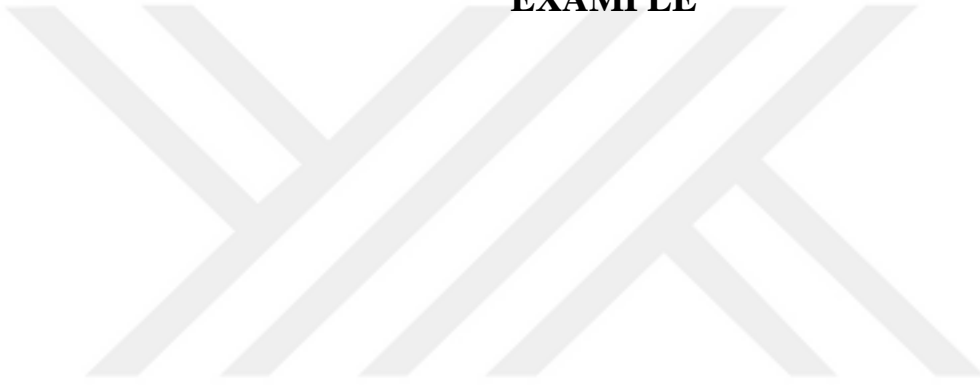


**A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF ÇANKIRI KARATEKİN UNIVERSITY**

**BLUE-GREEN INFRASTRUCTURE ANKARA BATIKENT
EXAMPLE**



**IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF MASTER OF SCIENCE
IN
LANDSCAPE ARCHITECTURE**

BY

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ÇANKIRI

2023

BLUE-GREEN INFRASTRUCTURE ANKARA BATIKENT EXAMPLE

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May 2023

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Büşra ÇALIŞKAN

ABSTRACT

BLUE-GREEN INFRASTRUCTURE ANKARA BATIKENT EXAMPLE

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Master of Landscape Architecture

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May 2023

For urban areas facing the challenges of climate change, blue-green infrastructures that combine hydrological functions and vegetation systems in urban landscape design are an appropriate and sustainable solution. Blue-green infrastructure, which is an application that strengthens urban ecosystems, is becoming more and more common with different examples in the world. However, there are not many studies on blue-green infrastructure in Türkiye. In addition, in Batıkent, which was determined as the study area, no study was carried out on open green spaces and water surfaces. In this study, the blue-green infrastructure system installation within the borders of Batıkent region of Ankara province Yenimahalle district in Turkey has been examined. In this context, open green areas and water surfaces were examined on site, zoning plans and ready-made plans were taken, and verbal interviews were made with the responsible municipalities and metropolitan municipality. The data were processed through Google Earth, Netcad, Yenimahalle municipality zoning application, and photoshop programs. There are more than 64 parks in Batıkent, planned to serve different groups with different activities at different scales. The study area has been evaluated within the scope of parks which have different functions than other parks, open and green areas, green corridor, green roof, urban water surfaces, rainwater use systems, natural wetlands, and mixed-use areas. The green corridor system and green roof application were designed were found to be quite lacking. The water elements, for which no work has been done within the scope of the sustainability principle, were used only as ornamental pools. There is no rainwater management system or natural water source. Elimination of such deficiencies and increasing well-designed blue-green infrastructure applications will contribute to the solution of problems encountered in urban planning and ensure climate-compatible urban sustainability.

2023, 71 pages

Keywords: Blue-green infrastructure, Batıkent, Sustainability, Ecology

ÖZET

MAVİ YEŞİL ALT AYAPI ANKARA BATIKENT ÖRNEĞİ

Büşra ÇALIŞKAN

Peyzaj Mimarlığı, Yüksek Lisans

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İklim değişikliğinin zorluklarıyla karşı karşıya olan kentsel alanlar için, kentsel peyzaj tasarımında hidrolojik fonksiyonları ve bitki örtüsü sistemlerini birleştiren mavi-yeşil altyapılar uygun ve sürdürülebilir bir çözümdür. Kentsel ekosistemleri güçlendiren bir uygulama olan mavi yeşil altyapı, dünyada farklı örnekleriyle her geçen gün yaygınlaşmaktadır. Bununla birlikte, Türkiye'de mavi ve yeşil altyapı konusunda çok fazla çalışma bulunmamaktadır. Çalışma alanı olarak belirlenen Batıkent'te açık yeşil alanlar ve su yüzeyleri ile ilgili bir çalışma yapılmamıştır. Bu çalışmada Türkiye'de Ankara ili Yenimahalle ilçesine bağlı Batıkent bölgesi sınırları içerisinde mavi-yeşil altyapı sistem kurulumu incelenmiştir. Bu kapsamda açık yeşil alanlar ve su yüzeyleri yerinde incelenmiş, imar planları ve hazır planları alınmış, sorumlu belediye ve büyükşehir belediyesi ile sözlü görüşmeler sağlanmıştır. Veriler Google Earth, Netcad, Yenimahalle belediyesi imar uygulaması ve photoshop programları ile işlenmiştir. Batıkent'te farklı ölçeklerde farklı aktivitelerle farklı gruplara hizmet verecek şekilde planlanan 64'ün üzerinde park mevcuttur. Çalışma alanı, diğer parklara göre farklı işlevlere sahip olan parklar, açık ve yeşil alanlar, yeşil koridor, yeşil çatı, kentsel su yüzeyleri, yağmur suyu kullanım sistemleri, doğal sulak ve karma kullanım alanları kapsamında değerlendirilmiştir. İncelenen parklarda tasarlanan yeşil koridor sistemi ve yeşil çatı uygulaması oldukça eksik bulunmuştur. Sürdürülebilirlik ilkesi kapsamında bir çalışma yapılmayan su unsurları sadece süs havuzu olarak kullanılmıştır. Çalışma alanında herhangi bir yağmur suyu yönetim sistemi veya doğal su kaynağı bulunmamaktadır. Bu tür eksikliklerin giderilmesi ve iyi tasarlanmış mavi-yeşil altyapı uygulamalarının artırılması kentsel planlamalarda karşılaşılan sorunların çözümüne ve iklime uyumlu kentsel sürdürülebilirliğin sağlanmasına katkı sağlayacaktır.

2023, 71 sayfa

Anahtar Kelimeler: Mavi yeşil altyapı, Batıkent, Sürdürülebilirlik, Ekoloji

PREFACE AND ACKNOWLEDGEMENTS

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LIST OF SYMBOLS

m^2	Square meter
m^3	Cubic meter
km^2	Square kilometer



LIST OF ABBREVIATIONS

BfN	Federal agency for nature conservation
BGI	Blue-green infrastructure
DMI	State weather station
DSI	General directorate of state hydraulic works
IMM	İzmir metropolitan municipality
MDRN	Maryland department of natural resources
METU	Middle East Technical University
MM	Metropolitan municipality
MTA	Mining technical exploration mineral
TDK	Turkish language society



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1. INTRODUCTION

Day by day, people prefer to live in cities in order to achieve a better quality of life due to both more job opportunities and the social and economic benefits of cities. According to research, by 2050, an average of seventy percent of the world's population will live in cities (United Nation 2014). Due to this rapid urbanization that continues today, the city borders also needed to be expanded. This expansion desire causes the suppression of our natural resources (Güneş 2015). Therefore we face many environmental problems that are increasing day by day.

Environmental problems such as increase in urban heat island effect, increase in polluting factors, decrease in air and water quality, and unhealthy air has emerged. The solution to these problems, which we face as a result of increasing urbanization, is only possible with a lifestyle that is sustainable, respectful to nature, and considers nature processes. In this context, the blue-green infrastructure approach shows a successful approach in eliminating the problems experienced.

Infrastructure as a term of urban science; that provides the basic conditions necessary for a city to function, grow and develop; In other words, it is defined as urban amenities such as water, electricity, and sewage network necessary for the construction of a building and providing sufficient shelter for the residents (Demircan *et al.* 2020). In parallel with the developing world, the urban infrastructure must continuously develop itself and ensure the development and continuity of the changing and complex social relations networks. Cities have two different infrastructures as they have a dynamic structure consisting of natural (blue and green) and man-made (grey) elements. These elements, which accumulate over time, shape the urban form. The interaction between blue, green, and gray elements decreases with increasing density and unplanned urbanization (Poletto and Tassi 2012). The first grey infrastructure is known as gray infrastructure as roads, sewer systems, and power lines. The second and blue-green infrastructure, becoming increasingly important today, is a holistic system with sustainable, ecological, and cultural values (Aytekin 2018).

Gray infrastructures are expensive systems that aim to perform only one intended function. Unlike the gray infrastructure, blue-green infrastructure is an economical, sustainable, robust, and reliable system in the long run (Eraslan 2019).

However, new standards and tools need to be developed to fill existing and future gaps in blue-green infrastructure implementation. Therefore, it is necessary to comply with the standards and tools developed to improve the planning, design and quality of blue-green infrastructure (Houghton *et al.* 2023). In addition, more increasing and severe consequences of climate change, such as elevated temperatures and flood risks, will also increase the negative consequences of urbanization (Grimm *et al.* 2008). Therefore, considering that cities are expanding in terms of population density and area, it is necessary to protect both the quantity and quality of blue-green areas (Pauleit *et al.* 2011; Hansen and Pauleit 2014; Sorensen and Mobini 2017).

Within the scope of the blue-green infrastructure, it is aimed to connect all kinds of open and green areas except for built areas such as rivers, coastal areas, parks, gardens, green roofs, wooded areas, woods, hobby gardens, open spaces, urban farms, cemeteries, and mosque gardens. It was noted that in Sørensen *et al.*(2021), more information and data at different temporal and spatial scales are needed to improve ecosystem services and conserve biodiversity. In accordance with this purpose, blue-green infrastructure, which is an application that strengthens urban ecosystems, is becoming more and more common with different examples in the world. However, there are not many studies on blue and green infrastructure in Türkiye. In Batıkent region, which is study area, the park areas, which we describe as open and green areas, are of sufficient density, but there is no sustainable system in these areas. In addition, water elements are only used as ornamental pools, and there is no available study within the scope of the sustainability principle. It will be the wrong approach to consider only park areas as a green infrastructure quality. Moreover, sustainable approaches such as green roofs are also quite lacking in the study region. In this study, the blue and green infrastructure system setup will be examined within the borders of Batıkent region.

