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PREFACE

As book editors, we would like to point out that spatial planning and design disciplines (architecture, landscape architecture, city and regional planning, interior architecture, industrial product design, etc.) should act together under the umbrella of **"Architectural Sciences"**.

In this context, **"The Journal of Architectural Sciences and Applications (JASA)"** was first published in 2016 to bring together related disciplines under the umbrella of "Architectural Sciences," to create a common mind, and produce and share information for technology development. JASA is an indexed journal that is indexed in various databases such as the TR index, DOAJ, BASE, ASOS Index, WorldCat, IdealOnline, I2OR, Crossref, Research, Journal Indexing, Scientific Indexing Services (SIS), Scilit, Turkey Tourism Index, CAB abstracts, and others.

The editors of JASA have also established objectives such as holding international conferences and symposiums, publishing books to produce and share knowledge, developing goods and technology, establishing a common language and offering a variety of added value. For this purpose, "I. International Architectural Sciences and Applications Symposium (IArcSAS-2021)" was successfully held online at Isparta, Türkiye, from October 27 to 29, 2021, by JASA Editors. The "II. International Architectural Sciences and Applications Symposium (IArcSAS-2022)" was successfully held online/face to face in Baku, Azerbaijan, from September 11–13, 2022, by JASA Editors.

In addition, JASA Editors published two separate volumes in December 2021, titled **Architectural Sciences and Protection & Conservation & Preservation** and **Architectural Sciences and Sustainability**, each containing original work in the fields of architecture, planning, and design.

Architecture and ecology are multidisciplinary due to their scope and bring together many professional disciplines such as architecture, landscape architecture, interior architecture, urban and regional planning, etc. In this context, the **Architectural Sciences and Ecology** book has

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been published in order to provide an opportunity to share information and ideas among researchers related to **"Architectural Sciences"**.

This book aims to be an important source for discussing the features and challenges of this vision in architecture and ecology. In the **Architectural Sciences and Ecology** book, examples are presented on subjects such as design with nature, ecological and cultural sensitivity, measuring sustainability in architecture, conservation of resources, rehabilitation, sustainable conservation, smart cities, urban landscapes, and plant use in urban landscapes.

Architectural Sciences and Ecology is the sixth volume of the **Architectural Sciences** book series. There are a total of 14 chapters in the book, each authored by a different group of 25 authors. Along with this book, "Architectural Sciences and Spatial Planning", "Architectural Sciences and Spatial Design", "Architectural Sciences and Building Materials", "Architectural Sciences and Urban Agriculture", and "Architectural Sciences and Building & Construction" books were also published.

We are delighted to have accomplished both objectives as JASA editors. These initiatives will continue as long as our objectives are made permanent and information is created and shared.

We would like to express our gratitude to all of the authors, reviewers, IKSAD Publishing House, and Prof. Dr. Atila GÜL, the general coordinator of the architectural sciences book series. We hope that the book will be useful to all disciplines in the field of architectural sciences, as well as scholars and other interested parties.

Regards,

EDITORS
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Today's Digital Environments: Ecological and Smart Cities

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1. Introduction

It is thought that at the beginning of human history, more than half of the population lived in cities, and by the 2030s, two-thirds of the world's population will continue to live in cities. The concept of ecological and smart city, which was put forward to ensure ecological, economic and social sustainable development in cities that are thought to reach this size, emerges as a popular topic of today.

The impact of cities on the country's economy is increasing, and as the demands increase, cities have difficulty in meeting the needs of citizens such as energy, water, transportation and other services. In addition, cities play an important role for socio-economic development, but also face the challenge of overcoming problems such as unemployment, homelessness, social inequality, traffic congestion, pollution, diseases and violence. The smart city concept is a response to these needs and problems (Camboim et al., 2018).

Today, the share of cities all over the world in resource and energy consumption is approximately 80% in carbon emissions and 75% in natural resource consumption (Deloitte, 2016).

Integrated hardware, software and network information technology systems equipped with real-time environmental awareness that can help individuals make smarter decisions, negativities can be eliminated. Smart systems realize the transformation of cities from their traditional forms into ecological and smart cities. It is necessary to strengthen public safety in cities, provide adequate infrastructure services (such as healthy drinking water, safe electricity, sustainable transportation and communication services), and provide public services in a timely and accurate manner. However, traditional cities cannot provide these services in an optimum way due to constantly changing conditions, and the authorities cannot access the necessary information in the right way and at the right time during the decision-making process. In other words, the ecological and smart city provides the necessary infrastructure for citizens and authorities to make smarter decisions. Bringing together software and telecommunication networks, sensors and identifiers with environmental awareness creates ecological and smart cities.

Misuse of resources, environmental pollution, and an increase in greenhouse gas emissions have all contributed to global warming and climate change. All of these issues have highlighted the idea of urban sustainability (Tuğluer & Çakır, 2018). The concept of "sustainability" comes first among the elements that create the concept of ecological and smart city. Sustainable cities are those that grow with consideration for the environment. Sustainable cities strive for social, economic, and environmental growth (Tuğluer & Çakır, 2021). The ecological and smart city connects people to the city through information technologies by creating an area that is sustainable, environmentally friendly, competitive, innovative and where the quality of life increases regularly. With smart systems, the city administration provides public services that will facilitate daily life such as transportation, communication, infrastructure, energy, environmental problems and disasters in the city's network systems, using information and communication technologies (ICT). At the same time, the possibilities of information and communication technologies are used to make the city greener and more efficient.

Ecological and smart cities that make up today's digital environments, and while giving information about their concepts, prominent examples and applications in the world are explained. As a matter of fact, the aim of this study is to indicate the contributions to urban sustainability if environmentally friendly, minimum carbon consuming, energy efficient, self-sufficient new living spaces are created with the concept of ecological and smart city, based on the literature.

2. Sustainable Cities and Urbanization in the Process of Sustainable Development

Looking at the historical process, rapid urbanization processes started with industrialization after the Industrial Revolution and urban areas were formed. Rapid urbanization has brought globalization and environmental degradation. In addition, with the rapid population growth, problems such as insufficient agricultural production for nutrition and the increase in the need for clean water have increased. As a matter of fact, at this point, globalization and environmental destruction endanger today's and future humanity.

The Stockholm Conference (1972) was the first environmental conference at the international level, where economic developments were prioritized and the development model focused on causing environmental damage. In this conference, it was emphasized that the needs of future generations should be considered today, and that natural resources and the environment are limited. Therefore, the basis of the concept of “sustainability” was laid.

In the 1980s, in the Brundtland Report of the World Commission on Environment and Development, the balance between the environment and development was emphasized and the idea of “sustainable development” was mentioned for the first time.

With the "sustainable development" that emerged at the end of the 20th century, it is a development model that envisages the opportunity to meet the needs of future generations while meeting the needs of today by prioritizing ecological elements. The common goal in this model approach is sustainability. Implementing a well-designed development model environmentally, economically and socially can meet the needs of today, but there may be problems for the needs of future generations. That is, with growth, irreversible environmental degradation occurs. At this point, social and economic structure and environmental interactions should be evaluated holistically, and the needs of future generations should not be ignored.

While sustainable development is the determinant of environmental policies in the world, its sphere of influence is not limited to the environment, but is also integrated with economic and social development understandings. 'Environment, society and economy' are considered as three basic components within the concept of sustainability, which are interrelated and supporting each other (Çelikyay et al., 2010; Tosun, 2013).

The concept of sustainability will exist with generations that are environmentally conscious and environmentally friendly. As a matter of fact, at this point, sustainability depends on human well-being and natural resources (Yazar, 2006).

“Sustainable cities” are called cities that operate holistically with the interaction of social economic structure, energy and environment in order to ensure the continuity of development and change. Cities that continue to grow with rapid urbanization pollute water resources, cause deterioration in the natural environment, and destroy forests and agricultural lands.

In today's developing world cities, it is seen that technological developments harm the environment such as air pollution, health problems, climate change and increase in carbon footprint. Sustainable urbanization policies are needed to deal with these problems. That is, with sustainable urbanization policies, a balance of both technological development and ecological protection is established. At this point, while smart city applications continue with technological developments in cities, ecological protection balance will be ensured by following environmentally friendly policies. Achieving this balance in cities will only be possible with ecological and smart cities by prioritizing sustainability policies.

3. Sustainable Urbanization Trends and Approaches

Due to problems such as rapid urbanization and irregular spread in cities, water resources and productive agricultural areas are damaged (Dönmez & Çakır, 2016). At the same time, increasing residential areas and motor vehicle use cause global damage such as climate changes and increasing carbon footprint. At this point, sustainable urbanization trends and approaches were needed in order to slow down the rapid and uncontrolled growth of cities and to transfer natural resources to future generations by protecting the environment. For this reason, sustainable urbanization approaches and movements such as green cities, smart growth, new urbanism, concentrated city, green building movement, green cities, ecological planning and eco-cities have emerged in many countries with international policies (Chandra et al., 2003).

Although the new definition proposals that emerged with sustainable urbanization trends and approaches have different names, they originally aim to control the development and growth of cities and to increase the quality of life by protecting natural resources and the environment. In line with these goals, sustainability will be ensured with developing ecological and smart cities.

4. Ecological and Smart Cities

Cities', which are concentrated in a single area, has been directly proportional to the prominence of the 'Smart City' concept. The reasons for this are that the concept is based on digitalization and information processing technologies, but also targets sustainability in many ways (Moir et al., 2014). In recent years, the combination of smart city and ecological city has become more popular. While the definition of ecological city emerged with the development of sustainable urbanization; the definition of smart city includes concepts such as sustainability, information management, technology and participatory management. Ecological and smart cities contain ecology and technology together. As a matter of fact, in this sense, the concept of 'eco-tech', which consists of the first syllables of the words ecological and technological, is used abbreviated. When today's needs are evaluated, ecological and smart cities emerge as a response to our needs. Although they seem to be contradictory statements, the proliferation of information processing technologies used while preserving ecological values will benefit humanity.

While the term ecological evokes the natural; smart technologies, on the other hand, evoke the artificial. However, the urban design that will emerge as a result of the use of ecological and smart technologies by the coming together of professional groups such as landscape architects, city regional designers, architects, interior architects, engineers will remove the gap between artificial and natural and cities will be at peace with the environment (Bogunovich, 2002).

Ecologically evaluated smart cities have a great importance in solving environmental problems. When information communication technologies (ICT) and environmentally friendly technologies come together, the solution of environmental problems can be easier. The ecological and smart city model, which is shaped according to local conditions, has a design approach based on nature (Ercoşkun & Karaaslan, 2009).

According to Bogunovich (2002), cities can be sustainable. Urban growth should be ecologically united and green. As a matter of fact, in this sense, he evaluated ecological and technological cities in 5 items. These are as follows:

1. Future cities.
2. Cities of the future are ecological. If the cities of the future are not formed ecologically, the future will not be formed.
3. The cities of the future are technological.
4. If we learn how to build ecological-technological cities, we can look to the future with hope. (Bogunovich, 2002).

Ecological and smart city, planning and design understanding, preserving ecological values, energy saving and sustainability are among the main targets. In this sense, considering ecological principles in the use of technology and combining technology with ecology and sustainability will ensure the formation of ecological and smart cities.

Decision makers in the public sector have the opportunity to make a city more livable, viable and sustainable, both economically and environmentally, through accurate and well-structured planning and investments. According to the Smart Cities Council (SCC), “improving the quality of life” means providing better living conditions for city dwellers. In an ecological and smart city, every individual can access a more comfortable, clean, inclusive, healthy and safe lifestyle.

Smart and ecological cities consists of views that integrate with the citizens, determine the wishes of the citizens, current and potential problems on time and on the spot, determine the problem priorities with objective criteria and produce solutions. This dimension, which can also be called knowledge-based development, will be fundamental in the future of cities. In the solution of environmental and social problems that may arise as a disadvantage in the face of these developments, the place and importance of the aforementioned information technologies is very important for the formation of a social structure that can use smarter solutions effectively (Komninos, 2002).

Smart city visions and concepts are adopted, it is essential to switch to cognitive-based power by preserving ecological values. Sustainable development in our age depends on accessing smarter solutions. Ecological and smart growth of a city, more efficient use of resources, is important for promoting a competitive, knowledge and innovation based economy.

Albino et al. (2015), the concept of smart city contributes to the development of the economy with low carbon emissions by using smart systems that create behavioral changes in urban life and society, as well as information cities, digital cities. In addition, by integrating smart city applications and communication and automation systems with private and public spaces, it will contribute to the transformation of the historical city into ecologically, environmentally friendly and energy efficient settlements and to reduce the carbon footprint of the city.

Today, people continue their lives in digital environments. Ecological and smart city concepts closely related to digital environments are as follows:

- **Free wi-fi areas**

Since one of the most important points of smart cities is data, the abundance of free wi-fi areas is just as important. The more easily city residents and tourists can access the internet, the more data obtained will increase and service will be provided accordingly.

- **Public transportation & car sharing apps**

Public transportation vehicles consist of zero- emission buses, that public transportation tickets can be purchased with the mobile ticket application, that there are many electric bicycles in the city and that the availability of these bicycles can be accessed via mobile phones and that cars are shared so that there are fewer vehicles in traffic.

- **Clean Energy and Lighting**

With this application, the lamps turn on as you walk. It is a method in which only the area you are walking is illuminated with the motion sensor in the lamp.

- **Smart parking spaces**

It will be convenient for the residents of the city to see the closest parking spaces through the city's mobile phone application while searching for a parking space.

- **Smart buildings**

Sensors of smart buildings in smart cities, the consumed energy, water and electricity are controlled and more savings are realized in this way.

- **Smart traffic**

Smart solutions are produced for sustainable transportation and billions of traffic data are processed.

- **Security**

One of the most important issues in smart cities is security. A large number of cameras in the city allow crime rates to decrease and criminals to be detected more quickly.

- **Intelligent garbage collection system**

The sensors in the trash cans, it is a great time saver for garbage trucks to learn which trash cans are full. Thus, daily routes are drawn and optimization is made accordingly.

- **City mobile app**

One of the sine qua non of smart cities is mobile applications. Thus, city residents can quickly convey their positive/negative views about the city and share their demands.

- **Digital kiosks**

The digital kiosks in the cities, the answers to the questions that come to mind can be obtained through these kiosks. It contains the places you want to visit, public transport hours, emergency numbers and all matters that are important to the tourist.

- **Intelligent water controllers**

By adjusting to soil conditions and weather conditions, water use is optimized on a large scale. In order to ensure that the software and hardware are compatible with each other and with the existing parking infrastructure, it may be necessary to customize the system according to site needs in consultation with an expert.

- **Drones**

Drones help effectively manage stormwater by monitoring green and gray infrastructure, in particular by sampling water quantity and quality for regulatory compliance. Drones can help reach difficult areas and are used to create consistent datasets.

- **Energy generating exercise equipment**

Energy-generating exercise equipment encourages park visitors to engage in physical activity and is especially valuable for those who do not have access to other on-site equipment. While the equipment can be adapted to suit different ages, it produces clean energy for a variety of minor uses such as charging phones.

- **Smart benches**

In addition to providing seating for visitors, smart benches provide access to the internet, monitor space usage and collect environmental data. The information can be useful for interacting with the community, facilitating operations and monitoring space usage.

- **Solar powered garbage compactors**

Solar-powered garbage compactors facilitate collection, prevent overflows, minimize pests, and promote increased recycling and proper waste disposal.

- **Smart water fountains**

Investing in smart water fountains provides access to clean water and encourages healthy beverage choices. It can also save energy and money and increase public confidence in water quality.

- **Automatic bicycle and pedestrian counters**

Automatic bicycle and pedestrian counters can be an effective way to track road usage. Along with visual displays and websites, meters also serve as a public engagement tool to promote physical activity and active transportation. Where dashboard surveys and census data have been used before, meters reduce staff time and increase data reliability.

4.1. Digital Environments

With the concept of environment, we first think of living space, home, school, family, etc. is coming; Today, the environment is not limited to these phenomena. Namely, with the computer in the 1990s and then the internet in the 2000s, a new environment, the digital environment, emerges. However, adapting to this new field is not easy for those who were not born into this field. Even in developed countries, it is observed that a significant part of the population is quite distant from these practices (Plamper, 2003).

Digital environments, in which ecological and smart cities interact, contain different meanings such as technological and sustainable cities and have the opportunity to be used in many areas. In this sense, some of the uses that are spreading rapidly in digital circles are as follows:

- Solar panels used on roads that produce their own electricity with solar energy
- Solar or wind energy panels/circuits used for all lighting poles of cities
- Smart parking sensors used in city parking lots

- Tracking and camera systems used in all public transportation and personal vehicles of cities
- Personnel tracking systems/products
- Smart trash cans used in cities
- Intelligent irrigation systems used in parks and gardens
- Artificial intelligence -based sensors that control traffic lights and vehicle rule violations
- Aerial control of emergency aid, fire and security drones in cities with high population density and keeping them ready on land
- Wi-fi hotspots in city squares and public transport of smart cities
- Digital libraries in public transport
- Possibility of charging in public transport
- New charging stations for smart and rechargeable vehicles
- Smart billboard etc.

4.2. Examples and Applications of Ecological and Smart City in the World

When we look at the cities in the world, many ecological and smart city applications are seen. These are as follows:

- The city of Amsterdam is considered successful in smart city applications with a good communication infrastructure. Amsterdam is also a city that has developed solutions in terms of sustainability, energy efficiency and use of renewable energy.
- Copenhagen city government has developed a smart bike system. In this system, air pollution and traffic congestion are monitored and

managed by providing real-time data and information exchange between the user and the management with the help of sensors.

- Malmö reduces energy costs by supporting less energy use and cleaner energy policies in the fight against climate change.
- Negative environmental effects and save energy with the help of Information and Communication Technologies (Green IT) by collaborating with the private sector, the user and the public sector within the scope of the city's sustainable environmental policies.
- A soccer field in the Brazilian city of AstroTurf has 200 piezoelectric harvesting tiles underneath the AstroTurf that power the field lights and allow community members to play on the field after dark. Footsteps power six LED floodlights that illuminate the space. The energy produced is complemented by solar energy collected during the day (Bowater, 2014).
- California Santa 34 solar-powered garbage and recycling compactors have been installed in parks and other public spaces in the city of Clarita. Instead of checking the trash bins daily, the staff monitored the trash cans via a mobile application. After the boxes have run for five months, the city has been noted to have collected 2.5 tonnes more recycled material than traditional recycling bins had previously collected (Heaton, 2013).

Ecological and smart city understanding has been adopted at the urban scale and there are many examples in cities around the world.

Ercoşkun and Karaaslan (2009), the Milton example in Canada is at the project stage and is one of the ecological and smart city examples to be located in the development area of the city of ' Milton '. The current city of Waitakere in New Zealand is an example of technology-based transformation with the eco-tech (ecological smart city) action campaign. 'Eco-Viikki' is very close to the capital city of Finland and Helsinki, one of the most developed countries in Europe, in the big city center, designed to serve the city. It is part of the technopolis. 'Arcosanti' is an important example as an independent city located in the USA. It is an example of ecological cities that keep up with today's conditions with technology. The example of 'Bo01', which is part of the city of Malmö in Sweden, one of the Scandinavian countries, is the most important example of sustainable settlement in Europe, competing with the 'Milton' project in technology and ecology. Integer projects are flexible package projects that can be built anywhere. Among these settlements, only Milton and Waitakere settlements have the adjective eco-tech (ecological and smart city) in their names (Ercoşkun & Karaaslan, 2009). The purpose and content of ecological and smart city examples are given in Table 1.

Table 1. Purpose and content of ecological and smart city examples (Ercoşkun & Karaaslan, 2009).

Ecological and Smart City	Project Objectıve	Project Content
Canada, Milton	Preparation of, economical and flexible designs that increase profits with ecological planning, local solutions and communication technologies.	It is the city of the future that will reduce its ecological footprint, give priority to renewable energy sources with the use of new generation communication technologies, and choose recyclable materials.
New Zealand, Waitakere	Urban residents understand and use information and communication technologies for ecologically sustainable work and quality of life.	Digital presentation of the Waitakere urban heritage inventory and preparation of the central database 'smart and green' housing design guide, access to health facilities, monitoring and management network for the local eco-system, eco-tech industrial park, eco-tech fairs.
Finland, Eco-Viikki	Saving energy and drinking water, reducing waste water, using environmentally friendly and durable building materials, optimum use of modern telecommunications and computer networks, supporting biodiversity and organic functioning.	Integrated settlement design that combines areas that generate electricity from the sun, afforested areas, housing with natural ventilation chimneys, service work and recreational areas.
USA, Arcosanti	Ensuring efficient circulation of people and resources, providing alternative benefits by constructing multi-purpose buildings in the city, creating a combined design of built and natural environmental systems with the awareness of ecology + architecture.	Creating a design nested in a creative environment with solar collectors to collect the heat in winter, virtual spaces equipped for the day with internet and communication technologies.
Sweden, Malmo Bo01 example	Ecological housing project solutions for a sustainable future in cities.	The use of rainwater, the conversion of waste into biogas with a vacuum piping system, the use of biogas for heating and generating electricity in cars and buses, solar panels on the roofs of buildings, a large wind power station at the port, electrical energy sharing systems with hybrid engines, green vehicles.
Integer projects	Integer with prefabricated housing systems (Intelligent and Green), ecological and technological housing design.	Solar panels, rainwater collection systems, recycled building materials, roof gardens, indoor smart multimedia and security systems, use of smart meters.

5. Conclusion

The main subject of this study is the situation of ecological and smart cities, which are formed in the whole of governance, mobility, environment and life components with the contribution of information and communication technologies and bring together many dimensions. Digital environments, in which ecological and smart cities interact, contain many different meanings such as technological and sustainable cities.

Digital environments clearly show people that energy efficiency, renewable energy sources, generation and distribution of energy, employment will change so that things improve the well-being of human life. Today ecological and smart cities are the best example of the transition from physical work to knowledge-based work while preserving ecological values.

Today's societies can use digital technology. In addition, developed countries, which use the blessings of the virtual world, create digital environments that contain ecological and smart cities.

Ecology (nature) and technology (energy) at their center, analyze geographical and climatic data and bring together human and nature with ecology, while also including technology in this cycle. As a result of this situation, while increasing the quality of life of people, a sustainable and healthy life is left for future generations. Economic, social and environmental balance are considered as dimensions of ecological and smart city understanding (Mozhdegani & Afhami, 2017).

Smart and ecological city can reach prosperity thanks to the basic infrastructure services that enable them to compete in the world economy. These services include broadband connections, renewable, clean, reliable and affordable energy, education opportunities, accommodation and efficient transportation services.

Vision of “Ecological and Smart City” has a great importance in the world. When the concept is evaluated closely, it is very important for the future of the world to determine holistic strategies in which urban relational processes are considered together with planning in all layers that make up ecological and smart cities, in terms of spreading the urban mind to all areas of life and reaching from technology-oriented cities to cities that increase ecological and life quality with technology support. The ecological and smart city ensures the efficient use of nature, human and financial resources and encourages savings. The goal is not to make large financial investments, but to make infrastructure systems run longer at lower costs. Using ecological and smart solutions for a quality life is the main goal for efficient use of resources, sustainable development and future cities.

Ecological and smart city approach, which aims to make designs that respect nature so that future generations do not experience resource problems, aims to create a built environment that will leave a sustainable environment for people. Urban environmental problems are the main reason why eco-tech city model is preferred. This understanding will bring solutions to the environmental problems of the city (Alıcı & Yıldız, 2020).

Ecological and smart city offers solutions for current and future climate and environmental problems. For example, today, in ecological and smart cities, air and noise pollution are reduced by using information communication technologies, regular public transportation and garbage collection systems are developed, and traffic congestion is prevented. Smart garbage cans send a signal to garbage collection stations to inform them that they are full, and smart street lamps can automatically light up with the energy they store during the day. Again, warnings for bad weather conditions can be sent via smartphone applications, and transportation vehicle tracking and time savings are provided.

For the formation of a smart and sustainable city, it is necessary to consider ecological principles in the use of technology and to consider technology together with ecology. While information technologies dominate in ecological and smart city applications, the ecological dimension should not be ignored (Çetin & Çiftçi 2019).

Ecology and technology, by providing energy conservation, in an environmentally friendly way to ensure sustainability. These recommendations are aimed at reducing the ecological footprint, preventing globalization and protecting today's future renewable energy sources. It also makes recommendations to protect natural resources, the environment, water resources, air quality, agriculture and biodiversity.

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City and Energy

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1. Introduction

Today, urbanization has increased as a result of rapid population growth and industrialization. Increasing cities in the world lead to more energy consumption. Half of the world's population lives in cities where a significant share of the world's annual energy is consumed either for the heating or cooling of living spaces, transportation, industrial areas, or active systems (Gaiddon et al., 2009). In this direction, it is necessary to reduce general consumption on a national scale and to produce targets to aiming energy efficiency by using renewable energy sources such as solar and wind.

In the last two centuries, cities have transformed from relatively compact to complex sprawl and have been built as settlements using fossil fuels. Today, the use of energy based on fossil fuels and build of cities independently from renewable energy sources cause environmental damages such as climate change, and the destruction of ecology and natural resources. In addition, the rapid depletion of fossil fuels is an important problem. Cities can improve air quality, provide economic sustainability and mitigate the negative effects of climate change by reducing fossil fuel consumption and adopting energy efficiency and renewable energy infrastructure. In this context, using renewable energy sources provide significant potential and these sources are seen as a solution proposal (REN 21, n.d.). In this respect, reducing the negative effects of fossil fuel consumption on a global scale, using energy effectively and supporting the use of renewable energy resources are among the basic strategies of many countries and many countries have developed sustainable city plans (Çelebi, 2021).

A large part of the amount of energy used in the world is consumed in the construction sector, especially in buildings to provide comfort conditions. In this respect, solving the energy problem in cities consisting of buildings can be seen as an important step for solving the world energy problem. In order to produce effective solutions to the energy problem, larger scale studies should be done like settlement scale instead of building scale solutions and more precautions should be taken. A city, building area or a settlement should be designed with a holistic approach by considering subjects such as architecture and urban planning and other areas where energy is used. In this context, in this study, the relationship between the city and energy is handled extensively and from an architectural perspective. It is aimed to reveal the relationship between energy and cities and the importance of energy-efficient cities in the light of the literature review in line to reach energy-efficient solutions at urban and architectural scale, manage the amount of energy consumption and use from renewable energy sources. In addition, it is aimed that the study will throw light on future studies about energy-efficient design and retrofitting.

2. Material and Method

In this study, it is explained the relationship between city and energy and the importance of this relationship. In the literature review direction, energy efficient settlement and building design, renewable energy system integrated city and buildings are explained in systematically created by us. At the same time, examples of energy-efficient cities in the world are analyzed and evaluated within the scope of energy-efficient urban planning.

3. Findings and Results

Although urban studies and energy efficiency studies are valuable, studies on the relationship between the city and energy, and energy-efficient urban studies are important. In this direction, in this section, energy-efficient settlement design parameters are explained systematically, and energy-efficient city samples are presented.

3.1. Energy Efficient Urban Planning

Building energy-efficient and sustainable cities is a fact that the pre-modern period of urban history is not unknown, but implementations have been severely and destructively interrupted by modernization. The idea of utilizing renewable energy resources such as solar and wind in the history of humanity dates back to ancient times. Ancient Greeks knew that buildings and cities must work in harmony with their climate region if they are to provide human comfort sustainably (Heywood, 2015). The Ancient Greeks realized the importance of site and community planning for the heating and cooling of buildings. Since they wanted their buildings to face the winter sun and reject the summer sun, their new towns were built on southern slopes and the streets ran east-west whenever possible. The ancient Greek city of Olynthus was planned so that most buildings could front on east–west streets. The ancient Greeks considered their solar design of buildings and cities to be modern and civilized. The Romans were also convinced of the value of solar heating, so much so that they protected solar access by law. The Justinian Code of the sixth century states that sunshine may not be blocked from reaching a heliocaminus (sunroom). While winter heating was critical to the ancient Greeks and Romans, summer shade was also very important (Lechner, 2015).

Cities that lead to large energy consumption have a key role to play in the transition to sustainable energy. A city should be designed with a holistic approach by considering subjects such as architecture and urban planning, energy. In this context, many countries have developed sustainable city plans. Urban planning and design strategies have been developed such as solar cities, sustainable cities, slow cities, ecological cities, eco villages, smart city initiatives, etc. All these sustainable city models aim to create sustainable and energy-efficient cities of the future by adopting parameters such as energy-efficient architecture and community design, land use, and transportation. Keeping the air and soil, water alive and keeping the thermal energy under control are sustainable cities' basic principles. The main purposes of sustainable cities are to reduce greenhouse gas emissions, reduce ecological footprints, the development of building design, and land use in the context of sustainability (Çelebi, 2021).

Urban systems have a highly complex structure, and the components of urban systems are interconnected and dynamic from food distribution networks and energy networks to transportation and green networks (Gaiddon et al., 2009). In this respect, energy demand (heat, electricity) and supply solutions and potential carbon absorbers (green infrastructure) in a city must be handled to become carbon neutral. Settlement design and architectural design, land use, sustainable transportation, and protection of green texture are the parameters of energy-efficient urban planning. In this study, energy-efficient design parameters of buildings that constitute a large part of green gas emissions and settlements consisting of buildings are handled. These design parameters are shown systematically created by us in Table 1.

Table 1. Energy efficient settlement planning parameters

Energy Efficient Settlement and Building Design	Parameters for settlement design	Site selection
		Settlement texture and distance between buildings
	Parameters for building design	Orientation of the building and space planning
		Building form
		Building envelope optical and thermophysical properties
		Solar control
		Natural ventilation layout
Renewable Energy Systems in Settlement and Building Design	Renewable energy systems in settlement design	
	Renewable energy systems in building design	

3.1.1. Energy efficient settlement and building design

In the direction of the energy-efficient settlement and building design, geographical, topographic and climatic data of the region where the settlement is located should be handled and analyzed. Accordingly, the variables related to the design should be determined. According to the studies, energy-efficient settlement and building design parameters are handled as in Table 2 (Berköz et al., 1995; Bradshaw, 2006; Manioğlu, 2011; Lechner, 2015).

Table 2. Energy efficient settlement and building design parameters (Berköz et al., 1995; Bradshaw, 2006; Manioğlu, 2011; Lechner, 2015)

<table>
<tr><th>Parameters for the physical environment</th><th>Parameters to users</th><th>Settlement design parameters</th><th>Building design parameters</th></tr>
<tr><td>Outside temperature</td><td rowspan="3">Parameters to user properties and conditions</td><td rowspan="2">Site selection</td><td>Building orientation and space design</td></tr>
<tr><td>Solar radiation</td><td>Building Form</td></tr>
<tr><td>Outside humidity</td><td rowspan="3">Settlement texture and distance between buildings</td><td>Building envelope optical and thermophysical properties</td></tr>
<tr><td rowspan="2">Wind</td><td rowspan="2">Physiological parameters</td><td>Solar control</td></tr>
<tr><td>Natural ventilation layout</td></tr>
</table>

3.1.1.1. Settlement design parameters

- ***Site selection***

In terms of energy efficiency, the location of the settlement area should be determined depending on the climatic character of the region and the climatic needs of the people. Firstly, slope analysis should be done for suitable site selection. Thus, straight areas and areas whose direction is suitable for settlement but whose slope is not suitable for settlement (areas of 24^{o} and steeper) are determined. The slope angle is determined between 0^{o} and 24^{o} for site location (Berköz et al., 1995). Solar and wind are important physical environmental factors to be analyzed at the site selection stage. Solar radiation gain is important for the period when heating is needed and demanded. In this direction, it is important for energy efficiency to determine the right direction in terms of solar radiation for each slope during the site selection stage, and therefore to relate the thermal zone, land slope and solar radiation gain. In the scope of energy conservation, it is important to benefit from the positive effects of wind on the settlement pattern and buildings in periods when heating is not needed.

- ***Settlement texture and distance between buildings***

The distance between the buildings, the heights of the buildings and their locations according to each other affect solar radiation and wind factors. Therefore, passively benefiting from or being protected from the effects of sun and wind changes depending on the settlement texture and distance between buildings. In direction of optimum benefit from solar radiation, the distance between buildings must be equal to or greater than the longest depth of area given by surrounding buildings (Manioğlu, 2011). The parameters for determining the distance between buildings are as follows:

- Determination of the day characterizing the period that heating is demanded,
- Determination of profile angles,

- Determination of shaded depths of area (u),
- Determination of the distance between buildings based on shaded depths of area (w).

The streets and settlement texture in the east-west direction are shown in Figure 1. This settlement texture is ideal for both winter solar access from the south and summer shading from the east and west (Lechner, 2015).

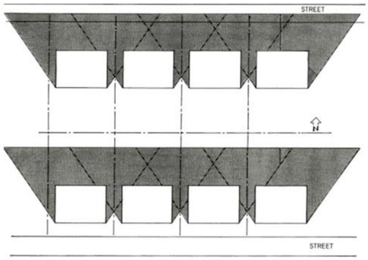


Figure 1. Settlement texture in the east-west direction (Lechner, 2015).

Green texture and landscaping of open areas are important factors affecting settlement design. The green texture design and its location are important in terms of benefiting from physical environmental factors. The effect of trees and plant communities increasing or preventing wind speed, and providing shaded areas and heat gain in terms of solar radiation should be considered (Lechner, 2015).

3.1.1.2. Building design parameters

- ***Building orientation and space design***

Climate elements such as solar radiation and wind change depending on the direction. The amount of heat gain in the interior spaces depends on the direction of the building envelope. In this direction, the orientation of buildings is one of the most important built environment variables. The buildings must be directed to the sun in terms of heat gain. The function of spaces is important concerning space layout. The function of the spaces determines the data on the spending time in it and in which parts of the day this time is. In this direction, the correct orientation can be determined (Lechner, 2015).

- ***Building form***

The building form is a substantial design parameter affecting heat gain and heat loss. Dimensions of the building and form factor demonstrate the horizontal and vertical dimensions of the building and the surface area of the envelope element surrounding the building. The amount of heat transfer through the building envelope is effective in providing indoor air quality and comfort conditions (Manioğlu, 2011). The form of the building should be determined according to heat gain and climate properties.

- ***Building envelope optical and thermophysical properties***

Building envelope optical and thermophysical properties are effective in determining the amount of heat transfer through the opaque and transparent components of the building envelope and indoor air temperature and interior surface temperatures. Optimizing the building envelope for the climate can substantially reduce the size of the mechanical system (Lechner, 2015). The optical and thermophysical properties that affect the heat transfer in the building envelope can be listed as follows:

- Absorption, transmittance and reflectivity coefficients of opaque and transparent components in the direction of solar radiation
- Total heat transfer coefficient of opaque and transparent envelope components
- Amplitude reduction factor and time delay of opaque components
- Transparency rate (Berköz et al., 1995).

The building envelope can be designed as a passive system in terms of solar radiation and heat gain. In passive systems, solar radiation is kept, stored and transferred to interior spaces by natural methods. The heat is transferred to interiors by convection and conduction with natural heat sinks.

- ***Solar control***

The solar radiation gain is important according to the period in which the heating is demand. In the period when heating is not in demand, it is necessary to be protected from the thermal load dependent the solar radiation. In this direction, solar control elements play an effective role. Solar control elements can be placed on facades, windows or interior spaces depending on architectural solutions. In the design of solar control elements, parameters such as the direction type (horizontal or vertical), operating type, control type, the number of pieces, surface properties, position in the window space, its vertical or not vertical to the window plane, and its position on the building envelope are evaluated and determined. At the same time, solar control elements should be designed so that they do not affect the solar radiation gain during the period of heat demand (Lechner, 2015; Mangan, 2015).

- ***Natural ventilation layout***

Natural ventilation is defined as the replacement of polluted air with clean air in an indoor space without mechanical systems or equipment. Natural comfort ventilation brings in outdoor air, both during the day and at night. Effective natural ventilation in buildings is provided by taking clean air into the building and circulating it inside, and removing the polluted air from the building. The effectiveness, quality and sufficiency of natural ventilation depend on the location of the building, its shape, the layout of the building units, the location, directions and dimensions of the building facade and the openings in the facade (Berköz et al., 1995). In addition, the other effecting factors of airflow through a building: pressure distribution around the building; direction of air entering windows; size, location, and details of windows; and interior partitioning details (Lechner, 2015). Natural ventilation in buildings is provided by different methods such as one-sided ventilation, cross ventilation and stack effect ventilation. Cross ventilation between windows on opposite walls is the ideal condition as shown in Figure 2.

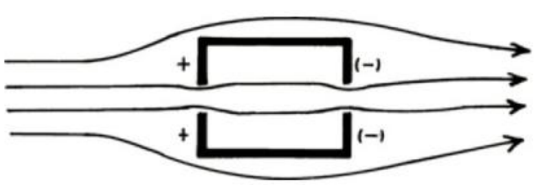


Figure 2. Natural cross ventilation (Lechner, 2015).

3.1.2. Renewable energy systems in urban and building design

Renewable energy sources are handled in two groups renewable and non-renewable energy sources according to their sustainability, environmental impact, and exhaustibility properties. Renewable energy sources are the types of energy that exist naturally in our environment and are in a constant flow. These sources are clean and eco-friendly.

- Solar energy,
- Wind energy,
- Water energy (Wave),
- Hydroelectric energy,
- Hydrogen energy,
- Geothermal energy and
- Biomass energy.

Renewable energy sources are used in various areas. In these areas, as in all activities, the most important subject is efficiency. In this section, the use of renewable energy sources as active systems is handled. Solar and wind energy systems, which stand out as clean, eco-friendly and unlimited sources, are explained in detail and the integration of these systems into the settlement and building texture is explained.

Solar energy emerges as a result of the fusion reaction that provides the hydrogen gas in the core of the sun to turn into helium and solar is a powerful energy. Solar energy can be used directly as heat energy or indirectly as electrical energy by converting it through developed technologies. These technologies are solar cells (photovoltaic systems) and solar collectors (Koç & Kaya, 2015). Heating-cooling and hot water supply in buildings with solar energy, electricity generation from solar energy, use of solar energy in agriculture, and the metal industry are some of the areas that benefit from the sun.

Wind energy is formed as a result of the different heating of the ground surfaces by solar radiation. It is renewable, natural, clean, and has limitless power. Differential heating of the seas and air causes a pressure difference, and this pressure difference causes the movement of the air. This movement of air from high pressure to low pressure is defined as wind. Wind energy is utilized to produce mechanical energy or electrical energy. The mechanical energy obtained is generally utilized for irrigation purposes in homes and farms. Wind Power Plants are utilized to produce electrical energy from wind energy (Koç & Kaya, 2015). In addition, building-scale wind energy is utilized by small-scale wind turbines.

