constantly changing, living systems, and new problems may arise before classical planning processes are completed. Therefore, UA is an approach that prioritizes rapidly implementable, flexible, and results-oriented solutions.

- **Citizen participation and use of local knowledge:** UA is based on bottom-up participatory processes. Even if local people are not designers, their perceptions, experiences, and spatial knowledge are decisive factors in the success of interventions. Participation not only strengthens implementation but also ensures the involvement of communities in the transformation process, producing sustainable results.

- **Education:** City residents play a critical role in understanding and adapting to interventions carried out in the urban environment, and in supporting transformation. Therefore, educational processes that enable individuals to correctly perceive their living environment and understand the purpose of interventions are of great importance. Raising awareness among local communities and their active participation in the process strengthens both the adoption and sustainability of UA practices. Communities empowered through education take a more active role in change processes by embracing the urban acupuncture approach.

- **Holistic approach:** UA requires a holistic assessment that considers not only physical interventions but also the environmental, economic, cultural, and historical context. For interventions to be effective, a multi-layered analysis of data, from the identity of the place to ecological needs, is necessary.

- **Generating big impact through small-scale interventions:** At the heart of UA lies the principle of "creating a wide impact with limited

interventions in small areas." Therefore, the scale of intervention is minimal in terms of both physical size and financial resources. Lerner (2014) emphasizes that "micro-intervention points" in the urban fabric affect the urban system holistically with a neural network logic. Point-based and targeted applications reduce the time and budget pressures required by large-scale investments thanks to their low cost, rapid production, and accessibility to wide segments of the population.

- **Creating places:** According to Morales, "creating places" means making visible and strengthening the potential in neglected areas. Lerner, on the other hand, aims to make these areas functional again by activating existing potentials. UA intervenes in "diseased tissues" where energy flow is blocked, restoring positive energy flow; thus, dormant areas are transformed into living spaces. This process encourages users to develop a sense of belonging, meaning, and social connection to space.

3. THE RELATIONSHIP BETWEEN URBAN ACUPUNCTURE AND PLANNING AND DESIGN APPROACHES

The spatial, environmental, and social challenges faced by rapidly expanding cities worldwide are increasingly highlighting the importance of sustainable urban planning and design approaches. The complex dynamics of urbanization often render traditional planning models, which rely on high-cost and large-scale projects insufficient. This necessitates alternative approaches that prioritize more flexible, low-cost, human-centered, and micro-scale interventions. Throughout history, planners and designers have developed various theoretical models and strategies to improve and ensure the sustainability of the urban environment but rapidly changing urban conditions and limited economic resources have restricted the applicability of these approaches. The needs of today's cities have increased the demand for more holistic and innovative tools that prioritize human well-being, environmental comfort, and spatial flexibility. In this context, UA, inspired by the metaphor of medical acupuncture, stands out as an innovative approach that aims to transform urban environments through small-scale but strategically impactful interventions that can spread throughout the urban system, and has gained increasing acceptance in contemporary planning understanding. UA is defined as a socio-environmental approach that combines contemporary urban design principles with the philosophy of traditional Chinese acupuncture. In Chinese medicine, the body is considered a holistic system in which life energy called qi circulates along meridians; an imbalance of yin-yang negatively affects the body. Acupuncture uses small stimulations at specific points to rebalance this energy. UA adapts the same metaphor to the city, suggesting low-cost, minimal interventions on public spaces, streets, and social nodal points that represent the city's "energy flow" instead of large-scale and costly projects

(Casanova & Hernandez, 2015). Thus, cities, just like living organisms, can be healed with small touches at the right points.

Cities, like the human body, are considered systems with complex energy flows. Urban acupuncture aims to reorganize this energy flow and enhance urban vitality by transforming unused, derelict, or dysfunctional areas. Green spaces and small-scale nature-based solutions-such as pocket forests-can function as "healing needles" in the urban system, thanks to their capacity to create microclimates and increase biodiversity. Such interventions provide multifaceted benefits, including reducing air pollution, mitigating the heat island effect, buffering floods, and improving aesthetic quality. Urban acupuncture can be applied at multiple levels in the planning and design process. Firstly, shaping urban morphology is one of the main areas of application for urban acupuncture. Just as the fluidity of meridians is important for bodily balance in acupuncture theory, ensuring the unimpeded flow of people, goods, and information is critical for urban vitality in urban planning. In this context, UA offers strategic interventions that support the strengthening of connections between transportation networks, public spaces, and open spaces (Guan, 2024). Intervention points are identified as areas that can create the highest remedial impact across the city; public spaces are therefore prominent concentration areas in UA applications (Manouchehri & Rafieian, 2023). Examples of applications include urban farming areas, vertical gardens, green corridors, pocket parks, renewable energy lighting systems, and sustainable urban furniture. Recent studies show that UA offers an effective micro-intervention approach, particularly against climate change, the heat island effect, and urban warming problems (Tousi et al., 2022). Furthermore, it is noted that UA applications in European cities create grassroots resilience mechanisms against climatic shocks, increase community participation, and support the preservation of spaces with local identity (Al-Hinkawi & Al-Saadi, 2020; Moussavi A et al., 2024).