2. LITERATURE REVIEW

2.1 Blue-Green Infrastructure Concept

We can define cities as human settlements with certain populations and structural masses. In other words, the city; is a settlement where the majority of the population works not in agricultural production, but in sectors such as administration, industry, and trade (TDK 2005). Cities are primarily related to housing, education, health, and production, etc. contain multiple functions. Due to increasing urbanization, today's cities are deprived of natural areas more and more. For this reason, the environment and quality of life in urban areas are gradually decreasing. The main reason for these problems is climate change, which is a serious problem on a global scale, and its consequences. The melting of glaciers, the formation of urban heat islands, sea level rise, biodiversity, and seasonal changes can be cited as examples. For this reason, it was deemed necessary to adopt blue-green infrastructure examples with a different and new approach in urban planning in order to maintain the natural ecological balance and maintain its sustainability in urban areas (Parlak and Atik 2020).

Blue-green infrastructure is identified by the Ramboll Foundation as a complementary factor to gray infrastructure; It is defined as a network of systems in which natural processes are supported and urban ecosystems are strengthened by combining vegetation and hydrological functions (Parlak and Atik 2020).

Even though the concept of blue-green infrastructure basically defines a sustainable system, there are different definitions in many different sources. According to the definition made by the European Commission in 2019, the term blue-green infrastructure is defined as networks of semi-natural or natural spaces that are planned, implemented and inspected to provide a wide range of ecosystem services such as water purification, air quality, recreation areas, mitigation or adaptation to climatic changes. . These green-blue networks of spaces aim to improve environmental conditions and the quality of life of users (European Commission 2019). When the existing concepts are examined, blue-green infrastructure is defined as a sustainable and interrelated network of blue and green areas that provide benefits to societies in terms of ecosystem.

According to this definition, urban blue-green infrastructure is an approach that plays an active role in all challenging processes such as climate change and protecting biodiversity of all sizes, from nature parks consisting of large-scale forests to green roads and green roofs (Pauleit 2019). Within the scope of the Green Surge Project, the concept of blue-green infrastructure has been defined as a multi-functional, multi-scale network system consisting of blue and green areas that can provide many ecological system services and are beneficial for people (Parlak and Atik 2020).

When the elements in the concept of blue and green infrastructure are examined separately; the concept of green infrastructure supports ecological and natural processes, aims to create sustainable areas and a more livable environment, and is a multifunctional green area network covering rural and urban areas. Blue infrastructure, on the other hand, is an approach in which the water structures and water elements used are evaluated in an orderly manner. The studies carried out in cities related to climate change aim to ensure the sustainable water cycle and therefore the ecological cycle. Blue infrastructure is a system that includes all water resources in a city, as well as water elements and forms (European Commission 2019).

According to the blue-green infrastructure definition of Ghofrani, Sposito and Faggian; it is specified as a network of interconnected natural and designed landscape components, including bodies of water and green and open spaces. For example; green roofs, renaturalized rivers, rainwater gardens. It has also been suggested that blue-green infrastructure provides numerous other benefits, such as air quality, biodiversity enhancement, and remediation efforts as well as water quality (Lamond and Everett 2019).

The term blue-green infrastructure is currently used in various contexts internationally and is applied at national levels of sustainable urban development planning. For example, in local practices, blue-green infrastructure is defined as a natural water cycle that brings together water management and green infrastructure, contributing to the comfort of cities (Kopp *et al.* 2021). Although blue-green infrastructure has come to the fore with its environmental importance, it is a very productive concept in terms of social and economic aspects. Blue-green infrastructure; it addresses environmental improvements such as clean water, reducing climate extremes and increasing

biodiversity. From a social perspective, blue-green infrastructure has the potential to empower new communities in cities and strengthen public health. Economically, the implementation of blue and green infrastructure provides opportunities for cost-effective stormwater, flood, water quality solutions and other ecosystem services (Kopp *et al.* 2021). If we consider all definitions, in brief, blue-green infrastructure can be defined as an ecological planning approach, sustainable, compatible with climate changes, and a wide service network that will provide biodiversity and aesthetic values.

2.2 Historical Process of Blue-Green Infrastructure Concept

Industrialization, urbanization, and rapid population growth in cities in the world bring environmental problems. A blue-green infrastructure system has been developed as a solution to the increasing environmental problems from the past to the present. Blue-green infrastructure is a system that supports and envisions the development of sustainable and ecological networks of regions and cities at all scales.

The concept of green infrastructure was developed by Benedict and McMahon. Benedict and McMahon defined green infrastructure as the connection of various natural and restored ecosystems and open and green spaces through a link or center. Here, the main purpose of blue and green infrastructure is to synthesize environmental management and ecological protection thinking with landscape planning practices (Benedict and McMahon 2002).

Although the concept of blue-green infrastructure is seen as a new concept, it is not a new idea. It basically started with planning and conservation work that started 150 years ago. With the transition to mechanization-based production, which started as an economic transition process all over the world in the 18th century, technology also developed rapidly and cities began to grow uncontrollably. There has been an incredible migration from rural areas to cities. Cities that were not ready for such an uncontrolled population growth were inadequate in terms of physical, social, and institutional infrastructure. As a result of this, urbanites living in worse and worse living conditions have emerged. With the widespread use of coal, problems such as increasing air pollution, dirty drinking water, diseases caused by failures in waste management, inadequacies in the provision of goods and services, unhealthy living conditions,

unhealthy and unethical working conditions, and injustice in income distribution have emerged.

Many urban approaches and urban movements have been studied in order to alleviate the urbanization and problems that increased as a result of the industrial revolution, and to organize urban structures. For example, the most influential in America is the Beautiful City Movement. The main purpose of this urban movement is to provide a social improvement as well as physical improvement for the citizens by planning green areas along with physical renewals of the cities. With such urban movements, green areas such as parks in the 19th century were seen as an escape area and savior for cities that were worn out as a result of the industrial revolution. In this period, parks, recreation areas, environmental quality, and physical and social activity have responded to the demands of the citizens as a solution (Sariarmağan and Var 2019).

Landscape architect Olmsted, who was the first person to study the concept of green infrastructure, used the concept of green infrastructure in the 19th century to focus on three concepts as ecosystem services and well-being, environmental restoration, and comprehensive planning. According to Benedict and McMahon, Olmsted's basic idea is that "Parks alone, no matter how big and how well designed, are not enough for users who want to take advantage of nature. Instead, residential areas and surrounding parks need to be connected". At the end of the 19th century, the concept of green infrastructure was combined with the discipline of urban planning for the first time with a project called the Emerald Necklace in Boston. Within the scope of this project, they aimed to connect green corridors and natural areas with each other and to develop multifunctional environmental designs. These corridors are mainly designed to manage water, but it has been understood that the existing transportation infrastructure and ecological situation should also be evaluated and it has been tried to combine not only the water but the entire landscape system (Eisenman 2009).

Howard developed the concept of Garden City in 1899 as a solution to the problems of unhealthy housing and urban life in England in the 20th century. In the center of the Garden City movement, holistic planning, which includes the idea of green infrastructure, also includes the concepts of multifunctionality, accessibility, and functionality (Pauleit *et al.* 2011).

In the 1960s and 1970s, a period in which environmental awareness increased within the framework of society and politics began. Movements have started against pollution originating from nuclear energy, chemical waste, and detergents. These movements turned into protests over time and environmental concerns revealed social awareness. In the 1980s and 90s, the USA introduced the concept of blue and green infrastructure as a basic concept that could emphasize ecosystem services against these uprisings. Thus, the concepts of blue and green infrastructure have taken a whole view with ecosystem services. Blue-green infrastructure principles have started to be used in water management and land use planning in the USA. According to Mell, the concept of blue-green infrastructure can be considered in three periods. The first period is the period called the Discovery Period between 1998-2007. In this period, the concept of green infrastructure began to be used. Before this period, synonymous terms such as green network and green space management were used. Benedict and McMahon published one of the first papers using contemporary green infrastructure terminology. Since then, researchers, planners, and practitioners have been intensely preoccupied with this concept. The second period is the period called the Development Period between the years 2005-2010. In this period, state institutions intensively worked on the concept of green infrastructure in their infrastructure works. At the same time, the concept of green infrastructure has been a subject of attention in regional-scale planning studies in this period. The third period, 2010 and after, is the Consolidation period. In this period, a common consensus has been reached on what the concept of green infrastructure is and how it can be developed. Approaches to global and thematic issues such as climate change and water management have begun to be developed. The concept of blue-green infrastructure is now used to develop smarter, more efficient, and more sustainable cities in this period (Sarıarmagan and Var 2019).

2.3 Blue-Green Infrastructure and Planning Relationship

Cities are high-rise and densely populated residential areas that are preferred because basic needs such as shelter, work, education, and health can be easily met. It aims to create more sustainable and high-quality urban areas by using natural and semi-natural green areas and water elements planned in urban areas, due to the negative effects of climate changes, urban heat islands, and decreasing water resources as a result of the increasing population and urbanization rate in cities.

Urban blue-green infrastructure aims to create sustainable, healthier, and livable environments that support natural and ecological processes. For this purpose, multifunctional and sustainable green network and water elements designs are developed for both new planning areas and existing planned areas in rural and urban areas. Blue and green infrastructures have been evaluated as a supportive and complementary whole within urban ecosystems. Blue-green infrastructure is a strategic planning approach that does not aim to create, design and manage a network for green space and water elements in the city in terms of ecosystem services (European Commission 2019).