3.1.2.1. Renewable energy systems in urban design

In urban planning, energy management is important for the sustainable future of cities. Integrating renewable energy sources into the urban planning system is a process that includes strategic and technical parameters. Renewable energy systems can be integrated with the settlement texture such as large-scale renewable energy power plants, residential areas, and energy-producing urban furniture that can provide the needs of the urban user. Climate characteristics are an important factor for renewable energy technologies. The energy production and consumption potential of renewable energy systems are directly related to climatic conditions (Bostancı & Erbaş, 2020). Large-scale solar or wind energy plants can be built appropriately for the urban climate. In addition, small wind turbines and solar panels can be used as urban furniture.

The use of renewable energy systems in urban planning is primarily based on the spatial analysis of regional and local energy potentials. Site selection, planning process and renewable energy source selection should be determined simultaneously. In terms of physical plan decisions, regional characteristics and resources should be analyzed completely. The site selection for renewable energy projects should be determined so that does not disturb the natural properties and the historical natural texture of the urban system. The stages of transition from the renewable energy project approach to the local clean energy planning stage in the urban planning process are as follows:

- Analysis of the current situation
- Determining the requirement program
- Decision stage
- Determine planning decisions
- Site selection stage
- Plan implementation stage
- Strategic plan creation process
- Feedback stage for post-project sustainability

- Developing future projections of the project (Bostancı & Erbaş, 2020).

On the settlement scale, at the same time, energy-efficient planning and the use of renewable energy systems in urban planning include strategies such as energy analysis, local characteristics, energy-space relations, and resilient designs. Local characteristics should be determined, climate, topography and built environment should be analyzed, and urban and rural energy demand should be determined. The energy-space relations should be considered most efficiently according to the determined flow charts, and the city form should be built that supports the energy-integrated city approach. In addition, designs should be handled by developing technology and requirements (Tokatlıoğlu, 2013).

3.1.2.2. Renewable energy systems in building design

Passive and active systems in buildings are design approaches that optimize the comfort conditions and energy efficiency of buildings (Bradshaw, 2006). In the context of energy efficiency, buildings should be designed as energy-efficient passive systems, firstly. After that, renewable energy systems should be integrated into the buildings for building service systems such as heating-cooling, ventilating, and lighting (Çelebi & Arpacıoğlu, 2022). In this direction, in this section, building-integrated renewable energy systems such as solar collectors, PV systems and wind turbines are explained.

- ***Solar collectors***

Solar collectors are used to heat air or water; are designed to produce hot air or water. Solar collectors are generally located on roofs. Hot air is used primarily for space heating, while hot water can be used for several purposes: domestic hot water, space heating, space cooling, swimming-pool heating, and commercial hot water (Lechner, 2015). Solar collectors provide heating of the cold water supplied to the system by collecting and concentrating solar radiation. Solar collectors are classified as flat-plane solar collectors, vacuum-tube collectors and concentrating collectors. Flat-plate solar collectors are mainly used in the construction industry and are used for domestic hot water (Figure 3) (Demircan & Gültekin, 2017).

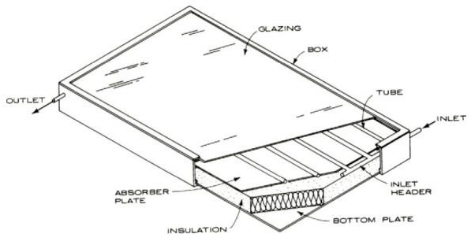


Figure 3. Flat-plate solar collector (Lechner, 2015).

- ***Photovoltaic Systems (PV)***

Photovoltaic systems are renewable energy technologies that providing produce electrical by solar radiation. PV systems are used to provide the energy required for building service systems such as heating, cooling, ventilation, and lighting systems. Photovoltaic system components; alternating, direct current (AC/DC) converter, storage unit, battery and control center. The direct current produced in the system is stored in the batteries and converted into alternating current with a converter, and used in buildings. PV systems can be considered into three groups stand-alone (off-grid), grid-connected and hybrid systems (Çelebi, 2021). In a grid-connected system, an inverter is required to change the direct current from the PV array to alternating current (AC) at the correct voltage of the grid. Batteries are not needed. In stand-alone systems, the excess electricity produced during the day is stored in batteries for nighttime and dark, cloudy days (Lechner, 2015). Hybrid systems are composite systems in which photovoltaic systems are used with other renewable energy sources such as wind.

In addition to producing energy, photovoltaic systems are considered as a building component in the design of the building form. Photovoltaic systems play an important role in the building envelope design, and therefore in the building design or construction process (Ünver, 2013). The support and additional structure for PV are not required. Also, PV provides heat, water, sound insulation and solar control. (Gaiddon at al., 2009; Lechner, 2015).

- ***Building-Integrated wind turbines***

Building-integrated wind turbines are considered in two groups off-grid and grid-connected. Off-grid battery systems are especially used in areas where the electrical network cannot reach such as suburban settlements, greenhouses, farms, etc. The low storage capacity of the batteries is the disadvantage of these systems in terms of efficiency.

Building-integrated wind turbines are used as a system type, independent of the building and connected to the building (Bektaş, 2013).

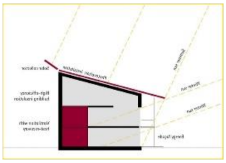
The wind turbines that are independent of the building are handled independently of the architectural design. Wind farms, and wind turbines integrated into the ground in gardens are examples of these systems. Building-mounted wind turbines use buildings as a tower, and do not use the building form to change or increase the existing wind flow (Bektaş, 2013).

Building integrated wind turbines (connected to the building) are based on the idea of wind energy-efficient design (wind energy-based design). Building-integrated wind turbines have a great impact on the architectural form and the system aims to transform the building into a mechanism that collects the wind and directs it to the turbine (Bektaş, 2013). The wind turbines can be mounted atop a building, and the increase in wind speed as it moves around the building can be used to advantage (Bradshaw, 2006).

3.2. Energy-Efficient Cities in the World

In this section, international energy-efficient city samples that are common in the literature are analyzed in terms of energy-efficient design parameters and are explained. These cities are Auroville Ecological City, Freiburg Solar City, Masdar Smart City, and Fujisawa Smart City. Cities are shown in Table 3.

Table 3. Examples of energy-efficient cities in the world

Auroville Ecological City, India 	Auroville urban planning is built in a spiral that is characterized as a 'Galaxy structure'. The city is divided into four zones on this spirally rotated movement around the city center, which function as "industrial, cultural, international and residential areas" (Anupama, 2007). In the galaxy-structured settlement, the residential buildings are oriented in the north-south direction, mostly open to the prevailing winds in summer. Auroville is known for its sustainable building examples. Building forms, materials and technologies vary. Local, natural and recycled materials are used in the buildings. Buildings are designed energy efficient to provide passive air conditioning. The energy required for building service systems such as heating-cooling, ventilating and lighting is provided by solar energy technologies. PV systems are integrated in the settlement texture and buildings. Wind, biogas and geothermal energy systems are used together with solar energy as renewable energy sources. At the same time, the settlement has mixed land use and sustainable transportation principles are adopted in the city (Auroville, n.d.).
Freiburg Solar City, Germany  	Freiburg is one of the sunniest regions in Germany. Solar Settlement is designed to be energy efficient. Settlement texture based on solar orientation. Smart orientation was a key strategy used to maximize energy efficiency. The distance between buildings is determined by calculating so that the buildings do not shadow each other. Buildings are designed for zero-energy. The buildings feature a simple passive heating and cooling strategy. The buildings are located according to the seasonal movement of the sun. Thus, solar heat gain is provided in the demand period of heating. The overhangs in the buildings and the balconies on the south facades of the buildings provide shaded areas in summer. The building shell envelope features high-efficiency insulation and three-layer glass is used in the windows. Solar energy is also used as active systems such as PV in buildings. The energy required for building service systems such as heating-cooling, ventilating and lighting is provided by solar energy technologies and passive design parameters. In addition, the settlement has mixed-use that emphasizes livability with a minimal footprint. (Çelebi, 2021; Michler, 2011).

Masdar Smart City, Abu Dhabi  	Masdar City is an ecological city implemented according to the zero-carbon principle. The main axis of the city was rotated to benefit from the prevailing wind. Streets are designed to maximize shadows and cool airflow throughout the day. Public spaces are cooled by green landscapes and using water elements. The designs of sustainable buildings in the city vary. Buildings' common features are that they are designed according to passive design strategies. The building's orientation is to reduce cooling loads. Buildings feature compact forms and courtyards. The energy required for building service systems such as heating-cooling, ventilating and lighting is provided by PV systems. In addition, efficient devices are used for lighting systems (Caine, 2014). A 10-megawatt solar plant has been built in the city, and the solar plant produces more than the amount of energy the city's daily use. City also benefits from wind energy. At the same time, the settlement features mixed land use and sustainable transportation (Masdar City, n.d.).
Fujisawa Smart City, Japan  	Fujisawa City was designed a smart to build a smart city in Japan. The site plan features buildings located around the main center and other designed areas. Settlement texture is designed to energy efficient scope of passive design strategies. The texture is designed to optimum benefit from solar radiation and provide the flow of wind in the city. The buildings in the city are located according to passive solar orientation. The buildings are rectangular and low-rise. Local material was used as a building material. The energy required for building service systems such as heating-cooling and lighting is provided by building integrated photovoltaic systems. In addition, LED devices are used for lighting systems. The ventilation feature is natural ventilation. It is aimed for the inhabitants to generate their own energy. PV systems are also integrated settlement texture such as street lamps and surface covering in public spaces. At the same time, the city is designed according to the mixed-use principle and there are sustainable practices such as sustainable transportation and water conservation in the city (Fujisawa SST, 2018).

4. Conclusion

When the relations between urban planning and energy are considered, three main factors stand out: population growth, economic development and energy demand. Energy demand is increasing owing to the increasing population and urbanization. Energy also has a critical impact on economic development. In this context, larger-scale studies is seen as a solution proposal. Solving the energy problem in cities can be seen as an important step for solving the energy problem. In this direction, larger scale studies should be done like urban scale and more precautions should be taken.

In this study, energy-efficient settlement and building design parameters that cities and buildings will provide the amount of the energy needed from passive and active strategies and renewable energy systems are explained. Energy-efficient city samples in the world are also explained. These cities are evaluated and presented according to energy-efficient settlement and building design, and using renewable energy systems on urban and building scale. In addition, the efforts of the examples to improve the settlement life and quality in the architectural context, and their efforts to handle environmental subjects at the settlement scale are evaluated. The evaluation of energy-efficient design parameters is shown in Table 4.

Table 4. Evaluation of sample cities' scope of energy-efficient design parameters

Energy Efficient Design Parameters	Auroville Eco-City	Freiburg Solar City	Masdar Smart City	Fujisawa Smart City
Energy-efficient Settlement Design	✓	✓	✓	✓
Energy-efficient Building Design	✓	✓	✓	✓
Renewable Energy System in Settlements	✓	*	✓	✓
Renewable Energy System in Buildings	✓	✓	✓	✓

✓ : It indicates the implementation of the strategy.
*: Indicates that information about the strategy could not be reached.

According to the sample cities examination, the settlement texture and buildings are designed to the energy-efficient in accordance with climate and solar factors. Benefiting from the sun optimally is the basic parameter of settlement texture and building orientation. Buildings are designed according to sustainable design strategies. Building forms are shaped according to the climate zone where the settlements are located. In general, local building materials were used, and in Auroville Eco-City, recycled building materials were also used. The buildings are designed as PV integrated and the energy required for building service systems is provided by building integrated photovoltaic systems. At the same time, passive heating and cooling and passive ventilation are provided in the buildings. In addition, renewable energy systems are integrated into the settlement texture in the cities of Auroville, Masdar, and Fujisawa. The common feature of the sample cities is that they also have mixed land use, and sustainable approaches such as sustainable transportation have been adopted. As a result, these cities were designed to be energy efficient and carbon neutral. In this direction, cities can produce their own energy required and they are self-sufficient. Evaluation of sample cities demonstrated that energy-efficient design parameters are important and effective for energy efficiency and for cities.

The energy-efficient urban planning process includes basic design and development strategies. Ecological settlement and building design, and renewable energy systems have a key role to play in the energy-efficient city. In this respect, settlement and building design parameters should be handled as the primary component of development-urbanization policies, architectural and urban planning processes. Energy-efficient cities can be built by integrating energy-efficient design strategies into urban design, especially in cities where urban transformation is on the agenda and in our country. It should be considered that sustainable, livable and energy-efficient settlements can be realized with the right decisions taken on a large scale.

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Child-Friendly City Initiative

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1. Introduction

Children will determine the future of the society, for such an important mission, it is important for the health, welfare and order of the society that children develop as individuals and complete their development in a healthy way. According to Article 1 of the Convention on the Rights of the Child, “A child is considered to be every human being below the age of eighteen, except for the earlier age of majority under the laws applicable to the child” (UNICEF, 2004). According to the 2021 data of the Turkish Statistical Institute (TÜİK, 2021), 30% of the world's population and 26.9% of Turkey's population are children population. The fact that these proportions in the population are children is important in terms of revealing the importance of the issue. The most important factor affecting the development of children is play. Urbanization that comes with the increase in population causes the limitation of children's playgrounds and opportunities. When it comes to children, the first thing that comes to mind is the concept of play. Since the first periods of humanity, play has been an indispensable part of society in every environment where children exist (Başal, 2007; Ayaz, 2020; Aynacıyan, 2020).

Play is a basic need in which the child acquires the skills and habits that he will use throughout his life. Child; learns through play that to cooperate, to observe, to discover, to take responsibility, to acquire habits, to gain experience, to understand his place in life, to communicate and most importantly to protect his own rights. Play, which is of vital importance for children's ideal growth, has a great contribution to the child. Games are support the child's physical (supporting the musculoskeletal system) development, social (by regulating social relations) and mental (by trial and error learning, language learning and improving empathy skills) development (Mangır & Aktaş, 1993; Coşkun, 2015; Karaca, 2016; Gülçek, 2018; Berkün, 2019; Muslu & Gökçay, 2019).

The personality and behaviors of the child are determined by the places/physical environment in which they live rather than their genetics (Barker, 1968; Bechtel, 1977; Wicker, 1979).For this reason, urban spaces such as residences and its immediate surroundings, streets, parks, schools and children's playgrounds, which constitute the physical environment in which the child interacts, have great importance in becoming an individual, socialization and development. Due to rapid and intense urbanization, natural playgrounds in open-green areas have been reduced to almost non-existent and a technology-dependent area is presented to children among concrete structures (Öztürk, 2001).

Technology addictions of today's children cause them to take part in society as individuals who cannot complete their physical, social and mental development. In this case, causes the emergence of different social problems in the society.

In order for children to complete their development with a game culture away from technology, it is important to meet their need for play in open spaces. The streets, which have free play opportunities in open areas, contribute to children's imagination, creativity, healthy growth, physical, emotional and social skills, learning real life, experiencing the environment, making friendships, and offer safe easy access due to their close proximity to their homes (Ayaz, 2020).The streets, which are of such importance in the development of the child, children cannot use the streets in their vicinity due to reasons such as safety problems, traffic density, the presence of disability and obesity in children, the use of technology and parental concerns (Tandoğan, 2014; Çakırer Özservet, 2015; Ayataç & Genç, 2015; Ayaz, 2020).

In the historical process, childhood has varied from culture to culture and time. In ancient and medieval times, children were seen as a worthless creature (Postman, 1995). After the Middle Ages and the Renaissance, childhood, as a valuable period, gained momentum as a period of social life, and childhood and adulthood were separated from each other (İnal, 1999). With the Enlightenment period, children began to be seen as the future of the state like an adult individual and the importance of child education was better understood. In the modern age, the child has begun to be recognized as an individual whose needs and rights are determined by law (Gül, 2010).

Throughout history, play has existed in all life stages of an individual from childhood (Başal, 2007; Ayaz, 2020; Aynacıyan, 2020). Play is a basic need in childhood, when an individual will acquire knowledge, skills and habits that he will use throughout his life. Through play, the child assimilates and reinforces helping each other, gaining knowledge by observing, discovering, taking responsibility, habit, gaining experiences by experimenting, understanding their roles in life, respecting the rights of others, and most importantly protecting their own rights (Muslu & Gökçay, 2019). Play types also change according to the development of children in time (Yavuzer, 2011; Muslu & Gökçay, 2019; Ayaz, 2020).

The physical, mental and cognitive health of the society depends on the healthy development of the individuals in it. The healthy development of individuals is possible when they complete their physical, mental and cognitive development during childhood, when their most basic needs are met. Within the scope of this paper, it is aimed to reveal the importance of the concept of child-friendly city for healthy societies.

For this purpose, the importance of the game, playgrounds, child-friendly street criteria and child-friendly city initiatives were explained and “What can be done to make a city Child-Friendly?” An answer to the problem has been sought.

2. Game Places

Housing and its immediate surroundings: Playgrounds are everyday place in the physical environment of the child. While the child feels restricted in the house, the child can act comfortably in the places are defined as the immediate surroundings of the house, such as in front of the door, steps, sidewalks and the street.

Public spaces: are public spaces where every citizen can move freely and enter without any problems. Urban structures, squares, streets, avenues and parks can be given as examples of public space.

Streets: At the beginning of the public spaces used by children, the street where the child knows the city, playgrounds and parks come. The street is the most important of the places where the child communicates with the outside world, which is a component of his physical environment and located in the immediate vicinity of the house.

Schoolyards: As the safest places, separated from traffic and within walking distance of children's homes, schoolyards are distinguished from other spaces in terms of offering open space potential and continuous protection and supervision. School gardens are places where there is no planning and design priority and professional standards are not established (Tandoğan, 2011).

Children's playgrounds: Children's playgrounds and parks, which are designed only for children, are among the spaces that allow the "play and other activities" which is important in the development of the child" (Tandoğan, 2011).

3. Factors Affecting the Child Street Relationship

The child population in Turkey is 48,5% in 1970, 41,8% in 1990 and 27,5% in 2019, and it is decreasing rapidly. Likewise, there has been a serious decrease in the number of children playing on the streets and in the places around their homes in the last thirty years (TÜİK, 2019; Ayaz, 2020). Urbanization and accompanying traffic, safety problems, use of technology, disability in children, obesity, economic reasons and parental anxiety are among the most important reasons for this situation. Children, who had the opportunity to play in large areas in the past, cannot find enough space due to urbanization today. This situation deprives children of their right to play and negatively affects their development (Artar et al., 2004; Mezkit, 2012; Tandoğan, 2014; Çakırer Özservet, 2015; Ayataç & Genç, 2015; Öz Pektaş, 2017; Arslan, 2017; Ayaz, 2020).

Traffic: One of the biggest threats to children's playing on the street is traffic accidents (Ayaz, 2020). According to the Swedish report, the risk of fatal injury to a child in a traffic accident is on average ten times greater than that of adults (Parker, 2008). Children of those who lost their lives as a result of traffic accidents in Turkey constitute 10,6% of those who lost their lives in all accidents. The 0-9 age group accounts for 42,1%, the 10-14 age group for 22,2%, and the 15-17 age group for 35,7% by the children who lost their lives in accidents (TÜİK,2019). According to these rates, traffic is one of the biggest threats that children and young people face on the street.

Security: In today's streets with heavy and fast traffic, abduction, murder, theft and attack etc. by foreigners aimed at children in the society. Due to the increase in social crime rates, the streets are seen by families as unsafe places for the independent movement of children (Hillman, 1999; Zubrick et al., 2010).

Use of technology: Today, technology has become indispensable for life. With the developments in the field of technology, many individuals can easily access the information and content they want, regardless of time and place. (Ayaz, 2020). While internet users around the world spend 6 hours and 43 minutes daily in the digital environment, it is 7 hours and 29 minutes in Turkey (Kemp, Digital 2020 Report, 2020). According to world statistics; In Turkey, 59,6% of the population uses the internet because it is easily accessible and cheap, and this rate is increasing day by day. Internet use at home ranks first with 65.6%. 45.6% of children use the internet every day. According to (TÜİK, 2021), internet users are in the 16-74 age group, but this age group is gradually decreasing to younger ages. Moreover, it is seen that children under the age of 15 use the Internet more functionally than adults (UNICEF, 2017). Children spend most of their free time either watching television or using digital tools (computer, telephone, etc.) due to reasons such as the change in family structure, unplanned urbanization and the decrease in playgrounds, and they become technology addicts over time (Gülçek, 2018). Technology addiction prevents children from spending time outside by changing their play habits (Clements, 2004; Ayaz, 2020).

Economic factors: Children who have to work due to economic inadequacies are deprived of games. While the rate of working children in the 15-17 age group in Turkey was 20,3% in 2017, this rate increased to 21,1% in 2018 (TÜİK, 2019). Children in working life have to give up their education and play opportunities. While the children of families with upper and middle income levels meet their gaming needs with the use of technology, the children of families with low economic income has learn the rules of life at an earlier age through activities such as playing different games and riding a bicycle in the streets (Lacey, 2007; Mete, 2019; Ayaz, 2020).

Disability and obesity status in children: Another factor that hinders children's outdoor activities is the state physical and mental disability seen in children. According to the World Health Organization, more than 500 million people are disabled and represent 10% of the population. (Ergün, 2005). 12% of Turkey's population, 8 million 431 thousand 937 people, are the disabled (Orakcı, 2010).

Refugee children: Another important problem affecting the situation of children in the world and in our country is the refugee problem. Turkey welcomes the world's largest registered refugees. There are registered four million refugees 1,7 million of whom are children in our country (UNICEF, 2019). The psychology of many of the refugee children has been disrupted during the war and migration. Playing allows bad events to be forgotten and makes them feel like children. Play is the right of every child (Ayaz, 2020).

Parental concern: Another obstacle to street use in today's changing world is parents' outdoor concerns or fears (Ayaz, 2020; Gezginci, 2020). Since 1990, there has been an increase in parental fears about the safety of children in public spaces, and accordingly, the child's independent movement in the city is restricted (Lacey, 2007; Tandoğan, 2017).

4. Child-friendly Street Criteria

Determining whether a street is child-friendly or not is very important to understand what aspects of that street are inadequate or what qualities make it child-friendly. This study, called “Kid Screet Scan” (Kiss 2.0), is an assessment tool for the Child-Friendly Street principles determined at the “Childstreet 2005” congress in Delf, how child-friendly the street is (Schepel, 2005; Tandoğan, 2011; Anonymous, 2019).

The main features of the child-friendly street are safety, walking, cycling, fun, playing, scale, arrangement, and accessibility (Baş, 2016).

Security: One of the criteria that a child needs on a street is a sense of security. The lack of adequate security in the street space causes parental anxiety, and the child is not allowed to play freely. The security attribute also affects other attributes. In this context, the safety criterion on the streets is of great importance. According to (Kiss 2.0), the "Safety" criterion was evaluated under two headings: social security and traffic safety (Schepel, 2005; Tandoğan, 2011; Baş, 2016; Genç, 2019; Anonymous, 2019).

Social security: Social security can be provided by the fact that adults can watch the street from inside their homes or there are people on the street (Jacobs, 1993; Schepel, 2005; Tandoğan, 2011; Baş, 2016).

Traffic safety: Traffic safety is directly related to the speed of motor vehicle drivers on the street. The qualifications required for the traffic safety of the street; the actual speed of the vehicles should be less than 15 km/h, the drivers' vision distance should be short and focused, and there should be no obstructions in the line of sight (Schepel, 2005; Tandoğan, 2011; Baş, 2016; Anonymous, 2019).

The walking ability criterion is related to the structure of crossing and walking areas. The criterion for children to be able to walk in the street depends on the provision of suitable conditions for crossing from one side of the street to the other - the criterion of crossing the street. Qualifications that meet the crossing criteria; (Schepel, 2005; Tandoğan, 2011; Baş, 2016; Genç, 2019; Anonymous, 2019). Pedestrian and bicycle crossings should be illuminated and marked, traffic safety should be ensured, there should be traffic lights, there should be a crossing distance (max 3,5 m) across the road, on both sides of the street, the walkable area should be at least 3 m wide, there should be a bicycle parking area and ramps (enough for the disabled). The pavement height should be at least 3 m and at most 15 cm. (Baş, 2016).

Cycling: It contributes positively to meeting the movement development of children. Qualifications required for cycling;

(Schepel, 2005; Tandoğan, 2011; Baş, 2016; Genç, 2019; Anonymous, 2019). If the vehicle speed is more than 30 km/h, the bicycle path should be more than 2 m, if the vehicle speed is less than 15 km/h, there may not be a bicycle path, the speed limit must be low, the number of vehicles must be low, there must be no vehicles parked on the road or on the bicycle path.

Ability to have fun: Streets are among the places where children spend time having fun. For Child Friendly Street, it is important for children to have fun on the streets. Therefore, according to (Kiss 2.0) for the street to be fun; (Schepel, 2005; Tandoğan, 2011; Baş, 2016; Genç, 2019; Anonymous, 2019). street view (attractiveness), planting (trees, bushes, flowers, grass, etc.), special elements in the private area (shops, workshops, landscaping, etc.), semi-private elements in the public area (play elements, seating elements, terrace, street art, etc.). There should be features that children like to see in the public space (water, bushes, grass, trees, animals, natural colors, sand and water, secret-private places, diversity, materials and equipment, etc.).

Being able to play: The play factor has a great contribution in the development of the child. For child friendly street, it means that the street should be a place suitable for playing. Qualifications required for the ability to play (Kiss 2.0) (Schepel, 2005; Tandoğan, 2011; Baş, 2016; Genç, 2019; Anonymous, 2019); The sidewalk width should be at least 4 m.There should be a variety of activities (playing with toys, playing with chalk, sitting elements, balancing and climbing, building a hut, jumping, hopscotch, skating, scooter, rope jumping, cycling, ball games, etc.), The street should be clean.

Scale: One of the criteria for a street to be child friendly is the size of the street. If the street is too long or too narrow, it is not suitable for the use of the street and for the benefit of children. Qualifications required for scale to (Kiss 2.0); The length of the street (max. 400 m), the width of the street (min. 3.7 m), the ratio between the street width and the length of the buildings, the distance between the facades of the buildings and the vehicle road (min. 1.5 m), front gardens (3.5 m or none), parking area size (2.5 x 5 m or 2.5 x 6 m for roadside parking), the number of vehicles passing per hour should be (max. 100 vehicles) (Baş,2016).

Editing: Another factor that shows how child-friendly the street is the regulation criterion. The qualifications used according to (Kiss 2.0) for the regulation criteria (Baş, 2016); Limitation of traffic and parking at certain times, Entry and exit points are clear (the entrances and exits of the street are clearly marked with street furniture, sculptures or artistic works), crossing places (having a route that allows passage every 300 meters), The street must be within understandable borders. Barriers to walking and playing should be removed.

Accessibility: An important feature for a street to be child-friendly is its accessibility. Ekawati (2015), on the other hand, argued that the quality of the street depends on the easy access of pedestrians, vehicles and disabled people to the street. Qualifications used according to (Kiss 2.0) for access (Baş, 2016); independent access, legibility of the street, access to the street by various means of transport and public transport.

5. Child Friendly City Initiative Concept and Scope

The concept of child friendly city is a subject with a broad perspective that is the subject of many different disciplines.

A child-friendly city is defined as a community, town, city or any local government system that undertakes and dedicates itself to fulfilling the rights of children in the Convention on the Rights of the Child, although it is not possible to make a clear definition (UNICEF, 2018).Despite various national and international regulations and sanctions, unfortunately, many children do not have the privilege of having a say in social and physical situations. In fact, the child becomes unable to exercise even the most basic human rights. In the issue of children, which is one of the most important duties of local governments, it is tried to create solutions at the international level despite the problems experienced. One of these efforts and studies is the “Child Friendly Urbanization Initiative” (Koç et al, 2015; Parlak, 2019). The child friendly city initiative was initiated on the basis of the principle of “children first”, under the leadership of UNICEF, as an extension of the decision taken at the Second United Nations Conference on Human Settlements (HABITAT II) in 1996, aiming to make cities livable environments for everyone (Sivri Gökmen, 2013).

These negative effects of cities on children increase the need for Child Friendly Cities (Turan, 2020). In this direction, child friendly city ınitiative aims to enable children to express their ideas and wishes in the decisions taken about the city they live in, to be protected from violence and abuse, to participate in social and social life, to make friends, to play games freely on the streets, to have more green spaces and to live in a sustainable and unpolluted nature. It aims to ensure everyone's right to life, ethnicity, religion, sect, gender or disability, and the right to have equal and all services. (UNICEF, 2004).

The nine criteria that guide and guide the local stakeholders within the scope of child friendly city are as follows. (UNICEF, 2004).

Participation of children: Listening to children's views on issues affecting/interesting them and encouraging their active participation, taking their wishes into account in decision-making processes.

Child-friendly legal framework: It is the provision of legal procedures that continuously protect and promote the rights of children.

Child rights strategy: Developing an agenda or strategy to establish a child friendly city.

Declaration of the rights of the child and coordination mechanism: It is the establishment of permanent structures within the scope of local governments that will primarily reflect the discourses of children.

Child impact assessment and measurement: The existence of a systematic process to assess the impact of policies and practices on children during and after implementation.

Child responsive budgeting: Committed to adequate income for children and conducting budget reviews.

Preparing continuous reports on the situation of children in the city: To collect resources on the subject by closely monitoring the status of children's rights.

Making children's rights known: To raise awareness of children's rights among children and adults.

Independent advocacy for children: Supporting organizations that support children's rights.

In this regard, in 2018, the Bernard van Leer Foundation and UNICEF established child-centered urban planning and design criteria. The child friendly urban design project (child friendly urban design) established criteria at micro, meso and macro scales in 2016-2017 (Krishnamurthy et al., 2018a; Krishnamurthy et al., 2018b). In order to realize the smallest possible intervention at the micro scale, criteria on street and street elements are generally developed. Mid-level interventions at the meso scale and measures that affect the neighborhood level and transportation networks have been developed. On the macro scale, child participation and family-friendly strategy in decision making were investigated (Aydoğan, 2020)

6. Conclusion

The child-friendly city initiative is an important movement that demonstrates an effective planning, design and governance approach so that the individuals who make up the societies are made up of individuals who have completed their mental, physical and cognitive development, defending the right to live in a healthy environment.

The professional discipline of landscape architecture, which has responsibility in the field of spatial planning, has important duties for the adoption and implementation of the child-friendly city initiative by local governments.

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Weight of Acoustic Criterion in National and International Green Building Evaluation Schemes in Türkiye

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1. Introduction

Green building rating systems or in other words certification defines green requirements or standards. Rating tools have been effective in encouraging design initiatives that lead to a reduced environmental footprint. These certification systems consist of a set of criteria that a building must meet and have to be considered sustainable. Each criterion has scores that vary depending on the type of building or its place in the life cycle (such as new build, existing building, renovation project). Evaluation; is in the form of examining the information collected and reported during the design and construction of the building according to each criterion and scoring as a result of this examination. The total score obtained as a result of the evaluation is accepted as an indicator of how sustainable (or green) the building is. This method is aimed to evaluate the building objectively based on real data. These systems are used to determine the level of sustainability by evaluating their structures over parameters such as environment and human health, energy, water, material, resource use, lighting, ventilation, and acoustic comfort.

Over the past twenty years, green building rating systems have become widespread and aim to improve the comfort of occupants while reducing the environmental impact of construction activity (Hayne, Brazukas & Marklund, 2016). Indoor environment occupants' satisfaction is related to thermal comfort, visual comfort, indoor air quality and acoustic comfort.

Some researches show that the aims of green buildings to provide a better indoor environment are not fully achieved, especially in acoustics. Post occupancy satisfaction surveys (POE) were conducted by the University of California at Berkeley's Center for the Built Environment and results showed that "green buildings" did not fine compared to standard buildings in point of acoustics (Huizenga, 2005). The mean satisfaction level is represented by a -3 (very dissatisfied) and +3 (very satisfied) scale. Many of the green-rated buildings are below the 50 percentile acoustic satisfaction, green buildings have an average satisfaction of -0.25, and other (regular) buildings are also negative, but only -0.20. In Canada and the northern United States, 12 green and 12 conventional office buildings are evaluated via the post-occupancy evaluation method (Newsham et al., 2013). 2545 occupants participated online questionnaire survey and they answered questions about environmental satisfaction, job satisfaction and organizational commitment, health and well-being, environmental attitudes, and commuting. A lower occupant satisfaction level is seen for acoustics across all environmental topics. Noise from HVAC systems was considered less disturbing in green buildings and except for this, no significant difference in acoustic satisfaction is not found between green and conventional buildings. A social survey (Kulak, 2019) was conducted with 250 people about noise annoyance at dwellings in Türkiye and 82.3 percent of the participants stated that they were disturbed by noise. Loud speech-shouting sounds, installation sounds and child running sounds were found mostly annoying sounds.

LEED, BREEAM and BEST are predominantly preferred over other green building rating systems in Türkiye. These rating tools have design criteria that are used to evaluate the indoor acoustic environment of buildings. This paper aims to compare how acoustic performance is evaluated in LEED, BREEAM and BEST schemes and how much importance is given to acoustics in each rating scheme for dwellings.

1.1. Green Building Rating Schemes Overview

There are many green building certification systems in the world (Table 1). The main ones are BREEAM (Building Research Establishment Environmental Assessment Method), which emerged in England in 1990, LEED (Leadership in Energy and Environmental Design) emerged in the United States in 1998, and IISBE (International Initiative for Sustainable Built Environment), which was established in 1998 by the coming together of developed countries, Greenstar adapted from BREEAM in 2003, created in Australia, CASBEE (Comprehensive Assessment for Building Environmental Efficiency) emerged in Japan in 2004, DGNB (Deutsche Gesellschaft fur Nachhaltiges Bauen) emerged in Germany in 2009, BEST (Ecological and Sustainable Design in Buildings) emerged in Türkiye in 2015 and YeS-TR (Green Certificate Regulation for Buildings and Settlements) created in Türkiye in 2017. Certification systems are dynamic systems and new versions are published depending on the new strategies developed over time. In addition, these systems allow the building to be re-evaluated by making improvements in the same building.

Table 1. Some of the green building rating schemes in the world in chronological order

Country	Rating Scheme	Year Issued
UK	BREEAM	1990
Hong Kong	BEAM	1996
USA	LEED	1998
Australia	GREEN STAR	2003
Japan	CASBEE	2004
Singapore	GREEN MARK	2005
China	GBAS	2006
Germany	DGNB	2007
India	GRIHA	2007
South Africa	GREEN STAR SA	2008
Netherlands	BREEAM NL	2009
United Arab Emirates	ESTIDAMA	2010
France	HQE	2013
USA	WELL	2014
Pakistan	SEED	2016
Türkiye	BEST	2015
Türkiye	YeS-TR	2017

1.2. BEST (Ecological and sustainable design in buildings)

The setup of existing certificate systems is generally similar to each other. Many countries create their own green building certification systems by utilizing existing systems. Studies in this field have been led by the Turkish Green Building Council (ÇEDBİK) since 2007 in Türkiye. In this context, ÇEDBİK created the BEST-Residential certification system for new construction projects. After the certification system was published for residential buildings in 2015, another certification was also developed for commercial buildings. For dwellings, BEST v2 and for commercial buildings BEST v1 are current.

In BEST, buildings are evaluated under 9 main headings. These are integrated green project management, land use, water consumption, energy consumption, health and comfort, material and resource use, residential/commercial building life, operation and maintenance, and innovation.

Buildings are scored over 110 points according to the strategies they implement under the given subcategories. They are certified under 4 different certification levels. These are Approved (45-64 points), Good (65-79 points), Very Good (80-99 points), and Excellent (100-110 points).

The database of green buildings in Türkiye is available in detail on the ÇEDBİK website. According to the ÇEDBİK report (URL-1), 591 projects have received international and 23 projects have received national green building certificates (BEST) in Türkiye. Of the projects that received international certificates, 498 have LEED and 70 have BREEAM certificates. The fact that the use of the BEST certificate is not widespread may be due to it having just been published.

1.3. YeS-TR (Green certificate regulation and assessment guide for buildings and settlements)

The domestic national green certificate system (YeS-TR), developed for the purpose of disseminating energy-efficient and environmentally friendly building and settlement practices at national and local levels in Türkiye, aims to issue certificates to buildings and settlements by authorized institutions. The regulation was first published in 2017, and then in 2022, the old regulation was repealed and replaced with the current version (URL-2). Since there is a new regulation and application, there are no buildings or settlements that have received certificates yet.

Green Certificate Assessment Guide for Buildings and Settlements, which must be followed in order to obtain a green certificate, has been published in Annex-1 of the Regulation and has been categorized as buildings and settlements that can receive green certificates, residences, office buildings, educational buildings, hotels, health buildings, shopping and commercial centers and other. In addition, a separate classification is made according to whether the building is new or existing. The criteria for obtaining a green certificate, criteria credits and criteria requirements differ for each category.

Certificates are classified into 4 groups according to the total score projects have achieved. Buildings that meet the minimum mandatory criteria are labeled as 'pass', those who score at least 40 from other criteria in addition to the mandatory criteria as 'good', those who score at least 55 as 'very good', those who score at least 75 and above as 'national excellence' in new buildings.

1.4. LEED (Leadership in energy and environmental design)

LEED is one of the green building certification systems and it is developed by the USGBC (United States Green Building Council) in 1998. As of September 2022, more than 155,423 buildings have been evaluated in 165 countries using the LEED System (URL-3). In the

LEED v4.1, the performance of the building is increased throughout its entire life cycle, and at the same time, a comprehensive measurement – evaluation including the interior of the building is included. LEED v4.1, the latest and updated version, includes 4 different types of certifications: for building design and construction (LEED BD+C), for operation and maintenance (LEED O+M), for interior design and construction (LEED ID+C), for neighborhood development (LEED-ND).

The criteria in the LEED system can be grouped into 9 headings: integrative process, location and transportation, sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality, innovation and regional priority.

The total of these criteria is 110 points, and structures subject to this valuation system need a minimum of 40 points to be certified. After fulfilling this minimum requirement, the degree of certification obtained changes depending on the score. A total of 4 levels of the standard certificate, silver, gold and platinum level LEED certificate can be obtained. 40-49 points are required to have a standard certificate, 50-59 points to have a silver certificate, between 60-79 to have a gold certificate and above 80 to have a platinum certificate.