Acupuncture points also hold an important place in urban landscape design. Spatial focal points inspired by acupuncture points contribute to the creation of open spaces designed to be more sensitive to the physiological and psychological needs of urban dwellers. The "needles" of acupuncture can be a single building or park, or they can include time-based interventions such as street festivals and temporary public events. These interventions strengthen the aesthetic and social dimensions of urban life by giving new meanings to forgotten spaces (Manouchehri & Rafieian, 2023). Therefore, acupuncture is a strategic planning and design tool that can create high impact with low investment (Salman & Hussein, 2021).

The therapeutic approach of acupuncture theory, which takes into account individual differences, can also be adapted to urban planning.

Personalized planning approaches that consider the needs of different user groups make it possible to create inclusive and accessible public spaces in the city. Developing micro-space designs inspired by acupuncture enriches the user experience by increasing comfort, safety, and functionality in the city. Careful planning of small spaces in particular, can have effects such as enhancing urban vitality, focusing user attention, and promoting relaxation (Guan, 2024; Salavati et al., 2025).

In conclusion, urban acupuncture is a powerful tool in planning and design processes, both theoretically and practically. The UA approach enables the development of contextually sensitive and flexible interventions that support social cohesion, encourage community participation, and offer sustainable and low-cost solutions. With these characteristics, UA offers a holistic transformation strategy aimed at improving not only the physical environment but also the quality of life of communities and it is gaining increasing importance as an innovative and applicable paradigm in urban planning (Casprini et al., 2026).

3.1. Micro-green spaces (Pocket parks, pocket forests)

Transforming idle parcels, parking lots, or urban vacant areas with low usage value within the city into pocketparks is one of the most distinctive forms of micro-intervention in the urban acupuncture approach (Silva, 2016). These small-scale green spaces play an important role in reducing the urban heat island effect, increasing rainwater permeability, and creating "micro-refuges" that provide short-term rest and socialization opportunities for users in dense urban fabrics. One of the most emblematic examples of this approach is Paley Park in New York. Located in a compact area of approximately 4,100 m^2, this pocket park is described in the literature as a "quiet urban oasis" because it offers an instant escape from the busy and noisy atmosphere of the city center, enhancing both physical and psychological comfort for users through biophilic elements such as a waterfall wall and dense plant textures (Ward, 2016).

Pocket forest applications are a micro-green infrastructure strategy based on transforming very small gaps remaining in the urban fabric into mini forests with densely planted arrangements of fast-growing, local species (Miyawaki, 1999). Such applications provide many ecological benefits, including improving air quality in the surrounding area, reducing overheating through shading, increasing the retention of rainwater by the soil, and creating microhabitats for wildlife. One effective example of this approach is the Natura Nostra Forest implemented at London's Southbank Centre. This pocket forest, established in a limited area, creates contact points with nature in a densely built environment, enriching the user experience and contributing to the regulation of the urban microclimate.

Natura Nostra demonstrates that compact green spaces can play a critical role in biodiversity and microclimate management.

3.2. Water-sensitive streets

Water-sensitive streets are one of the innovative design approaches based on nature-based strategies, aiming to align urban stormwater management with ecological processes. In this context, Water Sensitive Design (WSD) solutions including rain gardens, permeable surfaces, bioswales, and water collection pockets help reduce surface runoff, alleviate pressure on urban drainage systems, and lower the risk of flooding (Wong, 2011). A representative example of this approach is the Portland Green Streets Program, which has succeeded in reducing flood risk, supporting the capacity of urban drainage systems, and enhancing ecological services through green infrastructure elements that retain rainwater at its source.

3.3. Biophilic Corridors

Biophilic corridors encompass linear green infrastructure elements that support urban ecological continuity and enhance human-nature interaction. Various applications such as tree lines, shaded pedestrian routes, green streets, vegetated walls, rain gardens, and ecological connection lines benefit both the maintenance of biodiversity within the city and the improvement of users' thermal comfort. These corridors aim to create large-scale ecological and social impacts with small interventions at strategic points. In this context, the Seoul Dulle-gil project is a remarkable example reflecting the multifunctional nature of biophilic corridors. The project has created safe, shaded routes that encourage pedestrian movement while strengthening the continuity of the natural green belt surrounding the city. Accordingly, biophilic corridors are considered a low-cost and sustainable urban acupuncture intervention that contributes to cities' climate adaptation goals.

3.4. Temporary Interventions (Pop-up Urbanism)

Temporary interventions are a significant part of the urban acupuncture approach, enabling rapid, low-cost, and experimental transformations in urban spaces. Emerging within the scope of pop-up urbanism, these interventions consist of flexible solutions such as temporary seating elements, outdoor event spaces, pop-up markets, street art applications, and modular public furniture (Lydon & Garcia, 2015). Such applications create a directly noticeable change in the physical environment and increase the social usability of the space by encouraging community participation.