Blue-green infrastructure in urban areas such as green roofs, green walls, trees, rain gardens, rain ditches, park areas, cemeteries, agricultural areas, green corridors, forests, lakes and ponds, waterways, sewers, and wetlands in natural and semi-natural areas. integrates with the elements (Parlak and Atik 2020).

The urban blue-green infrastructure planning approach provides opportunities for the development of urban open and green spaces and water elements in cooperation with both local and central administrative government stakeholders. Collaboration with non-governmental stakeholders, not just between administrative sectors, is a necessary factor for successful blue-green infrastructure planning.

In the first stage of blue-green infrastructure planning, the priority should be to provide healthy and quality living spaces for individuals in ensuring urban development, to create urban areas that are resistant and harmonious against global and serious problems such as climate changes, and to protect biodiversity while doing all these. At the same time, it should make it a priority to create cities that support the quality of plans made in the past and to be made in the future, economically, culturally, socially, and ecologically with blue-green elements, ensuring sustainability by using resources efficiently, and economic development by providing social cohesion and inclusiveness in planning studies (BfN 2017).

In the second stage of blue-green infrastructure planning, the selection of suitable areas within the city is included within the scope of the plan. In urban blue-green infrastructure planning, workspaces cover all urban areas, including open and green

spaces, water elements, as well as structures, and indoor areas. In this way, it should be aimed to apply blue-green infrastructure principles in all areas at the spatial scale. However, unlike other planning approaches, a more holistic plan approach should be followed without accepting property elements as a base. Elements of all sizes such as green areas, water surfaces, or a single plant or tree can be accepted as the basic element in the area to be planned. It should be aimed that both blue-green and gray infrastructures develop together, supporting the elements considered as the basic element in the planning work (BfN 2017).

The potential and characteristics of the areas should be taken into account in the selection of areas to be protected and developed during the planning process. In order to create a successful plan, flexible blue-green infrastructure planning strategies that can adapt to different planning studies and policy changes that can be made in the future, operate at different scales, and are protected by certain laws should be developed. At the same time, plans that are compatible with climate changes and aim to reduce their effects, aiming to protect water resources and including transportation planning should be created.

In terms of urban planning, a blue-green infrastructure approach is used to achieve maximum benefit for sustainable urban development, water quantity and quality, and biodiversity provision and control. The benefits of this approach to sustainable urban development can be categorized under four broad areas. These are flood resilience, natural resource management, livability, transition, and innovation. When the blue and green infrastructure planning approach is examined, two important conclusions can be drawn. First, blue and green infrastructure is essential to most aspects of sustainable urban development. Secondly, design and planning studies using blue and green infrastructure planning create a multidisciplinary and integrated study in line with sustainable development goals (Kopp *et al.* 2021).

In light of all these requirements, a holistic sustainable, and ecosystem-friendly plan approach, where different disciplines and authorities work together, should be exhibited in order to ensure a sustainable and ideal blue-green infrastructure planning. For this planning approach, blue and green infrastructure and gray infrastructure must coexist, be strong, be multifunctional, and be socially inclusive (Benedict and Mc Mahon 2006).

2.4 Blue-Green Infrastructure Planning Practices and Good Practices in the World

Since 2003, the European Union Commission aimed to develop more concrete solutions to global problems such as climate change and urban heat islands by developing some approaches and solution proposals under the name of "Ecologically Based Solutions" and to create a framework for approaches based on ecosystem protection. The basis of blue-green infrastructure planning practices in European countries is to develop ecological networks, protect green areas and water surfaces, and restore and creation of new green areas and water surfaces. In European countries, policies are developed on the adaptation process to climate change, especially with a focus on green and blue infrastructure, and the potential and functionality of blue-green infrastructure in this process. The reason for the increase in blue-green infrastructure policy studies in this process, especially after 2010, is the increase in economic, environmental, and social awareness that will support this approach. Blue-green infrastructure applications have been adopted in a similar way in the United States, as in European countries, and there has been a rapid increase in applications. Especially in big cities such as New York, Chicago, and Philadelphia, blue-green infrastructure applications are carried out effectively in field management. In particular, multifunctional and flexible local government policies are being developed. Similar to these studies, climate, multi-functionality, and central administrative management policies have been developed in Spain, Scandinavian regions, and Italy. Asian countries, on the other hand, evaluated blue-green infrastructure applications as investment opportunities and focused on the added value of cities (Sariarmagan and Var 2019).

2.4.1 Good practice example from Barcelona

Barcelona is the second largest city in Spain. Its urban area is home to 5.5 million people in 2020. It is also one of the largest, densest, and the most compact urban areas in Europe with a population density of 16,000 people per kilometer. The city has a blue-green infrastructure area of 3,611 hectares. Of this area, 30% is public urban green space, 50% is Parc de Collserola parkland and 20% is private property. The application was implemented under the name of Barcelona Community Garden (Figure 2.1). With this application, reducing the urban heat island effect, ensuring social justice, increasing

air quality and waste management and environmental quality, ensuring the balance of production and consumption within the area, increasing access to food and green areas and responsible production and consumption, biodiversity, agricultural production, climate gains were aimed at increasing the knowledge and awareness of citizens on change issues.

With the global financial crisis in 2008, urban community gardens have become a trend in Barcelona, like other cities in Europe. The anger and social protests that emerged after the crisis in 2011 have also doubled down on urban gardening initiatives and neighborhood associations. Barcelona City Council, which has been designing public gardens since 1997, has put forward the Green Infrastructure and Biodiversity Plan between 2013-2020. Within the framework of this plan, many applications that will associate nature with the city are targeted. The plan considers urban gardens as an important element of the blue-green infrastructure approach. Within the scope of this idea, the Barcelona City Council has encouraged gardening in public vacant lots to cover 0.3% of the urban gardens in the total urban area. This application contains 2 types of gardens. The first is the privately owned areas that are divided into parcels by the Barcelona City Council, called hobby gardens. The other is community gardens, also known as self-managed horticultural ventures, where the land is collectively managed.

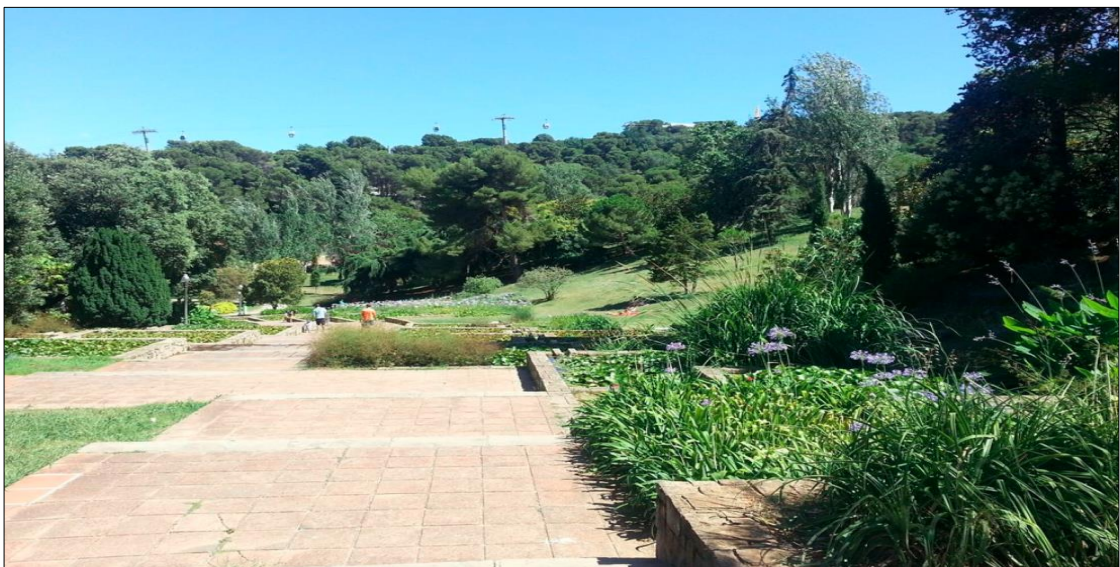


Figure 2.1 Community garden example in Barcelona (Yelp 2023)

Another application is the Empty Urban Spaces Plan with Regional and Social Participation, which encourages the renewal and revitalization of the urban fabric. This plan provides a temporary social and community use opportunity for certain vacant municipal land plots. Thus, the demands of the neighborhood communities are met and the empty spaces are used for social and environmental benefits. This relationship established through urban gardening also affects production and consumption relations (Arslantaş *et al.* 2020).

2.4.2 Maryland green infrastructure assessment

Maryland stretches across an area that stretches from the Atlantic Ocean to the Appalachian Mountains and has five types of physiographic zones. It has a wide variety of climatic conditions, landforms, flora communities and habitats for each region. Like many regions, Maryland is under the pressure of rapidly increasing population and accordingly urbanization. Rapid growth in urban areas causes soil and habitat loss, fragmentation of natural areas and their transformation into isolated habitats. In the face of this situation, towards the end of the 1990s, in order to determine the green infrastructure in the province, ecologically important areas of the region were determined, natural areas based on the connectivity of green infrastructure; river valleys are evaluated as linear corridors such as the lines formed by ridges and the centers where they are connected (Parlak and Atik 2020). Potential focal points and corridors for Maryland green infrastructure planning have been identified (Figure 2.2). An ecological order of importance was then established among these areas. Priority and risky areas, protection priority areas with high ecological value and Targeted Ecological Areas were determined, and planning decisions were taken in this direction.