1.5. BREEAM (Building research establishment environmental assessment method)

BREEAM is the world's first sustainability rating scheme for the built environment that originated in the UK in the 1990s. To date, BREEAM has been used to certify over 590,000 building assessments across the building life cycle and it is being applied in over 85 countries (URL-4). For new constructions, BREEAM v6 is current.

This certificate system, which classifies projects as communities, new construction, in-use, refurbishment and fit-out, has separate sustainability criteria for each group. The process is carried out by BREEAM evaluation experts through analysis according to evaluation criteria. According to BREEAM, buildings are evaluated according to 11 main criteria. The main headings of these criteria are as follows: management, health and wellbeing, hazards, energy, transport, water, materials, waste, land use and ecology, pollution and innovation.

Projects with at least 30 points out of 100 points are eligible for classification. Anything less than or equal to 30 is passed, those equal to or less than 45 are good, those equal to or less than 55 are very good, those equal to or less than 70 are excellent, those equal to or less than 85 are outstanding are named.

2. Material and Method

Sustainability assessment of buildings is related to a variety of different issues and one of them is indoor environmental quality (IEQ). Thermal comfort, visual comfort, acoustic comfort and indoor air quality are evaluated in the scope of IEQ. Effective acoustic design can provide occupants satisfaction and well-being, increase their productivity through high-level concentration, and facilitate communication in spaces.

Acoustic criteria in the current version of LEED, BREEAM and BEST green certificates were examined by comparison method. Since there is no building that has been evaluated with the YeS-TR certificate yet, it has been excluded from the scope of this study. Acoustic criteria were checked over 10 headings. These are noise pollution due to construction, exterior noise/noise pollution, service noise from mechanical or electrical services/indoor ambient noise, reverberation time, acoustical finishing materials, airborne sound insulation, impact sound insulation, vibration, speech privacy and sound masking.

Another acoustic criteria comparison was made for newly constructed dwellings in LEED, BREEAM and BEST certificates. Within the scope of LEED certification, there are 2 separate documents for multi-family and single-family homes. In this study, multi-family dwellings have been studied. In the BREEAM certificate, there is a single document that covers all newly built structures. In the BEST certificate, there are 2 separate documents for residential and commercial buildings, but only the document for dwellings was used in this comparison.

3. Findings and Discussion

Certification systems evaluate projects separately under different conditions or for the intended use. Buildings are first evaluated in a class under the headings of existing, new, temporary, renovation and maintenance-repair, and then they are categorized according to typologies such as residential, school, hospitality, healthcare, commercial, etc.

Table 2 shows for which building typologies the relevant prerequisite or credited acoustic criteria in the certificates are valid. The typologies in which the criteria are specified as prerequisites are indicated in parentheses, while the others are criteria that provide credit.

- The aforementioned relevant acoustic criteria are reviewed in the building design and construction (BD+C), interior design and construction (ID+C), and residential sections of LEED. The residential part has two criteria lists for single-family and multi-family homes. In the building design and construction section, acoustic criteria for service noise from mechanical or electrical services, reverberation time, airborne sound insulation and sound masking are defined for typologies of new construction, schools, data centers, warehouses&distribution centers, hospitality and healthcare. In addition to these, acoustic criteria regarding noise pollution due to construction, exterior noise, acoustical finishing materials, speech privacy for healthcare buildings; acoustic criteria related to noise pollution due to construction for hospitality buildings; acoustic criteria about exterior noise and acoustic finishing materials for schools. In the interior design and construction section, there are acoustic criteria about service noise from mechanical or electrical services, reverberation time, airborne sound insulation and sound masking for commercial interiors and hospitality. In the residential part, there is only one criterion for single-family homes, it is about service noise from mechanical or electrical services although there are 3 criteria for multi-family homes, they are about service noise from mechanical or electrical services, airborne sound insulation and impact sound insulation.

- When the international new construction section of the BREEAM certification is examined, it is seen that all typologies have prerequisites criteria for exterior noise. In addition, there are different criteria for non-residential, residential institutions and multiple dwellings structures about noise pollution due to construction site. Limit values for indoor ambient noise levels are defined as all building types except residential buildings, long-term stay residential institutions and special requirements for education buildings. The criteria for reverberation time are defined only in rooms used for speech or music. Airborne sound insulation values are defined separately for places used for accommodation and other typologies. In impact sound insulation, limit values are given for accommodation purposes only.
- BEST certificate consists of two separate sections for new residential and commercial buildings. For both residential and commercial buildings, there are criteria for noise pollution due to construction, service noise from mechanical and electrical services, reverberation time, airborne sound insulation and impact sound insulation. In addition to this there is also one criterion about exterior noise for dwellings.

Table 2. Acoustic requirements according to building typologies.

Green Building Schemes	**LEED**			**BREEAM**	**BEST**	
Acoustic Requirement	*Building Design and Construction (BD+C)_v4.1*	*Interior Design and Construction (ID+C)_v4.1*	*Residential_v4.1*	*International New Construction_v6*	*New Residential Building_v2*	*Commercial Building_v1*
Noise Pollution due to Construction	hospitality, healthcare			non-residential, residential institutions and multiple dwellings	dwelling	commercial
Exterior Noise / Noise Pollution	schools (prerequisite), healthcare			all building types (prerequisite)	dwelling	
Service Noise from Mechanical or Electrical Services / Indoor Ambient Noise	new construction, schools (prerequisite), data centers, warehouses&distribution centers, hospitality, healthcare	commercial interiors, hospitality	single-family, multi-family	all building types except residential buildings, long-term stay residential institutions and special requirement for education buildings	dwelling	commercial
Reverberation Time	new construction, schools (prerequisite), data centers, warehouses&distribution centers, hospitality, healthcare	commercial interiors, hospitality		rooms used for speech or music	dwelling	commercial
Acoustical Finishing Materials	schools (prerequisite), healthcare					
Airborne Sound Insulation	new construction, schools (prerequisite), data centers, warehouses&distribution centers, hospitality, healthcare	commercial interiors, hospitality	multi-family	all building types except residential buildings, long-term stay residential institutions; residential buildings and long term stay residential institutions	dwelling	commercial
Impact Sound Insulation			multi-family	residential buildings and long term stay residential institutions	dwelling	commercial
Vibration						
Speech Privacy	healthcare					
Sound Masking	new construction, schools, data centers, warehouses& distribution centers, hospitality, healthcare	commercial interiors, hospitality				

Another comparison (Table 3) between the 3 certifications was made for the content of the acoustic criteria valid for newly built dwellings and the score earned if this criterion is met.

- Noise pollution due to construction activities is evaluated only in the BREEAM and BEST certificates. In BREEAM, if there is no noise-sensitive building within an 800 m radius, it earns 1 credit directly or how much the construction site amplifies the existing background noise is measured separately for day and nighttime. If it does not exceed the determined limit values, it is accepted, if it does, 1 point is earned after taking the necessary sound attenuation caution. In BEST it is the same with BREEAM, if there is no noise-sensitive building within an 800 m radius, it earns 2 credits directly or if there is a noise-sensitive building, after the necessary precautions are taken and arrangements are made.
- BREEAM has prerequisite acoustic criteria for all building types for determining exterior noise level, sources and acoustical planning according to them. In BEST, it is not clearly expressed but just it is stated that 1 point will be earned in case of reducing exterior noise level.
- BREEAM doesn't have any criteria for service noise related to mechanical or electrical systems and indoor ambient noise levels. In LEED, if background noise levels from heating, cooling and ventilation systems are lower than 35 dBA for living areas and 45 dBA for kitchens and baths, 1 point is earned. In BEST, like BREEAM maximum

allowable noise levels are identified. Indoor noise levels ($L_{Aeq,nT}$) due to continuous noise service equipment must be lower than 30 dBA for bedrooms and 35 dBA for living area and kitchen and in addition to this indoor noise levels (L_{Aeq}) must be lower than 34 dBA for bedrooms and 39 dBA for living area and kitchen.

- Although there is no direct information about how long the reverberation time should be in the dwelling in BEST certificate, it is stated that 1 point will be earned if the auditory comfort for spaces is provided.
- The criteria for airborne and impact sound insulation are included in all 3 certificates. According to LEED, the minimum Sound Transmission Class (STC) for any separating building element from each other units or mechanical rooms should be STC 50, for exterior windows should be STC 34, dwelling unit entrance doors should be STC 30 and proper sealing of details should be provided. In addition to this, horizontal separation building elements from each other units or mechanical rooms minimum have impact insulation class (IIC) 50. If these two criteria are met, a total of 1 point is earned. Criteria related to sound insulation and indoor ambient noise caused by mechanical services are given as options for each other. In this case, a maximum of 1 point can be earned from either of the 2.
- In BREEAM, minimum airborne sound insulation value ($D_{nT,w}$ + C_{tr}) (dB) is scored 1 point if it is 48 dB or 3 points if 50 dB or 4 points if 53 dB and maximum impact sound insulation value $L'_{nT,w}$ (dB) is

scored 1 point if it is 59 dB or 3 points if 57 dB or 4 points if 54 dB. The sum of airborne and impact sound insulation scores cannot be more than 4 points.

- BEST certificate is based on the sound insulation limit values in the national regulation on the 'Protection of Buildings against Noise' (2017). Airborne sound insulation values ($D_{nT,A} = D_{nT,w} + C$) of the building elements are expected to provide at least C class. Class C building element should provide 52 dB if it separates two neighboring residential units, 58 dB if it separates the residential and commercial units, and 44 dB if it separates different spaces within the same residence. In residential buildings, the maximum impact sound level ($L'_{nT,w}$) to be provided for C class floors should not exceed 54 dB for independent units, 48 dB for technical rooms and 62 dB for floors separating spaces within the same residence. According to BEST providing noise control between spaces in the building 1 point is earned.

Table 3. Acoustic requirements for dwellings.

Green Building Schemes	LEED	BREEAM	BEST
Acoustic Requirement	*Building Design and Construction_Residential_ Multifamily Homes_v4.1*	*International New Construction_v6*	*New Residential Building_v2*
Noise Pollution due to Construction		***Option 1 (1 point)** Where there are, or will be, no noise-sensitive areas or buildings within an 800 m radius of the assessed site ***Option 2 (1 point)** The noise level from the proposed site or building, as measured, a difference is no greater than +5dB during the day (07:00 to 23:00) and +3dB at night (23:00 to 07:00) compared to the background noise level. If it is greater than this levels, sound attenuation caution must be taken	***Option 1 (2 point)** No noise-sensitive buildings within a radius of 800 m around the building ***Option 2 (2 point)** Identifying activities and equipment that may be a source of noise during construction, and taking necessary noise-reducing measures; using noisy equipment during official working hours, periodically making noise measurements, observing and proving the noise measurements periodically with tables
Exterior Noise / Noise Pollution		***Prerequisite**: Early design advice should be provided by acoustician about external sources of noise impacting the chosen site,site layout and zoning of the building for good acoustics, acoustic treatment of different zones and façades	*In the case of reducing exterior noise **(1 point)**
Service Noise from Mechanical or Electrical Services / Indoor Ambient Noise	***Option 1 (1 point)** For multi family homes; maximum background noise levels from heating, cooling and ventilation systems: 35 dBA for living areas 45 dBA for kitchens and baths		*Maximum indoor noise levels (L_{Aeq}) are 34 dBA for bedroom and 39 dBA for living area and kitchen. Maximum allowable indoor noise levels ($L_{Aeq,nT}$) due to continuous noise service equipment are 30 dBA for bedroom and 35 dBA for living area and kitchen
Reverberation Time			*In case of providing auditory comfort for the room acoustics in the spaces inside the building **(1 point)**
Airborne Sound Insulation	***Option 2 (1 point, together with impact sound insulation)** For any separating building element from each other units or mechanical rooms minimum Sound Transmission Class (STC) 50, for exterior windows min. STC 34, for dwelling unit entrance doors min. STC 30 and proper sealing of details	*Minimum $D_{nT,w} + C_{tr}$ (dB) value if 48 **(1 point)** or 50 **(3 point)** or 53 **(4 point) (The sum of airborne and impact sound insulation scores cannot be more than 4)**	*Minimum $D_{nT,A} = D_{nT,w} + C$ (dB) value should be 52 dB if it separates two neighboring residential units, 58 dB if it separates the residential and commercial units, and 44 dB if it separates different spaces within the same residence. **(1 point, together with impact sound insulation)**
Impact Sound Insulation	***Option 2 (cont.) (1 point, together with airborne sound insulation)** Horizontal separating building element from each other units or mechanical rooms min. impact insulation class (IIC) 50	*Maximum $L'_{nT,w}$ (dB) value if 59 **(1 point)** or 57 **(3 point)** or 54 **(4 point) (The sum of airborne and impact sound insulation scores cannot be more than 4)**	*Maximum $L'_{nT,w}$ (dB) value should be 54 dB for independent units, 48 dB for technical rooms and 62 dB for floors separating spaces within the same residence **(1 point, together with airborne sound insulation)**

The Center for the Built Environment (CBE) at the University of California Berkeley has created an online survey and reporting tool to examine occupant satisfaction and its relationship with indoor environmental quality indicators (Zagreus et al., 2004). The survey uses 7-point scale questions to evaluate occupant satisfaction IEQ parameters, workspace and building features, ranging from ‘very satisfied’ (+3) to ‘very dissatisfied’ (-3), with a neutral midpoint (0). The questionnaire has two questions about aural environment; noise level in your workspace and sound privacy in your workspace (ability to have conversations without neighbors overhearing and vice versa).

CBE survey has already been used in a lot of studies (Frontczak et al., 2012; Lee & Guerin, 2009; Lee & Kim, 2008; Abbaszadeh et al., 2006; Huizenga et al., 2005; Huizenga et al., 2003). The common result of all these studies is that the satisfaction about acoustic issues is the same or lower in green buildings compared to other buildings.

Another POE study was conducted by Altomonte and Schiavon (2013) and occupant satisfaction was compared in LEED and non-LEED certified buildings. 144 buildings, 65 of which were LEED certified, and a total of 21,477 individual occupant responses, 10,129 in LEED buildings were collected. Satisfaction level from noise and sound privacy were rated by occupants as -3 was very dissatisfied and +3 was very satisfied. Lowest mean score of satisfaction was observed with sound privacy across all IEQ parameters (LEED: M= -0.96; non-LEED: M= - 0.88).

LEED buildings have lower mean scores of satisfaction with noise (LEED: M= 0.00; non-LEED: M= 0.10).

Participants of conducted POE studies were asked to evaluate their satisfaction with the noise level and sound privacy. The fact that the questions are few and very general is insufficient to explain exactly which sound environment one is satisfied with and which one is not. Results showed that satisfaction levels were equal or low compared to non-green buildings. It is seen that the weights of acoustic criteria in the examined certificate systems are very low. In addition, most of these criteria are not mandatory and leave to the discretion of the project coordinator, resulting in structures that are not satisfied with their auditory environment. Another important issue may be the overlap of the design approaches of acoustics and other indoor environmental quality issues. For example, preferring natural ventilation instead of mechanical for energy conservation may cause outside noise to be carried inside and indoor noise to spread between spaces. Designing the façades more transparent in order to benefit more from daylighting and passive solar may cause a decrease in the sound insulation value of the façade, thus facilitating the passage of external sounds into the interior, the formation of reflective surfaces in the interior, and the lack of sufficient surface for sound absorptive treatment. Preferring lightweight steel frame design as the load-bearing system may cause low airborne and impact-induced sound insulation values due to the low mass. In this case, the performance of the system should be improved by taking extra precautions.

4. Conclusion and Suggestions

In BEST certificate, criteria related to acoustics are dealt under the noise pollution heading in the integrated green project management chapter and auditory comfort heading in the health comfort chapter. In LEED certificate, acoustic performance requirements are expressed only under indoor environmental quality part. In BREEAM certificate, under the heading of health and wellbeing, criteria for acoustic performance and under the heading of pollution, reduction of noise pollution are explained. Based upon the comparison presented in this study green rating certification systems are not fully addressing the acoustic design needs. Many criteria are not mentioned and not enough details are given on the mentioned issues.

BEST certification is very important in terms of being the local green building certification of Türkiye. The criteria can be expressed with more descriptive and clear values. In addition to stating that credits will be earned if exterior noise is reduced or C class sound insulation is provided, it may be more encouraging to set 3-4 different levels of target and score them separately.

If a project fulfills all acoustic criteria, it can earn a maximum of 5 credits out of 110 credits in BEST, 1 credit out of 110 credits in LEED, and 5 credits out of 100 credits in BREEAM. The weights of the acoustic criteria over total requirements are very low, as well as most of them, are not compulsory criteria. On a project where the required number of points can be achieved without considering acoustics requirements.

As a result, it is seen that acoustic issues are not given enough weight in the green building evaluation certificates, which are examined within the scope of this study. While preparing the current versions of the certifications, attention should be paid to this situation and airborne and impact sound insulation, which are the two most important issues in residential buildings, should be specified as mandatory criteria.

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All authors contributed equally to the book chapter. There is no conflict of interest.

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Sustainable Preservation in the Context of Building Certification Systems

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1. Introduction

In recent years, as a result of an increase in the world's population, the development of technology, globalization, and an intense rivalry environment, the consumption of natural resources has been increasing rapidly (Tuğluer & Çakır, 2019). Correspondingly, one of the most devastating consequences of increasing environmental problems is global warming caused by pollution of the ecological environment, and the other is the risks it carries for future generations as a result of wastage and misuse of resource utilization (Günaydın, 2011). In the face of increasing environmental problems, people have oriented toward environmentally friendly attitudes (Tuğluer & Çakır, 2021). Parallel with it, sustainable approaches that support green and new policies have started to be produced to reduce the damage done to the environment. Environmental problems, which were previously considered at the national level, have been carried to the international level since the 1970s, with the effect of the energy crisis. The publication of the “Limits to Growth Report” in 1972 and the UN Environment Conference held in Stockholm were the first global steps taken in this area. In the Brundtland Commission in 1987 in the report which is called "Our Common Future", the concept of sustainable development has been defined as "the ability of future generations to meet the needs of today's generation without jeopardizing their ability to meet their own needs" (Aksu, 2011; Tutkun & İmamoğlu, 2015).

The concept of sustainability, which emerged as a term at the United Nations Conference (UNC), is frequently used in all fields of study where human activity is related to the generation and management of resources. In the modernizing world, the construction sector constitutes a large part of the country's economy. This situation raises the issue of sustainability of these constructions in the name of environmentalist approaches. Sustainability in architectural structures is defined as the maintenance of sustainability regardless of the cultures, traditions, and lifestyles of the societies and civilizations living within the structure, and the climatic conditions and geographical situation of the location, and all the environmental factors which are exposed to (Erşan & Demirarslan, 2020). Historical buildings are important among the buildings that should be emphasized most in terms of sustainability.

In the context of sustainability, historical buildings are the main buildings that are especially important to preserve and hand down to the next generations. Historical buildings have the characteristics of documents and symbols urban and architectural style of the period in which they were built with the economic, social, and cultural accumulations of societies (Erşan & Demirarslan, 2020). Due to the change in the physical environment and the development of technology over time, historical buildings lose their functions because of the needs that arise as a result of changes in social features such as urbanization, infrastructure, etc. Therefore, it emerges as a necessity of sustainable life that historical buildings that have lost their functional properties are reused after their architectural restorations, which is carried out with ecological approaches.

The sustainability approach adopts principles that protect natural resources and try to minimize negative environmental matters. Management strategies are being developed from various approaches and aspects (Beyhan & Ünügür, 2005). One of these management strategies is sustainable certification systems. In order for a building to be called “sustainable”, “green” or “ecological,” there are certification systems that measure the environmental impact and performance of buildings. In the study, the most widely used and developed by different countries, Building Research Establishment Environmental Assessment Method (BREEAM), Leadership in Energy and Environmental Design (LEED), Green Star, and Comprehensive Assessment System for Built Environment Efficiency (CASBEE) certification systems were discussed (Alyami & Rezgui, 2012; Sev, 2011; Anbarcı et al., 2012). The study is to ensure the hand down of historical buildings to the next generations with the understanding of sustainable preservation. By doing this, it aims to evaluate the preservation of historical buildings through certification programs to exhibit an environmentalist attitude. Within the framework of this general purpose in the study, among the criteria in the certification systems developed to ensure the sustainability of the buildings, the criteria that are intensely focused (energy, indoor air quality, transport, water, resources and materials, land use, pollution, innovation, and management) have been revealed. At the same time, 15 buildings that are prominent in the world in terms of ecology and sustainability and received awards were selected, and their structural and spatial transformation features were revealed in line with the determined ecological design criteria. In addition, in the study, the importance of exhibiting an ecological approach was emphasized in terms of sustainable preservation in the processes of reuse and restoration of historical buildings.

2. Material and Method

2.1. Material

The first studies carried out in the field of sustainability started as a process of developing existing knowledge and ideas in a practical framework rather than new research (Cole et al., 2005). This process mostly included performance appraisals only under the title of “green”, without considering social and economic issues (Cole, 1999). According to Todd and Geissler (1999), the relevance of the issues being evaluated should consist of the availability of renewable or non-renewable resources, economic viability, and social acknowledgment. For this reason, the success of sustainability should be evaluated by considering ecological, economic, and social aspects (Ding, 2008). In the preservation process of historical buildings, it is necessary to take decisions within the framework of a sustainable preservation approach by evaluating the maintenance and repair of the building from an economic, environmental, and social point of view, as well as the physical authenticity of the building.

In the study, BREEAM, LEED, CASBEE, and Green Star certification systems, which are widely used in the world and evaluate the sustainability of the transformation process of existing buildings, are discussed. Information about the existing buildings, construction and restoration year, location of the buildings is summarized in Table 1.

Table 1. The properties of the buildings examined within the scope of the study

Project Name	Year/Restoration	Location
Boğaziçi University 1st Male Dormitory	1868/2009	Istanbul
Cambridge City Hall Annex	1871/2004	Cambridge
Blackstone Station Office Renovation	1887/2006	Cambridge
Whitaker Street Building	1890/2003	Savannah
Gerding Theater at the Armory	1891/2006	Portland
Thoreau Center for Sustainability	1899/1998	San Fransisco
Lion House at the Bronx Zoo	1903/2007	Bronx
S.T. Dana Building	1903/2003	Michigan
Alliance Center for Sustainable Colorado	1908/2005	Denver
Lazarus Building	1908/2007	Columbus
Howard M. Metzenbaum U.S. Courthouse	1910/2005	Cleveland
Saint Joseph French High School	1913/2010	Istanbul
Immaculate Heart of Mary Motherhouse	1932/2003	Monroe
John W. McCormack Federal Building	1933/2009	Boston
Chicago Center for Green Technology	1952/2002	Chicago

In the study, 15 buildings that were built at the end of the 19th century and at the beginning of the 20th century with important functions were discussed. The sustainability approaches that these 15 buildings were examined. These buildings were completely restored and re-used at the beginning of the 21st century. In the study, the sustainable preservation understanding of the buildings was evaluated within the scope of the criteria obtained from the certification systems.

2.2. Method

In the study, first of all, literature research on sustainable preservation and building certification systems in historical buildings was carried out, and a theoretical infrastructure was created. In order to limit the scope, which has a very wide research area as a result of the increasing awareness of sustainable preservation in recent years, BREEAM and LEED, which are widely used building environmental tools in the world, as well as CASBEE, which are specific building environmental tools, and Green Star certification systems are discussed. BREEAM, LEED, Green Star, and CASBEE are environmentally friendly building certification systems that aim to ensure sustainability in the energy and environmental design and certify the transformations with a certificate. A comparative method was used to determine the common aspects of these certificate systems.

As a result of the comparative method, which is a research method that aims to classify and explain the functional factors, the ecological concepts that these certification systems focus on in common and intensely have been revealed by associating them with the understanding of sustainable preservation. According to the sources in the literature, the common criteria in the BREEAM, LEED, Green Star, and CASBEE certification systems are (1) energy, (2) indoor air quality, (3) transport, (4) water, (5) resources and materials, (6) land use, (7) pollution, (8) innovation, and (9) management (Figure 1).

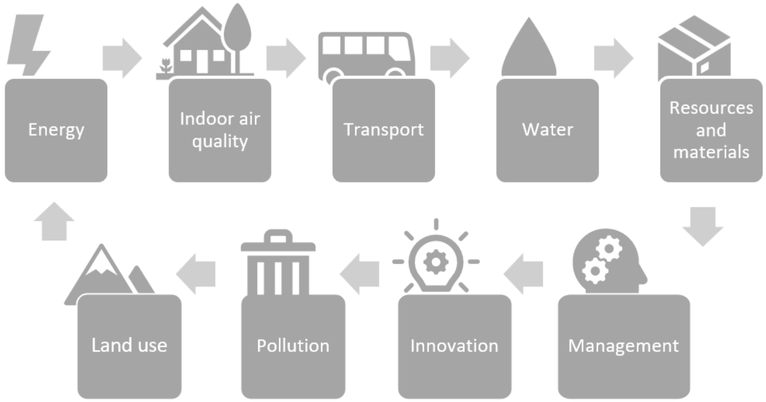


Figure 1. Common criteria of certification systems (Created by authors based on Tavşan & Yanılmaz, 2019; Carroon, 2010; Uruk & İslamoğlu, 2019; Ding, 2008; Tutkun & İmamoğlu, 2015)

The sub-criteria of these concepts have been determined and tabulated from existing studies, open access web pages with certificate systems, and texts published by certificate systems (Table 2, Table 3, and Table 4).

Table 2. The criteria (energy, indoor air quality and transport) and sub-criteria examined in the study (Created by authors based on Tavşan & Yanılmaz, 2019; Carroon, 2010)

Energy	Indoor Air Quality	Transport
• Low energy electronic devices • Low energy use • Thermal solar panels • Renewable energy use • Regular device maintenance	• Optimization of daylight utilization • Glare control • Ensuring lighting zones and controls • Natural ventilation • Indoor air quality and management • Controlling thermal comfort	• Proximity to urban furniture and services • Ensuring sustainability of public transport system • Transportation alternatives • Transportation facilities • Bicycle and pedestrian facilities • Maximum parking capacity • Reducing car use with a transportation plan

Table 3. The criteria (water, resources and materials, land use) and sub-criteria examined in the study (Created by authors based on Carroon, 2010; Uruk & İslamoğlu, 2019; Şimşek, 2012)

Water	Resources and materials	Land use
• Reducing water consumption • Water treatment system • Use of water-saving faucets • Rainwater harvesting system • Water-efficient landscaping • Water recycling • Onsite wastewater treatment systems	• Adaptive reuse of buildings • Insulation of the material • Versatility and durability of the material • Use of recycled materials • Using local materials • Waste material management • Low-emitting materials • Environmentally friendly materials	• Conservation of the ecological environment during construction impact • Reducing the environmental impact of construction • The location and density of the building • Increasing the ecological value

Table 4. The criteria (pollution, innovation and management) and sub-criteria examined in the study (Created by authors based on Tavşan & Yanılmaz, 2019; Şimşek, 2012)

Pollution	Innovation	Management
• Light pollution reduction • Noise pollution reduction • Controlling sources of indoor air pollution • Reducing CO_2 emissions • Pollution prevention during the civil construction • Decrease in the global warming impact of construction	• Innovative systems • Innovation and creativity in design • Use of innovative technologies	• Land management process • Use of existing buildings within the land • Management of the environmental impact of the construction site • Building manuals and building user guides

The determined criteria and sub-criteria are discussed in the context of existing buildings that have important locations and historical features at the time they were built. In addition, the sustainability of historical buildings needs to transform existing historical buildings by using certification criteria during the transformation in the preservation process.

3. Sustainable Preservation of Historical Buildings

Historical buildings have problems in surviving with the increasing population and irregular urbanization (Halaç & Ergün, 2020). An integrated and sustainable understanding of conservation is needed to solve all these problems. Preservation is the cultural continuum of change and development. On the other hand, sustainability is a multidimensional process and method that cultivates suggestions to prevent pollution and protect natural life resources and local economies in order to increase individuals' quality of life (Oktay Vehbi, 2012). The concept of sustainability is at the core of historical preservation studies (Günay, 2010).

On the relationship between sustainability and conservation, İlhan Tekeli indicates that today's historical preservation approach does not mean freezing the past but ensuring the continuity of the future with the past. For this reason, he states that the concept of sustainability has started to be used instead of the concept of protection in recent years (Tekeli, 2009).

Historical buildings are exemplary in terms of sustainable approach teachings (Tutkun & İmamoğlu, 2015). The sustainable preservation approach has recently found its place in historical buildings, and in a sense, it develops and matures in line with common principles. Preservation is not enough to ensure the sustainability of historical buildings alone. Preservation by reusing and preservation by transforming are the practices that will bring the cultural heritage to the future. It is necessary to adopt an approach that considers these tendencies in living, changing, developing, and transforming historical buildings (Ergün & Halaç, 2021). At this point, while preserving historical buildings, it is important for the sustainability of the building to be used together with the concepts of renewal, rehabilitation, and transformation. Preservation efforts necessitate not only the physical renewal of the historical fabric but also the equal benefit of the economic and social environment.

Preserving historical buildings and handing them down to the next generations is possible with education, knowledge, and regular maintenance. In addition to the struggle of historical buildings against natural disasters, adverse environmental conditions, and physical-chemical deterioration, there is also a struggle against accelerating the destruction process of historical buildings with the attitude taken by human beings against these buildings (Mahrebel, 2006). Some sustainability methods have come to the fore in order to prevent the unintended consequences caused by mistakes made during the restoration and repair of historical buildings.

In the light of the information obtained, these sustainability methods can be summarized as follows: (1) Historical buildings should be used carefully and protected without being harmed by people. (2) In order to reach the awareness of protecting the buildings, sufficient information should be given to the individuals in the society, and training should be given at certain times. (3) Regarding the restoration of the deformations that have emerged over time in historical buildings, although they are well preserved, it should be carried out by experts in accordance with the original, by choosing the right application techniques with materials suitable for the structure and nature. In this process, every step should be documented and recorded. (4) The process of reusing historical buildings in line with the needs of the period they are in should be carried out without making any changes to the original project of the building. When the function of the historical building in its own period is removed, it should be ensured that the building maintains the same value (Erşan & Demirarslan, 2020).

Re-use of historical buildings in a way that can meet today's comfort conditions is important in terms of sustainability and ecological values. The correct use of this opportunity brings ecological gains with it. In this context, green building certification systems play a guiding role in terms of sustainable protection and use in historical buildings. When sustainability and ecological approaches in the preservation of historical buildings are considered in the context of re-functioning, the “Old & Green” relation should emphasize the right of the old to live and exist together with the present (Tutkun & İmamoğlu, 2015).

Considering all these, it will be possible for historical buildings to be preserved without losing their original value and identity and to gain a sustainable building identity.

4. Building Certification Systems

Historical buildings are exemplary in terms of sustainable approach teachings. Historical buildings have experienced problems in maintaining their existence with the increasing population and irregular urbanization. They need an integrated and sustainable preservation approach. However, physical and structural preservation is not enough to ensure the sustainability of historical buildings. At this point, preservation by reusing and preservation by transforming are the practices that will carry the cultural heritage to the future. While aiming to reduce the environmental impacts of buildings and increase their sustainability performance, objective and quantitative evaluation systems are needed to make decisions. Green building certification systems are defined as a kind of rating system that tries to provide a measurable reference in revealing the effects of building-based projects on the environment in an objective and tangible way and revealing their sensitivity to protecting natural resources (Çelik, 2009). Certificate systems provide documentation of the work and bring prestige to institutions (Gelişen & Güzelkokar, 2019). Certification systems have improved considerably since the introduction of BREEAM in the UK in 1990. There has been a rapid increase in the number of certification system tools in use and in the development of certification systems (Cole et al., 2005; Sev, 2011).

In addition, it was observed that conferences and conventions in this field are increasing rapidly (Figure 2). The common reason for conferences and conventions is that, although the events that negatively affect the environment sometimes have regional consequences, in fact, the main effect of environmental events is global. For this reason, practices related to the solution of environmental problems should also be global.

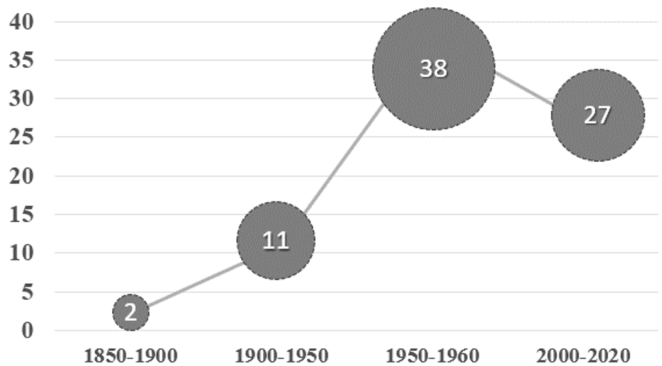


Figure 2. Increase in sustainability actions over the years (Created by the authors based on Carroon, 2010; Çamur & Vaizoğlu, 2007)

Since its development in 1990, the BREEAM system has been continuously updated and expanded to include the evaluation of buildings with many different functions (Yates & Baldwin, 1994). The first certification in the world, BREEAM has become the most widely used tool to evaluate the environmental performance of buildings in the UK (Prior et al., 2001). LEED was established by the United States Green Building Council (USGBC) in 1998 through a consensus process involving many stakeholders in order to transform and improve the understanding of green building (Zimmerman & Kibert, 2007).

The system aims to draw the attention of all individuals and organizations involved in the building design and implementation process to environmental values and to ensure that they continue their activities with decisions aimed at protecting the natural environment. Launched by the Australian Green Building Council (GBCA) in 2003, Green Star was developed to create a collaborative rating tool to measure environmental consciousness and awareness in the green building design and construction industry (Saunders, 2008). The Green Star certificate, the last regulation of which was made and published in 2016, was issued as Green Star-NZ in New Zealand and Green Star-SA in South Africa with changes according to regional and climatic factors (Mattoni et al., 2018). CASBEE was developed in 2004 by the Japan Sustainable Building Consortium, which includes committees in the academic, industrial, and government sectors. It includes various criteria for different phases of buildings under evaluation, such as planning, design, completion, and renovation (Gu et al., 2006; Say & Wood, 2008).

In the study, the distribution of the number of building certificates owned by the countries in the light of the current data obtained in 2022 is given. Since the BREEAM certificate is the first established certificate, it is seen that it is located on many continents in the world. While 61 buildings in Turkey have BREEAM certificates, it has been observed that 996 buildings have LEED certificates, and there are no buildings with Green Star and CASBEE certificates (Figure 3).

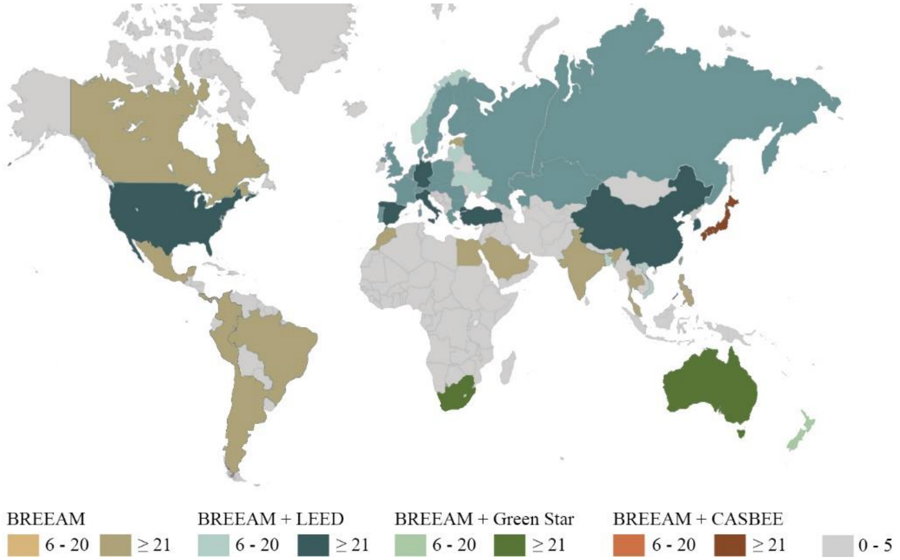


Figure 3. Distribution of certificated buildings according to the current data of 2022 (It has been arranged by the authors in line with the information obtained from the certificate web pages: URL-1, URL-2, URL-3, URL-4)

3. Findings and Discussion

The sustainable conservation approaches included in the transformation processes of the buildings under consideration were examined according to the sub-criteria of the certification systems, which are summarized in Table 5, Table 6, and Table 7. In line with the data revealed, evaluations were made for the use of these sub-criteria.

Table 5. Sustainable preservation approaches in the transformation processes of the buildings (range of construction year 1868-1891) within the scope of the study

Buildings	Transformation Approach
Boğaziçi University 1st Male Dormitory  	Efficient armatures, use of greywater, glass and doors with low heat permeability, user sensor lighting and natural ventilation systems with CO_2 sensors, mechanical ventilation systems with heat recovery, solar panels, and energy efficient bulbs, the waste management plan, airflow resolved with Computational Fluid Dynamics (CFD) analysis, bike parking spaces, use of hybrid and low-emission vehicles.
Cambridge City Hall Annex  	Proximity to public transportation, bicycle parking areas, highly reflective roof, photovoltaic system, ground source heat pumps, underfloor heating and regenerative ventilation, natural ventilation, daylight saving, recycled construction waste, recycled materials, skylights and interior glass, low VOC materials, carbon dioxide sensors.
Blackstone Station Office Renovation  	Proximity to public transportation, permeable asphalt materials, bike parking spaces, dual flush toilets, low-flow plumbing, waterless pissoirs, renewable energy, low-energy fluorescent lamps, controlled ventilation, mechanical and photovoltaic panels, recycled materials, recycled construction waste, fast renewable resources.
Whitaker Street Building  	Bicycle parking areas, city center/walking areas, proximity to public transport, environmental insulation, energy efficient shop windows, efficient HVAC system, cooling systems, high-efficiency lighting, dual flush toilets, 15-second faucet flush, low flow shower, reuse of existing materials, use that can be improved from other buildings.
Gerding Theater at the Armory  	Proximity to public transportation, Flexcar shared vehicle, bike parking spaces, Xeriscaping, rainwater harvesting system, ultra-low flow plumbing, dual flush toilet, chilled water plant, recycled construction waste, recycled materials, cotton insulation (wall), local materials, carbon dioxide monitors, recycling program, green cleaning policy.