One of pop-up urbanism's most important advantages is that it offers the opportunity to observe user behavior and test design decisions together. In this respect, it functions as a prototype for permanent projects,

providing valuable feedback on the demands, usage patterns, and spatial needs of urban residents. It also strengthens social interaction by making public spaces more accessible and attractive. The transformation of Times Square in New York is one of the best-known examples of this approach. The closure of the area to vehicular traffic and its transformation into a pedestrian square with temporary seating units and colorful pavements created a significant increase in the use of public space; subsequently, it laid the groundwork for the development of permanent design decisions.

3.5. Street Improvement

Street revitalization is one of the most visible application areas of the urban acupuncture approach, aiming to transform streets into safer, more comfortable, and socially vibrant public spaces through small-scale physical interventions. Common interventions include improving pedestrian and bicycle paths, creating temporary bike lanes, establishing community gardens, installing art installations, and adding street furniture. Narrowed roadways, widened sidewalks, shading elements, speed reduction regulations, and seating areas play a significant role in enhancing thermal comfort, improving safety, and promoting daily walking and socialization behaviors (Hemingway & De Castro Mazarro, 2022).

One important example of this approach is the Superilles (Superblocks) program in Barcelona, which aims to repurpose street spaces reserved for private vehicles and return them to pedestrians, offering an effective model that transforms urban street typology. The program clearly demonstrates how small-scale interventions can pave the way for large-scale transformations in public life. Similarly, in Brisbane, Australia, urban acupuncture has been used as a strategic tool to increase social interaction and revitalize public space. Houghton et al. (2015) leveraged social networks to support cycling, open-air cinema, theatre performances, temporary street furniture, and other diverse public activities, thereby strengthening the relationship between urban users and public space at both physical and social levels. These examples show that street revitalization is not just a physical arrangement, but also a tool that revitalizes urban culture, increases social interaction, and clarifies the "small intervention-big impact" philosophy of UA.

3.6. Public Micro-Functions

Public micro-functions are a fundamental component of the urban acupuncture approach, aiming to improve spatial and social quality of life by adding small-scale but high-impact functions to existing public spaces. Various interventions such as open-air libraries, mini playgrounds, temporary exhibition modules, seating niches, and pocket stages are considered low-cost, quickly implementable micro-scale interventions that

enhance user experience.

From a UA perspective, this practice acts as a restorative "micro-intervention" that recreates the meaning of public space and enhances environmental quality without requiring large-scale transformation. When applied to strategic points, it directly contributes to urban vitality by increasing pedestrian mobility and social encounters (Gehl, 2010).

3.7. Reducing the Urban Heat Island Effect and Improving Microclimate

In the fields of urban planning and design, various strategies have been developed to mitigate urban heat island effects and contribute to climate improvements at both local and global scales. These strategies aim to reduce energy consumption, lower surface and air temperatures, and improve intra-city microclimate conditions. Such approaches, used for many years in combating urban heat islands, emphasize the importance of acting in harmony with local environmental conditions while providing solutions that highlight practices that integrate with the natural, structural, and socio-economic characteristics of cities. In recent years, there has been increased interest in the participation of individuals and local communities in this struggle, thus recognizing that participatory and community-based approaches play a significant role in solving climate-related urban challenges. In this context, nature-based solutions (NbS) stand out as an important tool due to their resilience-enhancing, environmental, social, and economic benefits, and cost-effectiveness. In particular, micro and macro-scale nature-based interventions, primarily focused on green and permeable infrastructure (such as rain gardens, green roof systems, street tree planting, permeable surfaces, and urban meadows), can create catalytic effects in urban areas, reducing heat stress and improving quality of life (Moussavi et al., 2024; Rosso et al., 2023).

The urban acupuncture approach enables the identification of critical heat accumulation areas and the implementation of strategic interventions in highly vulnerable micro-regions. By identifying "sensitive points" in the urban fabric, UA produces low-cost, rapidly implementable, and highly effective solutions for these areas; thus, it transforms the spatial distribution of heat stress and increases thermal comfort. In this regard, UA interventions can significantly mitigate the urban heat island effect through small-scale green infrastructure components (e.g., park islands, green roofs, pocket forests, permeable street surfaces, and shade-providing tree rows) strategically placed (McD Berl, 2025). These interventions not only reduce physical temperature values but also improve users' thermal perception, encourage the use of public spaces, and reintegrate ecosystem services into the heart of urban life.

3.8. Nature-based Solutions

Small, abandoned, or underutilized areas within the urban fabric hold significant potential for expanding green infrastructure in densely built cities. Although often neglected, dysfunctional, or overlooked, these micro-spaces possess the capacity to generate high ecological and social value through appropriate interventions. Especially in the face of increasing urban density and climatic stresses, the reassessment and strengthening of such micro-spaces through nature-based interventions is becoming increasingly critical. These areas can contribute to increased biodiversity by supporting urban wildlife, improving urban ecosystems, and revitalizing natural processes within the city (Marie Hemingway, 2024).