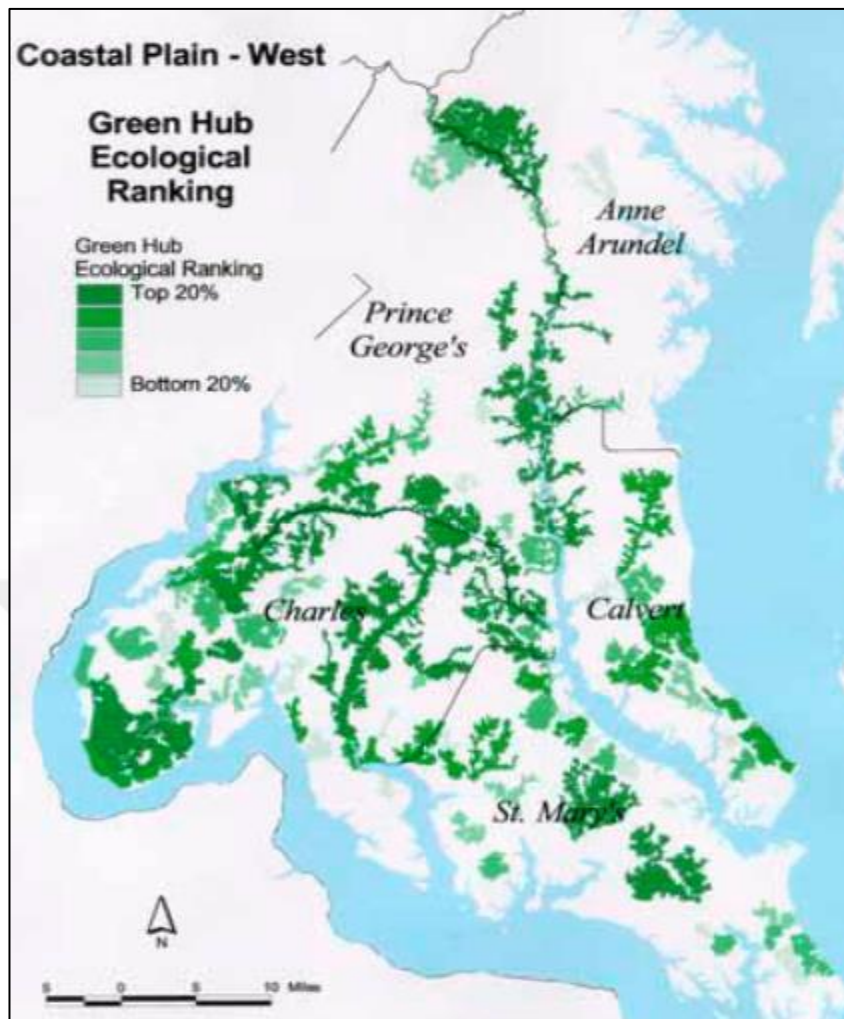


Figure 2.2 Maryland green system (MDRN 2003)

2.4.3 Emscher blue-green infrastructure strategy

Dense coal, prominent in the Emscher region, in western Germany leads to serious pollution problems that have occurred in water resources in the Emscher River basin and region due to mining and industrial uses. As a solution to these damages, the Emscher River Restoration Project was developed in the 1990s. Integrated water management is aimed to ensure an integrated water cycle. With this project, which focuses on water quality and environmental improvement, wastewater is directed to treatment plants with the 51 km main sewer line running parallel to the Emscher River. Apart from this, public awareness of blue-green infrastructure has increased (Parlak and Atik 2020).

Small-scale stormwater projects and reduction of impermeable areas with the 'Rainwater BIS Management Information System', the heavy industrial basin in Emscher has become a symbol of social, economic, and environmental change for the city as a result of the project implementations while the heavy industrial basin in Emscher is among the most degraded areas in Europe (Figure 2.3). Bern Park, which was created by the transformation of the old wastewater treatment plant, is an example of change. With the restoration works carried out in the basin area of the river, concrete canals were removed and the natural vegetation was restored. In this way, in addition to ensuring water quality and rainwater management, new habitats were created for animal species, incentives were provided for plant diversity and new recreation areas were created (Nickel *et al.* 2014, Perini 2017).



Figure 2.3 Emscher landscape park (Metalocus 2015)

2.4.4 Melbourne urban forest strategy

In order to prevent the extreme heat, severe drought, and water shortage that occurred between 1995 and 2009 in Melbourne, Australia, a green infrastructure system was established under the name of 'Urban Landscape Team' in 2010 (Figure 2.4). While large investments have been made in urban forests and heathlands, green areas and rainwater harvesting, permeable surfaces, protection of waterways and wetlands since 2010, it was aimed to reduce the urban temperature by 4 degrees and save energy with green areas. The Melbourne urban forest strategy is evaluated within the context of a range of environmental, economic, and social parameters that can be measured in terms

of community health, energy conservation, air quality improvement, and carbon sequestration. It is aimed to increase the surface consisting of trees from 20 percent to 40 percent, to increase the permeable surfaces, and to collect rainwater to meet 50 percent of the water required for the city (Parlak and Atik 2020).



Figure 2.4 Melbourne urban forests (City of Melbourne 2023)

2.5 Blue-Green Infrastructure Planning Practices and Good Practices from Türkiye

Within the urbanism policy, which progresses in two different branches, central and local government in Turkey, the regulation that all disciplines working on this issue takes into account the most is the Spatial Plan Construction Regulation. The purpose of this Regulation has been determined as "to determine the procedures and principles regarding the construction and implementation of spatial plans that bring land use and zoning decisions". Within the scope of this purpose, adequate expressions are not included for natural areas and countryside, which are important for the blue and green infrastructure system.

According to the statement in regulation, Environment Regulation Plan is expressed as: ‘It shows basic geographical data such as forest, river, lake, and agricultural lands in accordance with the target and strategy decisions of spatial strategy plans, if any, determines general land use decisions regarding sectors such as urban and rural settlements, development areas, industry, agriculture, tourism, transportation, and energy, provides a balance of protection-use with settlement and relations between sectors and it is the plan made as a whole with the plan notes and report that can be prepared at the regional, basin, or provincial level by using the scale-appropriate display on the maps with a scale of 1/50.000 or 1/100.000’. According to this definition, Environmental Plans include forests, streams, lakes, etc. It has provided an opportunity to protect the blue-green infrastructure elements in the areas and to make the plans to be made within this framework (Demiroğlu *et al.* 2019).

2.5.1 İzmir green infrastructure strategy

Within the scope of the Horizon 2020 program of the European Union, it is aimed to reduce the effects of climate change for the city of İzmir, improve air quality and water management, and also increase the sustainability of the city through innovative nature-based solutions. The main purpose of the project is to increase the urban environment and quality of life with nature-based solutions, naturalization of the city, water management solutions and green infrastructure applications (Figure 2.5) (IMM 2022).

The green infrastructure strategy of the city of İzmir, which is one of the local government applications for the blue-green infrastructure approach in our country, has basically developed nature-based solutions to the problems of climate change, uncontrolled growth, flood and flood risk, food and water security, and the decrease and loss of biodiversity. It is aimed to deal with the natural and semi-natural areas in the city of İzmir in a holistic way with urban built areas and to provide the maximum benefit from ecosystem services. With the project, which is planned to be completed in 2022, it is aimed to create green infrastructure elements integrated into the system in the city by creating green corridors and reducing the urban heat island effect, carrying out the necessary applications for bringing the city, use of renewable energy sources (Figure 2.6), storing and filtering the water, realizing the restorations for the river surroundings and increasing the green area surfaces (Parlak and Atik 2020).

STRUCTURAL ELEMENTS FOR GREEN INFRASTRUCTURE PLANNING AND GOVERNANCE	STRUCTURAL ELEMENTS FOR WATER AREAS	STRUCTURAL ELEMENTS FOR GREEN SPACES	STRUCTURAL ELEMENTS FOR CORRIDORS AND CONNECTION AREAS	STRUCTURAL ELEMENTS FOR BUILDINGS, IDLE AND REPAIRED AREAS
<ul style="list-style-type: none"> ▪ Green Economy/green infrastructure education and employment ▪ Green purchasing procedures, financing ▪ Eco-efficiency ▪ Green infrastructure governance panel, software and applications 	<ul style="list-style-type: none"> ▪ Dams, ponds and pools ▪ Swamps, wetlands coastal/terrestrial ▪ Floodplains ▪ Beach and beach areas ▪ Marine habitat, artificial reefs ▪ Rivers, streams and other streams ▪ Lagoon salt and fish ▪ River/stream corridors ▪ Irrigation channels, tanks and wells ▪ Coastal structures, culverts, breakwaters, coastal embankments, aqueducts ▪ Blue roofs 	<ul style="list-style-type: none"> ▪ Gardens ▪ Woodland and afforested areas ▪ Forest, urban forest/fruit forest ▪ Agricultural fields ▪ Children's playground, neighborhood park, neighborhood park, city park ▪ Recreation area ▪ Thematic green spaces ▪ Hobby gardens/urban orchards ▪ Recreational/picnic areas ▪ Green roofs ▪ Cemetery, burial grounds ▪ Sports fields 	<ul style="list-style-type: none"> ▪ Roadside trees, plants, banks and thresholds ▪ Border/ hedge plants ▪ Urban drainage areas: Water ditches, permeable surface coatings etc. ▪ Bicycle/pedestrian paths/routes and crossings ▪ Parklet ▪ Vertical gardens/ green walls ▪ Ecological bridges (wildlife) ▪ Pollinators: bee houses etc. 	<ul style="list-style-type: none"> ▪ Quarries (not in active use) ▪ Garbage-rubble dump sites ▪ Former industrial areas ▪ Abandoned construction sites ▪ Debris fields/junkyards ▪ Single urban green structures ▪ Worn gray infrastructures/ vacant lots

Figure 2.5 İzmir green infrastructure strategy themes (IMM 2022)



Figure 2.6 Bayraklı Ekrem Akurgal park and energy efficient roofs (IMM 2022)

2.5.2 Allaben Creek green corridor application- Gaziantep

Gaziantep, located in the Southeastern Anatolia region, shows continental climate characteristics. There are three urban forests in the city. In addition, the Allaben Stream, which flows on the east-west axis, passes through the city center. There is a green corridor along the stream (Figure 2.7). Allaben Creek Green Corridor application includes green corridor, river corridor, city parks, botanical park, permeable flooring and rainwater plant strip. With this practice, an increase in the amount of green space per capita and an increase in the socio-cultural value of the city occurred. In addition to the social effects, it also brought environmental effects such as flood control, increase in air, water and soil quality, noise reduction and increase in carbon sequestration. There are 18 thematic parks and natural areas integrated along the Allaben Stream (Figure 2.8). In all of these parks, there are plant strips with functions of stormwater runoff water control, infiltration, and filtering along the stream side (Arslantaş *et al.* 2020).