Table 6. Sustainable preservation approaches in the transformation processes of the buildings (range of construction year 1899-1908) within the scope of the study

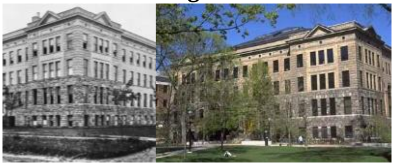
Buildings	Transformation Approach
Thoreau Center for Sustainability 	Electric car charging station, low-flow armature, gray water system, cotton insulation (wall), hydronic heating system, photoelectric sensor, natural cross ventilation, recycled construction waste, recycled materials, cotton insulation in walls, use of existing materials, interior lighting (common light).
Lion House at the Bronx Zoo 	Proximity to public transportation, bicycle parking areas, reduced light pollution, reduced wastewater output, irrigation system for landscaping, gray water system, ground source heat pumps, underfloor ventilation, energy saving systems, high-performance lighting, recycled construction waste and materials use of light, low VOC materials and coatings.
S.T. Dana Building 	Proximity to public transportation, bicycle parking areas, natural compost, low-flow plumbing, photovoltaic system, additional insulation, radiation cooling system, natural ventilation, digital controls, recycled construction waste, recycled and renewable materials, skylight/louvered windows, atrium, low VOC materials and coatings.
Alliance Center for Sustainable Colorado 	Proximity to public transportation, bicycle parking areas, low flow fixtures, dual flush toilets, digitally controlled building systems, Green-e wind energy certificates, energy efficient doors/windows, bronze mylar film (windows), automatic sensors, recycled materials, cotton-based fiber isolation, environmental education.
Lazarus Building 	A green roof, stormwater management, low flow fixtures, energy efficient windows, high-efficiency HVAC system, terrazzo flooring with recycled glass, reuse of waste materials, recycled solid surface plastic materials, renewable materials, recycled construction waste, bamboo flooring, daylight lighting.

Table 7. Sustainable preservation approaches in the transformation processes of the buildings (range of construction year 1910-1952) within the scope of the study

Buildings	Transformation Approach
Howard M. Metzenbaum U.S. Courthouse 	Proximity to public transportation, bicycle parking areas, underground parking, low-flow plumbing, sensor faucets, controlled ventilation, natural ventilation, recycled construction waste, recycled materials, repair of existing materials, local materials, carbon dioxide monitors, humidity control, green cleaning policy
Saint Joseph French High School 	Use of materials with recycled content, FSC certified wood, selection of façade glazing, lighting systems and mechanical systems, considering ASHRAE 90.1-2010 standard, construction management waste plan.
Immaculate Heart of Mary Motherhouse 	Proximity to public transport, built wetlands, xeriscaping, gray water system, low flow plumbing, photoelectric sensors, ground source geothermal heat pump, natural ventilation, recycled construction waste, new materials, rapidly renewable materials
John W. McCormack Federal Building 	Alternative transportation solutions, indoor bicycle storage, rainwater storage, gray water use, low flow faucets, dual flush toilets, energy-efficient doors/windows, recyclable materials use, and storage areas
Chicago Center for Green Technology 	Proximity to public transport, electric car charging station, bicycle parking areas, green roof, xeriscaping, biological structures, gray water system, low flow plumbing, photovoltaic system, ground source geothermal heat pump, low energy fluorescent lamp, recycled materials, local materials, canola oil elevator, recycling program

The transformations of 15 historical buildings were evaluated within the scope of the most common criteria in certification systems.

When the buildings are examined under the energy heading, it has been seen that renewable energy applications, which is one of the most common methods in buildings that produce their energy, are applied in many of these buildings. Low-energy electronic devices were preferred during the transformation of the buildings.

It has been determined that decisions are taken to consume optimum energy in lighting systems and that automatic sensors are generally used.

When the buildings are examined under the title of indoor environment quality, it has been observed that all of the buildings prefer economical windows and doors so that the optimum level of daylight can be used. In the transformation processes, a tendency towards controlled and natural ventilation methods has been shown. Heating and recovery mechanical systems are preferred. Wind energy has been tried to be used effectively. The indoor environmental quality has been increased with efficient lighting systems.

When the buildings are examined under the heading of transportation, it has been observed that regulations to encourage bicycles and public transportation are provided in all of these buildings. Especially for bicycles, parking areas have been created in many of these buildings. In addition, in many of these buildings, applications that allow the use of common vehicles for public transportation have been started to be used.

When the buildings are examined under the subject heading of water usage, it has been observed that studies have been carried out to reduce water consumption in all buildings. In particular, the fixtures and siphons in the buildings were changed to be water-saving, low-flow systems were started to be used. Rainwater collection systems were installed, and gray water was used. Wastewater management plans have been created, and regulations have been made that will minimally affect the environment.

When the buildings are examined under the heading of materials and resources, it has been observed that care is taken to use materials with recycled content in the transformation process of all buildings. Controlled plans were made for construction wastes in the transformation processes, and arrangements were made that would not harm the environment. Environmentally friendly materials were preferred in the materials used in the transformation process in the buildings. It has been observed that paints with Low Volatile Organic Compound (VOC) are used and to be prevented the mixture of harmful gases into nature.

When the buildings are examined under the heading of land use, it is seen that many buildings use the advantages of their location. It has been determined that encouraging studies have been carried out to prevent gas emissions, especially in matters where public transportation plays an important role.

When the buildings are examined under the heading of pollution, it is seen that the buildings include many important regulations in order to prevent pollution in both the construction wastes during the transformation process and the materials used after the process. Gray water use, recyclable material preferences, planned construction management, renewable material use, etc. It shows that the buildings carry out sensitive management in terms of pollution criteria.

When buildings are examined under the heading of innovation, it is thought that the recycling of buildings with an active function plays an important role in the understanding of sustainable preservation. The buildings, which are transformed with a function that is open to perpetual use, are also open to innovative designs in the process. In addition, the use of FSC-certified wood in the transformation process of the buildings, consideration of ASHRAE 90.1-2010 standards, the preference for automatic sensors, the use of low VOC materials and coatings, the selection of environmentally friendly materials, and the use of photovoltaic panels, etc. observed as innovative transformations. It is seen that it has been transformed with innovative design decisions.

When the buildings are examined under the heading of management, it is seen that the buildings are used with a planned management system both in the transformation process and after re-functioning.

6. Conclusion and Suggestions

As a result of the negative consequences of globalization in a world where resources are rapidly depleted, ecological practices and sustainable approaches have gained importance in historical buildings.

The use of environmentally friendly and recyclable systems that produce their energy in the long term in the sustainable preservation of historical buildings ensures both the sustainability of the building and the emergence of ecological results in its interaction with the environment. While using renewable energy sources in the renewal of historical buildings, it is necessary to benefit from the geographical and climatic conditions in which the building is located. In this direction, it should be ensured that the building sector benefits from scientific research and works with experts in the process. Waste from various units of historical buildings arranged for use in different functions should be reduced and recycled. Practices should be organized to disseminate sustainable approaches and ecological construction techniques in restoration and re- using, and research and development activities on the subject should be given importance.

A management process should be followed to approach all kinds of projects and applications with a sustainability understanding, use smart systems, benefit from innovative ideas, and reduce the natural resource use damage that may occur during use in all these processes. In addition, the necessity of the materials used to have sustainable properties, not to harm the environment and to be recyclable is one of the main issues that should be emphasized from an ecological point of view. The evaluations made in this study, which deal with ecological architectural criteria through historical buildings, will be a guide for new practices. The findings and suggestions of the study lay the groundwork for sustainable approaches in the renewal of historical buildings in different regions and their application in contemporary ecological architecture examples. It is thought that the ecological references evaluated at the scale of historical buildings in the study will pave the way for technological and technical applications for structures of different scales.

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Functions of Greenways as an Ecologically-Based Planning Strategy

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1. Introduction

Urbanization, which emerged as a result of technological developments, industrialization, and economic policies, is one of the biggest problems of the 21st century. Urbanization causes a decrease in ecosystem services and biodiversity (Wu, 2010), the destruction of urban green areas (Lafortezza et al., 2009), and the deterioration of the physical and psychological health of city-dwellers (Grahn & Stigsdotter, 2010).

Although urban areas make up only 2% of the world's land surface, they have a significant impact on global climate change by producing 78% of greenhouse gases (Bryant, 2006). In addition, urban areas are assumed to have a lower tolerance to climate change due to the fact that they are made up of a number of closed systems (Mell, 2009). Considering the intense population growth in cities, while the number of people living in cities around the world in 1960 constituted approximately 33% of the total population, this rate reached 56% in 2020. These trends put pressure on ecosystems and the quality of life of city-dwellers (Ritchie & Roser, 2021).

In addition to the unconscious use and rapid depletion of natural resources, urbanization also negatively affects the sustainability of cities. Cities are made up of structural areas and the functional areas surrounding them. The environment, other than the built areas, includes open and green areas that are semi-natural and/or created by humans. Urban open and green areas are planned for ecological, social, and economic purposes in parallel with the objectives of urban sustainability (Çetinkaya & Uzun, 2014). In urban ecosystems, the most important elements that support living and non-living elements with many functions are open and green areas (Bulut et al., 2010; Tuğluer & Çakır, 2019). Due to the increase in population in cities, the gradual increase in the rate of construction, inadequate environmental policies, illegal land occupations, and disruption of environmental protection applications cause a rapid decrease in urban open and green areas (Önder & Polat, 2012).

The destruction of urban open and green areas negatively affects the natural functions of ecosystems. In order for cities to maintain their ecosystem functions in a balanced and healthy way, to re-establish the relationship between humans and nature, and to ensure the sustainability of cities, planning and management approaches that deal with urban landscapes with an ecosystem perception are needed. In this context, landscape planning strategies have undergone radical changes since the end of the 20th century (Ahern, 1995). Urban open and green areas have great importance in planning studies aiming to protect and develop ecosystem functions. These areas play an important role in creating quality living environments with the environmental, social, and economic benefits they provide.

A comprehensive and systematic planning approach is required for open and green areas to fulfill the functions expected of them (Önder, 1997; Çorbacı & Dönmez, 2020). An urban open and green area system is defined as a long-term balance element for various uses in the structure of a city, as well as a living and sustaining organism that creates various possibilities for versatile outdoor uses (Öztan, 1998). In addition to controlling the climate, the social, psychological, and recreational needs of people can be met with open and green area systems that are designed correctly within the urban ecosystem (Kurdoğlu et al., 2010; Çorbacı & Dönmez, 2019; Tuğluer & Çakır, 2021).

Today, as a result of the studies carried out to eliminate the negative effects of urbanization and to create sustainable cities, the common idea accepted by landscape planners and environmental scientists has been the necessity of creating an ecological infrastructure (Ahern, 1995). Ecological infrastructure will not only form the basis of the nature conservation approach but will also increase the awareness of the interaction between nature and humans (Jongman et al., 2004). The basic component required for the creation of ecological infrastructure is the establishment of connections that will unite fragmented natural areas. Studies carried out in this context have laid the groundwork for the development of the greenway concept.

Greenways are networks of land containing linear elements that are planned, designed and managed for multiple purposes including ecological, recreational, cultural, aesthetic, or other purposes compatible with the concept of sustainable land use (Ahern, 1995; Arslan et al., 2004).

This study was carried out to determine the functions of greenways, which is an ecologically based planning strategy. In this context, the components of greenway systems, the classes of greenways, and their basic features were examined.

2. Material and Method

This study is based on answering the question of what the functions of greenways are. The main material of the study is greenways. In this context, first of all, the concept of greenway, which is an ecologically based planning strategy, was examined. Accordingly, the components, classification, and basic features of greenways were investigated. Then, the functions of greenways were determined and suggestions were made that greenway systems could be an important ecological-based strategy in reducing the negative effects of urbanization.

3. Findings and Discussion

3.1. The Concept of Greenway

Greenways are defined as linear open areas integrity that are planned for ecological, recreational and cultural/historical uses, protected and managed in line with these purposes (Fabos, 1991). It is known that the word "green" in the concept of greenway comes from the "green belt" and the word "way" comes from the "parkway" (Ekren, 2020). Greenways are systems that include the following elements (Arslan et al., 2004);

- Stream beds and valleys,
- Ecological corridors,

- Coasts,
- Cultural assets,
- Existing green patterns,
- Parkways and paths,
- Parks,
- Historical routes,
- Wildlife corridors,
- Green belts.

3.2. Classification of Greenways

Little (1990) classified greenways, which are created as protected linear corridors and provide recreational opportunities as well as increase the quality of life and the environment, into five categories. This classification is as follows (Little, 1990);

Urban riverside (or lakeside) greenways: These greenways are typically developed as part of a reconstruction initiative along abandoned and frequently dilapidated city waterfronts.

Recreational greenways: Recreational greenways are built on natural corridors such as canals and abandoned railways. They include walkways and different sorts of trails and are frequently relatively lengthy in distance.

Ecologically significant natural corridors: They are areas that sometimes continue along ridges and elevations, and sometimes include rivers and streams. They are greenways used for scientific research, wildlife protection and hiking purposes.

Scenic and historic routes: These are roads and areas that continue along a highway, which in certain places also allow for pedestrian activities.

Comprehensive greenway systems or networks: They are systems planned in accordance with the natural land form (ridge, valley, etc.). These are the systems where new alternatives are developed by connecting open and green areas with various uses at different scales with greenway systems.

3.3. Basic Features of Greenways

According to Ahern (1995), it is possible to classify the basic features of greenways under five headings, which are explained below.

Linearity: The most important spatial feature that distinguishes greenways from other landscape planning concepts is that they are linear. In this way, they contribute to the circulation of species, various materials and nutrients. It is also a supportive feature for recreational activities (walking, cycling, etc.).

Linkage: It is an important feature that defines the greenway and offers opportunities to interact with landscape structures of different scales. They also contribute to the protection of natural assets thanks to this feature.

Multi-functionality: Greenways can have ecological, recreational or cultural functions. Due to its multi-functionality, it is especially important to determine the target uses accurately and clearly in greenway planning. Because some targeted functions may conflict with each other. For example, while the need for recreation and the protection of wildlife habitats require spatial separation, their association requires special management. In cases where this cannot be achieved, one of the uses may need to be eliminated.

Sustainability: The greenway strategy supports the sustainability principles by considering the conservation/use balance.

Integration: Greenways represent a distinct spatial strategy based on the particular characteristics and advantages of integrated linear systems (Ahern, 1995). In this context, greenways should not be considered as an alternative to the concept of landscape planning, but as an approach that supports it.

3.4. Functions of Greenways

Although they have different functions when designed for special purposes, the functions of greenways are generally the protection of biological diversity, the provision of recreational activity opportunities, the protection of water resources, the protection of historical and cultural resources, and the control of urban sprawl (Fabos, 1995; Arslan et al., 2004; Ekren, 2020). These functions of greenways were explained in detail below.

Conservation of biological diversity: With the integration of ecology into planning, the protection of biological diversity has become the most important goal of ecological planning. One of the most basic functions of greenways is the development and sustainability of biodiversity, which includes the protection and management of plant and animal communities in the most suitable habitats for them (Linehan et al., 1995). Greenways contribute to the conservation of biological diversity by connecting existing patches within the landscape structure. Some of these links and the benefits they provide were described below. In landscapes where the matrix is less suitable for biodiversity, it is important to establish greenway corridors to ensure the movement of species. In the matrix suitable for the species, the species has the possibility to switch between the matrices, while in the matrix that is less suitable for the species, the existing connecting corridor may be the only possibility of movement for the species (Figure 1) (Bentrup, 2008).

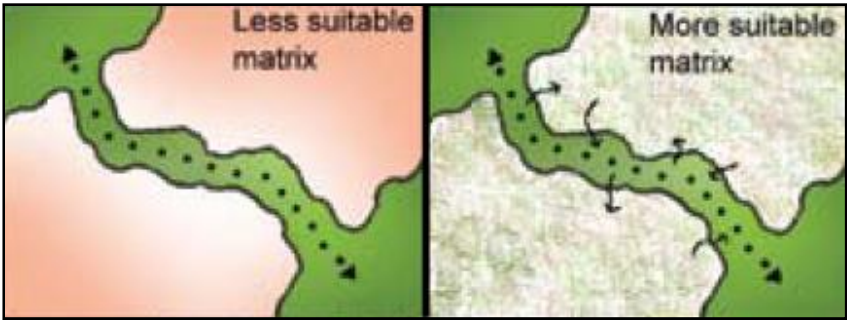

Figure 1. Using corridors to ensure species mobility (Bentrup, 2008)

Combining the fragmented and restricted habitats with corridors in the existing landscape structure enables the recolonization of the species, especially by enabling the migration of wildlife (Figure 2) (Hoşgör, 2005).

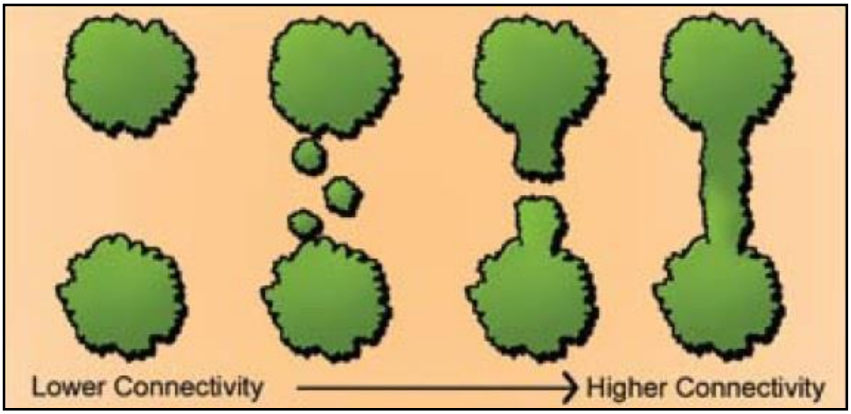

Figure 2. Connectivity level (Bentrup, 2008)

Connecting the patches with more than one corridor will facilitate the movement of the species (Figure 3). However, at this point, precautions should be taken considering that possible diseases and problems caused by invasive species can spread rapidly (Bentrup, 2008).

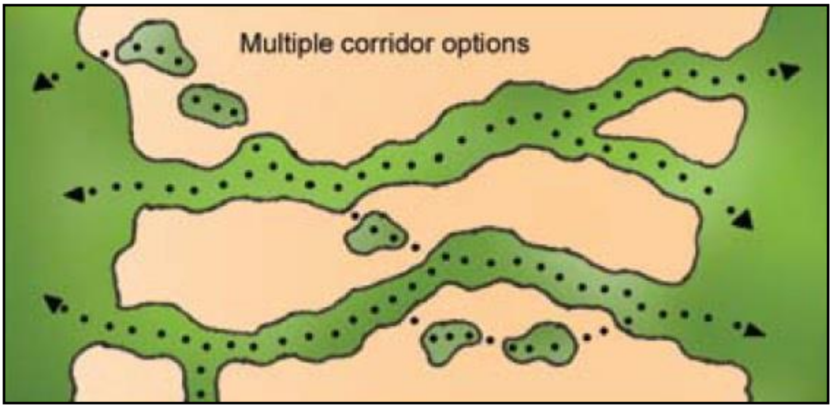

Figure 3. Creation of corridor alternatives (Bentrup, 2008)

<u>Conservation of water resources:</u> Greenways have an important function in the protection, restoration, and management of water resources, including water basins, river corridors, and wetlands.

Aquatic plants along the water source corridor filter excess nutrients and toxic chemical waste. Thanks to the plants used along the greenways, the sediments brought by erosion and the pollutants from the settlements and roads are prevented from filling the water resources or covering the stream beds (Arslan et al., 2004). At this point, the factors to be considered are the distance of the greenway to the pollution source, the appropriate width of the corridor, the diversity of plant species, and the necessity of following the natural form of the land (Figure 4).

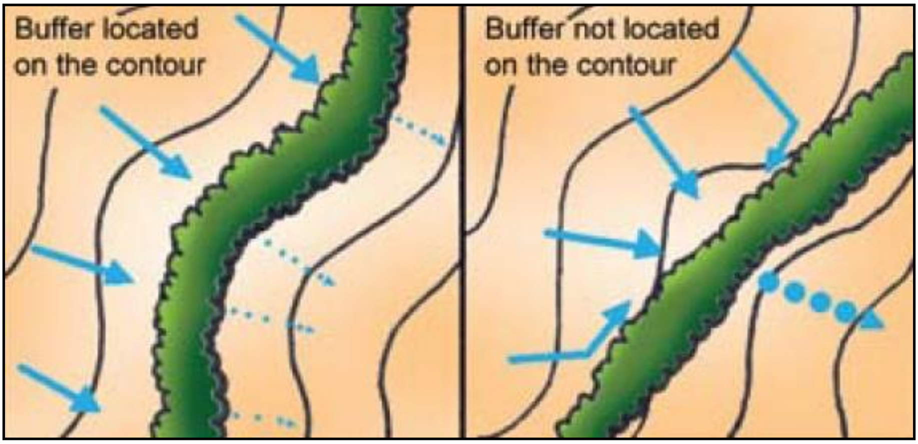

Figure 4. Corridors' relationship to landform (Bentrup, 2008)

Greenways along the stream may have a fixed width where homogeneous flow occurs (A). However, runoff is often inhomogeneous due to topography, tillage practices, and other factors (B). In such cases, greenway widths can be increased in areas with the high flow by mapping flow areas and their corresponding greenway corridors (C, D) (Figure 5) (Bentrup, 2008).

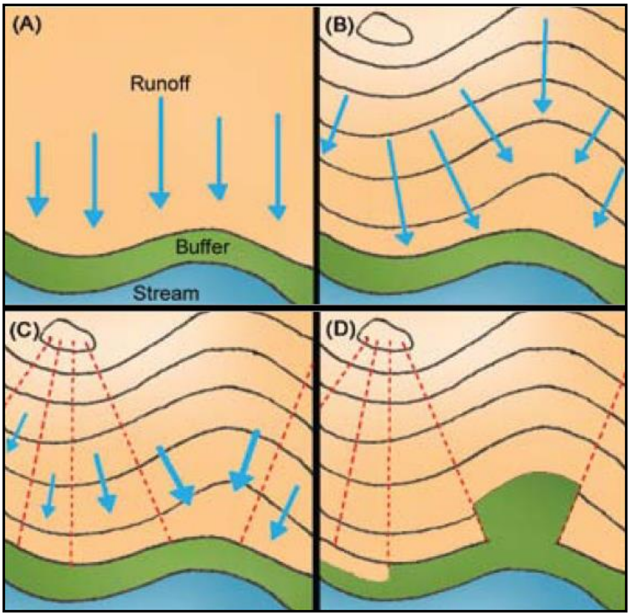

Figure 5. The relationship between greenway widths and flow (Bentrup, 2008)

Land slope and soil type have a significant impact on the greenway's ability to filter pollutants from the runoff. Steeper slopes allow more pollutant transport and less time to filter, reducing performance and requiring wider greenways in these areas. Soils with higher infiltration capacity can reduce flow more than soils with lower infiltration. Soils with low infiltration capacity require wider greenways (Ekren, 2020).

One of the benefits of greenways within the scope of protection, development, and management of water resources is to prevent or reduce the negative effects of floods. Greenways created along water resources help prevent flooding by controlling runoff (Yu et al., 2006).

Creation of recreational activity opportunities: The most important feature that distinguishes greenways from other ecological corridors planned for protection is that they also provide recreational activity opportunities. Especially when they are created in natural corridors such as streams, ridges, and valleys, they create scenic routes for recreational activities such as walking, jogging, and cycling (Hoşgör, 2005). In addition, greenways provide a setting for nature walks, horseback riding, wildlife watching, botanical excursions, and water-related recreation (boating, canoeing, fishing, etc.). It is important to consider the appropriate viewing distances of the users while planning greenways that provide opportunities for these recreational activities (Figure 6) (Flink et al., 2001).

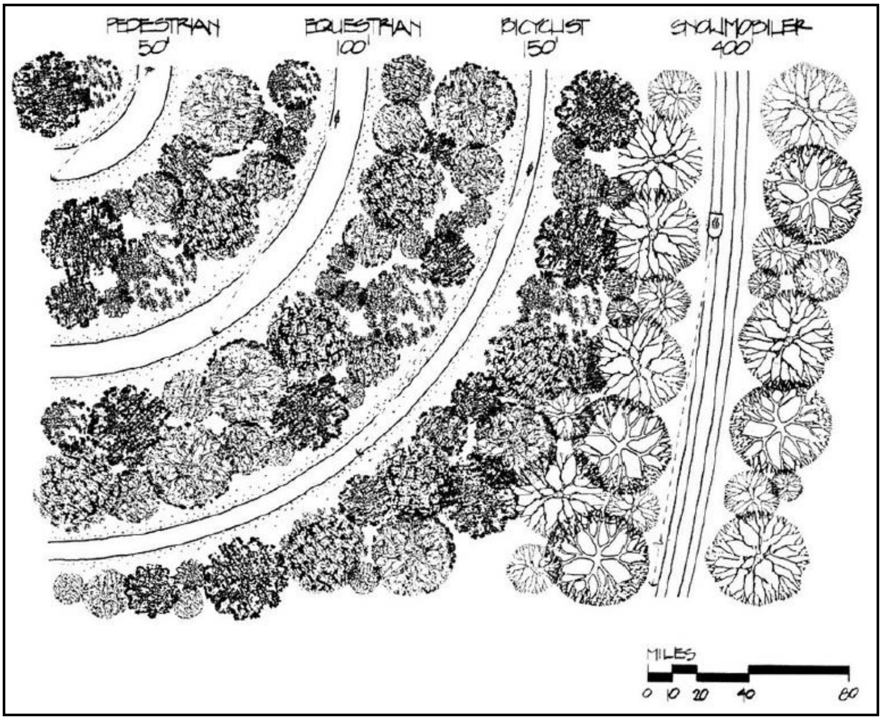

Figure 6. Suitable viewing distances for greenway users (Flink et al., 2001)

Greenways ensure that recreational resources are accessible to city-dwellers. In the Urban Audit Report prepared by the European Commission, urban open and green areas are included in the public service group, and the ideal walking time to reach these areas is determined as 15 minutes. The greenways, which contribute to the homogeneous distribution of green areas in the city, will enable city-dwellers to reach these areas under equal conditions and in a more comfortable way (Yaman & Doygun, 2014). In addition, ensuring continuity between greenways and urban open and green areas allows users to easily and safely pass between these areas.

Recreational activities can have negative effects on biodiversity through the destruction of the natural environment and on public health through air, water, and soil pollution (Demir, 2002). In particular, the greenways that will be created along the coastal corridors are critical areas for many ecological functions that may be adversely affected by recreational trails. In order to minimize these possible negative effects on ecological functions and to prevent the recreational areas from being damaged in a possible flood, the paths should be designed outside the coastal corridor and access to the coast should be provided in strategic areas where only water-based recreation will be provided (Bentrup, 2008).

The fact that greenways follow natural corridors makes these areas more attractive for users. It is important for users to observe and understand nature in different time periods in order to increase environmental awareness in society (Korcan Çulcuoğlu, 1997). In this context, nature education programs organized along the greenways help users of all ages to get to know nature more closely and to increase their level of awareness of this subject. In addition, greenways play an important role in people getting away from the stress of daily life and reducing the negative impact of urbanization on people. Therefore, while creating greenways, it is necessary to carry out work that will contribute positively to the aesthetic feelings of the users as well as their physical needs (Ekren, 2020).

<u>Conservation of historical and cultural resources:</u> Most of the historical and cultural resources are located on the coastline (rivers, lakes, seas, etc.), which has been the main transportation routes for thousands of years. For example, Lewis (1964) identified 220 resources in the trail plan he proposed for the protection of natural and cultural resources in the State of Wisconsin and emphasized that approximately half of these resources are historical and cultural resources. He also stated that these sources are mostly located on the coastline along the river corridors. Therefore, greenways, which generally follow natural corridors, contain many historical and cultural resources, and they have an important contribution to the protection of these resources and the connection between them (Fabos, 1995).

<u>Control of urban sprawl:</u> The unplanned and uncontrolled expansion of urbanization and industrialization has led to the gradual loss of natural landscape elements (Akpınar, 2014). The spread of cities is becoming

unstoppable day by day. Greenways create a green system by connecting urban open and green areas with each other. While this green system provides the transition from the urban area to the rural area, it also defines the current urban development and contributes to its orientation in line with the targets (Çelik, 2005).

4. Conclusion and Suggestions

Urbanization, which increases the pressure and destruction on natural resources day by day, causes many environmental problems. In cities, where ecological relations are put in the background by intensive construction and industrialization, an artificial living environment is formed as a result of the gradual decrease of natural areas and an "urban ecosystem" emerges. The solution to these problems occurring in cities is the implementation of integrated development plans in which social, economic, ecological, and cultural criteria are considered together.

With the increase in the rate of urbanization, the intensification of land use in cities and the wrong land uses cause landscape fragmentation. It is possible to see successful examples of the greenway concept, which has developed as a result of the studies carried out to prevent the negative effects of landscape fragmentation and offers a strategic approach to landscape planning, especially in western countries.

Greenways are linear corridors that connect natural corridors such as rivers, ridges or valleys; canals converted for recreational use along the railway route; scenic roads or parks; natural reserve areas; cultural objects; or historical settlements to each other and settlement areas.

Greenways have important functions such as protecting biological diversity, protecting water resources, providing recreational activity opportunities, contributing to the protection of historical and cultural resources, and keeping urban sprawl under control (Fabos, 1995; Arslan et al., 2004; Ekren, 2020).

Greenway systems can be planned at different scales. Greenways can be systems that connect open and green areas in the city, as well as the city to the countryside or a settlement to another settlement. When applied at the urban scale, they increase the quality of life of city-dwellers and the livability levels of the cities. Greenway planning in rural areas can also be seen as a rural development project. Greenways, which contribute to the socio-economic development of the rural settlements they pass through, also realize the rural development goals in the planning processes.

Greenway planning is a planning strategy that requires multidisciplinary work. It should be clearly defined who will manage the project and which professional disciplines will be included in the project group. In addition to the contribution of many professional disciplines, it is a process that requires the participation of the public in the planning, implementation, and management stages. This will increase the success of the greenway. It is also possible for the public to work voluntarily on the greenway project after the plan is implemented.

One of the important issues for greenways to show the expected benefits is planting design. In greenway applications, in order for the planting design to affect the user throughout the year, attention should be paid to the selection of plant species as well as the correct design. It is important to use natural plant species belonging to the region where the implementation will be conducted. These plants will ensure the continuity of the implementation and prevent diseases and pests that are likely to be carried to the area with exotic plants. If it is necessary to include exotic plant species in implementations due to planting design or other conditions, it should be investigated whether the examples of those species in the region show suitable growth in climatic conditions.

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Author Contribution and Conflict of Interest Declaration Information

All authors contributed equally to the book chapter. There is no conflict of interest.

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Pedestrian Sidewalk Corridors the Case of Süleymanpaşa District in Tekirdağ/Türkiye

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1. Introduction

Streets, which make up the majority of urban spaces, are the common areas where social life begins. Increasing the walkability in the urban space makes the public space colorful and dynamic; it contributes to the development of livable communities by mediating social interaction. With the New Urbanization Movement that started to emerge after the 1990s, in the solution of problems in urban areas; the importance of designing walkable, pedestrian-friendly streets was emphasized. For this reason, solutions such as pedestrian spaces that increase the usability of urban space are gaining importance today (Aydemir, 2018). Plans were made based on pedestrian transportation in historical settlements and in order to prevent noise in Ancient Rome, heavy freight cars were prohibited from entering the city in the evenings and comfortable circulation was ensured in the city (Kuntay, 1994). Until the beginning of the twentieth century, nearly all cities were car-free. (Kuntay, 1994; Patel et al., 2016). In parallel with the development of new vehicles, cities spread over larger areas and the use of vehicles increased. With the increase in the use of vehicles, the sprawl of suburbs was encouraged, street life was limited in street-dominated cities, encouraged the sprawl of suburbs and networks containing independent pedestrian routes in urban areas began to be proposed in the 1930s.

In livable, safe and sustainable cities, good walking opportunities are a prerequisite for urban life. When you strengthen the pedestrian life, many social and recreational opportunities automatically arise (Gehl, 2019). Streets and streets are places where daily activities are carried out and if their use by pedestrians decreases, the responsiveness of urban uses to social activities also decreases. Urban outdoor spaces are enriched by the increase in the accessibility of pedestrian roads (Bakan & Konuk, 1987). Pedestrian routes constitute one of the most important elements of urban corridors. Urban walking corridors; It forms part of the urban pedestrian system, which usually extends along the street edges from the carriageway edge to the property boundary (Boodlal, 2020). These areas, in terms of the aesthetic, ecological and economic values they add, are the indispensable possibilities of the cities and which should be carefully considered (Yerli & Kapak, 2007). In this sense, applications that enrich the urban walking corridors in terms of function and aesthetics gain importance.

According to the Declaration of Pedestrian Rights adopted in the European Parliament in 1988, "pedestrians live in a healthy environment; have the right to freely enjoy public spaces under conditions conducive to adequately protecting their physical and mental health". In addition, pedestrians have the right to live in urban areas that allow them to meet their daily needs on foot or by bicycle (Anonymous, 1988).

The purpose of pedestrian transportation; It is to create spaces for pedestrian journeys as a mode of transportation and at the same time to create spaces that are free from traffic chaos and vehicle occupation, enriching social and cultural life (Şişman & Uyguner, 2009).

Traditionally, the design of pedestrian corridors with design parameters according to the standard pedestrian; not limited to one type of pedestrian user; It should be designed to serve all users, such as children, the elderly, parents with strollers and the disabled. In order to achieve success in the pedestrian walkway design, the following sections should be included in the pedestrian walkways;

- Building frontage zone; it is the distance between the building wall and the walking zone. Since walking directly adjacent to the building facade reduces the comfort of pedestrians, there should be a distance of at least 0.6 cm.
- Pedestrian travel zone; it is an area reserved for pedestrian walking, free from all obstacles and at least 1.8-3.0 m wide. Walking zones should not be less than 1.2 m.
- Planter/furniture zone; located between the curb and the pedestrian walking zone, with a width of 1.2-1.8 m, providing a buffer to the street traffic; It is the area reserved for public services such as poles, signage, benches and telephone booths.
- Curb zone; it is the first 0.15 m of the walking path on the highway side. It is the area that provides drainage on the pavement and prevents motor vehicles from entering the pavement (Boodlal, 2020).

Pedestrian sidewalk corridors;

• Accessible to all users,

• Establishing a connection between pedestrian areas and other modes of transport,

• Having continuity,

• Having easy and comfortable areas to use,

• Creating social spaces where pedestrians can safely participate in public life,

• Adequate width,

• Safe to use (users should not be threatened by adjacent traffic),

• Creating a buffer between pedestrians and traffic,

• It is very important to have a sufficient number of furniture (Bakan & Konuk, 1987; Payaslı, 1997; Karahan & Canatan, 2019; Boodlal, 2020).

In this research, it is aimed to explain the importance of pedestrianization studies and the pedestrian walking corridors that form a part of the urban system and to evaluate them in the example of Tekirdağ Süleymanpaşa district. In this context, Fatih Sultan Mehmet Boulevard and Atatürk Boulevard, which are the two main arteries in transportation in the district, have been evaluated in terms of the existing standards in terms of the qualities that pedestrian corridors should have such as accessibility, appropriate width, safety, continuity, plant arrangement, social area and quality of space.

2. Material and Method

The main pedestrian walking corridors in Tekirdağ Süleymanpaşa district constitute the material of the research (Figure 1). There are 3 main axes that provide transportation in the city. According to their location, the first of these axes is Fatih Sultan Mehmet Boulevard at the entrance to the city and Atatürk Boulevard passing through the city center in the continuation of this boulevard. Government Street, on the other hand, constitutes the 3rd main axis.

Figure 1. Location of the research area

Within the scope of the research, Fatih Sultan Mehmet Boulevard and Atatürk Boulevard, which are important in terms of urban circulation in the urban transportation system and are used extensively by the public, were evaluated (Figure 2). These streets both provide traffic flow and serve the people of the city by meeting their recreational needs. The spaces were chosen because of their intense use and interconnectedness.

Figure 2. Research areas

In the research, the criteria related to the subject were determined by scanning the literature. At the next stage, the results of field studies and on-site observations were processed in the field forms and the results; accessibility, appropriate width, security, continuity, vegetation arrangement, social area and quality of the space were evaluated in terms of standards (Payaslı, 1997; United Nations, 2004; Yerli & Kapak, 2007; Özcan, 2008; Prime Ministry Administration for Disabled People, 2010; Ministry of Family and Social Policies, 2011; World Disabled Foundation, 2011; Sari et al., 2020; Boodlal, 2020). The criteria used in the evaluation;

• Accessibility; the physical condition of the roads, the compliance of the features of the ramps with the standards,

• Appropriate width; the status of walking corridors according to the need for people's activities, sight areas, visual places, signs to be seen and promotional signs,

• Security; elements that are directly related to walking safety, such as the road's relationship with the vehicle road, its physical properties, slope, coating material, lighting and the standards it should have,

• Continuity; ensuring uninterrupted transportation of the pedestrian to the destination they want to reach in the most appropriate way,

• Vegetative regulation; adequacy, place of application, area covered, branch height and pouring properties,

• Social area; the nature of the space where pedestrians can safely participate in public life,

• Venue quality; it has been determined as urban reinforcement elements and visual adequacy of the area.

3. Findings and Discussion

In the research, Fatih Sultan Mehmet Boulevard (4584 m) (Figure 3) located at the entrance to the city and Atatürk Boulevard (3850 m) passing through the city center and important in terms of city circulation (Figure 4) were evaluated in terms of sidewalk corridors. Many avenues and streets extending to the north and south are connected to these streets, which are approximately 8434 meters in length and serve as a main axis in city transportation.

Figure 3. Fatih Sultan Mehmet Boulevard

Figure 4. Atatürk Boulevard

In the study, the features consisting of the titles of accessibility, appropriate width, safety, continuity, plant arrangement, social area and space quality on the walkways are explained below;

3.1. Accessibility

In terms of accessibility on pedestrian roads; surface materials, level changes and slip resistance are important. As flooring material in research areas; concrete interlocking parquet was used.

In both boulevards, there are differences in the slope of the pavement, which is one of the factors that can cause problems for users on the pedestrian roads. There are no ramps that need to be implemented in order to prevent the elevation differences that occur at the junction of the pedestrian roads with the main road and which are especially important for disabled transportation. Sudden level changes occur along the walking corridors due to occasional collapses and protrusions from manhole covers (Figure 5). According to TS 12576; There should be no obstacles on the pavement surface so that the disabled can walk freely on the roads reserved for pedestrians, without being hindered and without stopping and to use the pavement with awareness of their movements. Any irregularity that would be dangerous should be avoided.