In this context, urban environmental acupuncture is based on the idea that numerous small green touches can come together to produce large-scale environmental benefits, and it establishes a strong partnership with NbS. NbS is defined as "solutions that are inspired by nature, supported by nature, cost-effective, and simultaneously produce environmental, social, and economic benefits," and plays a significant role in cities' adaptation to climate change and disaster risk reduction processes (Eggermont et al., 2015). The implementation of nature-based strategies enables the strengthening of ecological cycles, the increase of carbon sequestration and water management capacities, and the improvement of urban dwellers' interaction with nature. In this context, the local-scale, low-cost, and user-directed nature of NbS applications is highly compatible with the philosophy of urban acupuncture. Water-sensitive urban design elements such as rain gardens, permeable surfaces, natural filtration areas, and microbiological water harvesting systems are small-scale NbS examples that correspond to UA's "systemic improvement through point intervention" approach. These strategies build resilience against increasingly severe hydro-meteorological risks in cities, such as floods, droughts, heat island effects, and surface runoff, and support the sustainability of urban infrastructure. Practical applications include urban meadows, rainwater-retaining natural wetlands, living walls, micro-habitat modules supporting pollinators, rain gardens, and green roof systems. These interventions both integrate ecosystem services into the urban space and contribute to social interaction by increasing urban vitality. Particularly in medium-sized cities, NbS-based micro-solutions against drainage and flood problems triggered by rapidly developing unplanned growth processes form a strategic line of defense in the context of urban acupuncture (Chen et al., 2025; Huang et al., 2020; Oral et al., 2020).

3.9. Social Integration and Biophilic Design

In recent years, particularly with the deepening of environmental

crises and the increasing importance of sustainable development goals, the trend of "rediscovering nature" in cities has significantly increased. This tendency stems not only from an aesthetic admiration for nature but also from the need to improve human health, well-being, circularity, and urban resilience. The NbS approach, pioneered by the European Commission (2015), was developed in this context; it emphasizes. Low-cost, ecologically and socially holistic solutions to complex urbanization problems can be offered through interventions inspired by, supported by, or mimicking the workings of nature.

The concept of biophilic design plays a significant role in rethinking the relationship between nature and the city. Erich Fromm's (1964) definition of biophilia as "love of life" was later reinterpreted by Kellert as an innate human inclination towards natural systems and processes (Kellert, 2016a). Initially considered an interest in living organisms, biophilia has since the 1990s been evaluated within a broader framework encompassing the psychological, sensory, and experiential dimensions of the human-nature relationship. With the 21st century, the concept has been transferred to the fields of architecture and urban design; it has been adopted as a design strategy aimed at increasing the visibility, accessibility, and experiential value of natural elements in the built environment (Zhong et al., 2022). Biophilic design fills a significant gap in existing sustainability approaches by not only enhancing environmental sustainability but also strengthening user satisfaction, emotional connection, and motivation (Kellert, 2016b).

This multifaceted approach of biophilic design shows a significant conceptual intersection with urban acupuncture. UA is based on "creating places" in the city, improving areas with low potential, and triggering large-scale transformations through micro-interventions. Biophilic design, on the other hand, deepens urban experience by transforming these places into sensorially rich spaces that forge stronger connections with nature. Therefore, biophilic interventions, even when implemented on a small scale, function as natural catalysts that enhance the quality of life for city dwellers and strengthen the healing effects of urban acupuncture.

Examples of biophilic urban projects that apply this approach on an urban scale include Gardens by the Bay in Singapore and Bosco Verticale in Milan. In these projects, nature-based components such as vertical gardens, natural filtration systems, rainwater management, the use of local plant species, and living facade designs come together to produce both ecological and social benefits. Paley Park in New York, an early and influential example of biophilic design, is also noteworthy in this context. Opened in 1967, the park, with its waterfall wall, dense tree cover, semi-permeable ground surfaces, and micro-landscape organization offering acoustic/sensory richness, serves as a "biophilic sanctuary" providing tranquility, shade,

thermal comfort, and psychological relaxation within the dense urban fabric. The powerful spatial experience created by Paley Park on a small plot demonstrates how low-scale, nature-based interventions intersection with an urban acupuncture approach and how they enhance the quality of urban life. As highlighted by the Terrapin Report (2025), such practices improve walkability and cycling accessibility, enhance microclimate, strengthen urban ecosystems, and most importantly, contribute to social sustainability by strengthening community ties.