Figure 2.7 Gaziantep province green corridor example (Arslantaş *et al.* 2020)



Figure 2.8 Gaziantep province green corridor project (Arslantaş *et al.* 2020)

2.5.3 Porsuk Stream coast green corridor application- Eskişehir

The shore of the Porsuk Stream, which divides the city center of Eskişehir into two, has the feature of a green corridor in the city today (Figure 2.9). Along the approximately 10 km long coast, green areas have been created almost continuously with the efforts of protecting, repairing and recreating the existing vegetation on both sides, and the continuity of the green corridor has been ensured. Porsuk Stream was used for recreational purposes as well as providing drinking and irrigation water by the people of Eskişehir until the mid-1970s. Porsuk Stream pollution has created a big problem for Eskişehir due to the negative effects of growing industry and urbanization of Eskişehir and Kütahya provinces. Known as the most important asset of the city in 1999, Porsuk Stream has now emerged as the most important problem of the city. In 2002, Porsuk Stream was defined by the Organization for Security and Cooperation in Europe as 'the most dangerous stream in terms of pollution and health, where no living things other than harmful bacteria and viruses live, whose bed is full of wastes'. Eskişehir Metropolitan Municipality started to implement it by providing loan support from the European Investment Bank within the scope of the project prepared for the improvement of the parts of the Porsuk Stream within the city. This project consists of

approximately 257.000 m² area. The city park contains approximately 150.000 m² of green area. There are many activity areas such as cafes, buffets, artificial ponds, 310m long artificial beach, sports fields, children's playgrounds, and horseback riding areas in the city park (Figure 2.10) (Arslantaş *et al.* 2020).



Figure 2.9 Green corridor example in Eskişehir (Arslantaş *et al.* 2020)



Figure 2.10 Active green area in around Porsuk river (Arslantaş *et al.* 2020)

2.5.4 İsmet İnönü park application-Ankara

İsmet İnönü Park, which is the application area; is located within the Çankaya District of Ankara Province. It is located close to Birlik District, one of the most crowded neighborhoods of Çankaya District, and Yıldız District, which is also very active commercially. The park which has been evaluated as a green area despite the commercial recreation and zoning pressure around it, has formed a part of the green system that extends from the Imrahor Valley in the south to the Presidential Palace in the north and narrows in places, together with the older Lausanne Park and the Zafer Park designed together with this park. The park, which has a total area of 52.000 m², has 33.000 m² of green space. In addition to indoor and outdoor facilities where recreational activities can be carried out in the area, there is also Çankaya House where residents of the neighborhood can perform their sociocultural activities (Figure 2.11) (Arslantaş *et al.* 2020).

There is a biological pond covering an area of 1.400 square meters in the area (Figure 2.12). This pond is treated and cleaned by using only beneficial organisms and plants without the use of chemicals. At the same time, bird species in the region also benefit from the pond. The most striking point of the area is that its topography has not been tampered with and it has been designed with its ecological value in mind. At the same time, all the trees in the area were protected during the construction phase of the park area. The natural pits in the park have been used as a pond, and the slopes as a bush area to prevent landslides and to create landscaping. Lavender fields and recreational amphitheaters have been designed in pit areas where ponds cannot be created. Green roofs have also been applied to the administrative buildings in the park. Another important feature of the blue-green infrastructure system is the permeable surfaces designed in the field. With these surfaces, it is aimed to ensure the water cycle by providing rainwater accumulation (Arslantaş *et al.* 2020).



Figure 2.11 Ankara İsmet İnönü park (Arslantaş *et al.* 2020)



Figure 2.12 Ecological pond in İsmet İnönü park (Arslantaş *et al.* 2020)

2.6 Ankara City Planned Development Period and Blue-Green Infrastructure

Relationship

The first plan of Ankara was prepared by Carl Christoph Lörcher in 1924 with the aim of meeting the new requirements of the city. After Ankara became the capital of the Republic of Turkey, the central area of Ankara was developed by Herman Jansen in 1932. Ankara continued to develop with the plans made by Jansen and Lörcher in the 1950s. The plan prepared by Nihat Yücel and Raşit Uybadin in 1955 won the competition. In 1970, a plan for 1990 was created by the Ankara Metropolitan Plan Office. In 1990, Prof. Dr. Ankara 2025 plan was prepared with the coordination of R. Raci Bademli. Final and current plan In 2006, the Master plan targeting 2023 was approved (Celep 2009).

2.6.1 Jansen plan

The Jansen Plan, which won the competition, was approved in 1932, different from the competition project, and entered into force. Jansen has done a study that includes a specific system for open and green spaces in the Ankara Zoning Plan. The aim of the study was to create a balance between open and green spaces and buildings. A plan study was carried out considering the amount of green space per capita, the use of areas suitable for ecological conditions, aesthetic and functional open and green space planning and a holistic plan approach. In the Jansen plan, the agricultural areas surrounding the city, green areas in the valley in a radial order, afforested hills, roads, parks, sports fields, green areas surrounding the settlement areas were designed in an organic way. Among the main elements are Youth Park, Hippodrome (former Atatürk Cultural Center, now a People's Garden), Güvenpark and Golfa Course (now Altınpark). Jansen stated that creeks and valleys should definitely be protected in order to meet Ankara's water needs. Incesu Valley was determined as the main recreation area of Ankara in the plan and was evaluated as the swimming pool facilities of the Bent Stream (Çulcuoğlu 1997).

After the plan was approved in 1932, it underwent many changes and unplanned disruptions until the 1950s. Yenışehir (current Kızılay) and Cebeci residential area, State Administration Center, Higher Education Institutions, hospitals and some urban infrastructure facilities have been developed in accordance with the plan. However, in

addition to all these planned developments, there were also organized and unorganized unplanned developments in Bahçelievler, Beşevler and Çankaya regions. In order to regulate these developments, an environmental plan with a scale of 1/10.000 was prepared in 1938. However, this plan could not adequately get rid of the pressures. Thereupon, Jansen had his signature deleted from the bottom of the plan in 1938 and resigned (Bademli 1994).

2.6.2 Uypadin and Yucel plan

In 1953, a competition was opened by the Ankara Zoning Directorate in order to create a solution for the uncontrolled development of the city of Ankara. The duo of Uypadin and Yücel won the competition. The competition project was approved with the revisions made in 1957 and entered into force. In the plan, a city with a single center, no slums, and a very dense and almost homogeneous population of 750.000 was designed. However, the plan set unrealistic goals. The city, which was determined to have a population of 750.000 for the year 2000, exceeded this population in 1965. This situation has led to serious density and illegal construction within the zoning boundaries (Bademli 1994).

Regarding open and green areas in the plan, an Olympic site in the Ankara Stream, a recreation area in the İncesu Valley and a zoo were proposed. According to the plan report, a green area of 32 square meters per person has been considered. However, this figure could not be reached. In 1960, Ankara became an unhealthy slum city and its problems increased. It has been understood that a new understanding of urban planning needs to be developed. Ankara Metropolitan Master Plan Bureau was established for this purpose in 1969. In 1968, Prof. Dr. Yuksel Oztan, with his doctoral thesis titled "The Study and Determination of the Green Field System of the City of Ankara and Its Surroundings in Terms of Landscape Architecture Principles", proposed a green belt or two to create an open and green space system for the city of Ankara (Çulcuoğlu 1997).

2.6.3 Ankara metropolitan plan 1970-1990

In 1969, Ankara Metropolitan Area Master Plan Bureau was established under the Ministry of Construction and Settlement. As a result of the studies carried out by this office until 1975, three principles were decided. Keeping the development of the city in

macroform under control, the rapid development of the western corridor, the public taking great responsibility in directing the urban development, and the creation of the public land stock primarily for this purpose (Demirel 1994).

As a result of extensive research conducted by the Ankara Metropolitan Area Nazım Plan Bureau between 1970 and 1975, a plan scheme with a 20-year perspective was developed. This scheme, which was approved and put into effect in 1982, is not an Implementation Development Plan. Until this period, a complex local plan was in effect with the floor plan and plan changes that were changed frequently. However, all zoning activities to be carried out in this period must be prepared in the light of the Master Plan Scheme. Therefore, this new scheme has the status of a planning-implementation control tool. The AMANPB Plan Scheme directed the developments, especially in the western corridor of the city. It has contributed to development areas such as Sincan slum prevention zones, new settlements, Batıkent, Ankara Organized Industrial Zone. However, a sufficient amount of work has not been carried out for the areas within the borders of the Uypadin- Yücel Plan. In the AMANPB plan, particular importance was given to valley-based open and green space functions. A green belt study has also been proposed around the existing settlement. By evaluating the recreational potential offered by the open spaces in the immediate vicinity of the city, recreation studies have started in the İmrahor- İncesu valley, Bayındır, Çubuk Dams and Gölbaşı. In the same period, Ankara Municipality also carried out studies. It started to carry out planning studies independently of the Municipality Zoning Directorate. This action ended with the establishment of a planning unit within the Municipality in the 1977-1980 period. Unlike AMANPB, the Municipality has carried out important works within the boundaries of the plan. Ankara 1990 Master Plan, which was approved in 1982, could only be implemented for 2 years with the closure of the office in 1984. In this period, initiatives related to the applications of Altınpark, Atatürk Cultural Center, Abdi İpekçi Park and Kızılay Pedestrian Area started (Arslan *et al.* 2004).