Pedestrian pavement should be anti-slip and easy to walk around, steps on the roads, etc. The underground installation manhole covers on the road surface should not protrude, sudden level changes, uninterrupted, continuous or the same level of ground should occur (TS 12576).

There should be pavements on both sides of the vehicle road (TS 12576). It has been determined that there is a pavement on one side of the road mostly along the route on Fatih Sultan Mehmet Boulevard and there are pavements on both sides of the road on Atatürk Boulevard.

Ramps should be made as comfortable and safe as possible, considering that they will also be used by disabled people with wheelchairs and walking sticks. It should never be steeper than 8% (1:12). For the visually impaired, there should be a 150 cm long flat and different textured area at the beginning and end of the ramps (TS 12576).

Figure 5. Collapses and manhole covers along the sidewalk corridor

It has been observed that the guide lines required to guide the visually impaired pedestrians in the research areas are insufficient and their continuity is not ensured (Figure 6). It has been determined that these lines do not exist, especially in Fatih Sultan Mehmet Boulevard, but only at the beginning and end of some roads.

Figure 6. Inappropriate guide lines on Fatih Sultan Mehmet Boulevard

3.2. Suitable Width

Many avenues and streets extending to the north and south are connected to these streets, which serve as the main axis in urban transportation. This situation causes an increase in its functions by getting crowded during the day and a significant density on the pavements and the importance of pavement widths emerges. It is seen that this width is approximately 1.80-2.0 m in Atatürk Boulevard and there are variations in width from Fatih Sultan Mehmet Boulevard from place to place. It was observed that the width, which was approximately 2.80 m, decreased to 0.50 m in some places and sometimes reached 7.0 m without adding any function to the area (Figure 7).

Figure 7. Different widths seen along the sidewalk corridor

The width of the sidewalks should be sized according to the density of use and the road class and group and should be made in accordance with TS 7937. The sidewalk must be at least 150 cm clear so that all pedestrians can move freely. In addition to the net size of the sidewalk, there should be a safety strip of at least 25 cm on the side of the property and 50 cm on the border stone, including the border stone. Depending on the pavement width and road groups, the safety strips can be up to 50 cm at the property and up to 120 cm on the kerbstone side.

3.3. Safety

Separating pedestrian and vehicle roads with a green band or a limiting element is beneficial in terms of security (Bakan & Konuk, 1987). Due to the density of vehicle traffic and the inadequacy of the vegetative arrangement that will have a buffer effect, circulation safety in the walking corridors cannot be adequately provided. Especially on Fatih Sultan Mehmet Boulevard, there is no buffer planting that distinguishes pedestrian and vehicle traffic. On the other hand, there is buffer vegetation in the coastal and 100th year areas of Atatürk Boulevard (Figure 8). The guide lines for visually impaired pedestrians on Atatürk Boulevard are located on the side of the vehicle traffic and on the roadside. This poses a risk for disabled pedestrians (Figure 9).

Depending on the width of the pedestrian pavement, the trees to be planted on the sidewalk with the vehicle road must comply with TS 8146, as well as electricity, traffic sign poles and ornamental plants, flower beds/pots, pedestrian guardrails, etc. The facilities should be placed evenly in a strip of minimum 75 cm and maximum 120 cm width along the sidewalk including the curbstone. If there is a level difference at the property border of the sidewalk, a railing should be built between the pavement and the garden (TS 12576).

Figure 8. Buffer green area between the sidewalk corridor and the road

In both sidewalk corridors, vehicle and pedestrian traffic intersect and there is no pedestrian crossing at vehicle connections (Figure 10).

Figure 9. Guide lines that are not suitable for safety

According to TS 12576, the pedestrian sidewalks at the intersections should be widened, the pedestrians and the disabled should be allowed to move freely and no notice or information boards should be placed on the corners. Pedestrian crossings should be selected in accordance with TS 7635 and selected pedestrian crossings should be marked with horizontal and vertical signs. Care should be taken to ensure that the lines drawn on the vehicle road are fixed and permanent. As stated in Hepcan et al. (2006), it is important to ensure that there are no uses on the sidewalks that will impede pedestrians and endanger their safety and that they are implemented and inspected in accordance with the relevant TSE standards.

Figue 10. Areas where pedestrian and vehicular traffic intersect

3.4. Continuity

It was observed that the pedestrian path on Fatih Sultan Mehmet Boulevard is one-sided in the north of the road, on both sides of the road on Atatürk Boulevard it is uninterrupted in the direction of the coast and on the opposite side it is narrow and interrupted. It has been determined that the pavements in the study area do not have continuity and continue for a maximum of 1 km. The starting and ending points of the pedestrian roads are not clear and the connections to the main roads are interrupted. In order to prevent vehicles from entering the enlarged areas on Fatih Sultan Mehmet Boulevard, the roads were closed with concrete blocks (Figure 11). However, it is seen that vehicles are entered and parked from the lower points along this route. This is an element that threatens pedestrian safety (Figure 12).

Figure 11. Use of concrete blocks to prevent vehicle entry

Figure 12. Vehicles parked on the sidewalk corridor

3.5. Vegetative Arrangement

In pedestrian corridors, plants have a calming effect on traffic and improve the pedestrian experience by acting as a visual and auditory buffer. As a result of the evaluation of the vegetative arrangement of the walking corridors in the research area, it was determined that the plant material was insufficient in Fatih Sultan Mehmet Boulevard and that Atatürk Boulevard partially had vegetation in the form of a green band. Existing vegetation does not have the characteristics of a vegetative buffer since it is not located on the vehicular traffic side. Considering the place of application, coating and branch status of the plants in the research areas; It has been determined that there are applications that constitute an obstacle in all areas. Since the plants are mostly located in the middle of the roads, they prevent the passage of pedestrians using the walking path. It is desirable that the plants in the pedestrian walking corridors have a trunk height of at least 2-2.9 m (Ürgenç, 1990). At the same time, the growing environment left for the plants is insufficient. At least 1x1 m plant growth area should be left for plants in road afforestation (Ürgenç, 1990). It was observed that these were limited to 30 cm or not left at all in the research area (Figure 13). Planting places of trees on the pedestrian sidewalk must comply with TS 8146. In addition, branch heights are below the head rescue distance. The vegetative arrangement consisted mostly of deciduous plants. This makes the floor slippery due to the pollution it creates.

3.6. Social Area

Considering the state of being able to participate in the public life provided by the sidewalk corridors to the pedestrians; It is seen that Fatih Sultan Mehmet Boulevard is insufficient in this respect, but partially supports social life with the pocket parks located next to the sidewalk corridors (Figure 14). Atatürk Boulevard, on the other hand, is very rich in terms of social area in terms of recreational opportunities it provides due to its proximity to the coastal area, being visible and perceptible.

Figure 13. Insufficient plant growth areas in the study areas

Figure 14. Pocket parks

3.7. Venue Quality

Gehl (2019) identified 12 quality criteria for the pedestrian landscape. These 12 quality criteria are discussed under three main headings as protection, comfort and pleasure. When the research areas are evaluated in terms of these criteria, it has been determined that in terms of protection, especially on Fatih Sultan Mehmet Boulevard, where the protection against traffic accidents for pedestrians is very limited, it coincides with the pedestrian vehicle traffic in most places. Night lighting in both places is in good condition. High concrete lighting elements are used. Both boulevards have insufficient properties in terms of protection against disturbing sensory experiences (wind, rain, dust, noise, etc.). In terms of comfort, spaces should offer various opportunities (watching, talking, resting and playing, exercising, etc.) for pedestrian walking, standing, sitting and spending time (Gehl, 2019). When evaluated from this point of view, it has been seen that Atatürk Boulevard has more positive features in terms of pedestrian comfort, while there are important deficiencies in Fatih Sultan Mehmet Boulevard. Enjoyment, which is another criterion, is to benefit from the positive aspects of the climate (warm/cool, breeze, sun/shade, etc.) and positive sensory experiences (good design details, good materials, beautiful scenery, trees, plants, etc.), especially designed according to human scale. etc.) (Gehl, 2019).

4. Conclusion and Suggestions

In order to ensure the movement of individuals in the city, there is a need for spaces that are completely separated from motor vehicle traffic by borders or planting and are designed for pedestrian use only. These areas provide interconnection of different spaces, continuity and integrity within the city (Dizman, 2015). It is seen that there is a significant need for the creation of sidewalk corridor in the research areas, especially on the routes located in the commercial center where the working population is concentrated and in the dense residential areas. However, considering the current urbanization and topographic structure of Tekirdağ, the possibilities of expanding the spaces used by pedestrians are limited.

As a result of the investigations; the current situation of the walking corridors and the elements to be considered in the design process are explained below;

• Tekirdağ is quite inadequate in terms of green areas and safe walking areas. The ability of pedestrians to move freely in the city is limited. Management plans should be prepared taking into account the research results.

• Insufficient pavement widths on pedestrian roads, solving the slope with high ramps and using high curbs reduce walkability. Making improvements in accordance with the standards in these areas will contribute to the creation of barrier-free, useful and livable urban areas and structures that support accessibility.

• Selected surface material on sidewalk corridor; It should be slip resistant and facilitating circulation, underground installations and manhole covers should not form protrusions and by avoiding sudden level changes, attention should be paid to the formation of the floor at the same level. The flooring material in the research areas is a slip resistant concrete interlock cobblestone. However, the differences in the slopes of the pavement, the protrusions caused by the infrastructure and the grille holes pose a danger especially for pedestrians with mobility impairments.

• In order to increase accessibility in the research areas, the length of the ramp should be minimized by lowering the pavement height at the points where the pedestrian roads meet with the vehicle.

• Pedestrian roads are not wide enough, especially in cases of heavy use. This situation becomes crowded during the day, increasing its functions and causing significant congestion on narrow pavements due to heavy traffic. If the existing problem is solved, the comfort of pedestrians will be increased and a significant increase in the amount of open space will be achieved.

• It has been determined that pedestrian safety is not adequately provided due to the applications in the research areas and the density of vehicle traffic. Pedestrian safety will be ensured with pedestrian crossing applications to be made at the junction points of pedestrian roads with vehicular traffic and arrangements that will create a vegetative buffer on the road side.

• It has been observed that pedestrians are under the threat of vehicular traffic. Especially on Fatih Sultan Mehmet Boulevard, where there is an excessive increase in road widths, concrete blocks were placed in order to prevent vehicles from entering the area and this had a negative impact on pedestrian traffic.

• In terms of the continuity of the sidewalk corridors, these practices should be eliminated and areas free from vehicle traffic should be created with the green zone created within the area.

• The plant potential in the research areas is insufficient and has a limited living environment. With the vegetative arrangements to be made along the road, a visually and psychologically comfortable environment will be provided to the pedestrians who tend to prefer the pedestrian axes separated by vegetation. In addition, the living areas of the trees will be enlarged and covered with grilles to prevent the roots from protruding into the pedestrian corridor.

• Improvements should be made in the walking corridors and urban equipment that is found to be inadequate in line with user requirements should be revised. The existing reinforcement elements, which are observed to be in the middle of the road, should be repositioned in a way that does not hinder the pedestrian flow.

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The Square in Urban Landscape Design: The Cumhuriyet Square Mürefte

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1. Introduction

Throughout the history, cities are optional, which changes depending on geography, economy and demonstration. Squares, which we can define as urban open spaces that meet the need of people to gather and come together in urban areas; it has become a symbol because it is the place of important social movements. The most effective use of the squares, which were used for various purposes in different periods of history, was during the Ancient Greek and Roman Empires. Agora, which is expressed as "city square" in its simplest form, corresponds to the Greek term "ageiro" meaning "to gather, to come together" and in later processes it has turned into an agora, which means "gathering place" (Polat & Önder, 2012; Candur, 2019). City squares in history; it has been called by different names such as agora, forum, campo, piazza. During the Middle Ages, Industrial Revolution, capitalism, modernism and globalization periods, there were changes in the functions and physical structures of city squares (Akman, 2020). Squares that we can define as urban open spaces that meet the need for people to come together in urban areas; it has become a symbol because it is the place of important social movements (Figure 1).

The factors that affect the formation of a square are; building facades, width or perspective of connecting streets, floor coverings, plant texture or plastic elements in the square (Yıldız, 2007; Aykılıç, 2015) (Figure 2). The dimensions of the square must be at human scale. For this purpose, elements such as sculpture, monuments and fountains are used in the square (Figure 3).

Figure 1. Symbol squares Red Square and Trafalgar Square (Wikipedia, 2021b)

Figure 2. Helsinki Piazza del Senato (Original, 2017)

Urban design, which forms the core of urban planning studies, is three-dimensional design studies that aim to add value and character to the urban space on an environmental scale. Urban landscape design, in addition to bringing naturalness to urban life, aims to achieve both functional and visual harmony between structural forms and urban space (Kaplan & Küçükerbaş, 2000).

Figure 3. Use of sculpture in the square (Original, 2017)

Successful design depends on a solution-oriented “design process” that provides insights into the space and can help create optimal combinations. The design process includes three basic stages. The first stage is the “Survey” or collection of data and issues that may affect the design results. The second stage is “Analysis” or an appraisal that will reveal the effects of one factor on another factor. The third stage, called “Synthesis”, is the shaping of the analysis results into comprehensive forms and organizations for solutions (Barış, 2004).

The aim of this study; emphasizing the importance of square design for the city, which is a part of urban landscape design studies, determining the problems in Mürefte Cumhuriyet Square within the scope of the landscape design process and arranging a proposed landscape project for the solution.

2. Material and Method

The material of the study; it constitutes the Cumhuriyet Square with an area of 1174 m² in the Mürefte neighborhood of the Şarköy district of

Tekirdağ (Figure 4). The square is an important focal point of the city with its touristic, social, cultural, commercial and historical background. Located in the south-west of Tekirdağ city center, Şarköy was conquered by Rumelian Fatih Süleyman Pasha in 1356 and while it was initially called Şehirköy, it started to be called Şarköy over time (Şarköy Belediyesi, 2022). The population of the district, which doubles in the summer months, is 33,902 and the population of the Mürefte neighborhood is 2503 (TURKSTAT, 2020). The district, which is famous for its olives, grapes and wine, is the tourism center of Tekirdağ with its natural beauties.

Figure 4. Location and boundaries of the study area

Study was carried out in four main stages as observation, data collection, analysis and evaluation. In the observation phase; the natural landscape features of the study area (vegetation, viewing points, water presence, etc.) were examined in situ and supported by photographs.

During the data collection phase, the site plan of the area, topographic map, 1/1000 scaled implementation development plans, projects, reports, photographs and documents and interviews with the relevant parties were taken into consideration. A proposed landscape design project for the square was prepared by interpreting the data obtained. In the preparation of the landscape design project of the area the landscape design process was discussed in 6 stages (Küçükerbaş & Özkan, 1994; Özkan et al., 1993; Yılmaz & Yılmaz, 1999; Barış, 2004; Şişman et al. 2008).

The project was arranged taking into account the landscape design process;

- ✓ Identifying goals and problems
- ✓ Survey and literature studies
- ✓ Environmental analysis, program analysis and functional diagram
- ✓ Bubble diagram
- ✓ Preliminary project
- ✓ Application projects.

3. Findings and Discussion

For the preparation of the landscape design project, the landscape design process specified in the method was taken into account. For this purpose, the following steps were carried out in order.

3.1. Identifying Goals and Problems

The initiation of a design work on landscaping depends on the subject and the existence of the demand. In these studies, the subject often appears as a problem and the design process turns into an action to solve this problem (Özkan et al., 1993). The aim of the study is to determine the problems in Mürefte Cumhuriyet Square within the scope of the landscape design process and to arranging a proposed landscape project for its solution.

Problems in the field;

- ✓ the square is not functional
- ✓ misuse of urban furniture
- ✓ the existing floor covering is not functional and aesthetic
- ✓ too much hard floor
- ✓ lack of green space
- ✓ lack of aesthetic concern of the railing and lighting elements on the dock
- ✓ the location of Atatürk monument is wrong
- ✓ the monument is surrounded by a railing
- ✓ all urban furniture is devoid of aesthetic concern

3.2. Data Collection to Determine the Exiting Situation (Survey)

This stage of design consists of researching the restrictions and requirements of the project. The architect analyzes current features in the location, such as existing walkways, buildings and utilities. They also consider environmental factors such as climates, micro-climates, moisture retention, existing plants and soil structure. They infer areas rather than focus on specific calculations and details (Figure 5).

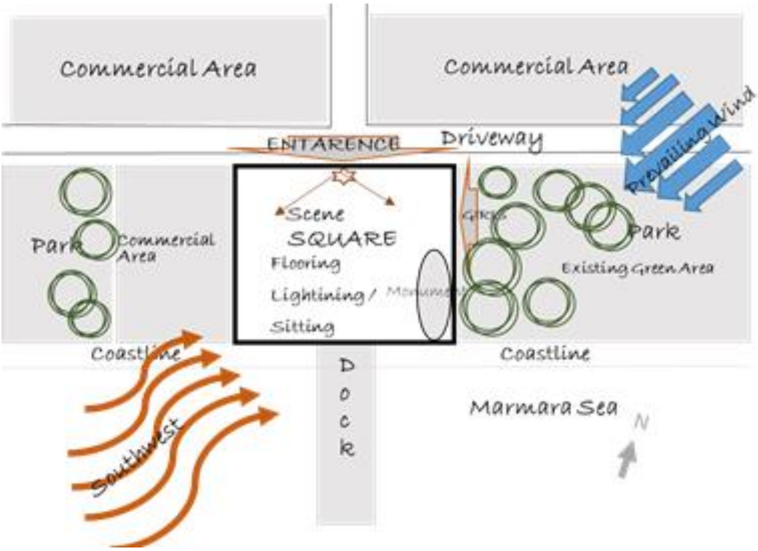

Figure 5. Survey diagram (Original, 2021)

The square is located on the seafront and parallel to the sea (Figure 6). Considering the natural factors affecting user comfort, the area is under the influence of the southwestern wind. The annual average temperature of the region is 14.1 °C and the annual average precipitation is 690 mm. The highest amount of precipitation occurs in December with 111 mm. The area is flat and the elevation is +1.00 meters. There is no plant element in the area. However, there are existing parking areas to the east and west of the area.

Figure 6. Relation of pier and square (Original, 2021)

In the square, there is the Atatürk Monument, which is surrounded by aluminum railings (Figure 7).

Figure 7. Atatürk monument (Original, 2021)

Interlocking concrete paving blocks was used as the floor. Urban furniture includes lighting elements, wooden benches, flowerpots and trash cans (Figure 8).

Figure 8. Urban furniture (Original, 2021)

The criteria that the square should have are gathered under three main headings and the sub- criteria determined depending on these and the current situation are summarized in Table 1.

3.3. Environmental Analysis, Program Analysis and Functional Diagram

As the data about the field is collected, ideas about the design begin to form (Barış, 2004). A relationship diagram is created in which the designer conveys his thoughts on how to bring the uses together in the plan and how they can be related to a circulation.

Table 1. Evaluation criteria of Cumhuriyet Square (Prepared according to Bağış, 2010; İnceoğlu & Aytuğ, 2009)

Main Criteria	***Sub-Criteria***	***Current Situation***
Sociocultural elements	Variety of activities	The square serves mainly pedestrians.
	Service for purpose	Ceremony and meeting area
Physical elements	Accessibility	The square is easily accessible from different parts of the city.
	Spatial closure	The square is surrounded by a park, the road is surrounded by 5-6-storey buildings parallel to this road and the sea.
	Ratio/ Scale	The square is appropriate in terms of proportion and scale.
	Pedestrian circulation	There is pedestrian circulation
Aesthetic elements	Floor coverings Plat material	Existing flooring is available No plant material
	Seating units	Seating units is available
	Lighting	Lighting is available
	Artistic objects	Atatürk Sculpture
	Water element	Seashore

At this stage, in the design process of Cumhuriyet Square; as a result of the field studies and the analysis of the data obtained, the following uses are included in order to solve the existing problems:

- ✓ Atatürk monument and ceremony area
- ✓ sitting areas,

- ✓ green spaces,
- ✓ urban furniture,
- ✓ pedestrian circulation
- ✓ dock

A “program analysis” was made by grouping the elements in the created requirement program according to their functions and a “functional diagram (relationship diagram)” was prepared in line with this analysis (Figure 9).

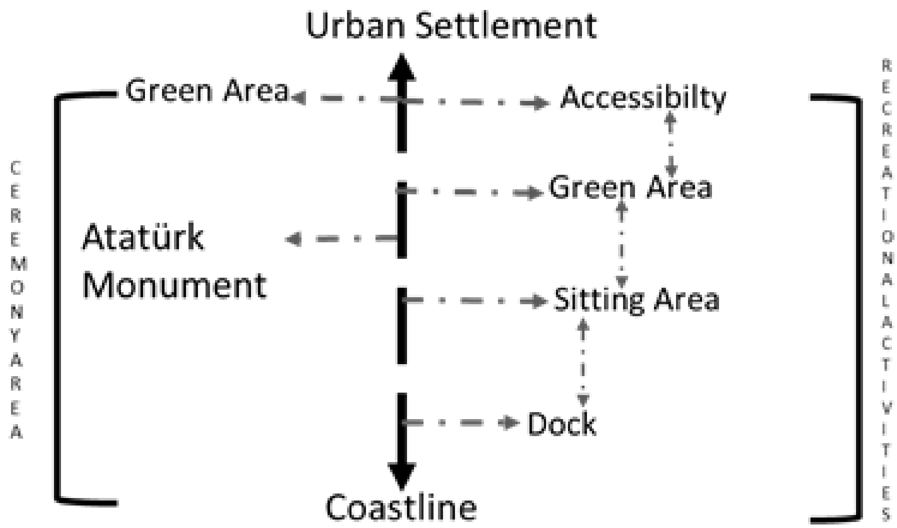

Figure 9. Functional diagram (Original, 2021)

3.4. Bubble Diagram

Evaluation phase in design studies; It aims to eliminate an infinite number of options depending on the determined principles in order to reach a conclusion. During this elimination, different results emerge, which vary according to the designer. The ideas in the bubble diagram are not mature yet (Özkan et al., 1993). A stain diagram was created by placing the program elements in the function diagram in the appropriate places without scale, taking into account their relationship with each other and proportion (Figure 10).

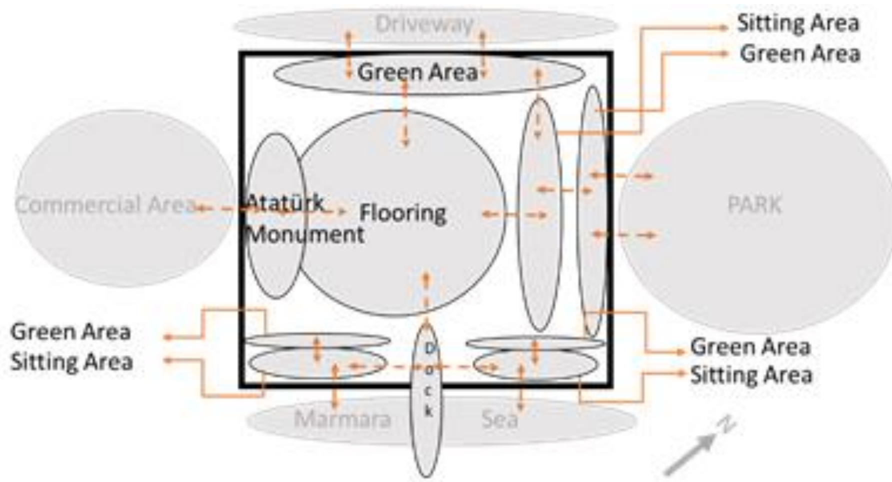

Figure 10. Bubble diagram (Original, 2021)

3.5. Preliminary Project

The preliminary project is the first official and intermediate solution of the design (Seçkin et al., 2011). "Preliminary Project", which means a draft or preliminary project for the area, was prepared by transferring and shaping the uses shown as spots in the stain diagram to scale on the project. Accessibility, functionality and compliance with the aesthetic criteria were discussed in the proposed design study for the area and suggestions were developed in this direction**.**

✓ In the design of the square, floor coverings should be used considering their directing, limiting and complementary effects. One of the features that give a sense of space is the shape of the square floor, that is, the shape of the floor and the characteristics of the buildings in or around it (Aykılıç, 2015). By changing the existing floor covering, a different color and textured material was proposed to limit the square (Figure 11).

Figure 11. Preliminary project (Original, 2021)

✓ In order to reduce the hard ground effect, afforestation was made between the northern vehicle road and the square and plant beds were proposed (Figure 12).

Figure 12. Proposed plants (Original, 2021)

✓ Architectural and artistic elements such as monuments, statues and obelisks in the square represent the common culture, history and values of the city (Aykılıç, 2015). The sculpture has been preserved in the square. However, its location has been changed. It is located on the west side, which is more suitable in terms of direction and location and tall flagpoles are proposed in order to break off its visual relationship with the building behind it (Figure 13).

✓ At the intersection of the dock and the square, a transition area was created with a wooden arkad in order to increase the perception of the entrance (Figure 14).

Figure 13. New location of Atatürk sculpture (Original, 2021)

Figure 14. Arkad that connects with the dock (Original, 2021)

✓ Urban furnishings such as seating elements, waste bin and lighting elements are placed in accordance with their function (Figure 15).

Figure 15. Furniture use (Original, 2021)

✓ Ramp design have been made in order to ensure the use of the square for disabled and cyclists (Figure 16).

Figure 16. Ramp design for the square (Original, 2021)

4. Conclusion and Suggestions

As a result; a proposed landscape design project has been prepared for Cumhuriyet Square, which is located at the focal point of the city in the Mürefte neighborhood of Şarköy district, which is one of the important tourism centers of Tekirdağ. The area is used intensively with the increasing population especially in the summer months. Considering the problems in the square, suggestions have been developed for their solution. With this proposed project; It has been tried to create a more livable environment for the citizens by giving a character to the place. An accessible space has been created by connecting the area with its surroundings. The functionality of the area has been increased with the urban furniture used in the square. Structural elements are used in harmony with each other. Thus, the area has gained aesthetic value. In addition, with the use of plant elements in the area, the space has been brought to life and the effect of hard structural elements has been softened.

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Author Contribution and Conflict of Interest Declaration Information

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The Effects of Biodiversity on Landscape Perception and Preference in Urban Green Areas

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1. Introduction

The content and context of the concept of landscape differ within the framework of the perspective and specialization of the person who deals with the concept. The most accepted definition of landscape is made in the European Landscape Convention (Council of Europe, 2000). According to this convention, landscape means “an area, as perceived by humans, whose character is the result of the action and interaction of natural and/or human elements” (Council of Europe, 2000).

Since the 1960s, there has been an increase in research on landscape perception and preference, and the topic has grown to include several techniques and theoretical foundations (Lindberg, 2012).

Depending on the theoretical underpinning of each study, landscape perception and preference research is split into four categories: psychological, cognitive, experiential, and expert techniques. Additionally, Lothian (1999) divided these paradigms into two rival groups: the subjectivist and the objectivist paradigms (Lothian, 1999).

The subjectivist paradigm comprises the psychophysical, cognitive/psychological, and experiential/phenomenological clusters, whereas the objectivist paradigm includes the specialized, ecological, and formal aesthetic clusters (Lothian, 1999).

2. Landscape Perception Theories

2.1. Objectivist (Physical) Paradigm

The objectivist or physical paradigm can be summarized as seeing beauty before your eyes in a physical scene. Beauty is a distinctive quality of landscape (Lothian, 1999).

The objectivist paradigm, according to Lothian (1999), considers landscape quality to be "inherent in the physical landscape". This is a viewpoint that philosophers of aesthetics have long held, and it is a characteristic of the landscape that ought to have an equal impact on everyone. According to Lothian (1999), the paradigm is not at all objective because, among other things, it frequently depends on review by just one or a small number of people and cannot be replicated.

According to Zube et al. (1982), this paradigm is known as the expert method and can be further broken down into the categories of formal aesthetics and ecological aesthetics.

Subjectivism has been proven to be more useful and appropriate for landscape preference research than the objectivist paradigm (Lindberg, 2017).

2.1.1. Expert approaches

This includes the assessment of landscape quality by skilled and trained observers. In the expert approach, it is assumed that trained professionals can objectively analyze natural beauty and translate landscape features into formulas that can be used in design (Zube et al., 1982).

2.1.1.1. Formal aesthetics

It is based on design theories and attempts to define the landscape using the concepts and terms of philosophy and art criticism. Formal aesthetics provides a language for describing landscape aesthetic qualities, mainly in relation to design, and is fundamentally linked to design theory, aesthetic philosophy, and art (Ode, 2003).

It defines visual landscape features and their interrelationships and makes this information usable in design, planning and evaluation (Lindberg, 2012).

Instead of trying to create a landscape that everyone likes, the formal aesthetic approach to landscape design aims to produce one that seems natural (Lucas, 1991; Lindberg, 2012).

It can be assumed that the physical components of our world can be broken down into four basic unit types: volume, plane, line, and point, in order to visualize this method. These units can be combined to describe any scene or item. These fundamental components, according to Lucas (1991), include quantity, position, direction, size, shape, texture, color, visual strength, etc. Depending on the factors, it shows up in many ways. Form has been acknowledged as the most important factor influencing how all compositions seem visually (Lucas, 1991; Lindberg, 2012).

2.1.1.2. Ecological aesthetics

It was developed by Nassauer (1992) and based on the assumption that having knowledge about the ecological functions of the landscape can affect the preferences related to the landscape, the theory mentions that the knowledge about the landscape can be an important driver of the choice (Tveit et al., 2015; Oktay, 2017).

It is assumed that acceptance and even preference for "scattered" natural environments with high ecological value will increase with knowledge of ecological function.

Ecological aesthetics argues that an ecologically healthy landscape will be preferred by interpreting landscape preferences ethically (Tveit et al., 2006).

This theory views landscape preferences from an ethical perspective (Nassauer, 1992). In addition, it adds a new dimension to the concept of landscape ecology. However, according to this theory, if a landscape is ecologically healthy, then that landscape is preferable (Zaleskienė & Vileniske, 2014; Oktay, 2017).

According to ecological aesthetic theory, if the general public has access to the correct information, they will accept landscape change and recognize healthy ecosystems. However, some authors contend that altering how we interact with and shape the landscape is more important than educating the public about ecological concepts (Lindberg, 2012).

2.1.1.3. Care and protection

According to Nassauer (1995), the main issue is that biologically relevant locations aren't always aesthetically acceptable to (modern) humans, who frequently perceive such areas as "messy". This is due to the fact that the concept of nature is extremely culturally coloured, which causes scenic traditions to be blended with "ecological quality". People typically think of picturesque nature as a landscape that is well-kept, such as one that has been freed of overgrowth, marshes, and dead trees.

In order to both develop and retain ecological function and the human love of aesthetics, landscape ecology and design must frame actual ecological purpose with culturally acceptable manifestations of nature.

The key to striking this balance is to offer "care recommendations", or information or behaviors that show human activity and management yet do not impair or lower ecological quality (Nassauer, 1995).

2.2. Subjectivist (Psychological) Paradigm

This concept of landscape beauty is "a product of the imagination, the sight of the beholder", according to Lothian (1999). The subjectivist paradigm judges beauty from the interpretation of the mind behind the eyes. The paradigm includes psychophysical, cognitive and experiential approaches.

Preference is ultimately a personal and individual experience that can be changed by several elements, which is a prerequisite for them all (Lothian, 1999).

2.2.1. Experiential/phenomenological approach

It focuses on the subject's personal interpretations of the landscape experience. Therefore, it is the most subjective model (Tveit et al. 2015; Oktay, 2017).

Since this strategy seems to be the least common in choice research and theory, there isn't much literature on it. Landscape values "are shaped in the interactive process and should be founded on the experience of human-landscape interaction", according to Zube et al., (1982). Ode (2003) asserts that the experimental approach may not be generally applicable since it has a lesser connection to its visual features than the psychophysical and cognitive approaches.

This method concentrates on aspects of everyday experiences including familiarity, social space, and landscape style because the observer is also a participant (Lindberg, 2012).

2.2.2. Psychophysical approach

It is an approach that considers both the physical characteristics of the landscape and the user preferences. In this respect, it is in a position between the subjective approach and the objective approach (Tveit et al. 2015; Oktay, 2017).

The experimental psychophysical technique aims to identify people's actual preferred landscape characteristics (Ode, 2003).

It is based on correlating the physical features that can be measured in the landscape with the user preferences for the landscape. In this respect, the number of trees in the landscape, the ratio of bare soil cover per unit area, the percentage distribution of colors, etc. landscape features are calculated and regression models are established between the preference scores of the users for the same landscape, and analyzes are applied that show how much of people's preferences can be explained by these measurable physical relations of the landscape (Oktay, 2017).

This method has been mostly used in Scandinavian nations to perform choice studies, which have helped, for instance, to inform management suggestions for recreational forest areas (Lindberg, 2012).

2.2.3. Cognitive/psychological approach

It is an approach that focuses on the user's experience rather than the features of the landscape. In this respect, it has a subjective point of view (Tveit et al. 2015; Oktay, 2017).

With this method, the scenes are categorized based on their content and spatial layout. Consequently, common preferences for several categories might be found (Kaplan & Kaplan, 1989).

In particular, categorization is one of the prominent methods of this approach (Oktay, 2017).

This perspective holds that accurate interpretation of the information we gather from our surroundings has become a must for survival. Similar to the psychological strategy, the cognitive strategy heavily relies on visual cues (Ode, 2003). However, the cognitive approach theory does not end there. The preference matrix presented by Kaplan & Kaplan (1989) has been very influential in explaining preferences.

2.2.3.1. Preference matrix

The environmental information that must be understood and how easily it may be gathered forms the basis of the preference matrix. The capacity to comprehend and make sense of one's environment is subjective and is influenced by prior experiences. In contrast, our need to explore motivates us to learn more about our surroundings, which improves our ability to comprehend foreign environments and to infer deeper meanings from everyday events (Kaplan & Kaplan, 1989).

There are two types of information extraction (usability): information that is currently available and information that is extracted (predicted)

(Kaplan & Kaplan, 1989). Consistency, complexity, legibility, and mystery were the four notions that developed when the categories of information demands and information availability were united.

2.3. Psycho-evolutionary Theories

An important tenet in psycho-evolutionary theory is the recognition that the function and adaptability of any particular aspect of human activity cannot be understood in terms of the activity's current role, but rather its former function in the Pleistocene epoch, when modern humans evolved (Ruso et al., 2003).

2.3.1. Emotional response

According to Ulrich et al. (1991), interaction with natural content instantly and subconsciously sets off human emotional responses to nature. Many emotions, including fear, rage, and grief, are allegedly evoked in this manner. Therefore, preference for aesthetics is just one of many subconscious emotions. The individual's reaction can vary depending on the circumstances, from stress to healing. Simply put, after a stressful period, natural settings that are suited for supporting human existence should have an immediate noticeable positive effect on people's wellbeing.

2.3.2. Dominating the view-sheltered space theory

The theory developed by Appleton (1975) is based on the role of ancient humans as being both hunter and prey in nature (Lindberg, 2012). In this context, people must not be seen in order not to be hunted, but must see in order to hunt. The theory argues that modern humans instinctively prefer certain landscapes because ancient humans lived under these conditions (Appleton, 1975; Lindberg, 2012).

Appleton (1975) argues that the existence of both prospect and refuge areas in a landscape provides an advantage for primitive human communities, and therefore, according to this theory, the landscape preferences of today's people reflect this historical situation.

Hudson makes the well-known argument for Appleton's hypothesis that rather than the act of hunting and hiding from dangerous creatures, what gives us such an aesthetic disposition may be the requirement for protection from the weather, a safe spot for socializing, and an overview for planning purposes (Lindberg, 2012).

2.3.3. Habitat theory

The definition given in the book "The Experience of Landscape", in which Appleton (1975) describes the Prospect-Refuge theory that all findings show that the aesthetic satisfaction experienced while watching the landscape; evoking connotations of environmental conditions signaling survival, whatever the actual situation; He proposes that it comes from the unconscious (spontaneous) perception of landscape features such as forms, colors, spatial arrangement and other visible features. He call this proposition the “habitat theory.” is in the form (Appleton, 1975).

Many of our current emotions and behavioral responses to environmental forms can be thought of as evolutionary remnants that initially helped us seek good habitat locations (Ruso et al., 2003).

2.3.4. Savanna hypothesis

Orians (1986) stated the first to propose that humans have a predilection for savanna-like settings. According to this savanna hypothesis, early human development revealed an innate predilection for open areas with numerous, huge trees. These settings offered them food, shelter, and a prevailing perspective (Lindberg, 2012).

Savanna landscapes provide our ancestors with openings to view the landscape and have an easily climbable vegetation that allows them to easily escape and hide from a potential threat (Lothian, 2017; Oktay, 2017).

Many evolutionary biologists agree that the West African savannas are the regions where humanity underwent its early stages of evolution and first began walking on two legs (Buss, 2008; Oktay, 2017). This may be the reason why savanna-like landscapes are preferred more than other landscapes. This clarifies a situation that has long puzzled researchers. Regardless of where they live, the landscapes that people create decisively in many parks and home gardens can be an indicator of their innate savanna predisposition (Baling & Falk, 1982; Oktay, 2017).

3. Urban Green Space Perception and Preference

In the literature, preference studies for urban green space are less common than those for forests and other natural/green environments. Urban green spaces differ in terms of density, scale, the impact of water, etc. since they can be thought of as quotations from or representations of natural or produced ecosystems (Tuğluer & Çakır, 2019). Many of the findings from research on general preferences that have been conducted in relation to urban green space should also apply to urban green space. Parks and gardens, however, differ from natural settings since they can have highly ornamental patterns and several man-made components. This distinction is also influenced by how close the urban green space is to its users and by its particular recreational uses. However, it should be highlighted that the samples were taken from a wide range of diverse situations and locations, and that cultural variations may lessen the geographic generality of these findings. It may also be challenging to generalize landscape perception and preference findings across all populations because many studies study disparities between social groupings (Lindberg, 2012).

The influence of green space design and vegetation structure, as well as the impact of prior biological knowledge on landscape preference, may now be used to describe how people perceive and value urban green space (Lindberg, 2012).

3.1. The Effect of Green Area Design and Vegetation on Landscape Preference

Existing vegetation in an urban setting will significantly affect how people see the outdoors. Once more, it is obvious that the design aesthetic and plant pattern of the urban green area have a significant role in the selection and utilization of these spaces (Tuğluer & Çakır, 2021). Landscapes that imitate savanna environments, have open ground surfaces, and have a scattering of trees are the most favored.