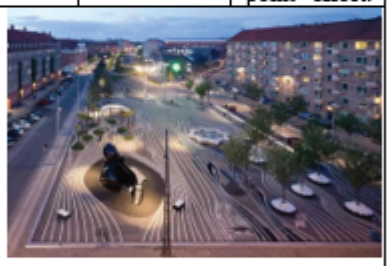
4. URBAN ACUPUNCTURE APPLICATIONS: AN ANALYSIS FROM A GLOBAL AND NATIONAL PERSPECTIVE

Urban acupuncture stands out as an approach that can create large-scale transformation through small-scale interventions applied in different socio-cultural and spatial contexts around the world. This section systematically examines the conceptual and practical gains demonstrated by international examples, as well as the micro-spatial interventions that are becoming increasingly widespread in Türkiye. Application examples are not only introduced but also analytically evaluated within the context of the fundamental principles of urban acupuncture: small intervention, rapid impact, low cost, community participation, ecological improvement, and spatial continuity.

4.1 Urban Acupuncture Practices Worldwide

International examples provide strong evidence demonstrating how UA works at different scales and in diverse social and environmental contexts. Their commonality is that a small spatial intervention can create expansive physical, social, and economic impacts. The following international examples illustrate how urban acupuncture can create social, ecological, and spatial transformation through small-scale interventions (Table 2).

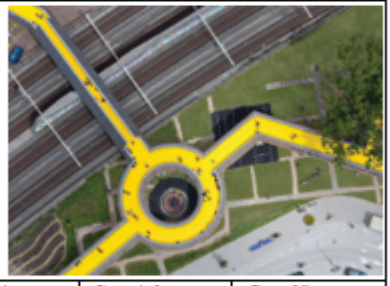
Table 2. Urban Acupuncture Practices from Around the World: Intervention Type, Effects, and Conceptual Evaluation.

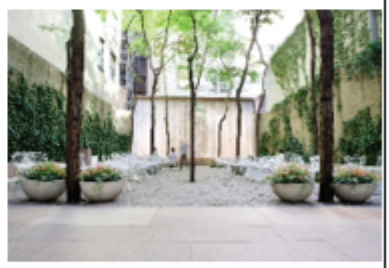
Application	Intervention category	Intervention description	Effect of urban acupuncture.	Conceptual evaluation
Superkilen Park, Copenhagen / Denmark	Socio-cultural acupuncture	Public space design focused on cultural identity.	Social cohesion, perceptual transformation, spatial revitalization, and social interaction.	An example of social acupuncture that re-establishes the flow of social energy at the neighborhood scale through small-scale public space interventions; creating a "cultural needle point" effect.
	Superkilen Park, located in Nørrebro, a neighborhood with a high immigrant population, is designed as a public space that enhances social inclusion through local cultural objects, shading elements, and flexible usage areas. It is an example of urban social acupuncture where small-scale spatial arrangements create perceptual, aesthetic, and social transformation in the neighborhood. 			
Times Square Pedestrianization Project, New York/USA	Tactical Acupuncture / Public Space Acupuncture	Blocking vehicular traffic and arranging temporary pedestrian arrangements.	Increased pedestrian mobility, improved safety strengthened public life.	This is a "rapid impact" example of a developmental innovation that proves low-cost, fast, and temporary interventions can create lasting transformation.

	The intervention, which began with simple painting, mobile seating elements, and traffic closure, quickly transformed into intensive use and high public quality; demonstrating the "small move-big impact" mechanism of acupuncture in its most visible form. 			
Cheonggyecheon Ecological Corridor, Seoul, South Korea	Ecological Acupuncture	Opening up a closed stream bed and transforming it into an ecological corridor and public space, water corridor restoration.	Microclimate improvement, ecological restoration, strengthening of the water cycle, increased community use.	It is a powerful ecological acupuncture application that re-establishes the natural flow of energy within the city by creating an ecological "healing needle" effect.
	The uncovering of the closed stream has become an example of ecological acupuncture, creating an ecological breathing space in the city center and revitalizing both environmental and social life. 			
High Line Park, New York/USA	Morphological and Ecological Acupuncture	Transforming a derelict train line into a linear park/green corridor.	Spatial and economic revitalization, increased social attraction, reduction of the urban heat island effect.	Transforming an unused linear piece of infrastructure creates a socio-economic chain reaction throughout the surrounding area; it is a "morphologi

				cal needle line."
	The transformation of a derelict railway line into a linear park is proof of how a small piece of infrastructure can act as a catalyst for large-scale neighborhood transformations. 			
Cicada Pavilion-Marco Casagrande, Taipei/Taiwan	Temporary/Ecological-Artistic Acupuncture	A low-cost, temporary public space created with recyclable materials.	It fosters increased social interaction, redefines space, and creates a cultural focal point.	This is an experimental example of Acupuncture that embodies the "minimal intervention-maximum social awareness" approach of acupuncture principles.
	This temporary intervention, created with organic materials, reintegrated a forgotten military site into public life, reflecting the temporary-revitalizing potential of UA (Key Art Center). 			
Central Park, New York/USA	Biophilic Acupuncture	Creating a large green core within a dense urban fabric and implementing ecosystem-based spatial improvement.	Creates a macro-scale acupuncture effect in terms of psychological and physical health support, micro-climate balance, social interaction.	Reduction of urban stress, nature-human interaction, and strengthening biophilic energy flow.