2.6.4 Ankara metropolitan municipality planning period after 1983

After AMANPB was closed, the office was transferred to the Metropolitan Planning Department, which was established under the Ankara Metropolitan Municipality. As a result of the studies carried out on the zoning and local government legislation, the

structure of the Ankara Municipality has changed, and its duties, powers and opportunities for planning, implementation and planning have expanded. In addition to Ankara Metropolitan Municipality, independent municipalities were established in Altındağ, Çankaya, Keçiören, Mamak and Yenimahalle, and then in Sincan, Etimesgut and Gölbaşı district municipalities, Kazan, Hasanoğlan, Elmadağ, Çubuk, Akyurt, Pursaklar, Bağlum and Yenikent. In 1986, the Ministry of Public Works and Settlement and the Ankara Metropolitan Municipality decided to prepare a structural plan. In 1987, a research team consisting of METU (Middle East Technical University) City and Regional Planning Department prepared a structural plan for an Ankara macroform change process targeting 2015 (Figure 2.13). With this plan, it was suggested that the new settlement areas should jump out of the city rather than inside the city and the population should be limited to 300,000. In addition, it is foreseen that a belt with a thickness of 8-10 km can be formed in order to prevent pollution of the green belt is created and to create airflow between the city center and its surroundings (Erdoğan *et al.* 2004).

Within the scope of the 2025 Ankara Urban Development Project, which was started after 1992, the expropriation of Batıkent, Eryaman, and Çayyolu Mass Housing areas was completed and implemented. For the green areas determined within the scope of the 2025 Master Plan, the Portakal Çiçeği Valley and Dikmen Valley projects were adopted in order to save the Ankara valleys from evaluating the green areas as a whole, to protect the water basins, to strengthen the green belt and to provide green areas to the residential areas of the valleys (Erdoğan *et al.* 2004).

Due to the urbanization problem experienced in Ankara towards the end of the 1970s, the Batikent settlement began to be considered as a metropolitan secondary core in the north of the Istanbul-Ankara road. However, no project has started. With the 1990 projection plan, a satellite city plan called Akkondü was targeted. In line with this goal, it was planned to expropriate 1034 hectares of land. In 1975, an expropriation of 200 hectares was made. In 1976, the 1/5000 scale plan was approved by the Ministry of Public Works and Settlement. In 1977, the industrial zone between Batikent and the Istanbul-Ankara highway was removed from the planned area. Within the framework of this plan, it was clearly defined in this plan that 50.000 residences would be placed to meet the housing needs of 200,000 people (Keskinok 200). The proximity of the Istanbul-Ankara highway and the Ostim Industrial Zone had a great impact on the shaping of this plan. The area is planned as a transition zone to the city, separated from the highway and industrial zone. It is also adjacent and connected to Eryaman campus, which is another new project with a multifunctional green area (Celep 2009). The last plan affecting the Batikent region is the 2023 projection plan. In this plan, the area is the busiest and most important settlement center of Ankara's western corridor. Although social and cultural areas are included in this part of the plan, the area is currently the opposite. Social, cultural, administrative and similar activities are no longer sufficient for the area. On the other hand, there are still revisions and plan developments that encourage housing development and discourage central activities. With the said plan study, it was thought that it should be accelerated with public and private initiatives and interventions from the very beginning. The policies also stated that central development should not be limited to shopping malls. And it has aimed to create areas where all the necessary needs such as social, cultural uses and facilities will be realized and the quality of life will be increased. However, all these policies have not been implemented when looking at today's structuring, and the opposite approach has been followed (Yenimahalle Municipality 2021). The Batikent settlement area was initially considered as a satellite or a settlement extending as a town rather than a sub-centre. However, when the applications started, it was seen that the area had a high income. Thus, with the development of residential areas, commercial development areas began to be formed outside of the high-rise housing and apartment building and the areas determined in the plan. In addition, the administrative units and places of employment determined in the master plan studies gradually became smaller (Celep 2009).

Today, many applications and modifications have been made on the Batikent plan. Almost all of the plan amendments have gone beyond the original purpose and have been revised in the name of rent. Thus, the area, which is the center of the plan, has gone beyond the development of administrative and social facilities and has now turned into a residential and commercial area. Thus, Batikent started to lose its first identity (Yenimahalle Municipality 2021). Today, the use of the area still lacks central activities. As stated in the previous sections, the land planned as a district center could not be developed as it should be. The center should have had more public uses to attract people. However, the Batikent sub-central area has not been able to achieve this, given the actual use and development process. Residential and commercial areas were designed not pedestrian-friendly, but car-oriented. In addition, the residential areas were designed to form a small neighborhood with large green areas surrounded by walls to emphasize that these areas belong to private use (Celep 2009).

2.7.2 Morphological and spatial analysis of Batikent

Batikent plan, which is based on cooperative settlement, has a hierarchical organizational structure that centers various settlement units such as 'residence environment', 'neighborhood', 'district' and 'center'. In terms of basic design, the smallest residential unit around a cooperative block is a residential neighborhood with a population of 5.000 within 5 cooperative blocks and containing a basic school. When the two circles meet, a neighborhood of 10.000 inhabitants is formed and includes a shopping mall and schools. 5 neighborhoods combine to form a district with the market place, medical center, birth center, high school, post office and police station. At the same time, there are cultural, commercial and recreational facilities serving a population of 50.000. Finally, in the heart of Batikent, there is the central business district (Batikent City Center) serving the entire community. Since the location of the city center is a dry river bed, a low-rise zoning is envisaged in the master plan to prevent dense construction and urban rent and to protect the forehead as a recreation area (Kürelî 2021). It was noted that there are two different housing types approaches have been expressed for this region. The first approach considered housing as an economic issue. And they are grouped according to the purchasing power value of the residents. The first group in the Batikent region is the private housing areas, which also constitute a large part of the housing stock. The rest is made up of leases. There are two subspecies

of the privately owned group. These can be called day houses and loan houses. Gündüzkondu houses targeted low-income users who are poor, immigrants or displaced from slums. They are two-storey buildings with a maximum size of 100 square meters. Loan houses are for middle-income users. They are less in number compared to the day dwellings. They are located in sub-centres and city centers (Global 2021). The second approach has three groups of housing units and is based on density. Density types are associated with specific housing typologies. It provides social homogeneity by matching it with a suitable model for each user group (Atici 2017). This situation has been evaluated as a utopian vision in which Batikent facilitates affordable property ownership and aims for a collective movement (Cengizkan 2005). For low-density residential areas, 350 people are targeted on an area of 1 hectare. They are two-storey duplex blocks located in the north, northeast and southeast of the Batikent region. It covers the housing types specified as Gündüzkondu. It covers an area of 230 hectares in total. Medium density residential areas targeted 425 people per hectare. They are five-storey blocks located in the northwest of Batikent. It covers the types of housing specified as loan houses. They cover an area of 165 hectares. High-density residential areas target 600 people on 1 hectare. They are ten-storey blocks located in the center of Batikent. They are in rental housing type. These residences cover an area of 102 hectares in total (Eryıldız 1995).

In an interview by Murat Karayalçın, architects Hasan Özbay and Merih Karaaslan, it was stated that Ankara municipality gave single parcels for adjacent buildings for these areas during the initial construction phase and this situation forced the construction. In the first place, the architectural office of the cooperative was asked to develop model houses with practical solutions. Quantitative goals were desired to be achieved in the projects considered as "first generation projects" of Batikent; qualitative aspects were not a priority. But there were changes in the second generation projects, with the municipality's decision to allocate an entire urban island per cooperative. Small blocks, now mostly planned for low-density housing, consisting of several parcels, later came together to provide higher planned area developments. Thanks to this decision, the architecture office now has the flexibility to design and plan not only the house but also the needs of the users. At the end of these two projects, covering the years 1979 and 1984, third generation projects, which aimed for the future and gave priority to urban

and environmental design, began to be formed (Karayalçın 1988). With this development, residential settlements have expanded the scale of architectural design from the parcel scale, which is the smallest unit of traditional housing planning, to the urban island scale. However, housing densities have gradually increased. Densities are quite high when compared to the gross density of Batıkent. As a result, an unhealthy environment consisting of repetitions of cramped and diverse housing types has begun to emerge (Küreli 2021). There are two upper limits, which can be understood from the Batıkent macroform analysis (Figure 2.14). The first is the cooperative borders based on the plan made in 1979, while the second is the municipal border based on the Yenimahalle Municipality responsibility area as of 2021.

According to Küreli (2021), the macroform has changed as a result of rapidly increasing urbanization. There is a marked difference in plot sizes between blocks between the first and second borders. The new blocks, especially in the northern part, have gradually become smaller and fragmented in gross areas. Low and medium density residences are the most common types in the region. Although they are few in numbers, high-density residences are the most crowded and largest residences in terms of unit area. When the morphology of the area is examined, low-density residences are mostly concentrated in the housing types specified as day houses and loan houses. From the very beginning of the project, the area has grown and as its population has increased, the number of medium and high-density residences has also increased, and it is aimed to occupy less space with more crowded residential units. This contradicted the original purpose of the project. There is now a much higher density of housing than was anticipated in 1979. When the buildings in our area are examined according to the number of floors, it is seen that the housing densities were planned according to the topographic characteristics of the region. If we examine it according to three height groups; low-density dwellings are usually 2 or less storey dwellings. Medium density residences are generally 5-9 storey (mid-floor) residences. High-density residences are generally 10 floors and above buildings. Low-density housing is generally concentrated in the highest areas in terms of topography. Likewise, high-density areas are located in the lowest parts (Figures 2.15-2.16 and 2.17).