Bjerke et al. (2006) discovered that a moderately dense (enclosed) parking lot was favored over a very open or extremely dense parking area when evaluating fitness for recreation based on intensity (although all were considered suitable for recreation). A dense forest also tends to reduce preferences in forest situations (Bjerke et al., 2006; Lindberg, 2012).

Different age groups can assess intensity or level of management in different ways. Young people seem to prefer natural, dense, and secretive woodlands more than adults and kids do. Additionally, it has been discovered that plant density has an impact on one's sense of security. As the plant density increases, the perception of security decreases (Lindberg, 2012).

Özgüner & Kendle (2006) conducted a study comparing public preference between intensive care and natural parks in England, determined that both design regimes have unique and different values.

A formal design was not only more serene and tranquil, better experienced in terms of stress reduction and regeneration, and had a beneficial impact on one's sense of security. Another intriguing discovery was that when compared to the developed urban landscape, individuals perceived any green space as natural and they were also able to discern naturalism from the formal utilization of plants (Özgüner & Kendle, 2006).

Homeowners liked this style of formal design if and only if the majority of their neighbors' front yards had such designs, according to another Detroit study on suburban homeowners' attitudes about front yard designs using native plants and nature-inspired plantings. He emphasized that views on designs that promote biodiversity support "what the neighbors desire" rather than broader cultural norms in this case (Nassauer & Wang, 2009).

As previously said, green spaces seem to have a calming and helpful impact on people's stress levels. A statistically significant correlation between perceived restorative properties and aesthetic choice also appears to exist. Lindberg (2012) stated to appreciate situations that make us feel better, or we feel better by staying in environments we love, may be one of the two roots of this association.

In another study to be given as an example to this subject, there may be habitat selection among vertebrates, which tends to prefer environments where species thrive (Lindberg, 2012).

3.2. The Effect of Previous Ecological Knowledge on Landscape Preference

People's preferences for certain environmental or landscape elements might be influenced by their prior knowledge or information supplied to them during the interview, according to a number of research on the topic (albeit primarily on forest preferences); The majority of current psychology research on people's preferences for landscapes is based on a 'rational' model that emphasizes making sense-based decisions. According to this strategy, preferences need to be significantly influenced by ecological knowledge. For instance, those who are more knowledgeable about ecosystems should favor settings that are environmentally viable (Tyrväinen et al., 2003; Lindberg, 2012).

For instance, it's commonly accepted that people love different landscapes less when dead or fallen trees are present. However, the authors discovered that people appreciate dead or fallen trees more when they are aware of the ecological benefits of doing so (Lindberg, 2012).

According to Gundersen & Frivold (2011), the physical impairment it causes or the seeming lack of care it exhibits may be the cause of people's general dissatisfaction with the dead or fallen tree. Studies have revealed that the general public dislikes dead or fallen trees. Even if there was unhappiness among the populace, those who understood ecology demonstrated that they were not upset by this existence and were aware of how it contributed to the destruction and rebirth of the world and the cycles of life.

3.3. Evaluation of Green Space Preferences

There are various examples of how various forms of urban green spaces affect biodiversity, as well as the physical environment in general, people's perceptions of and preferences for green space in particular, and so on. If we review the data we have so far and provide a brief overview;

- Dead wood is often unwelcome in any environment.
- In general, people will dislike vegetation that is difficult to access and extensive undergrowth.
- Litter, intrusive human interference, damage, or poor upkeep will not be well received by the general public.

- However, because they cannot perceive care in natural environments, people will not generally enjoy well-kept areas.
- People tend to choose visually expansive green areas with scatted trees that resemble savannahs.
- People will generally respond to contextual rather than spatial layouts, at least in wooded contexts.
- In general, people will be more vulnerable to evident human influence in settings that appear natural.
- Areas with a high species diversity will be easier for ecologists, landscape architects, and other specialists to pinpoint.

Compared to the general population, professionals in the fields of ecology, such as landscape architects and ecologists, will be more accepting of or supportive of maintenance techniques that support biodiversity (Lindberg, 2012).

3.4. The Effects of Biodiversity on User Perception and Preference in Urban Green Spaces

3.4.1. Case study I: Ramlösa Brunnspark, Sweden

The study was carried out at Ramlösa Brunnspark, which is situated in the southern portion of Helsinborg, a city on Sweden's southwest coast (Lindberg, 2012). Utilizing an on-site study method, the research was conducted with users.

The study area was divided into regions and sub-regions and a 1.6 km long track was created passing through these regions. Each 25 m section of the course is numbered from 1 to 65. These sections are designated as photo shooting points (Lindberg, 2012).

After the research area was established, the biodiversity of various regions was assessed, and areas with higher and lower biodiversity within the overall, continuous green area were found. Then, the regions received their allotted degrees of species diversity.

In the study, which was carried out with the participation of 67 people, 2 user groups were formed. Preference group and perceived species richness group. Later, these groups were divided among themselves as expert and non-expert groups and the study was started with a total of 4 groups consisting of 14-22 people.

International and Swedish postgraduate students from Alnarp University of Agricultural Sciences who were enrolled in a specialized course on vegetation design and dynamics, landscape ecology, and related topics at the time comprised the expert groups. Local campuses in Helsingborg and Lund, along with a few foreigners, created non-specialist groups.

A guided tour of the pre-formed trail, which was marked with a numbered tag every 25 meters, served as the basis for the research approach. Each participant was told to snap a total of 10 photos and write a brief commentary next to each one while making notes on the images.

The participant in the preference groups was told to shoot five photos of the elements he liked (items, situations, or occurrences) and five images of the things he hated during the course of the park stroll.

Perceived species richness groups were instructed to take five photographs of places or objects they believed to represent high species richness and five photographs they believed to represent low species richness.

Following the taking of the photos and the posting of the remarks, questions about ecology were posed to the users in an effort to gauge and test their prior knowledge of ecology.

The study's findings:

-Both professionals and non-experts should be capable of recognizing differences in habitat quality within an urban green area. The main indices of species richness were vegetation and landscape features. In photo interpretations, some discrepancies between specialists and non-experts were discovered.

- The study also revealed that people's perceptions of urban green space in general are strongly influenced by both specific (landscape) aspects and contextual characteristics. The perception of habitat quality appears to be significantly influenced by the presence or nature of vegetation, whereas human characteristics or indications of human activity affect preference. The study also provided examples of human constructions that were deemed to blend in well with the park setting, despite the fact that the infrastructure's layout and design seem particularly vulnerable to unfavorable perceptions. This finding emphasizes how crucial it is to plan and implement human interventions in recreational spaces.

- The study's findings also revealed that people's preferences for a location were not positively correlated with their knowledge of or perception of its species richness. The study's findings actually show a bad association between measured biodiversity and preference.

3.4.2. Case study II: Sheffield Botanic Garden Park and Endcliffe Park, England

The investigation was conducted in Sheffield, England. The Sheffield Botanical Garden, which serves as an illustration of a formal landscape, and Endcliffe Park, a nearby public park, which serves as an illustration of a typical natural landscape, were chosen as research locations (Özgüner & Kendle, 2006). Sheffield was chosen as the study's ideal location because its residents have a wealth of experience with both formal and scenic style parks.

In order to investigate the impact of landscape styles on public perception and, consequently, desires for urban green space, a comparative research methodology was adopted in this study.

Participants were chosen using a straightforward random selection technique from the regions' entrances or major thoroughfares. At the conclusion of each interview, a random person was chosen to be the first person to visit the park. Participants were chosen from park visitors during the day, both during the week and on the weekends, in order to generate a representative sample. People who were unfamiliar with both study regions and consequently unable to compare them because of the comparative nature of the questionnaire were excluded from the study. At the study locations, 200 park visitors (100 from each region) participated in a face-to-face survey. Participants were invited to draw similarities and were asked questions regarding both places.

Three stages of the preferences for landscape styles were investigated. First, participants chose their favorite aspects from a list of "natural" and "formal" landscape features from each of the two study regions. Second, the participants were presented with a number of suggested modifications to the "formal" and "naturalistic" styles for the study regions and asked to select which modifications they would want to see in the study regions. Finally, participants were questioned about their preferences for study regions, different outdoor places, and various landscape types to determine whether their consciously expressed preferences were connected to specific landscape styles. Before being asked about the values of the work areas and the potential benefits they received in the work areas, the participants were asked directly which region they preferred and the rationale for their selection in as to prevent any potential consequences.

Results of the study:

- In the setting of two urban green spaces in Sheffield, England, this study investigated public views and preferences of urban natural landscapes vs a more formal design of green open spaces. The findings showed that people can distinguish between more explicitly designed landscapes and more naturalistic landscapes, and they can get both identical and different benefits from either.

- According to the study, some people might benefit more from natural landscape designs than from formal, well-maintained ones. People have discovered, for instance, that Endcliffe Park, a natural setting, allows them to better experience a sense of naturalness and freedom. There was a more conducive setting for socializing than a formal landscape.

- However, the study also showed that "formal nature" offers benefits of its own. The study found that certain of nature's advantages are more appropriately connected to "formal" landscape settings than "natural" ones.

-People, for instance, felt safer in an official landscape setting (Botanical Garden). For urban residents, formal landscapes can be valuable and advantageous.

-Landscape specialists frequently prefer the complexity of little candid images produced by nature to the more straightforward structures and lines of man-made creations. However, switching to naturalistic forms shouldn't imply ignoring other kinds that the public values, therefore decision-makers in charge of planning and managing urban green spaces should take this aspect into consideration.

4. Conclusion and Suggestions

This article's goal is to outline the conceptual or theoretical paradigms used in research up to this point and to evaluate the benefits and drawbacks of each paradigm's contribution to theories of landscape perception and planning.

It is challenging to evaluate the overall impact of a sizable body of work on the significance of current landscape interactions and their effects on people's quality of life and well-being.

Our findings demonstrate that just providing green space misses the fact that those spaces can vary significantly in terms of their contribution to biodiversity and human health. This area's quality can make it useful for a variety of things, including boosting biodiversity, offering ecosystem services, fostering possibilities for natural contact, and enhancing psychological well-being.

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Plant Material Use in Urban Landscape Design: The Major Problems and Potential Solutions

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1. Introduction

Urban areas are built environments equipped with hard surfaces, isolated from nature, with a growing population increase. Cities, which are shaped by their own natural and cultural resources in each region, offer many public services. Green spaces, which are one of those public services, provide an environment for urban ecosystems and also a ground for a range of social and cultural activities for urban society. Atıl et al. (2005) defined the term ‘city’ as “a city is a cultural ecosystem consisting of living things living in a certain area and constantly interacting with each other, and their inanimate environments as a whole”. Man-made ecosystems in cities can be improved and upgraded thanks to technology. If this variable structure is not well planned, they can cause various problems by sometimes adding additional loads to the natural structure. Because each region has its own unique resources and a design character should be created in accordance with them. Thus, a sustainable and aesthetically pleasing green environment should be designed, constructed, and maintainied in cities for the health of urban dwellers. For this reason, all decisions and applications in the processes of selecting, designing, using and maintaining the plant materials that form make up the green areas require a special topic of interest. Sarı & Karaşah (2018) emphasized that a sustainable relationship between humans and nature should be established to design such an environment in cities. Besides, such an approach can contribute to the aesthetic, functional and ecologically sustainability of urban landscapes. In fact, the main goal of landscape architecture studies is to regulate the relations between human and nature and to use plant material in functional and aesthetic designs for this purpose (Erduran Nemutlu & Çelik Çanga, 2021). Within this context, one of the major goals of Landscape Architecture profession is to design and ensure a well-balanced relationship between humans and nature by using functionally and aesthetically suitable plant materials and relevant species.

Accordingly, the purpose of this study is to evaluate the major problems implemented in landscape planting design as well as to explore potential solutions.

1.1. Planting Design in Urban Green Spaces

Urban outdoor spaces are spaces open to the use of all ages, genders and occupational groups, where all the activities of public life, unlike private life, continue (Bakan & Konuk, 1987). Green areas, which are an important element of outdoor spaces, form the character of cities, provide a livable environment for urban dwellers, and contribute to the mental and physical health of society (Çelik, 2012a).

Urban green spaces consist of green areas, parks, playgrounds, recreation areas, road trees, public space gardens belonging to public and private institutions, and residential gardens, each of which has different uses (Erduran Nemutlu, 2013).

Basically, widespread, effective and successful plant design throughout the city provides multi-faceted contributions to the citizens and investors. Every planting is an investment. However, this investment requires time, which is even more valuable, as well as labor and money. Because woody plants, especially trees and shrubs, are generally slow-growing perennials and can achieve the functions expected from them in many years.

The fact that the city has an effective green system and planting design increases the land prices and makes it a center of attraction. Because the city becomes a healthier and more comfortable living space. In addition, the urban area has many different uses and planting design should be made conducted according to the functions of those areas. Just like the functions of a hospital garden and the functions of playing grounds.

1.2. The Major Functions of Plant Materials in Urban Landscapes

Plants improve the environment, protect and support nature (Scarfone, 2007). In urban areas, softening the hard lines of the structural elements, increasing the visual quality and creating a fund are the most important functions (Robinson, 1992). Thus, plants integrate the city with nature and bring it closer to humans. They realize these features only in a certain period of time and give the landscape the fourth dimension, time (Erduran Nemutlu, 2012). At the same time, plants control foot traffic, prepare an environment for different scientific studies and research, create recreational potential, relieve people from the pressures of daily life and create the opportunity to meet with nature (Eroğlu et al., 2005; Çelik & Yazgan, 2007; Karaşah

& Var, 2012; Çelik, 2012b). To be able to fulfill these, they must be well designed. Because the landscape planting designs created function with each other and in combination with inanimate materials according to their usage situations. We can briefly summarize these functions as follows: Plants define the space by strengthening the structural lines of the city and increase the perception of space. They carry the two-dimensional lines on the ground into the third dimension and are effective in the organization of the spaces. Properly made plant designs take on ecological, climatic, engineering, architectural, aesthetic and socio-cultural functions and can maintain this for many years.

1.3. Sustainable Landscape Planting Design

From the point of a landscape designer, we can define sustainability at the urban level as follow: Sustainability is not exceeding the carrying capacity of global ecosystems despite the increase in the quality of life of societies (Oktay, 2001). If we adapt this to the planting design, the desired function and aesthetic appearance with the composition can be obtained in the same way during the maturity period of plants.

Booth (1990) states that the sustainability of a landscape is possible when the use of planting design criteria (harmony and contrast, balance, emphasis, sequence and diversity) are in harmony with each other (Bekçi et al., 2013; Sarı & Karaşah, 2018). According to Çelik Çanga (2021a), the most important in sustainable landscape architecture studies are; to benefit and apply the opportunities offered by natural plants. These plants, which are part of the natural balance, have very important ecological functions in terms of repairing ecosystems, creating and ensuring the continuity of habitats.

With the provision of sustainable planting design in urban landscapes, the urban ecosystems can be preserved and used in future. The sustainability of cities also increases the life quality of citizes by providing solutions to environmental problems. Thus, it is possible to create livable cities today and in future. For this, interprofessional studies should be carried out, and the human-nature-economy triangle should be established with urban landscape designs (Atıl et. al., 2005).

2. Material and Method

The main materials of the study are the plant materials used in urban landscape architecture designs. As a method, literature review was conducted, and landscape architecture practices in Turkey were examined. The experiences gained in the past years was also used in the study. In addition, the information obtained as a result of the studies related to planting design was brought together and the problems were determined. As a result, it has been suggested to use a report card in which the characteristics of the plants can be compared by making use of visual icons in a chart prepared. With this method, it is aimed to make more accurate plant selection according to the characteristics of each region.

3. Findings and Discussion

Design solves problems, brings innovation and carries aesthetic concern. In this direction, first of all, the functions of planting design are determined. Then, the most suitable composition and the plant species to be used in this composition are determined. It is also very important that the design creates an aesthetic effect.

3.1. Mistakes and Precautions in the Design of Landscape Plants

When it comes to plant design in any region, it is necessary to consider many factors together to determine the correct species to be selected. For this reason, it should not be forgotten that landscape architecture studies should be very comprehensive. Considering that the plant kingdom is very wide, detailed studies should be carried out, knowledge should be acquired and connections should be established with different professional disciplines. In addition, one of the most important problems of today is the creation of the urban green system without complying with scientific data and design principles, and insufficient care is taken in the selection of plant materials. We can briefly list the most common mistakes made in planting design studies as follows:

3.1.1. Lack of individual approach

The first and most important mistake of designers is that they do not design individually for each project and client. According to Starke & Simonds (2013), this problem can be caused by the fact that the landscape designer, who is a professional, has a wide background and creates a monotonous, mechanical working style over time. However, each project is unique and its character should be different. In fact, the designer also develops himself by learning different things from each project. Which style will be used in herbal design depends on the concept and idea decided to express it with the design. Like the difference between the elegant, subtle plant design of the Porsche Pavilion and the naturalistic plant design of the Royal Bank of Canada's London Wetland Center (Starke & Simonds, 2013).

3.1.2. Ignoring the universal principles of design

The basic design principles; unity (balance, harmony, color, scale and proportion, symmetry-asymmetry, diversity, rhythm, similarity, contrast and emphasis) should not be ignored in herbal design works. If the final version of the design is considered in three dimensions at the beginning, this error will not occur. It is necessary to be inspired by the practices of designers who are successful in the design process, and the preliminary research part should not be neglected. In this direction, first a list of design principles is prepared and plants are added and removed until the most suitable design is obtained. At this stage, the natural vegetation and climatic conditions of the region should also be taken into account. At the same time, plantings made in cities without considering design principles create afforestation areas. It can cause different problems such as the formation of a closed area more than necessary, excessive shade, incompatibility with the structural elements, closing other plants, not being aesthetic, damaging the infrastructure and culturally invading the new area to be created. In fact, the fact that these areas become neglected and uncontrolled green areas makes it easier for them to turn into areas that can be used for criminal purposes and for bad purposes.

3.1.3. Recon without the design features, size and area ratio of plants

The most important design features of plants are size, form, texture and color. In planting designs, different senses and perceptions can be activated by using a wide variety of plants with different colors, shapes, sizes, textures and scents (Çelik Çanga, 2021b). The size of the plant directly affects the dimensions of a space, the interestingness of the design and the whole skeleton of the design. Size is the most striking feature, as people react to the outward appearance of plants as a first reaction (Booth, 1990; Erduran Nemutlu, 2014). Therefore, roads, boulevards, squares, etc. It is necessary to establish the space-measure relationship well in the vegetative designs of the areas (Var, 1997). The person who observes a successful design in terms of scale freely without getting lost in the space and feels comfortable (Karaşah & Var, 2012).

According to the genetic characteristics of each plant, the design elements are different and have different effects. In addition, the plant type should be selected by taking into account the dimensions of the working area, the emotions and perceptions to be created. Otherwise, the plants will not be perceived well. Of course, the plant species used in a small private garden and a city park should not be the same. Because if the species that will develop in accordance with the size of the area is not selected, the plants will grow unevenly, cover the area more than necessary, hang over the adjacent structures, and a very closed and dangerous area will be created. In order to prevent this problem, it is necessary to show with drawings how the plants will change and grow from the beginning of the design process to the final state. Hand drawings or different digital programs that make it easier to do this can be used. These images should be prepared according to all seasons, and the texture and color characteristics of the plants should be added to this.

3.1.4. Not having enough command of the characters of the plants

How plants will develop over time and their characteristics should be well known. Because in this way, it can be understood how it will look in the future in the field of design. If the designer knows the following features of the plant well, he/she can make a healthy and aesthetic design that will satisfy the user: What height and crown width it will reach, branch and stem characteristics, when and how long it will flower, leaf and fruits characteristics or important for human health whether there are any harms (Starke & Simonds, 2013). Although this information can be obtained from different publications, in order for the designer to use this information, he or she must observe the plants throughout the year, examine them together with different species and calculate the planting intervals, and follow the nurseries produced. Because many different compositions can be created from plant species according to their changing images every season. These compositions should be able to fulfill the functions that users need.

3.1.5. Using little or no planting at all by area

A large grass area can be preferred due to its visual effect. However, it should not be forgotten that maintenance is expensive, consumes a lot of water, and requires time and effort. This situation should be explained to users and customers with sufficient convincing and scientific facts and they should be enlightened about the functions of woody plants. Different plants or alternatives can be used as ground covers.

3.1.6. Ignoring the time dimension of design

The biggest mistake of designers is to create short-term solutions. Of course, the design should have an impact at the time it was made. However, the long-term results of the project and its sustainability should be well calculated from the beginning. The best way to achieve this is to give priority to species belonging to families from the region's vegetation cover, which are easily adaptable to the area and require low maintenance. Thus, effective and aesthetically sustainable herbal designs can be obtained for many years.

Landscape plants to be used in open and green areas should make the environment high quality and should have an ecological approach in order to integrate it with the ecosystem (Çelik et al., 2017). In other words, it should be chosen from the species found in the flora of the region. Because plants that are foreign to the region, which we call exotic species, can be used to add interestingness and effect to designs. However, they should be chosen well and should not take up too much space. Otherwise, they may invade the biodiversity of the region and cause the deterioration of the food sources that the wildlife is accustomed to over time.

3.1.7. Using the same vegetation list for each project

Some experienced designers always use plants they are used to. Sometimes a designer cannot give up any plant like a collector. These practices drag the designer into a vicious circle or reduce the quality of his design. However, plant design is unlimited. It should constantly produce new designs and try to create more attractive compositions. In addition, in the designs to be made, the needs of the citizens, the function of the area and the function and aesthetic of the design plants to be created should be handled one by one and the plant should be selected accordingly.

3.1.8. Ignoring the characteristics of plants according to the seasons

Designers often imagine the design taking into account the period when plants are most effective. However, not all plants bloom at the same time of a year and have different visual effects at different times. What determines the talent of the designer is which plants she/he designs by bringing together and the garden has an aesthetic appearance in all seasons. This is the important professional perspective that distinguishes a landscape architect from other professional design groups. For this reason, designing alternatives should be created by creating diagrams for each season. Flowers blooming in spring, beginning, middle or end of summer, fruits forming in summer or autumn, colors formed by leaves in autumn, rustling of leaves, evergreen plants in winter or carigraphic effect of branches in winter should be taken into account one by one.

Space design with plants begins with the positioning of trees: Trees, with their trunks and leafy masses, form the main lines and spatial closure of the planting design. Then, small trees, shrubs, climbing-climbers and ground cover plants are included in the design.

3.1.9. Continually and enough failure to take care of plants

Continuous maintenance should be implemented to achive the sustainable landscape design. In order to avoid problems during the maintenance, some precautions should be taken during the landscape planting design. Such as not planting trees too close to structures, paying attention to road elevations and leveling curves when determining the planting point, giving planting intervals in a way that will not prevent pruning, not planting broad-leaved trees too close to conifers. Another precaution is to group the trees with shrubs surrounding their trunks to prevent damage to the trees when mowing the lawn. In addition, in order to organize the plant layers better, a sequence should be made in the form of trees first, then small trees, shrubs, ground weavers and flowers, and their distances should be taken into account.

3.1.10. Not using the right plants in the right places

Each plant can grow well in different climatic conditions. If the light and humidity conditions required by the plants are suitable, all their genetic characteristics will emerge (flowers, fruits, etc.) and their aesthetic effects will be fully visible. In order not to choose the wrong plant, the ecological conditions of the region should be discovered before hand. In addition, plants can create different effects depending on the nature and function of the place where they are used. For example, if the design used to emphasize the road on both sides in vehicle road vegetation is used in the same way on a park road, which is a walking road, it can narrow the perspective by preventing the wide view of the road's surroundings.

4. Conclusion

While planting design, first of all, the sunshine status of the study area, location of the site, surrounding vegetation, structural elements, climatic data of the region, water possibility should be evaluated well with field studies. In addition to the analysis of these features together, the designer must first know the plants very well and follow the innovations well in order to the plant designs to be accurate and sustainable. Because the diversity in cultural species is very high and new species and varieties are constantly being added. Their characteristics should be examined comparatively in detail, and the most suitable species should be preferred according to the field studies. Considering the design to be created by combining these genres, it is clear that many combinations will occur. For this reason, morphological features such as leaves, flowers, fruits, stems and their ecological demands should be well known. In order to compare these individual qualities, a report card stated in Figure 1. has been prepared as an example. In this report card, the characteristics of different plants are expressed together, visually, and perception becomes easier. The synthesis of these evaluations constitutes the decision-making process, the most suitable for the purpose and the most effective species can be selected. In addition, the external appearance of the plants, in which the most effective images are reflected, should also be drawn. While these features add quality to the city in terms of aesthetics, they also balance the emptiness of the city. In addition, since it is desired to ensure success in their use with structural elements and to maintain the desired effect for many years, with this report card, the designer can well predict the effect of time, called the fourth dimension, in the designs to be formed. At the same time, the designer must successfully construct the relationship between the elements he uses and the five senses throughout the design process, and design solutions that appeal to all five senses must be created.

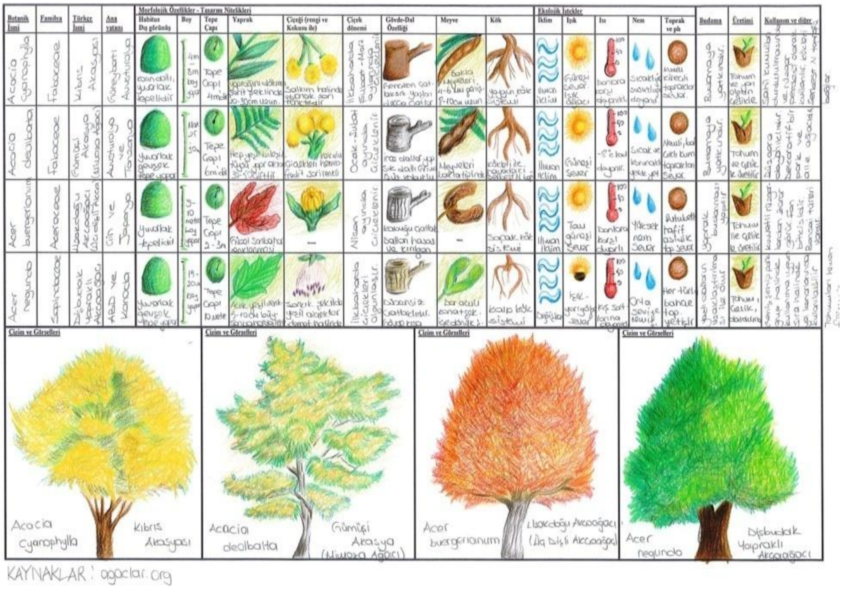

Figure 1. Definition of designing plants

Positioning the plants in different ways in herbal compositions shapes their relations with each other and the resulting design effects. Likewise, different individuals of the same species in the compositions or differences in the size and form characteristics of different species also affect the creation of design principles (Kösa & Aksöğüt, 2020). Kösa (2019) emphasizes that while the provision of plant design principles is possible with the use of only one of the design elements, it can also be achieved by the use of several of them together. Therefore, these should be taken into account as well as plant characteristics.

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Urban Lawn Management for Improving Ecosystem Services of Turfgrasses

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1. Introduction

Recent years have seen a fast increase in the global area covered by turfgrasses, which has continued to dominate ecosystems that are becoming more urbanized. Today, the aesthetic and environmental problems that come to the fore with rapid urbanization increase the importance of green areas even more (Konakoğlu & Bekar, 2021). Space is a purposeful construct that is the expression of a limitation and an artificial change that man performs in the natural environment. Urban spaces are the leading areas where people make this artificial change (Akten & Akoğlu, 2017). It is well known that the presence of green spaces in urban spaces, which are one of the important components of cities and where people interact both with themselves and with their environment (Bekar et al., 2021), contributes significantly to the quality of urban life (Akoğlu & Akten, 2022). People's lives have benefited from urban green areas for the preservation of ecosystems throughout history and even today (Tuğluer 2021; Tuğluer & Ekren 2022). Due to the fact that cities are the center of economic and social developments, rapidly increasing urbanization movements increase the population density in cities (Metin, 2022). The increasing growth of metropolitan areas around the world causes more people to live in urban areas than rural areas (Crane & Kinzig, 2005). This trend is likely to continue for a number of reasons, such as the fact that employment and incomes are frequently easier to come by in cities and that regions with dense populations need less land for food production (Johnson, 2013). The requirement for green spaces where recreational activities can be carried out increases along with the urban population growth (Gezer & Gül, 2009; Çorbacı & Ekren, 2021). Urban green spaces constitute an important part of the urban ecosystem, and they have many benefits to nature, environment and life cycle. These benefits are providing many ecosystem services such as supporting biodiversity, sequestering carbon and providing oxygen, regulating urban microclimate, contributing to the aesthetic appearance of cities, contributing both physically and psychologically to those living in the city (Gezer & Gül, 2009; Akkurt & Akten, 2021; Kökdoğan & Dönmez, 2021). Green areas, which provide a more livable and lively appearance in the areas where they are used, provide the opportunity to meet with nature by getting rid of the pressure of daily life on people (Bekar & Çakır, 2022). The advantages of turfgrass are becoming more obvious as the need for green space in densely populated metropolitan areas keeps rising. Recreational spaces offer intangible benefits that are frequently underappreciated and neglected. Turfgrass is the plant community that is most frequently found in cities. Turfgrasses, a significant part of both urban and rural landscapes, are used in parks, gardens, sports fields, airports, cemeteries, and other areas to improve people's quality of life (Beard, 1989; Kırteke & Oğuz, 2022). In a symbiotic interaction with the soil and wildlife, turfgrasses offer a uniform appearance. Particularly in places that are often utilized by people for recreation and sports, they are crucial in the creation of a uniform and long-lasting green spaces. Turfgrass makes up 50–70% of all urban green spaces and is the most prevalent type of vegetation worldwide (Ignatieva & Hedblom, 2018) At least 50% of German cities, including Leipzig, have public park lawns (Haase & Nuissl, 2007). Similarly, 50% of urban green spaces in Sweden are made up of lawns (Hedblom et al., 2017). Surprisingly, Chinese cities are today among the biggest users of turfgrass, and in the USA, turfgrass surfaces dominate urban and suburban landscapes and account for over 2% of the nation's terrestrial area (Thompson & Kao-Kniffin, 2017). In Australia, the total area covered by turf makes up 11% on average of the total area of the cities (Cumming, 2018). Turfgrass has been an essential part of environmental protection for many years, long before contemporary civilizations began to consider it a major national and global issue. The turfgrass species that are currently in use have been cultured for more than ten centuries to improve the environment and quality of life. They have evolved during the past 50 million years. For both urban and rural communities, managed green spaces like golf courses, athletic fields, landscaped recreation areas, and public parks all offer valuable social, cultural, environmental, and economic resources. According to Beard and Green, the benefits of turfgrass can be broken down into functional, recreational, and aesthetic categories (1994). Green spaces serve a number of purposes, including providing worthwhile open spaces for recreation, enhancing people's health and quality of life, and, with careful planning and management, enhancing biodiversity and advancing environmental protection aims (Strandberg et al., 2012). These changes improve the city's quality of life, which directly benefits residents' physical and emotional well-being (Jim & Chen, 2006).

This study's objective is to accumulate evidence regarding the ecosystem services provided by turf. The relationship between urban lawn management and ecosystem services, as well as the ecosystem services provided by lawns, were assessed for this purpose. The objective is to portray the current situation based on what is thought to be the best evidence, not to give a systematic or exhaustive assessment of a wide variety of subjects. This study discusses what urban lawns are, what they offer to people, the inputs required for managing lawns, and the chances for cultural upkeep. The difficulties and possibilities for promoting and achieving sustainable turf management are described in this document.

2. Material and Method

A keyword search of the literature on urban lawn management was conducted. Only academic and peer-reviewed literature was used for the research. Keywords that are specifically relevant to particular ecosystem functions and advantages of turfgrass are used. ‘Turfgrass’, ‘grass’, ‘grassland’, ‘lawn’, ‘lawn use’, ‘urban temperature’, ‘carbon’, ‘air quality’, ‘soil quality’, ‘water quality’, ‘pollution’, ‘infiltration’, ‘runoff’, ‘aesthetics’, ‘recreational’, ‘economic’, ‘functional’, and ‘maintenance’ are some of the keywords mentioned. Articles, including literature reviews, were chosen because they contained hypotheses about the subjects presented that was based on empirical research or well-accepted models.

3. Findings

3.1. Ecosystem Services

Urban regions need more green space as a result of fast population expansion and dense populations. In the middle ages, lawns, which are particularly created ecosystems, first appeared in Europe (Ignatieva, 2017). They are made to provide various ecological services. In comparison to other agricultural crop systems, turfgrass performs a wide range of services in urban landscapes and has very different requirements and expectations. A community of grass known as "turfgrass" is a nearby ground cover that endures regular mowing and traffic (Beard, 1973; Turgeon, 2008). A managed, artificially created plant community with turfgrass as its dominant species is referred to as a "lawn" and is intended to provide a variety of ecosystem services (Thompson & Kao-Kniffin, 2017). The turfgrass community as well as the top layer of soil, along with roots and other subsurface plant elements, are all included in the definition of "turf" (Johnson, 2013). This term is used to describe plants that have the potential to develop into sod that can be kept at a height and density suitable for their intended usage. This concept mostly refers to grassy landscapes that are aesthetically pleasing and still function as functional groundcover while seeing a substantial level of foot traffic. Groffman et al. (2009) describe urban lawns as adaptable to semi-regular mowing, and may get fertilization, irrigation, and management for aesthetic or recreational value. Ecosystems of what are referred to as "urban turfgrass" are perennial turfgrasses that are cultivated and managed by people for esthetic, recreational, or functional reasons (Groffman et al., 2009; Thompson & Kao-Kniffin, 2017; Türker, & Gül, 2018). With this description, a variety of land uses, geographical scales, and links are made, from sports fields or golf courses to front lawns or roadside vegetation. The term "urban turf" refers to a variety of management densities, including high-quality sporting fields and meticulously maintained golf courses, as well as residential, commercial, institutional, and park lawns or playgrounds and roads that are not regularly fertilized, irrigated or mowed (Thompson & Kao-Kniffin, 2017). A minor percentage of turf consists of carefully maintained golf courses and sporting fields used for competitive play that use fertilizers, irrigation, pesticides, and intense cultivation techniques. The majority of lawn landscapes do, however, have a vast and widespread network of patches that include public and private lawns, playgrounds, parks, and strips of grass along sidewalks, roads, electrical utility routes, and less protected railroads (Turgeon, 2005; Puhalla et al., 2010; Christians et al., 2016).

An ecosystem is a system that is created when living and non-living objects coexist and each creature forms relationships that are mutually supportive and interdependent (Çepel, 1992). Researchers and decision-makers have grown more interested in assessing the link between people and the natural world during the past two decades as a result of the development of better data gathering and analytical technology (Charap et al., 2020). Ecosystems are both open and self-contained systems. Ecosystem functions are the physical and chemical processes that come from the life-sustaining actions of organisms. Ecosystem products and services are resources that are obtained as a result of this process and function. Ecological services are defined as beneficial resources gained both directly and indirectly through ecosystem functions (Costanza et al., 1997). The United Nations codified the conceptual framework of this interaction, known as ecosystem services, in the Millennium Ecosystems Assessment Report, which was published at the beginning of the twenty-first century. The anthropocentric concept of ecosystem services contends that the natural world meets people's needs in quantifiable ways by creating raw materials, maintaining natural systems through chemical processes, regulating climate and ecosystem health, and offering advantages to culture (Charap et al., 2020).

The benefits of ecosystem services to people are examined in four groups: provisioning, regulating, cultural and supportive services (Millennium Ecosystem Assessment, 2005). Services that can be utilized directly by individuals are provisioning services. Regulating services are benefits derived from processes in nature. Cultural services include intangible services, and supportive services include processes that are natural in nature. The ecosystem service potential of a place refers to the ecosystem goods and services that are created in that region but are not immediately utilized (for instance, the growth of grass on a grassland area but not yet devoured by animals). These services create an ecosystem service flow from nature to society when they are actively utilized, such as when the grass is gathered for animals (Colinvaux, 1986; Qian & Follett, 2002; Hector et al., 2002; Milesi et al., 2005; Millennium Ecosystem Assessment, 2005; Pouyat et al., 2009; Raciti et al., 2011).

Urban lawns are turfgrass-dominated landscapes that serve a number of purposes and are common in regions that are experiencing urbanization and population growth. Despite the fact that these landscapes are thought to largely serve aesthetic purposes, they actually perform a variety of beneficial ecological services that impermeable surfaces do not (Thompson & Kao-Kniffin, 2019). Recent studies in Europe and the United States found that people's appreciation of turfgrass is correlated with the critical role that turfgrass plays in landscapes (Poskus & Poskiene, 2015; Ignatieva, 2017; Rall et al., 2017; Ignatieva, 2018; Ignatieva & Hedblom, 2018; Stolz & Schaffer, 2018; Pisa, 2019; Ramer et al., 2019). Short-cut turf is linked to greater personal safety and quality of life. Although there is water scarcity and drought around the world, turfgrasses are chosen because of their uniformly green appearance and are thought to be the primary means of raising the quality of life in emerging nations (Elgizawy, 2016). Turfgrass areas are commonly used for a variety of activities including quiet rest (such as reading, talking, and walking), sports, games, and picnics. Today, green areas are glorified as a worldwide cultural standard, and their aesthetic role in the urban environment is prominent. However, green areas have a favorable impact on people's physical and mental wellbeing (Trudgill, 2010; Ignatieva, 2017; Daniels et al., 2018). The world's warming has begun to escalate into a significant worldwide issue. Green areas currently serve as an essential eco-balancer in urban settings. Some of the functional benefits of well-managed turfgrass are rainwater retention and drainage, groundwater recharge, flood control, protection against soil erosion, dust prevention/stabilization, soil remediation, soil restoration, enhanced retention and biodegradation of synthetic organic compounds, cooling effect, oxygen production, carbon dioxide sequestration, improved heat dissipation, noise abatement, glare reduction, flow reduction, regulating the water cycle, removing water from sediments and pollutants, preventing visual pollution, reducing harmful and allergic pollen, providing habitat for urban faune species, reducing heat island effect, creating microclimatic effects, air filtration, providing traffic safety on the roadside, reducing the fire hazard through fire barriers, providing security by providing high visibility zones, etc. (D’Ottavio et al., 2018). A few of the recreational benefits include a low-cost surface for outdoor sports and leisure activities; increased player physical health; and a particular low-cost cushion against personal impact injuries. Just a few of the aesthetic advantages include improved beauty and attractiveness; a supportive relationship with the entire landscape ecosystem of flowers, shrubs, and trees; improved mental health with a positive therapeutic impact; social harmony and stability; increased work productivity; and an overall higher quality of life, particularly in densely populated urban areas. In addition, lawns improve people's mental and physical health by offering an appropriate setting for social activities and other forms of enjoyment (Ulrich, 1984; Beard & Green, 1994; Maller et al., 2002; Pretty et al., 2007; Türker, & Gül, 2018; Gökçek & Dönmez, 2020). The provision of public recreation spaces is one of the well-known ecological services provided by lawns. Ecosystem services, as described by Shackleton et al. (2016), are "functions, processes, and qualities provided by the ecosystem that have perceived or unfavorable effects on human well-being." According to Dunn (2010), Döhren & Haase (2015), Lyytimaki (2015), and Campagne et al. (2018), hazardous pathogens, pests, and parasites are examples of ecological traits that have negative effects on health, society, or the economy. All the ecosystem benefits offered by other vegetation types are provided by well managed green spaces. Conversely, when lawn maintenance procedures are insufficient or incorrect, they have a negative and expensive influence on the environment and their contribution to the community (Monteiro, 2017). High temperatures, heavy traffic, and other factors can harm green spaces and diminish their aesthetic value. In addition, extensive use of pesticides and herbicides pollutes the soil and water. Ecosystem services are effectively provided by human activities and environmental forces outside of human control. Some ecosystem services can start out positively before going wrong. Recreational places, for instance, are one of the fundamental ecosystem services provided by green spaces, but when the incorrect turfgrass species is chosen, when there are too many users and heavy traffic, the homogenous appearance is lost, gaps appear, and it becomes hazardous for users.