	Although Central Park is a mega-scale park, the numerous micro-interventions, point programming, spatial nodes, and social catalysts it contains make it suitable for the basic principles of urban acupuncture. 			
Plaza del Mercado de San Antón, Madrid/Spain	Socio-economic Acupuncture	Transforming an abandoned market area into a multifunctional neighborhood hub.	Fostering social mobility, commercial vitality, and strengthening neighborhood identity.	An example of a social catalyst described as a "micro-scale social catalyst"; a small building block creates an impact mechanism that boosts social energy throughout the entire neighborhood.
	The renovation of a micro-building block has generated vibrancy across the entire neighborhood, demonstrating UA's role as a social catalyst. 			
Rua Gonçalo de Carvalho Reforestation Initiative, Porto Alegre / Brazil	Community-Based Ecological Acupuncture	A tree planting intervention was carried out by neighborhood residents in a small street.	Reduced heat island effect, increased pedestrian safety, improved street life.	The UA example, which was initiated by the community and created an ecological "green needle" effect, represents the power of local activism to transform space.

	The small-scale tree planting movement by the local people created micro-climatic and social transformation throughout the street; it has entered the literature as an example of "community-sourced acupuncture". 			
Luchtsingel Pedestrian Bridge, Rotterdam/Netherlands	Circulatory/Connectivity Acupuncture	Connecting three disconnected urban areas with a wooden pedestrian bridge.	Increased pedestrian accessibility, economic revitalization, and integration of public space.	An example of "network-oriented acupuncture" where a single connecting element reorganizes the flow of socio-economic energy in the city.
	This crowdfunded pedestrian bridge demonstrates how a physical connecting element can trigger social and economic revitalization. 			
Park Güell, Barcelona/Spain	Biophilic - Morphological Acupuncture	Organic forms, public space integrated with topography, landscape-architecture integration.	Spatial diversity, psychological healing, strengthening cultural identity.	Gaudi's design creates a large-scale "biophilic energy field" through small, topography-focused interventions. It is considered a "natural healing needle" that balances urban density.

<table>
<tr><td></td><td colspan="4">Through organic forms, spatial arrangements integrated with topography, and natural landscape elements, it creates a powerful "healing green core" within the dense urban fabric. Thanks to the aesthetic, ecological, and psychological effects created by small-scale spatial decisions on the entire area, Park Güell is considered a typical example of biophilic acupuncture in terms of reducing urban stress, enriching user experience, and strengthening the interaction between city, culture, and nature.
  </td></tr>
<tr><td rowspan="2">Paley Park, New York/USA</td><td>Micro-spatial acupuncture / pocket park</td><td>Transforming into a small open space in the city center with a waterfall wall and shade trees.</td><td>Noise reduction, micro-climate improvement, psychological relaxation.</td><td>The high spatial and psychological impact achieved in a 390 m² area is a classic example of urban acupuncture's "smallest intervention - highest impact" principle.</td></tr>
<tr><td colspan="4">Paley Park has become one of the most iconic micro-scale applications of urban acupuncture by transforming a small 390 m² space within a dense urban fabric. Thanks to the waterfall wall, shade-providing trees, and seating arrangement offering acoustic and visual relaxation, it creates an urban sanctuary that provides an "instant healing effect" in a public space. The noise-reducing sound of water, the micro-climate-regulating green space, and flexible spatial usage possibilities make Paley Park a model example of acupuncture, demonstrating how a small intervention can make a psychological, social, and environmental difference in intense urban life.
  </td></tr>
<tr><td>Curitiba, Brazil</td><td>Transportation-focused micro-spatial intervention, Connection acupuncture.</td><td>The placement of enclosed tube bus stops, designed in a transparent cylindrical</td><td>This accelerates pedestrian flow, increases public transport efficiency.</td><td>It demonstrates the chain reaction effect of a single, small-scale structural</td></tr>
</table>

		form, enabling quick boarding and alighting, and accessible to people with disabilities, at strategic points throughout the city.	reduces traffic congestion, lowers carbon emissions, and supports social mobility.	element transforming the entire urban mobility system. It is one of the strongest examples of UA's principle of "systemic transformation through point intervention." By reorganizing the energy flow (movement, accessibility, circulation) within the city, it promotes a sustainable transportation culture.
	The tube bus stops in Curitiba are one of the frequently referenced examples in the urban acupuncture literature. Although the intervention is a small-scale public transport element, it has created behavioral change citywide by increasing the speed of public transport, reducing private vehicle use, and paving the way for a more sustainable transportation infrastructure. Therefore, the project is considered a typical example of urban planning that demonstrates how a small spatial adjustment can transform the entire urban system. 			