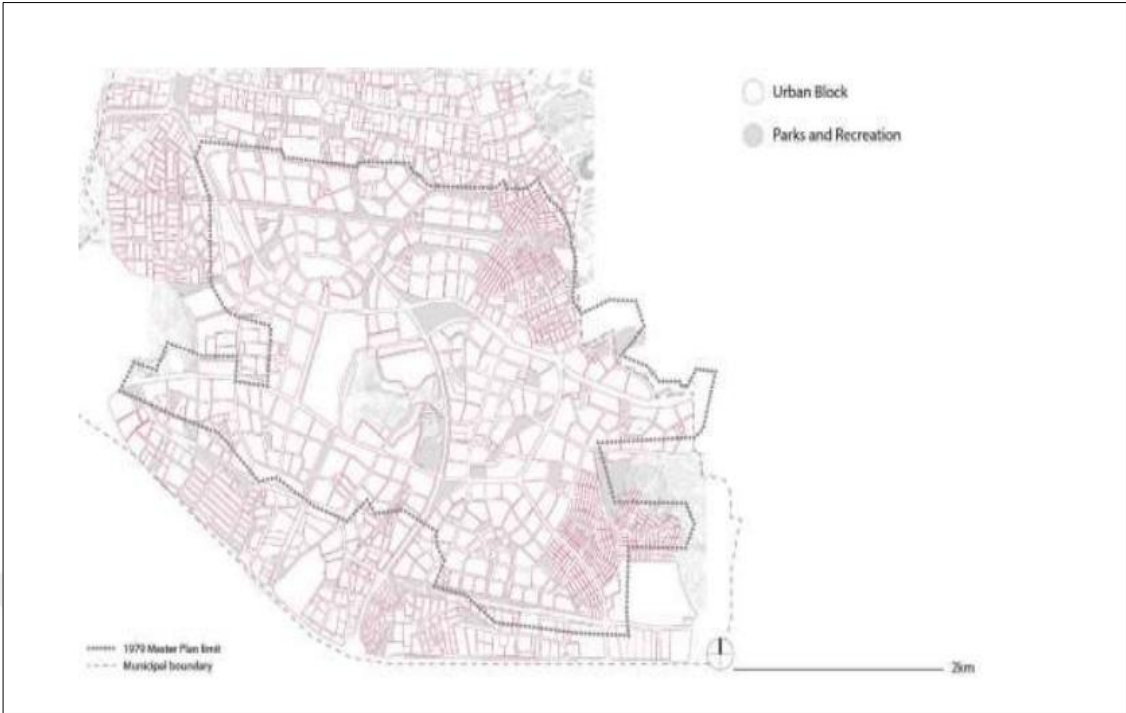


Figure 2.14 Macroform study of Batıkent (Kürelı 2021)



Figure 2.15 Low-density housing in Batıkent (Google Earth 2023a)



Figure 2.16 Medium-density housing in Batıkent (Google Earth 2023b)

According to Küreli (2021), among all these rapidly developing residential islands, very little space has been left for the formation of the 200 public spaces that were foreseen in the first place. Special areas in Batıkent which was founded on cooperatives strictly separated from public spaces and streets. There is little or no interaction between public and private spaces. In Batıkent, it is found along roads, boulevards, busy streets and other arteries with moderate traffic. Although these roads dominate the sense of direction thanks to vehicular routes, they are reinforced with pedestrian paths that encourage the experience of walking among trees and greenery. However, stand-alone footpaths are usually found in parks and hiking trails. Connections between residences are mostly provided by vehicle routes extended with sidewalks. The area also has two levels. The largest part is the industrial zones located in the east and south of Batıkent. In this part, the transition from the industrial zone to Batıkent is also felt with a strong change from the busy business areas to the living environment. On the other hand, there are residential clusters and spaces that can be perceived remotely with their architectural features.

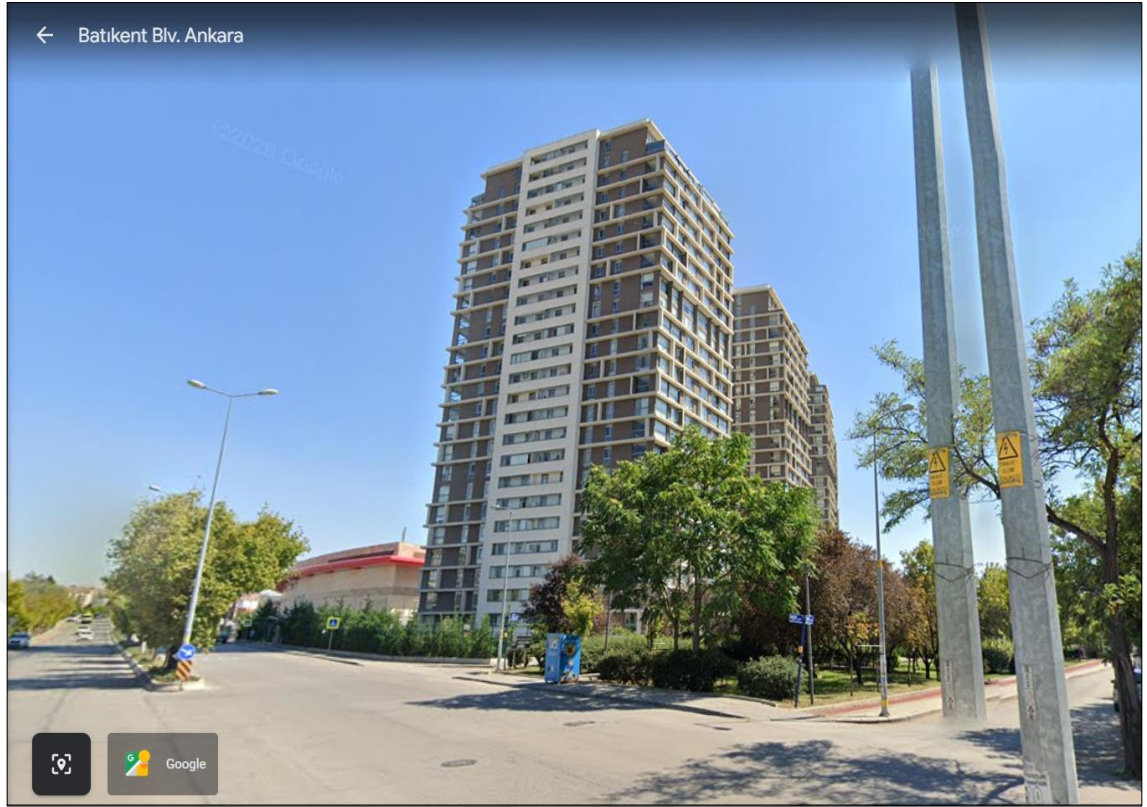


Figure 2.17 High-density housing in Batıkent (Google Earth 2023c)

3. MATERIALS AND METHODS

3.1 Material

The main material of this research is the Batıkent region within the borders of Yenimahalle district of Ankara province (Figure 3.1). Ankara is surrounded by the Provinces of Bolu and Çankırı in the north, Çorum, Kırıkkale and Kırşehir in the east, Aksaray and Konya in the south, and Eskişehir in the west in the Central Anatolian Region of Ankara. The province is located between the mountain ranges that distinguish it from the sea and other regions in terms of topography and morphology, as an area suitable for settlement. The city is rapidly growing around the center where the urban settlement is developing and spreading towards the valuable agricultural lands in the plains and plains such as Kazan, Çubuk and Gölbaşı (Ankara MM 2017).

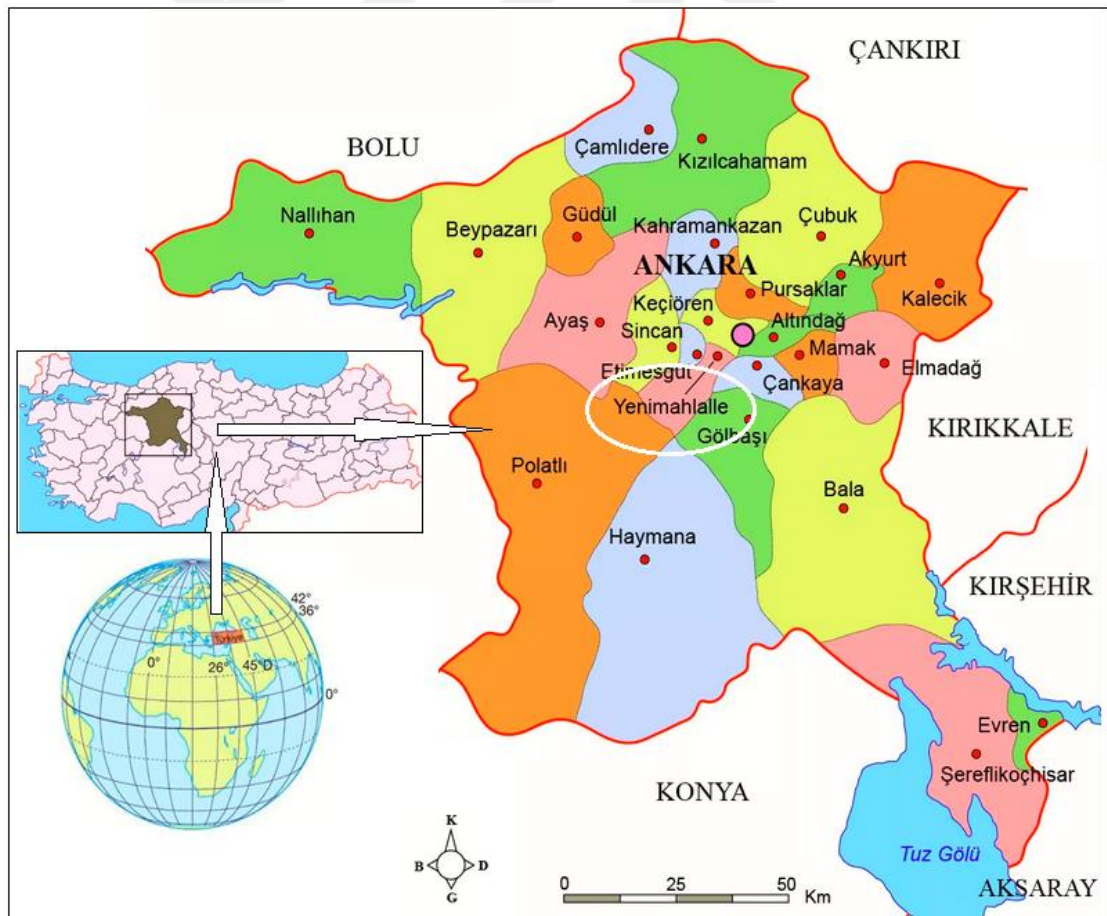


Figure 3.2 Location of Ankara Batıkent region (Google 2023a)