The way the grass is used affects how it interacts with the environment. In a 2009 study, Townsend-Small & Czimzik (2009) looked at the nitrogen content and carbon sequestration in ornamental grasses and sports grounds. Soil cores were collected on a regular basis to measure the levels of organic carbon and nitrogen in the soil. This athletic lawn has a lower value for carbon sequestration due to frequent mowing, and lawn grass has been observed to emit more N2O due to higher fertilizer frequency. Due to the minimal upkeep required, ornamental grass sequesters more carbon.

3.1.1. Moderation of urban temperature extremes

Through evapotranspiration, reflection, and shadowing, plants reduce ambient temperatures. On the other hand, plant canopies, such as those found in shelter beds or windbreaks, can reduce cold temperatures by blocking radiation from escaping into the atmosphere and by preventing cold air from mixing with warmer air. In urban squares, trees have been proven to lower temperatures by an average of 1.9 °C, making them the best vegetation type for reducing high temperatures (Brom et al., 2009;

Wu et al., 2007). "Mown meadows" have the highest surface temperatures of the plant species studied (Brom et al., 2009), but in urban settings, the presence of turfgrass (compared to the absence of vegetation) has been shown to reduce temperature peaks in the middle of the day by about 1 °C (Wu et al., 2007). Furthermore, maximum surface temperatures for green-growing turfgrass (31 °C) are well known to be significantly lower than those for brown-summer-dormant turfgrass (52 °C), bare soil (39 °C), or synthetic artificial turf (70 °C) (Beard & Green 1994). Yaghoobian et al. (2010) simulated the thermal effects of natural and artificial turf and discovered that natural turf is by far the coldest surface (roughly 20°C less than artificial turf at noon) and that artificial turf can raise the air temperature by 4 °C compared to irrigated grass. However, they ultimately came to the conclusion that natural turf landscapes use more energy than artificial turf due to the embodied energy of irrigation water.

3.1.2. Oxygen production

During photosynthesis, carbon dioxide is converted into oxygen in plants. Therefore, photosynthesis, also known as net primary production in ecological studies, is positively related to the creation of oxygen. Photosynthesis is influenced by a variety of elements, such as irradiance, plant species, water, and nutrient availability. Given that grasslands are typically located in arid or semi-arid locations in both China and the rest of the world, Gao & Liu's (2008) calculation that grasslands are the plant type in China with the lowest annual net primary output makes sense. Using the net production of the world's biomes as an estimate for urban contexts could be deceptive because it refers to different climates. According to Wang et al. (2010), the most oxygen was created by the shrub (middle) succession stages, and the most recent grassland phases were more productive than the forest stages (2010). Wu & Bauer (2012) discovered that golf course grass had a higher yearly net primary production (1,100 g C m^{-2}) than average lawn grass using a remote sensing-based model (771 g C m^{-2}).

3.1.3. Carbon sequestration

A biome ultimately uses the biomass already present in the system to store carbon. According to Wang et al. (2010), the greatest above-ground biomass was present during the shrub and forest succession periods (2010). The biomass in the grassland stages was much lower than it was in the other stages. Wang et al. (2010) did not measure subsurface biomass, despite the fact that it is well-recognized to be important in lawns. When carbon sequestration in several shrubs and herbaceous landscape types was studied by Whittinghill et al. (2014), a Kentucky bluegrass lawn had the maximum below-ground carbon content (kg m^{-2}). Because of human management techniques like irrigation, fertilizer, and mowing, turfgrass that is managed also experiences significantly different carbon cycling than turfgrass that is found in natural habitats (Zhang et al., 2013). Although research on turfgrass landscapes suggests there is significant potential for C sequestration, especially belowground, C cycling in urban environments is yet little measured (Pouyat et al., 2002; Zhang et al., 2013). Turfgrass landscapes often have higher soil carbon stocks than agricultural systems and may even reach levels seen in native forests (Raciti et al., 2011). When the disturbance is kept to a minimum, there is enough water (natural or irrigated), and fertilization promotes soil organic matter growth, carbon storage may be significant in turfgrass systems. Of samples obtained from six US cities and Moscow, Russia, soils on a golf course in New York City were found to have the highest soil organic C (SOC) density (28.5 kg m^{-2}) (Pouyat et al., 2002). In the greens and fairways of golf courses, soil organic C was shown to rise at a rate of 0.1 kg m^{-2} yr^{-1} during a 25- to 30-year period (Qian & Follett, 2002).

Sequestration of carbon by turfgrasses was regarded as beneficial, with carbon accumulating in the soil (Townsend-Small & Czimczik, 2010; Zirkle et al., 2011; Selhorst & Lal, 2013; Huyler et al., 2014; Kong et al., 2014). According to several authors and models, it can take anywhere between 66 and 199 years for a standard-managed US home turf to attain equilibrium. When working with turfgrasses from Hong Kong (Japan), Kong et al. (2014) indicate 5 to 24 years. Applications that decrease the organic matter of the soil, such as those used on some sports grounds, can diminish or eliminate this beneficial effect (Townsend-Small & Czimczik, 2010). The most accurate projections made an account for the necessity of leaving clippings in the turf to decompose in order to increase plant development without excessive nitrogen (N) fertilization (Selhorst & Lal, 2013). Turfgrass clipping recycling, or letting the clippings degrade, has a low carbon sequestration efficiency since the majority of the carbon in the clippings is breathed out into the atmosphere.

Urban landscapes may sequester more carbon if their urban grasslands are more diverse. There is strong evidence to support the idea that the abundance of plant species enhances an ecosystem's ability to use and transform absorbed resources into plant biomass (Cadotte et al., 2008; Cardinale et al., 2011, 2007; Hooper et al., 2005). The accumulation of aboveground biomass is not always indicative of the sequestration of carbon because soil stocks hold more than 70% of the terrestrial carbon (Catovsky et al., 2002). This is especially crucial in turfgrass systems since routine mowing reduces aboveground biomass. Increased assemblage diversity could boost belowground production and C compound deposition in urban grasslands, potentially resulting in higher SOC accumulation rates. However, further study in turfgrass systems is required to test this theory.

3.1.4. Pollution decrease, improving air, water and soil quality

According to Wood et al. (2006) and Terzaghi et al. (2013), plants can reduce the amount of particulate matter in suspension and remove contaminants from the air (Lohr & Pearson-Mims, 1996; Zhu et al., 2015). The relative contribution of turfgrass to the removal of air pollutants should be investigated further in comparison to other vegetation types. According to Zhu et al. (2015), who looked at different vegetation types (including sagebrush, cut grass, steppe grass, and no vegetation), thick long grass exhibited the greatest reduction in fine particle matter.

According to Barthès & Roose (2002), runoff and soil erosion are adversely associated with the stable macroaggregate content (> 0.2 mm) in the topsoil. According to Bronikk & Lal (2005), adding lawns enhances soil aggregates by increasing soil carbon content, and herbaceous vegetation is more effective than trees at enhancing aggregate stability (Fattet et al., 2011). Additionally, turf offers a staggeringly high shoot density, and resistance to water flow, reduces velocity, enables more time for penetration, and minimizes erosion strength, according to Beard & Green (1994).

The type of soil has a significant impact on water infiltration (high on sandy soils and low on clay soils). Effects of vegetation include: A site in Australia with vegetated patches has a ten times larger capacity for infiltration than bare ground, according to Dunkerley (2002). The rate of water penetration is increased by increasing soil organic carbon and increasing soil stratification (higher carbon levels at lower depths) (Franzluebbers, 2002). The same region (soil and climate) with 1145 mm of mean annual rainfall is where Thompson et al. (2010) give water infiltration statistics for a grass field with 11.77 mm h^{-1}, a pine plantation with 5.3 mm h^{-1}, and an 80–100-year-old hardwood site with 14.4 mm h^{-1}. Although no statistically significant difference in infiltration could be shown between the three vegetation types, the turf field exhibited reasonable infiltration rates. Plant roots can also contribute to the physical stabilization of the soil by forming many channels in the soil and enhancing infiltration rates. Increased infiltration rates may not always be advantageous on steep slopes, increasing the risk of shallow landslides (Ghestem et al., 2011). Similarly, trees are not always a good choice for stabilizing slopes because their weight might cause the slope to become unstable (Genet et al., 2010).

3.1.5. Reduction of noise pollution

Cook & Van Haverbeke (1971) looked at the influence of trees on noise reduction and discovered a considerable noise reduction depending on the type of surface available: noise reduction is better when trees are paired with grass-covered surfaces instead of concrete, gravel, or crushed rock (pavement, gravel, or crushed rock). The majority of more recent research simply compares turf surfaces with different plant species and demonstrates no differences or increased noise attenuation (Kragh, 1981; Huddart, 1991). As there are so many different turf pitches, there are also many different types of vegetation to work with. According to Onuu (2006), tall grass in Nigeria attenuates excessive noise better than non-intense woodland. After reviewing several natural solutions to minimize traffic noise, Van Renterghem et al. (2015) determined that low-flow resistance grasslands (i.e., tall grass or grass) bordering a road provide acceptable noise reduction.

3.1.6. Providing wildlife habitat

Invertebrates maintained by the grass ecosystem include insects, ants, mites, nematodes, earthworms, and spiders, which are crucial components of the food web, according to Beard & Green (1994). However, closely mowed turfgrasses eliminate some pesky critters (including snakes, rats, mosquitoes, ticks, and diseases they can spread) while providing copious new growth (which some herbivores greatly appreciate) (Beard & Green, 1994). Pollen and seed are two food items that don't offer shelter or places for animals to procreate. The variety and amount of food and shelter will undoubtedly grow if trees and bushes are added to the landscape, as already occurs in a number of contexts, and/or if certain unmowed areas (or a few years of mowing) are permitted.

3.1.7. Lower risk of important fires

Mown grass considerably lowers the risk of fire due to its low above-ground biomass (Beard & Green, 1994). Although dry grass burns swiftly and does not easily spread to other materials that are more difficult to ignite, it ignites easily. The risk of fire is far lower on irrigated lawns than on the unirrigated ground. If not largely watered, landscape types with high above-ground biomass levels can raise the danger of catastrophic fires.

3.2. Aesthetical Benefits

The most crucial consideration in choosing a landscape is aesthetics, followed by environmental concerns and other interests (Hayden et al., 2015). Turfgrass serves essential aesthetic purposes in that it serves as a straightforward backdrop for all other landscape aspects and serves as the framework that highlights or emphasizes other features. The ground level is established for the height. It makes the land's contour appear like a fitted garment. It provides a neat appearance that is prized in many cultures.

3.3. Recreational Benefits

Turfgrass provides space for recreation. It's essential to have some good turf on playgrounds for certain sports. Sports like golf, baseball, soccer, or American football require an open-field surface that is permeable, non-heated, injury-preventive, and impact-cushioning while still being reasonably priced. Turf supplies this surface. Despite being quite common in some sports fields, synthetic artificial turf can get extremely hot and harm users' health. The effect of irrigation on artificial grass temperature is temporary and does not endure throughout a typical sporting event (McNitt et al., 2007; Serensits et al., 2011). Nothing can match the quality that natural turf provides in a recreation area, and no other plant species can fulfill these needs.

3.4. Economic Benefits

According to Brethour et al. (2007), reduced heating and cooling expenses, increased property prices, lower maintenance costs for outside areas, and side effects like parks, sports facilities, and more tourists all contribute to the economic benefits of vegetation. The reduced heating and cooling costs relate to the moderation of urban temperature extremes. Turfgrass plays a significant role in the aesthetic aspects that vegetation contributes to a property, which is strongly tied to rising property prices. The substrate/vegetation type affects the lower maintenance expenses. Classic, low-maintenance turf is listed as a landscape style that requires a lower annual time input in CMHC's (2000) maintenance work for a variety of landscapes.

3.5. Social/Psychological/Physiological Benefits

The sociological, psychological, and physiological advantages of vegetation include a rise in serenity; a rise in well-being and life satisfaction; a rise in self-esteem and civic pride; a rise in healthier and more cohesive communities; and a fall in stress and illnesses (Beard & Green, 1994; Brethour et al., 2007; Cameron et al., 2012; Metin & Çağlak, 2022; Metin & Gül, 2022). Increased productivity in the workplace and schools; quicker hospital recoveries; horticultural treatment in care facilities and prisons; less crime; and improved safety are just a few of the advantages that have been noted. Although the relative importance of turfgrass has not been defined, these grasses are an essential component of shared landscapes and offer the perfect setting for social activities like games and picnics. Additionally, people believe that "healthy, green landscaping" enhances public safety, lowers crime, and improves the quality of life (Khachatryan et al., 2014). According to sociological and cultural theory, grass can represent money and power or serve as a reflection of the owner's personality; for example, a neglected lawn denotes a negligent owner

(Nassauer, 1993). Due to the popularity of turf and the competition between lawn owners, there may have been some exaggeration regarding lawn maintenance and what to anticipate from a lawn.

4. Conclusion and Suggestions

The study and science of turfgrass management focus on the grasses that are utilized on golf courses, sporting fields, lawn tennis courts, bowling greens, and other high-traffic locations. Effective soil management and plant-water interactions are essential for healthy turf. For a lawn to be successfully maintained, aeration and other soil-related aspects are essential. Additionally, it is crucial to control illnesses and pests. Improved breeding methods and genetic development of turfgrass species are crucial. The large field of turf management includes the creation of seeds and turf, lawns, sports fields, and the installation and management of turf in parks, schools, cemeteries, and golf courses, among other things.

Compared to many other plant species and even many types of grass, turfgrass plants grow in a distinct way. Effectively, leaf growth is forced upward from below. The turfgrass's growing point is often at or just above ground level. It is known as the "crown" component. Low-mowing durability is correlated with crown height above ground. Turf plant stems are typically quite short and bundled into a crown. Additionally, this keeps the plant's growing tips close to the ground. A mat of plant parts and roots that partially covers the soil or lateral growth is the final characteristic that distinguishes turf. Rhizomes, stolons, or tillering are responsible for this lateral growth. The turfgrass can compete with other plants growing in the plant community while also filling up divots in the turf caused by wear and continuing use. This lateral growth enables a thick and durable turf to emerge. Turfgrass plants stand out from all other plants most significantly because of their tolerance for traffic stress and resistance to frequent mowing. The key characteristic of maintaining a lawn is to continuously mow it short. The dense form has a substantial impact on the growth and development of plants due to the reduction in leaf area and, consequently, the ability for photosynthetic activity. This reduces root depth and somewhat restricts root growth. To maximize their ability to photosynthesize, plants respond to mowing and a decrease in leaf area by increasing the number of their shoots. However, in sports turf applications, mowing height can be significantly lower. 12-15mm on soccer fields, golf course tees, and fairways, down as low as 2-3mm on golf course putting greens. Most turf areas are clipped to a height of between 25 and 100 mm (Johnson, 2013).

The issues facing lawn management in the future are numerous and diverse. Conflicts arise at the nexus of land management (including grass management) and the environment as a result of rising demands for natural resources, particularly land, water, and energy, brought on by economic development and population growth, as well as government demands for greater environmental protection. Urban locations, where the bulk of managed turfgrass plants are found, and dry and semi-arid regions, where demands on natural resources are most prominent, are two places where the situation is most dire. The existing scenario will get worse as a result of population expansion, migration, and climate change as there will be more rivalry for resources among various industries like agriculture, urban planning, tourism, and the environment. The difficulty is how turf plants will react to and adjust to growing operational costs for inputs like labor, electricity, and fertilizers (Rodriguez Diaz et al. 2010). Enhancing resource use effectiveness, lowering management costs, and minimizing environmental impact will be crucial to future sustainable lawn management. In this situation, all grass facilities' planning, design, building, and administration must fully take into account the preservation and improvement of ecosystem services (Rodriguez Diaz et al. 2010).

However, the diversity of turfgrass and urban ecology must be taken into account while managing turfgrass regions to maintain the advantages or ecosystem services. It shows a balance between certain services and others (Kareiva et al., 2007). Turfgrass communities have less biodiversity due to management requirements, aesthetic requirements, and functional requirements, but they nonetheless provide many of the same ecosystem services as grassland communities (Kareiva et al., 2007). To balance the use of turfgrass, its advantages, and functions, and the adverse impacts of the management practices necessitates involve a complex decision-making process. Sustainability will be established by finding that equilibrium. Busey & Parker (1992) provided a thorough analysis of the energy requirements for managing turfgrass and saw turfgrass as a resource as opposed to a commodity. Although it's not the sole factor, energy plays a significant role in establishing what is sustainable. As summarized by Kareiva et al. (2007), the balance of some ecosystem services in the urban landscape "will guide human activities to minimize the negative aspects and accentuate the human benefits. A more durable stewardship would manage trade-offs among ecosystem services so that nature and people simultaneously thrive."

It is certain that there will be increasing pressure on turfgrass regions, and at the same time, there will probably be less input available to manage most of those areas. The several facets of sustainability will need to be important considerations in management decisions. In the turfgrass scientific literature, certain management techniques are examined and frequently addressed in terms of sustainability. But because every location, urban landscape, and turfgrass site has different needs, their management doesn't lend itself to a "recipe book"-style or more pre-prepared ways. Instead, managers must have a deep understanding of the ecology of turfgrass communities and sites, which necessitates substantial knowledge of entomology, soil science, plant biology, and other scientific fields. Additionally, crucial is management and communication abilities. However, the capacity to think creatively, troubleshoot issues, and comprehend the effects of every action taken on the grass area is what matters most (Johnson et al., 2013).

All turfgrass managers undoubtedly need knowledge, experience in creating management strategies, and the ability to react to actual problems. Numerous education programs in turfgrass science and associated fields are available in regions including North America, Europe, and Australia as one-year certificates, two-year associate degrees, four-year bachelor's degrees, and graduate degrees. Additionally, managers who have not completed traditional programs can receive a basic education through university-run Extension programs, and those who have can continue their studies. While not all educational programs are based on sustainability, they typically give students the fundamental knowledge of plants and the environment they need.

When the irrigator, in this case, the school custodians, was involved in the decision-making processes, educated, and then given the freedom to make decisions based on their knowledge of the local circumstances, water savings were increased, according to a study of water conservation at public schools in Utah, USA (Kilgren et al., 2010). These concepts and two examples make it clear that sustainable turfgrass management requires more than just applying inputs to turfgrass regions. The effects on the neighborhood environment, those responsible for maintaining the turf, and those who use it must all be taken into account. Turfgrass management won't go in the direction of sustainability unless all of these are integrated (Johnson et al., 2013).

Plant breeding methods or the adoption of native grass species have been popular options to reduce pesticide and fertilizer inputs in turf ecosystems (Simmons et al., 2011). While these strategies are crucial, applying ecological theory to the selection and design of lawn communities may result in additional benefits for lawns. Increased biodiversity in turf systems can be more easily incorporated into optimum management practices with a better awareness of the advantages associated with it.

Professional turf managers face challenges across the board in the turfgrass industry, including adapting to changing consumer needs while maintaining high standards of quality and safety and safeguarding the environment. Priorities for sustainability in lawn maintenance or agronomics should center on the use of the lawn before its appearance. To sustain the amount and quality of open space, effective management techniques must be developed, disseminated, and adopted.

A strong premium is placed on growing healthy grass, preserving the ecosystem, and guaranteeing a toxic-free atmosphere (European Union 2009). The lawn business can play a role in this situation by lowering its reliance on chemical plant protection chemicals. An integrated approach to pest and disease management (IPM) has been introduced by the EU Directive as a means of promoting healthy turf and lowering pesticide usage. IPM is a method of making decisions that employ all suitable methods to create high-quality turf and to reduce pest damage and pesticide use to levels below those that result in economically unacceptable loss or damage. Management in the future needs to be more targeted, efficient, focused, and organized. One option for the future is to register lawn management practices and record those using IPM principles. Sports fields, golf courses, and other locations where management regularly inspects turf areas can all benefit from IPM. The environmental goals outlined in the EU Directive can be met through lawn management by using IPM as a catalyst for pesticide reduction (Strandberg et al., 2010).

Our capacity to coexist with ecosystems and prevent the overuse of natural resources has a significant impact on the state of our global society. More sustainable management techniques must be developed for the benefit of both the natural environment and the cultural landscape in order to stop biodiversity loss and the degradation of ecosystem services (Government Offices of Sweden 2006; Nordic Council of Ministers 2008; European Union 2011).

It is evident that the lawn business faces a variety of regional and global issues that call for coordinated and collaborative solutions supported by sound, applied science. Ecosystem services and biodiversity, integrated pest management, and sustainable use of natural resources are three international and multidisciplinary topic areas that have been recognized. These, taken together, will benefit the industry's economy and environment and raise the caliber of managed turf areas. In order to manufacture turf to a high standard, sustainably use natural resources, and support healthy ecosystems, the turf industry, like other land-based companies, must assume responsibility for sustainable social development. The turfgrass industry produces a number of desirable and beneficial consequences when it assumes responsibility for sustainable development. The treatment of urban wastewater and excess water, increased opportunities for recreation and nature encounters, increased natural and cultural values in the cultivated landscape, increased biodiversity in urban areas, and alternative employment to work in agriculture and forestry are a few examples of this. New information is required in a number of critical areas, as well as organized, effective work on the environment and sustainable development, in order to tackle the difficulties facing the industry. The industry must continue to invest in research and development to support industrial development and progress in order to gain fundamental new knowledge.

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Use of Medicinal and Aromatic Plants in Healing Gardens: The Case of Isparta

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1. Introduction

The terms "medicinal" and "aromatic" plants are often used together. Medicinal and aromatic plants are used in the pharmaceutical industry to prevent diseases, maintain health, or improve diseases (Faydaoğlu & Sürücüoğlu, 2011). While medicinal plants are used in fields such as medicine, complementary therapy, and food supplements; aromatic plants are used in the cosmetics and spice industries to give food a nice smell and taste (Acıbuca & Budak, 2018). In recent years, medicinal and aromatic plants, apart from the areas where they are used, have an important place in landscape architecture, especially in healing gardens, in terms of both being included in landscape designs and increasing their recognition and protection (TAB, 2020).

Pouya et al. (2015) and Vapaa (2002) argue that the function of a healing garden is more related to the reduction of stress and the relaxation effect of the area than to its direct effectiveness in treating a person. Healing gardens, which are a way for people to connect with nature, are also important in terms of ecopcyclogy (Metin & Gül, 2022). Healing gardens serve healthy individuals as well as sick people in order to calm down, rejuvenate, or regain mental and emotional health. In short, healing gardens restore the natural balance of individuals and remove them from stress and other pressures in their daily lives. In this context, the use of healing gardens and medicinal and aromatic plants, in other words, medicinal plants, which have many aspects in common with health and healing gardens, enables people to meet nature in these gardens and to complete the psychological healing process (Arslan et al., 2018).

According to the WHO, there are around 20,000 medicinal plants in the world. However, since some medicinal plants are used locally, an exact number could not be determined. Therefore, it is thought that this number may rise to 75,000. Medicinal plants have gained an important place in our daily lives again, with natural treatment methods creating a considerable agenda in the public. It is estimated that 70% of the medicinal plants used today are collected from nature and 30% are cultivated (TTB, 2020).

There are many plant materials used as food and raw materials in the industrial, medical, chemical, cosmetic, and perfumery fields in Turkey's flora (Karasu & Öztürk 2014; Dönmez, 2016). The vast majority of medicinal and aromatic plants with a wide range of uses are used for the production of medicines and spices (Oran Kalkınma Ajansı, 2015; Sargın et al., 2013, Özderin et al., 2014, Dönmez et al., 2016, Dönmez & Salman, 2017; Dönmez, 2022). Medicinal aromatic plants, which are also used as ornamental plants, are natural materials used in agriculture to combat pesticides. For this reason, the need for medicinal aromatic plants is increasing day by day.

The natural riches of Turkey's flora are unconsciously destroyed for various reasons, and many plant species are facing the danger of extinction day by day due to the lack of measures being taken. Ornamental plants are a sector that increases the quality of life in urban areas and interiors therefore has a direct impact on human health and psychology (Gülgün, 2015; Bekar & Çakır, 2022). Many studies emphasizing the desire of people to be more intertwined with nature and the importance of our natural species have played an important role in the preference of medicinal and aromatic plants today. Natural species are also in an advantageous position compared to other ornamental plants in terms of their economic and ecological demands (Tuğluer, 2019; Tuğluer & Ekren, 2022). Landscape design gardens, which are created in appropriate areas such as health and public institutions and where health- and human-themed medicinal aromatic plants are used in public or private areas, have recently started to take place frequently in our lives frequently (Şakar, 2011).

The main purpose of this study is to shed light on the planting designs to be made by identifying the natural medicinal and aromatic plants grown in Isparta climatic conditions and examining the use of the determined plants in landscape architecture.

2. Material and Method

703 plants naturally distributed in Isparta were evaluated (Bizim Bitkiler, 2020; TUBIVES, 2020). As a result of both biochemical and ethnobotanical studies in the literature, 120 medicinal and aromatic species were included in the study. The plants were evaluated in terms of their use in plant designs in terms of 8 parameters: showy flower, showy leaf, showy fruit, fragrance, using as solitary, using in flower beds, using as live hedge, and suitability for pruning.

An expert survey was conducted in order to determine the weight of the features of the plants in the design. The expert questionnaire was applied to a total of 50 undergraduate (27 participants) and graduate (23 participants) graduates of the landscape architecture department. Within the scope of the questionnaire, the participants were asked to rate the weight of each parameter mentioned above for plant design between 1 and 10. Scoring was made separately for trees, shrubs and ground covers, and flowers. The weight value of each parameter was determined according to the survey results. The weighted average and arithmetic mean of the resulting scores were taken and rounded to whole numbers (Table 1). Plants with a score of 28 or above for trees and shrubs and 26 points or more for shrubs, groundcovers, and flowers are highlighted.

Table 1. Scoring list based on expert survey results

Parameters	Trees	Shrubs, groundcovers and flowers
Showy flower	8	7
Showy leaf	7	7
Showy fruit	6	5
Fragrance	7	7
Using as solitary	7	5
Using in flower beds	7	9
Using as live hedge	7	6
Suitability for prunning	7	5
Total	**56**	**51**

Isparta is located in the Lakes Region, in the north of the Mediterranean Region (Figure 1). The city, which has a surface area of 8,933 km^2, has an average altitude of 1050 m. 68.4% of the province consists of mountains, 16.8% of it is plains, and 14.8% of it is the plateau. The province of Isparta is located in the transition zone between the Mediterranean climate and the continental climate prevailing in Central Anatolia. For this reason, both climatic characteristics are seen within the borders of the province. Isparta province has a semi-arid, less humid climate with cool winters and hot summers. In the southern regions of Isparta, which are close to the Mediterranean, the characteristics of the Mediterranean climate are observed. The summers are hot and dry, and the winters in the city center are warm and rainy compared to the northern parts. As you go to the northeast, continental climate characteristics show themselves. Winters are colder. Northern regions receive less precipitation (Isparta Ktb, 2019).

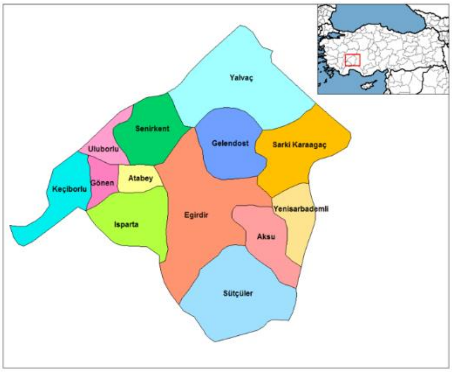

Figure 1. Geographical location of Isparta province

3. Findings

Medicinal and aromatic plants that naturally spread in Isparta province grow in very different ecological conditions, but they are more common in forests, pastures, alpine meadows, and rocky slopes. It is seen that the most prominent species are in the *Lamiaceae* and *Rosaceae* families. *Lamiaceae, Asteraceae,* and *Rosaceae species* are some of the ones that can be used in flower beds, scent gardens, and landscape designs for exhibition and demonstration purposes because they usually have fragrant and showy flowers.

The arithmetic averages of the evaluated planting design parameters were taken according to the expert survey weight score results. Plants with a score of 28 or above for trees and 26 points or more for shrubs, groundcovers, and flowers were determined. In Table 2, 8 trees with 28 points or more came to the fore. In these determined plants, showy leaf, showy fruit, and using as solitary parameters got the highest score. In Table 3, 45 groundcovers and flowers with a score of 26 or above came to the fore. In these plants, the showy flower and fragrance and using as live hedge parameters got the highest score. In the tables given, the species that are considered to be used in landscape design areas are shown in bold.

Table 2. The use of medicinal and aromatic trees growing naturally in Isparta in planting design

Plant species	Potential Use in Landscape Architecture								
Trees	**Showy flower**	**Showy leaf**	**Showy fruit**	**Fragrace**	**Using as solitary**	**Using in flower beds**	**Using as live hedge**	**Suitability for prunning**	**TOTAL SCORE**
Liquidambar orientalis		7	6		7			7	27
Cornus mas	8		6	7	7			7	35
Quercus cerris		7	6		7			7	27
Quercus ithaburensis subsp. *macrolepis*			6		7			7	20
Quercus coccifera			6		7			7	20
Tilia platyphyllos	8	7	6	7	7			7	42
Fraxinus ornus* subsp. *cilicica	8	7		7				7	29
Olea europaea	8	7	6		7		7	7	42
Phillyrea latifolia	8	7		7	7		7		36
Sorbus torminalis				7					7
Populus alba		7			7			7	21
Styrax officinalis	8	7		7	7		7	7	43

The study has shown that it is possible to establish a healing garden containing medicinal and aromatic plants using native plant species. Although there are all colors among the species, it has been observed that yellow, white, and purple flowers dominate the most. These plants bloom mostly in March and April. In January, the number of flowering species was quite low.

Table 3. The use of medicinal and aromatic shrubs, groundcovers and flowers naturally grown in Isparta in planting design

Plant species	**Potential Use in Landscape Architecture**								
Shrubs, groundcovers and flowers	**Showy flower**	**TREES**	**Showy flower**	**TREES**	**Showy flower**	**TREES**	**Showy flower**	**TREES**	**Showy flower**
Sambucus ebulus	7	7	6				8		28
Galanthus gracilis	7	7				9			23
Lisaea papyracea	7								7
Cynanchum acutum	7	7			5		8		27
Scilla bifolia	7								7
Ornithogalum lanceolatum	7								7
Ornithogalum umbellatum	7								7
Achillea grandifolia	7	7		7	5		6		32
Achillea biebersteinii	*7*					*9*	*6*		22
Artemisia campestris				7	5	9			21
Achillea wilhelmsii	7					9	6		21
Anthemis cretica anatolica	7					9			15
Anthemis tinctoria	7								7
Carthamus tinctorius	7	7			5	9			28
Cirsium arvense subsp. *vestitum*			5					5	10
Doronicum orientale	7					9			16
Dorycnium pentaphyllum* subsp. *haussknechtii	7		5		5	9			26
Echinops viscosus subsp. *viscosus*	7								7
Helichrysum plicatum	7				5		6		18
Pilosella hoppeana	7						6		13
Tripleurospermum decipiens	7						6		13
Tussilago farfara	7						6		13
Berberis crataegina	7		6				8	8	29
Berberis cretica	7		6					8	21
Corylus avellana	7	7	6		7		8	8	43

Alkanna tinctoria subsp. *subleiocarpa*	7						6		13
Alyssum sibiricum	7		6				6		19
Arabis caucasica	7			7	5	9	6		34
Campanula lyrata	7				5		6		18
Campanula persicifolia	7	7			5	9			28
Centranthus longiflorus	7				5	9	6		27
Lonicera etrusca	7	7	6	7	6				33
Helianthemum nummularium* subsp. *ovatum	7	7					8	8	30
Acantholimon acerosum subsp. *brachystachyum*	7					9	6		22
Saponaria mesogitana	7								7
Saponaria prostrata	7								7
Silene aegyptiaca	7				5	9	6		27
Silene compacta	7	7	5			9			28
Silene vulgaris	7	7	5			9	6		34
Sedum album	7	7				9	6		29
Cyperus longus	7		6						13
Euphorbia aleppica	7		5				1 2		
Euphorbia kotschyana	7	7							14
Adenocarpus complicatus	7						6		13
Astragalus gymnolobus	7						8		15
Astragalus vulnerariae	7						8		15
Chamaecytisus eriocarpus	7	7					6		20
Colutea cilicica	7						8	8	21
Coronilla varia	7					9	6		22
Gonocytisus angulatus	7						8		15
Lotus aegaeus	7	7				9	6		29
Medicago lupulina	7	7			6			8	28
Medicago sativa	7	7			6			8	28
Ajuga chamaepitys* subsp. *chia	7			7	6	8	8		36
Ononis natrix hispanica	7	7				8			22
Trifolium repens* subsp. *giganteum	7	7				8		8	30
Vicia villosa subsp. *dasycarpa*	7			7					14
Centaurea cariensi	7						6		13
Pelargonium endlicherianum	7	7	5			9	6		34
Hypericum perforatum	7	7	6		8	8	8		44

Iris pseudacorus	7	7		7	5	9			35
Iris xanthospuria	7	7				9	6		29
Sideritis phrygia	7								7
Stachys cretica anatolica	7			7					14
Stachys cretica subsp. *smyrnaea*	7			7					14
Stachys lavandulifolia	7			7					14
Teucrium chamaedrys	7			7	5		6		25
Teucrium chamaedrys subsp. *lydium*	7						6		13
Teucrium montanum	7						6		13
Thymus longicaulis **subsp.** ***chaubardii***	7			7		9	6		29
Thymus sipyleus		7	5	7	5	9	6		39
Thymus zygioides	7	7		7		9	6		36
Thymus zygioides **subsp.** ***lycaonicus***	7	7		7		9	6		36
Tulipa orphanidea	7				5	9			21
Malva neglecta wallr.	7	7				9	6		29
Jasminum fruticans	7	7	6			8	6		34
Epilobium angustifolium	7	7	5		5		6	5	35
Anacamptis pyramidalis	7				5	9			21
Dactylorhiza iberica	7	7				9	6		29
Chelidonium majus	7								7
Glaucium flavum	7						7		14
Glaucium leiocarpum	7				5		6	5	23
Vinca herbacea	7	7			5	9			28
Digitalis cariensis	7	7				9			23
Digitalis davisianado	7	7		7		9			30
Plantago minor subsp. *İntermedia*	7								7
Polygonum bistorta	7	7	7			9			30
Rumex acetosella	7						6		13
Rumex conglomeratus	7						6		13
Lysimachia atropurpurea	7	7			7		6		27
Lysimachia punctata	7	7		7			6		27
Consolida hellespontica	7	7		7			6		27
Reseda lutea	7	7							14
Filipendula vulgaris	7	7			5	9			28
Potentilla micrantha	7	7							14
Potentilla recta	7						6		13

Rosa canina	7	7	5	7	7		6	5	44
Rosa damascena	7	7	5		7	5	6		37
Rubus canescens	7		5	7	7		6	5	37
Sanguisorba minor	7		5		7		6	5	30
Galium verum	7	7			7	5	6		32
Cruciata taurica	7						6	5	18
Viscum album	7		5						12
Verbascum blattaria	7						6		13
Verbascum cheiranthifolium subsp. *heldreichii*	7				7				14
Verbascum cheiranthifolium subsp. *pisidicum*	7				7				14
Hyocyamus niger	7								7
Solanum nigrum subsp. *schultesii*	7	7							14

While choosing plants for planting designs, their aesthetic appearances are taken into consideration as well as their ecological demands and functional uses. The aesthetic features of the plants determine their areas of use in designs and enable the creation of effective compositions. In this study, 120 medicinal and aromatic plants that are suitable for Isparta ecological conditions and spread naturally were determined. It is aimed at introducing medicinal and aromatic plants, such as trees (8 pieces), shrubs, groundcovers, and flowers (45 pieces), suitable for aesthetic and functional uses, as determined by the design studies to be carried out, to the people of the region.

Some of the 53 determined medicinal and aromatic plants (*Tilia platyphyllos, Fraxinus ornus* subsp. *cilicica, Olea europaea* subsp. *europaea, Jasminum fruticans, Lonicera etrusca* etc.) are known by designers and are widely used in designs. On the other hand, other species that stand out in terms of both aesthetics and usage area are not very well known.

It is thought that medicinal and aromatic plants that will be included in planting design studies will be a solution to the problem of imported (exotic) plants in landscape designs. On the other hand, endemic species in the region attract the attention of ecotourists, and many people want to see and photograph these species. Along with the other natural beauties of the region, medicinal and aromatic species should be promoted, and these medicinal and aromatic species should be used in ecotourism studies (Akyol et al., 2010; Dönmez, 2016).

As a result, in Turkey, which hosts important species in terms of ornamental plants and medicinal and aromatic plants, the importance given to medicinal and aromatic plants should be increased, and the existing species should be protected.