The global urban acupuncture examples presented in Table 2 demonstrate that small-scale interventions implemented in diverse geographical and socio-cultural contexts can produce similar transformative mechanisms, despite their limited scale. While the forms of intervention vary from socio-cultural revitalization and green infrastructure improvements to ecological connection corridors, tactical pedestrian arrangements, and

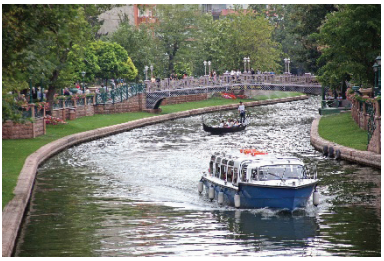
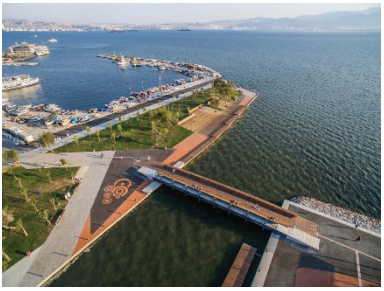
micro-public space designs, all projects share a common acupuncture approach: a small touch at a strategic point triggers a chain reaction of social, spatial, and ecological change within the urban system. All examples show that low-cost and rapidly implementable micro-interventions enhance the quality of public spaces, strengthen social interaction, improve microclimatic conditions, and reorganize the urban circulation network. In this context, UA transcends being merely a spatial design technique and positions itself as a contextually sensitive, participatory, and sustainable intervention paradigm. Furthermore, most of these projects revitalize derelict, fragmented, or dysfunctional urban fabrics, creating new socio-ecological focal points and thus playing a catalytic role in supporting larger-scale planning processes. These findings demonstrate that urban acupuncture is a flexible and innovative strategy adaptable to different urban fabrics; that it can significantly strengthen urban vitality, resilience, and spatial integrity even with limited physical interventions; and that it should be considered an important tool for achieving sustainable urbanization goals.

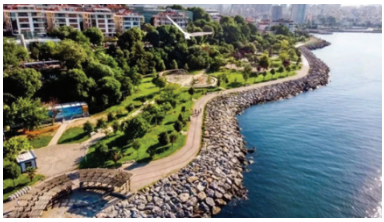
4.2 Urban Acupuncture Practices in Türkiye

In Türkiye, the UA approach mostly manifests itself within the scope of tactical urbanization, community gardens, coastal and shoreline development, land reclamation, and micro-scale public space interventions. These practices are consistent with the principles of UA due to their sensitivity to the local context, low cost, and participatory nature.

Table 3. Urban Acupuncture Practices in Türkiye: Intervention Type, Effects, and Conceptual Evaluation.

Application	Intervention category	Intervention definition	The effect of urban acupuncture.	Conceptual evaluation
Zümrütevler Square Transformation, Maltepe, Istanbul	Tactical Public Space intervention / Socio -spatial revitalization	Transforming a vehicle-priority intersection into a child-focused, pedestrian-priority square and micro-activity area; colorful ground paintings, seating units, playgrounds.	Increasing pedestrian safety, strengthening social interaction, opening the square to multi-functional use.	A tactical acupuncture application where community participation and low-cost rapid interventions strengthen social belonging by transforming spatial behaviors.
	 Child-focused public space design is considered a typical tactical public space application due to its rapid implementation, low cost, and participatory nature.			
Roman Garden, Beyoğlu, Istanbul	Community Garden/ Ecological Micro-Intervention	Transforming a derelict rubble area into a community-based agricultural garden; increasing biodiversity with local plants.	Ecological improvement, strengthening local community solidarity, repurposing a derelict area.	An example of an ecologically focused community-based intervention where small, nature-based interventions create a widening impact on social sustainability and ecological vitality.
	 As an example of community-based ecological improvement, it is a powerful community-based intervention that revitalizes a derelict area socially and ecologically.			

Porsuk Riverbank Arrangements, Eskisehir	Green infrastructure improvement / Creation of ecological-spatial corridors	Pedestrian/ bicycle path, seating areas, green texture improvement and landscape arrangements along the riverbank.	Micro-climate improvement, revitalization of water-related public life, strengthening of ecological connection.	An application in the nature of "corridor acupuncture" where linear and continuous micro-interventions trigger ecological and social integration.
	 Micro-scale arrangements that improve the coastal ecosystem, increase pedestrian routes and strengthen public space transform the Eskişehir example into a "water-focused acupuncture" application.			
Bostanlı Pedestrian Bridge and Sunset Terrace, Karşıyaka, İzmir	Micro-public space design / Creating a socio-cultural focus	Transforming the coast into an accessible and attractive public space with wooden platforms, seating steps, and terrace arrangements.	Increased pedestrian mobility, strengthened socialization practices, and increased coastal usage intensity.	A spatial acupuncture application that increases social attraction and transforms urban behavior by creating a strategic focal point on the coast.
	 Small-scale interventions that transform coastal use have produced large-scale spatial results in terms of social interaction and accessibility.			

	Pedestrian-Bicycle Continuity / Coastal Micro-Landscape Interventions	Walking paths, bicycle routes, seating areas and green space improvements.	Increased accessibility, improved micro-climate comfort, extended public life duration.	A mobility-focused acupuncture example where point-based arrangements along the coast create continuity and a holistic coastal experience.
Fashion Beach Arrangement, Kadıköy, Istanbul	 Point-based arrangements that increase pedestrian continuity and the quality of coastal use are considered "accessibility acupuncture".			