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Relationship Between Global Warming and Urban Landscape

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1. Introduction

Although the world's climates do not seem to change after the transition of humanity to a settled order, the findings obtained from the past to the present show that this is not the case. The world's climate has been changing for natural reasons, but today anthropogenic influences are also greatly contributing to this (Aksay, Ketenoğlu & Kurt, 2005; Abdi & Oğuz, 2020). Anthropogenic effects such as the emergence of different types of pollution in parallel with rapidly developing industrialization and intense urbanization, forest fires, misuse of lands, and use of chemicals in agricultural lands increase the pressure of humans on nature. As a result of the aforementioned effects, deterioration in the ecological balance can be observed, especially climate change (Metin & Gül, 2021). It is known that the city is a constantly changing formation and the most important source of this change is the population. Depending on the increase or decrease in the population, the spread areas of the city will change and this will bring some transformations (Akten & Çetinkaya, 2014). Global warming and climate change are the biggest threats to life on earth. Therefore, it has become one of the most popular agenda items in recent years. Human beings cannot be expected to remain insensitive to this danger. On the contrary, it is necessary to raise awareness about this issue and take preventive measures. (Sağlam, Düzgüneş & Balık, 2008; Çakır, 2021; Eray & Kutlu, 2021; Kırteke & Oğuz, 2022).

The atmosphere consists of various gases (Oğuz, 2013). Sunrays pass through the atmosphere and warm the earth. Gases such as carbon dioxide (CO_2), methane (CH_4), nitrogen protoxide (N_2O), ozone (O_3), and chlorofluorocarbon (CFC) in the atmosphere keep some of the heat coming from the sun to the earth and keep the earth at a certain temperature. Thanks to the heat retention feature of the atmosphere, the freezing of the seas and oceans is prevented. This warming and retaining property of the atmosphere is called the greenhouse effect (Akın, 2006). The atmosphere, along with soil and water, has begun to get polluted as a result of environmental issues that have emerged as a result of fast urbanization and human unconscious behaviors. The greenhouse gases that are rapidly increasing in the atmosphere reflect the sun's rays by forming an impermeable layer in the atmosphere, resulting in global warming by creating a greenhouse effect (Tuğluer, 2021). It is also known that the most important source of harmful gases released into the atmosphere is urban areas. Urban open-green areas, which have an important place in the urban landscape, are suitable places for individuals to lead a comfortable life (Akoğlu & Akten, 2022). They play a role in reducing the greenhouse effect (Tuğluer & Çakır, 2021). Open-green spaces can also be effective in microclimate conditions in cities where there is heat stress (Metin & Çağlak, 2022). Therefore, the urban landscape is directly, positively or negatively, related to global warming. In order to move forward in this relationship in a positive direction, the urban landscape should be of high quality. In this review, the role of the urban landscape in the fight against global warming has been examined.

2. The Relationship Between the Urban Landscape and Global Warming

"Global warming" is a term commonly used to describe a potentially dramatic increase in the Earth's annual mean global surface temperature. This temperature increase is estimated to be in the range of 1.5 °C to 4 °C (Houghton et al., 1996; Drake, 2014). Certain gases on our planet capture long-wave radiation radiated from the Earth's surface, resulting in a global mean temperature of 15 °C as compared to an estimated -18 °C without an atmosphere. This situation makes our world habitable. Global warming emerges as a result of the accumulation of greenhouse gases in the atmosphere starting from the Industrial Revolution over time, more than it should be.

Due to these increases, the greenhouse gas effect strengthened in the atmosphere, which has brought about the current problem of global warming and global climate change (Özmen, 2009). The greenhouse effect diagram is given in Figure 1.

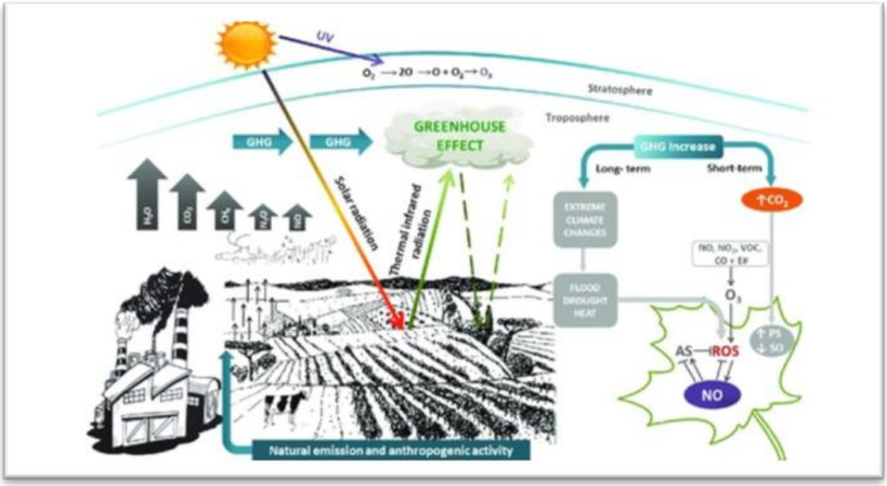

Figure 1. The greenhouse effect (Cassia, Nocioni, Correa-Aragunde & Lamattina, 2018)

According to a study conducted by the Ministry of Environment and Forestry of the Republic of Turkey, the contribution of various human activities to global warming has been determined as 49% of energy use, 24% of industry, 14% of forest burning and destruction, and 13% of agricultural activities. In other studies on the same subject, the effect of human energy use on global warming was found to be the highest (Kadıoğlu, 2002; Türe, 2003; Akın, 2006; Oğuz et al. 2009).

The potential consequences of global warming are as follows:

- The increase in average temperature value; accordingly, the decrease in precipitation, causing drought and the process leading to desertification,
- Surface and underground water changes; deterioration of soil structure,

- Changes in the characteristics of large ocean currents,
- The vital processes of many living and plant species are affected by heat waves and deaths occur,
- Changes in the distribution areas of plant species,
- As a result of the depletion of the ozone layer due to the effect of greenhouse gases that cause global warming, ultraviolet rays pass through the ozone layer and endanger life on earth,
- The increase in natural calamities such as hurricanes, tornadoes, lightning, landslides, erosion, and floods,
- The increase drought and forest fires,
- Negative effects on living things with the increase in sea and ocean temperatures,
- The decrease in fresh water resources with the increase in temperature,
- The occurrence of desertification with the increase of day and night temperature differences
- Diseases caused by sudden climate changes and the increase in epidemics,
- The negative impact on the world economy and socioeconomic structure and global economic losses,
- Disruption of human psychology (Akın, 2006; Özmen, 2009; Tuğluer, 2021).

The abovementioned factors causing global warming are generally caused by human effects in urban areas. All the elements that make up a city are parts of the urban landscape. The most important components of the urban landscape are structural elements and open-green areas (Dönmez et al., 2018; Çorbacı & Ekren, 2021). The amount of open-green area in a city is important for that city's ability to be livable.

Green areas are very important for the ecological sustainability of cities (Yazıcı et al., 2014; Ekren, 2017; Konakoğlu & Bekar, 2021). At the same time, urban open-green areas are carbon sinks in cities (Tuğluer, 2021). These areas help to reduce the greenhouse gases emitted by storing carbon. As the increase in buildings in the city will increase energy consumption, it will also increase the amount of greenhouse gas emissions.

3. Conclusion and Recommendations

Global warming is one of the most important problems threatening our world. Increasing human needs make it difficult to prevent this problem. In order to combat global warming, first of all, it is necessary to reduce our endless consumption needs.

Urban areas are the areas with the highest carbon emissions. These areas are one of the primary reasons for the increase in global warming. Urban open green areas, known as carbon sink, need to be increased in urban areas. Therefore, the greater the open green areas in the urban landscape, the greater the carbon absorption will be. Some of the measures that can be taken in cities to reduce global warming are as follows:

- To increase the amount of open green area in the city,
- To create greenway and green infrastructure systems in cities,
- To increase urban afforestation activities,
- To increase the urban forest and forest areas around the city,
- To use natural plant species with high ecological value in planting designs,
- By switching to low-energy systems by making building energy measurements,
- To prioritize projects that will reduce energy consumption in manufacturing and industry,
- Determining the carbon sinks in the cities and calculating the storage amounts,
- To take measures to reduce the carbon footprint of city dwellers,
- To raise awareness of the city dwellers about global warming,
- To combat climate change nature-based solutions can be use because NBS provide many benefits for ecosystems (Gül et al., 2021),
- To increase urban agriculture areas in the cities have the potential role in reducing the impacts of climate change (Türker et al., 2021). Urban agriculture is a productive land

use and have positive impacts on urban ecological systems (Türker & Akten, 2020; Türker & Anaç, 2022, Türker, 2021).

Increasing the amount of open-green space and plantations alone is not enough to prevent global warming. Reducing carbon emissions and carbon footprints in cities should be a priority goal.

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Spatiotemporal Change of Actual Evapotranspiration: A Case Study of Adana, Türkiye

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1. Introduction

Evapotranspiration (ET) can be defined as the combination of all processes by which water moves from the ground of earth to the atmosphere via evaporation and transpiration from vegetation. ET is a good indicator of irrigation effectiveness and total water consumption from vegetation (Çakır & Tuğluer, 2019). ET is also difficult to measure and monitor.

The remote sensing has become one of the valuable data sources and accurate estimation of evapotranspiration is considered as the key factor in water management (Beg et al., 2016). Normalized Difference Vegetation Index (NDVI), Leaf Area Index (LAI), surface albedo, surface emissivity, and land surface temperature (LST) can be retrieved by remote sensing technology to be used in ET calculation (Tuğluer & Çakır; 2019). LST is one of the most critical factors affecting the accuracy of the ET estimates. It directly indicates how much energy and water may be available over the land surface. LST and other surface variables like surface albedo, soil moisture, emissivity, fractional vegetation cover, NDVI, and LAI affect the accuracy of the retrieved ET (Liou & Kar, 2014).

In this study, SEBAL model was employed in order to calculate actual ET using Landsat 8 and Landsat 9 imageries for the province of Adana, Turkey. There are several models for ET calculation using remote sensing techniques and SEBI, SEBS, S-SEBI, SEBAL, METRIC, and TSM are some of them. Widely used and popular model, SEBAL, was employed in this particular study. In the past 10 years, several articles have been published on retrieving evapotranspiration using Landsat 8 data (Liou & Kar 2014; Beg et al., 2016; Oğuz 2020; Oğuz 2021).

For this study, Landsat 8 and Landsat 9 data with different years (2013 and 2022), both cover the province of Adana, were downloaded from the USGS webpage. The main objective of this study was not only to retrieve the ET for Adana but also to analyze the spatiotemporal change of ET.

The main purpose of this study is to monitor the changes in ET during the 9-year period. Direct field estimates of evapotranspiration (ET) are challenging since they are expensive and have low spatial representativeness. Remote Sensing technology helps us to overcome this problem.

2. Material and Method

2.1. Input Data

Landsat 8 and Landsat 9 imageries are the core part of this particular study. A Landsat 8 scene acquired on September 13, 2013 and a Landsat 9 scene acquired on August 29, 2022 were downloaded from USGS website. Landsat 8 and 9 captures images of the earth every 16 day and can be downloaded free of change from USGS webpage (USGS, 2022). Landsat 8 has two sensors on board: the operational land imager sensor (OLI) and thermal infrared sensor (TIRS). OLI has 9 bands with 30m spatial resolution (except for panchromatic band) while the TIRS has two thermal bands with 100m spatial resolution as illustrated in Table 1 below.

Table 1. Landsat 8 band descriptions (USGS, 2022)

Band Number	Description	Wavelength (µm)	Spatial Resolution (m)	Radiometric Resolution (bits)
Band 1	Coastal / Aerosol	0.43 - 0.45	30	12
Band 2	Visible blue	0.45 - 0.51	30	12
Band 3	Visible green	0.53 - 0.59	30	12
Band 4	Visible red	0.63 - 0.67	30	12
Band 5	Near-infrared	0.85 - 0.87	30	12
Band 6	Short infrared	1.56 - 1.65	30	12
Band 7	Short infrared	2.10 - 2.29	30	12
Band 8	Panchromatic	0.50 - 0.67	15	12
Band 9	Cirrus	1.36 - 1.38	30	12
Band 10	Thermal infrared	10.60 - 11.19	100	12
Band 11	Thermal infrared	11.50 - 12.51	100	12

Table 2. Landsat 9 band descriptions (USGS, 2022)

Band Number	Description	Wavelength (µm)	Spatial Resolution (m)	Radiometric Resolution (bits)
Band 1	Coastal / Aerosol	0.43 - 0.45	30	14
Band 2	Visible blue	0.45 - 0.51	30	14
Band 3	Visible green	0.53 - 0.59	30	14
Band 4	Visible red	0.63 - 0.67	30	14
Band 5	Near-infrared	0.85 - 0.87	30	14
Band 6	Short infrared	1.56 - 1.65	30	14
Band 7	Short infrared	2.10 - 2.29	30	14
Band 8	Panchromatic	0.50 - 0.67	15	14
Band 9	Cirrus	1.36 - 1.38	30	14
Band 10	Thermal infrared	10.60 - 11.19	100	14
Band 11	Thermal infrared	11.50 - 12.51	100	14

SEBAL model was employed in this study. SEBAL can be calculated using the following equation:

$$ET = Rn - G - H \tag{1}$$

Where;

ET: Actual evapotranspiration rate (mm/hr)

Rn: Net radiation flux (W/m^2)

G: Soil heat flux (W/m^2)

H: Sensible heat flux (W/m^2)

More detailed information regarding SEBAL model is provided by Waters et al. (2002). Model Builder in ArcGIS has been used to calculate actual ET from the satellite imageries.

2.2. Study Area

Adana is selected as the study area because it is the sixth most populated city in Turkey. The city is situated on the Seyhan River, 35 km inland from the north-eastern coast of the Mediterranean Sea. The southern and central portion of the province mostly falls within the Çukurova Plain, to the north, the plains give way to the Taurus Mountains. The provinces adjacent to it are Mersin to the west, Hatay to the southeast, Osmaniye to the east, Kahramanmaraş to the northeast, Kayseri to the north, and Niğde to the northwest. The province is divided into 15 districts but Ceyhan, Yüreğir and Seyhan districts were selected as the study area since they are among the most populated districts of Adana as illustrated in Figure 1. Home to 2.2 million people, Adana is one of the largest province in Turkey, as well an agriculturally productive area, owing to its large fertile plain of Çukurova. The north of the city is surrounded by the Seyhan reservoir. The Seyhan Dam, completed in 1956, was constructed for hydroelectric power and to irrigate the lower Çukurova plain. Two irrigation channels in the city flow to the plain, passing through the city center from east to west. There is another canal for irrigating the Yuregir plain to the southeast of the city. Adana has a hot-summer Mediterranean climate (Csa) under both the Koppen classification, and a dry-hot summer subtropical climate (Csa) under the Trewartha classification. Winters are mild and wet. Frost does occasionally occur at night almost every winter, but snow is a very rare phenomenon. Summers are long, hot, and humid. During heatwaves, the temperature often reaches or exceeds 40 °C (Wikipedia, 2022).

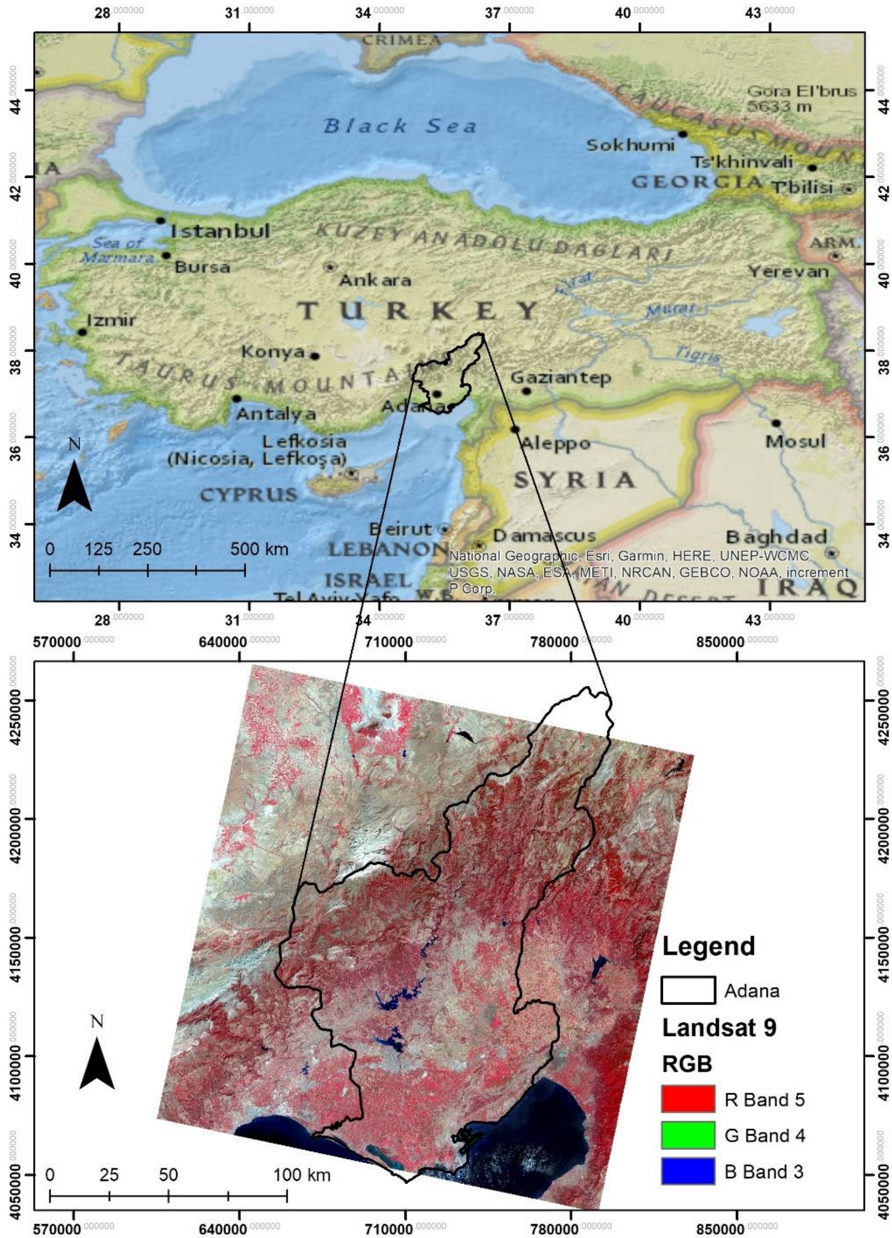

Figure 1. Location map of Adana.

3. Findings and Discussion

Using Model Builder in ArcGIS, NDVI, LAI, surface albedo, emissivity, net radiation and ET were calculated and their spatial distribution maps were created as illustrated in Figures 2-7 below.

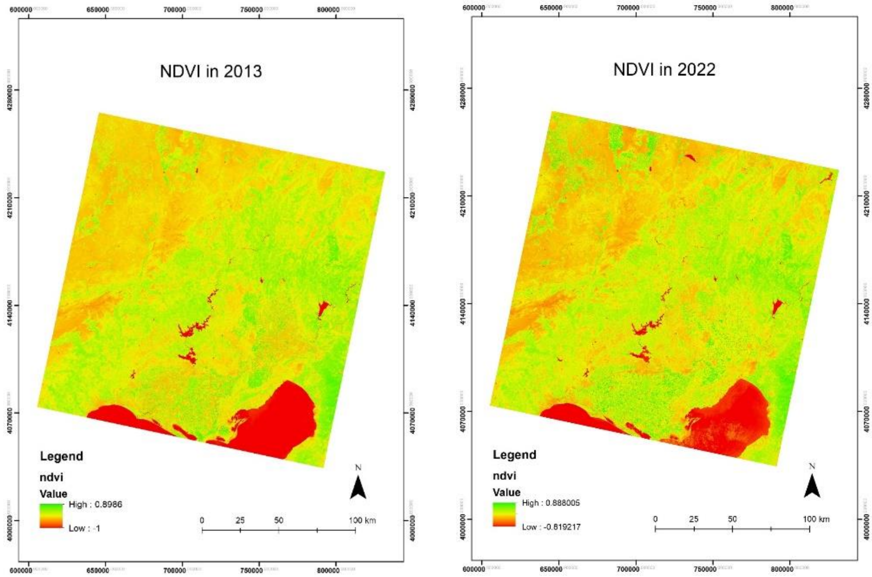

Figure 2. Spatial distribution maps of NDVI (2013 left, 2022 right)

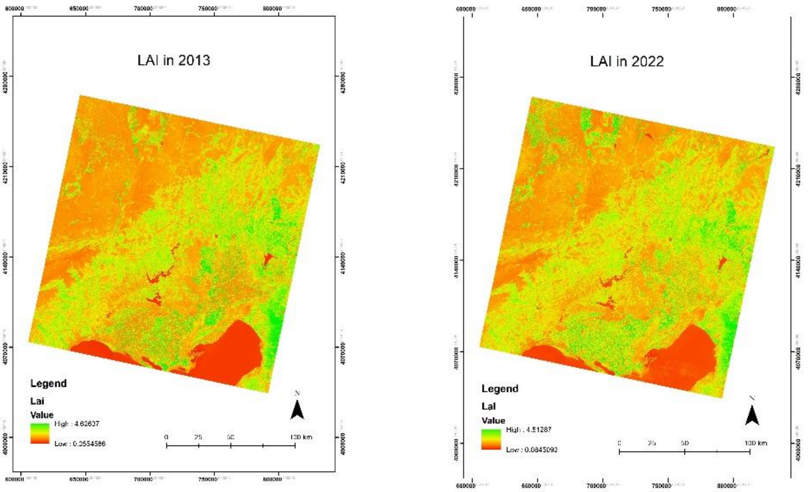

Figure 3. Spatial distribution maps of LAI (2013 left, 2022 right)

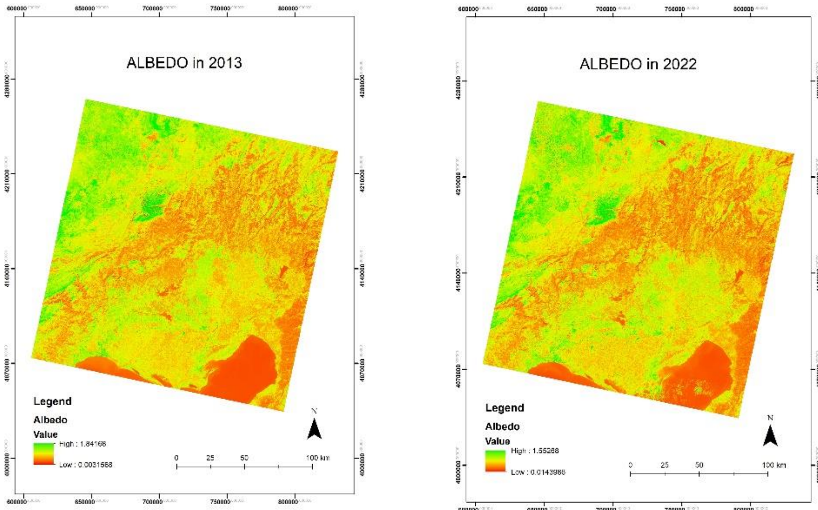

Figure 4. Spatial distribution maps of albedo (2013 left, 2022 right)

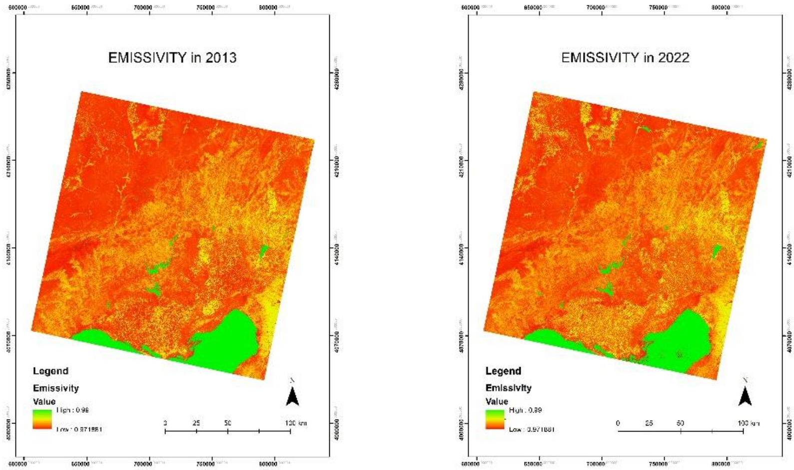

Figure 5. Spatial distribution maps of emissivity (2013 left, 2022 right)

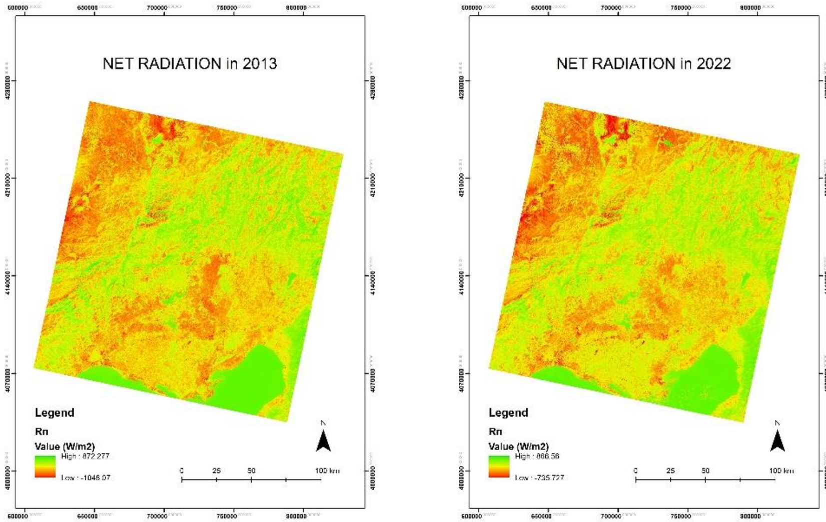

Figure 6. Spatial distribution maps of net radiation (2013 left, 2022 right)

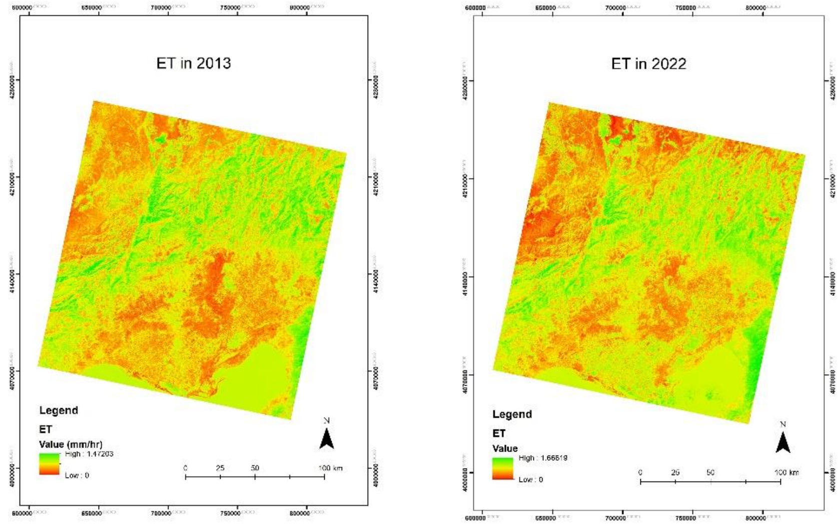

Figure 7. Spatial distribution maps of ET (2013 left, 2022 right)

Four central districts of Adana, which are Çukurova, Sarıçam, Seyhan, and Yüreğir were merged in ArcGIS and then spatial distribution maps for the central districts were clipped out in ArcGIS. Figures 8-13 below illustrate spatial distribution maps at district level.

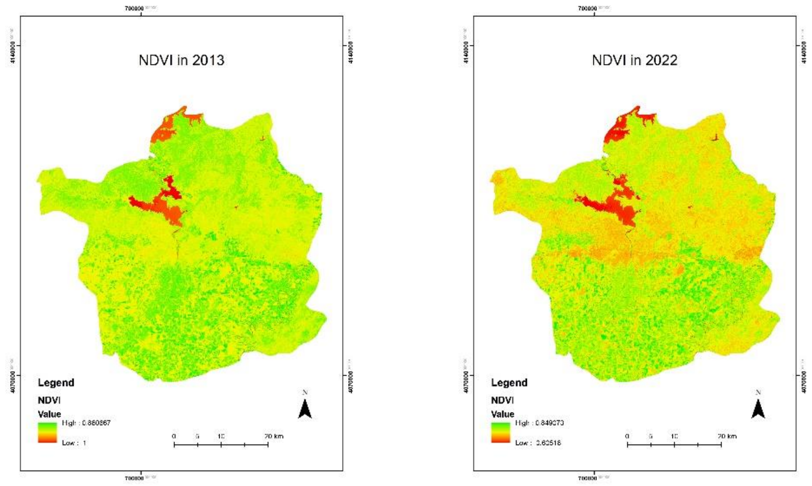

Figure 8. Spatial distribution maps of NDVI in central districts (2013 left, 2022 right)

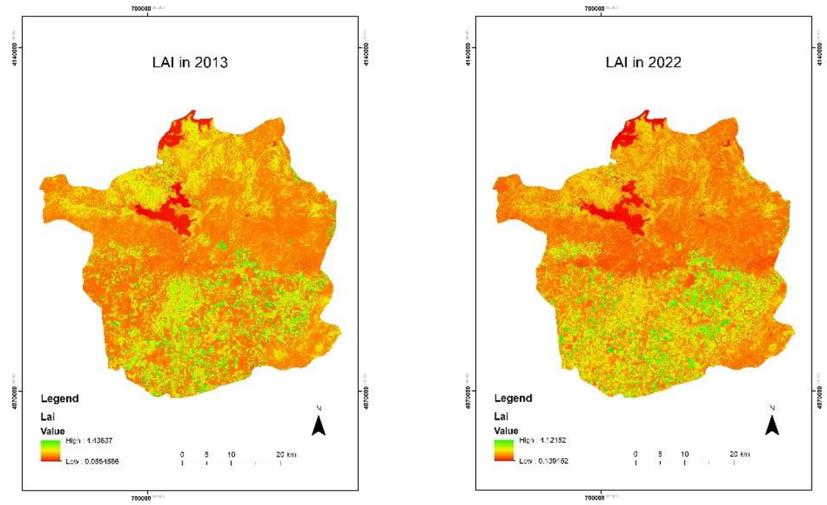

Figure 9. Spatial distribution maps of LAI in central districts (2013 left, 2022 right)

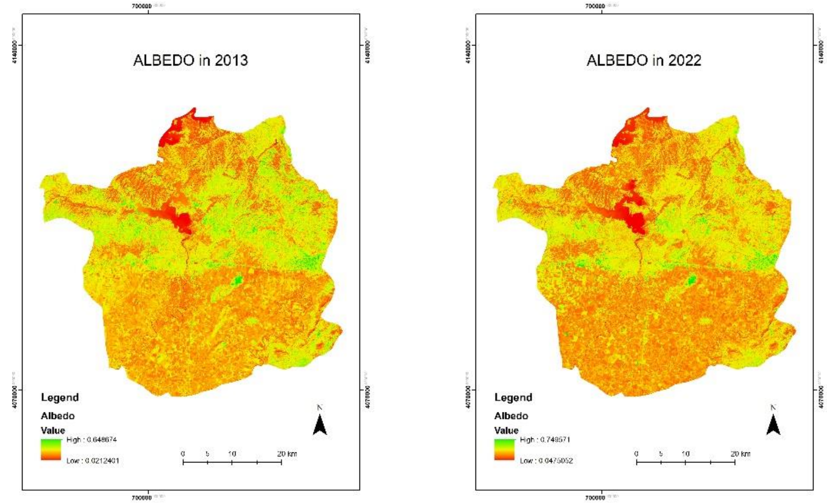

Figure 10. Spatial distribution maps of albedo in central districts (2013 left, 2022 right)

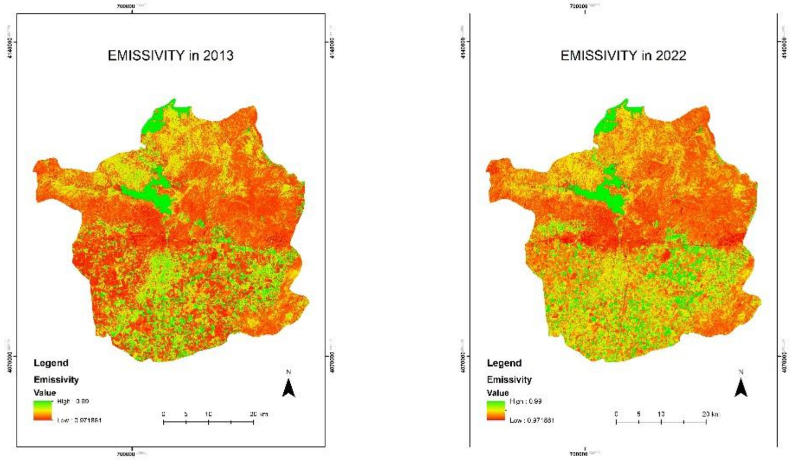

Figure 11. Spatial distribution maps of emissivity in central districts (2013 left, 2022 right)

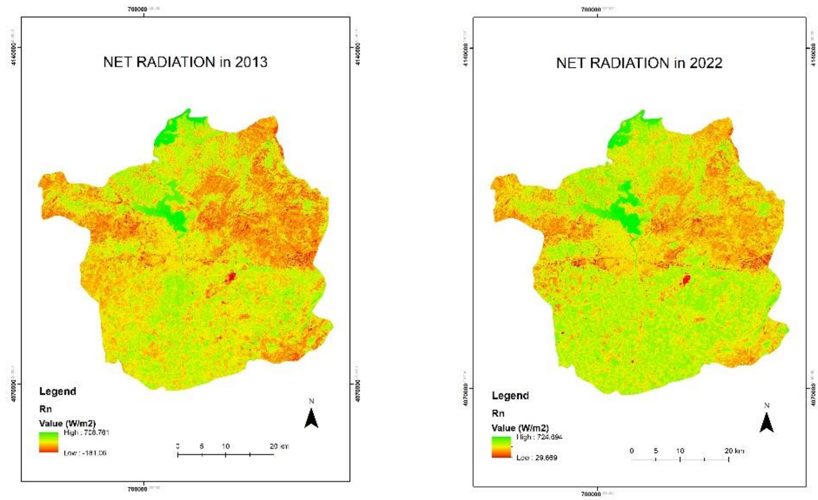

Figure 12. Spatial distribution maps of net radiation in central districts (2013 left, 2022 right)

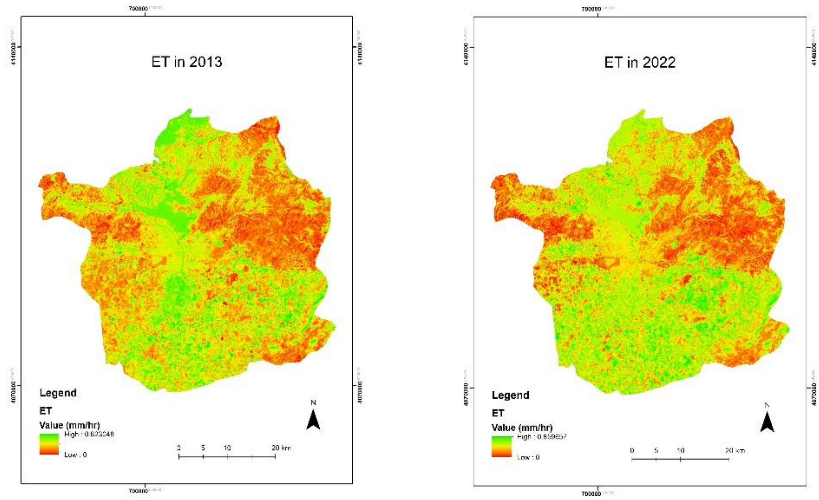

Figure 13. Spatial distribution maps of ET in central districts (2013 left, 2022 right)

Mean ET values for central districts in 2013 and 2022 were found to be 0.14 and 0.31mm/hr respectively. This clearly indicates higher rate of ET in 2022 compared to 2013 image. Of course, these ET rates represent the instantaneous ET rates that were captured at the time of satellite image acquisition.

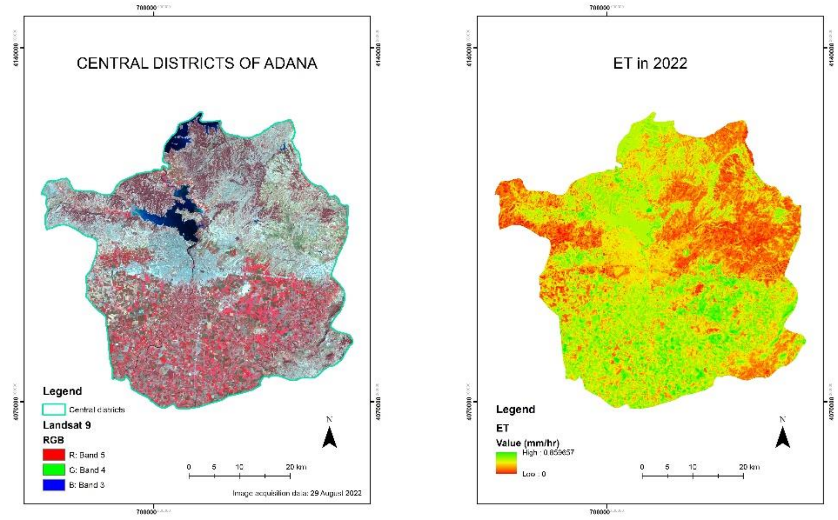

Figure 14. Spatial distribution maps of ET in central districts (2013 left, 2022 right)

Figure 14 above clearly indicates that high ET rates occur on agricultural areas and dam lake.

4. Conclusion and Recommendations

In this paper, we presented a RTE based ET retrieval over 9-year period in Adana, Türkiye using satellite imageries. For large areas, direct field estimates of evapotranspiration (ET) are challenging because they are quite expensive and have low spatial representativeness. Monitoring the evapotranspiration through remote sensing technology, has been popular in disciplines such as agriculture, hydrology or climatology, for a variety of purposes such as optimizing the irrigation scheduling and for the prediction of natural hazards such as floods and droughts. The multi-source satellite data should be tested whether or not they provide more accurate estimates of the surface parameters which are relevant to evapotranspiration processes.

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The book chapter complies with national and international research and publication ethics. Ethics committee approval was not required for the study.

Author Contribution and Conflict of Interest Declaration Information

The book chapter has a single author and there is no conflict of declaration.

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