The Türkiye examples presented in Table 3 demonstrate that the urban acupuncture approach is a viable strategy applicable at different urban scales and in diverse spatial contexts. Each project, despite its limited intervention scale, has generated expansive social, ecological, and spatial impacts on urban life, thus practically validating the fundamental philosophy of the acupuncture approach: "systemic transformation through targeted intervention." The diversity of intervention categories used in the examples -tactical urbanization, nature-based solutions, micro-public space designs, and green infrastructure improvements- shows that urban acupuncture offers not just a single design technique, but a flexible intervention option contextually adaptable to urban problems. Looking at the projects holistically, three common trends stand out. First, all applications produce expansive spatial and social benefits through low-cost and rapidly implementable micro-interventions. This is significant in demonstrating that effective transformations are possible in the Turkish urban context despite limited economic resources. Second, improving the quality of public space and strengthening social interaction has emerged as a key objective in all projects. Particularly in the examples of Zümrütevler Square and Bostanlı Terrace, it is observed that small design touches visibly transform user behavior. Thirdly, as in the examples of Roma Garden and the Porsuk Riverbank, ecological improvement and microclimate regulation effects reveal that nature-based acupuncture interventions are gaining increasing importance in Turkish cities. Overall, although urban acupuncture applications in Türkiye are still limited in number, it shows that they possess a strong transformative capacity at different scales and themes; and when combined with the principles of participation, contextual sensitivity, and resilience, they make significant contributions to

sustainable urban development. In this respect, Türkiye examples, in line with practices in the global literature, offer valuable experiences indicating that micro-spatial interventions can create macro-scale effects in the urban system.

5. CONCLUSION

The spatial, environmental, and social challenges faced by rapidly growing cities have highlighted the limitations of traditional large-scale planning models and demonstrated their inadequacy in responding to complex urban dynamics. This has increased the need for more flexible, low-cost, and site-oriented interventions, bringing UA to the center of contemporary planning discussions. Inspired by the metaphor of medical acupuncture, UA offers an innovative intervention paradigm that aims to produce scalable, healing effects within the urban system through small-scale touches at strategic points. As detailed in previous sections of this chapter, the theoretical framework of UA is based on a holistic understanding that treats the city as an organism, with public spaces, social meeting points, and ecological flows as vital energy lines of this organism. This approach provides a multidimensional perspective to planning and design processes, encompassing not only spatial arrangements but also social, ecological, and cultural layers.

The fundamental principles of urban acupuncture are: Identifying sensitive points, small-scale and rapid interventions, low cost, scenario development, participation, contextual sensitivity, place creation, and training demonstrate that UA is not merely a design technique, but a sustainable and inclusive method of urban transformation. By focusing on the nature of the intervention point and its impact within the urban system, rather than the scale of the intervention, UA reinforces the idea that micro-scale decisions can produce macro-scale results. In this respect, UA serves as an alternative strategic tool, particularly in contexts where resources are limited or the implementation of large-scale projects is difficult.

The application examples examined in this study, both from around the world and Türkiye, have shown that UA produces similar impact mechanisms in different geographies, cultural contexts, and planning traditions. International examples such as Superkilen, Cheonggyecheon, High Line, and Luchtsingel reveal how socio-cultural revitalization, ecological restoration, micro-climate regulation, pedestrian-oriented public space design, and community-based interventions become powerful catalysts under the urban acupuncture approach. These projects demonstrate that intervention at a strategic point creates a chain reaction of transformation at the environmental, social, and economic levels. Similarly, Turkish examples reflect the contextual adaptability of UA.

Examples such as Zümrütevler Square, Roma Garden, Porsuk Riverbank, Bostanlı Pedestrian Bridge, and Moda Beach show that small-scale, low-cost, and community-participatory interventions can produce significant improvements in the quality of public spaces, increased social interaction, improved pedestrian safety and mobility, and even positive effects on ecological quality and micro-climate conditions. Another prominent finding in the Turkish context is that UA tends to develop particularly through tactical urbanization and nature-based micro-interventions.

When both global and national examples are considered together, three main conclusions emerge. First, UA, as a flexible, contextually sensitive, and applicable approach, complements traditional planning processes. Second, small-scale interventions, when implemented in the right locations, have the potential to alleviate large-scale urban problems. Thirdly, UA is not merely a design tool that transforms physical space, but a holistic urban improvement method that strengthens social dimensions such as belonging, participation, resilience, and place identity. Consequently, urban acupuncture offers an innovative, sustainable, and human-centered solution to the complex problems of contemporary urbanization. This approach, which produces therapeutic effects in different layers of the urban system through micro-spatial interventions, is considered a powerful tool that can contribute to the creation of a more equitable, flexible, livable, healthy, and resilient spatial order in the cities of the future.

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