3.1.1 Geological properties of Ankara

The oldest unit is Paleozoic formations in the geological structure of Ankara. Then comes the Lodumlu formation, which consists of Mesozoic (Permian) aged reef limestones. Above this, there is the Elmadağ complex consisting of Upper Carboniferous, Permian and Triassic limestone blocks in a greywacke, anduvase and/or volcanic matrix. On the Elmadağ Complex is the Yakacık formation consisting of pebbles with Lower Jurassic schist, crystallized limestone and gabbro pebbles. On the pebbly level and in harmony with it, sandy, inclined levels with red burgundy colored marls and limestones are observed at the top. Irmak Mixture is located after Yakacık formation. Over this succession, with angular unconformity, is the Upper Jurassic-Middle Cretaceous aged Alacaatlı Formation, lithologically composed of clayey limestones and marls (MTA 1980). climate, topography, etc. There are various soil groups in Ankara due to various reasons. According to the researches, most of the soil profile in Ankara, where most of the brown soils are formed, is calcareous. The total area in the province is 1,706,806 hectares and I., II., III. and IV. class landcover an area of 56.4%. 37.8% of brown soils are used as meadows and pastures (Ankara MM 2017).

3.1.2 Climatic properties of Ankara

Due to its spread over a wide area, the climate characteristics of Ankara vary from place to place. While the harsh steppe climate characteristics are dominant in the southern parts, the temperate and rainy climate characteristics of the Black Sea are observed in the northern parts. However, it generally has continental climate characteristics. Summers are quite dry and hot. Annual average precipitation in Ankara city center is 367.0 mm. The average number of rainy days is 102 days. The months with the most rainy days are December and January with an average of 13 days, and the month with the least is August with an average of 2 days. In general, the temperature difference between summer-winter and day-night is evident. The long-term precipitation average of the province is 419 mm/year. According to the data, the highest precipitation occurs in May and the least precipitation occurs in August in Ankara. According to DSI (Devlet Su İşleri) data, the average flow efficiency is 2.5 l/s/km^{-2} and the average flow/precipitation ratio is around 0.20 (DSI 2021).

3.1.3 Hydrogeological features of Ankara

Ankara is within the hydrological basins of Sakarya, Kızılırmak and Tuz Gölü. The total average flow rate of the three main streams leaving the lands of Ankara province is 5 430 million m³. 2.900 million m³ of this amount is Sakarya, 2.500 million m³ is Kızılırmak, and 30 million m³ is Peçeneközü Stream (MTA 2017). Important water resources in Ankara are given in Table 3.1.

Table 3.1 Important water resources of Ankara (Ankara MM 2017)

NAME	TYPE	LOCATION	CAPACITY (m ³ yıl)	QUALITY	THE SETTLEMENT THAT PROVIDES DRINKING WATER
Çubuk	Dam Lake	Çubuk	22.445.000	I. Class	Ankara
Bayındır	Dam Lake	Kayaş	6.581.000	I. Class	Ankara
Kurtboğazi	Dam Lake	Kızılcahamam	71.500.000	I. Class	Ankara
Eğrekkaya	Dam Lake	Kızılcahamam	85.000.000	I. Class	Ankara
Çamlidere	Dam Lake	Çamlidere	52.674.000	I. Class	Ankara
Akyar	Dam Lake	Kızılcahamam	150.000.000	I. Class	Ankara

Natural lakes in Ankara are Salt Lake, Eymir Lake and Mogan Lake. Approximately 490 km² of Tuz Gölü, which has a total surface area of 1600 km², is within the borders of Ankara province. The total surface area of Mogan and Eymir lakes is approximately 7 km². Mogan and Eymir Lakes are within the borders of the Metropolitan Municipality, and Tuz Gölü is outside the metropolitan contiguous area. Mogan and Eymir Lakes are young lakes that are formed as a result of the accumulation and damming of alluvial material (creating a natural barrier) and form the starting point of the Imrahor Valley water system (MTA 2017). According to the information received from DSI, as of 2006, the groundwater potential of Ankara is around 200 million m³. Most of this potential (75%) is located in Ankara Plain, Kazan-Mürted Plain, south of Polatlı and Şereflikoçhisar-Peçenek basin. Other basins that are productive in terms of groundwater potential are Kirmir Basin (Between Kızılcahamam and Beypazarı), Nallıhan Basin and Çubuk Plain. The demand for groundwater in Ankara has been increasing in recent years. Especially in Ayaş, Beypazarı, Polatlı, Kazan, Gölbaşı and Çubuk districts, many wells are drilled, mostly for irrigation purposes. In addition, the

activities of drilling wells for irrigation of parks and gardens belonging to the sites or villas in and around the city from groundwater are intensifying day by day (MTA 2008).

3.1.4 Disaster situation in Ankara province

Our country frequently encounters natural disasters due to its geological, topographic, and meteorological location. Approximately 93% of our country is located on the active seismic belt. In addition, these settlements are struggling not only with earthquakes but also with natural disasters such as floods and rockfalls.

According to the research carried out between 1950 and 2000 within the borders of Ankara province, a total of 702 disasters occurred. 51% of this number is listed as landslides, 22% as rockfall, and 18% as floods. The districts with the highest number of disasters, respectively, are Altındağ with 18%, Kalecik with 11%, and Mamak with 9%.

According to Figure 3.2, Ankara is generally in the 4th Degree Earthquake Zone on the Earthquake Zones map. However, due to the 3rd degree earthquake zone and the active zones around it, it is in a very sensitive position against earthquakes.

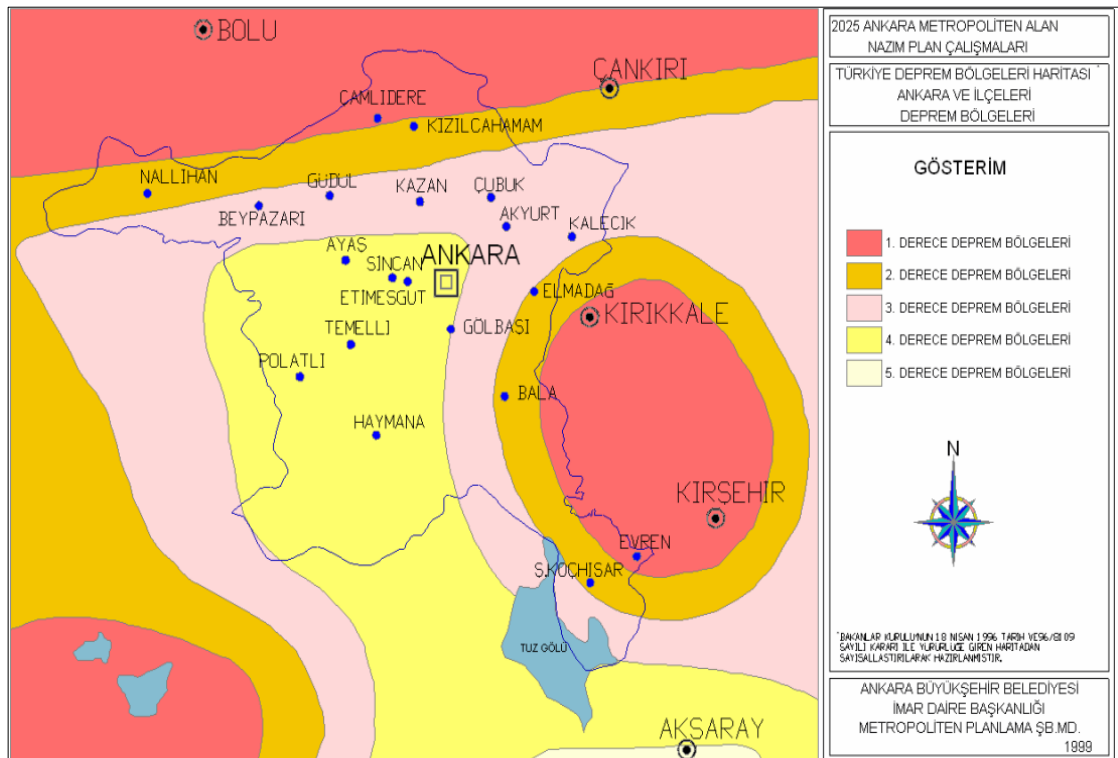


Figure 3.2 Ankara earthquake zones map (Ankara MM 1999)

3.1.5 Landuse in Ankara province

45% of Ankara province is used as agricultural land. This is followed by other areas with 21%, forest areas with 18% and meadow-pasture with 16%. According to the data of the Ministry of Agriculture and Forestry for 2018; It is the agricultural lands that cover the largest area with 58% of the province of Ankara. This is followed by forest and semi-natural areas with 36%. Wetlands constitute the smallest area with 0.32% (Figure 3.3) (Ankara MM 2021).

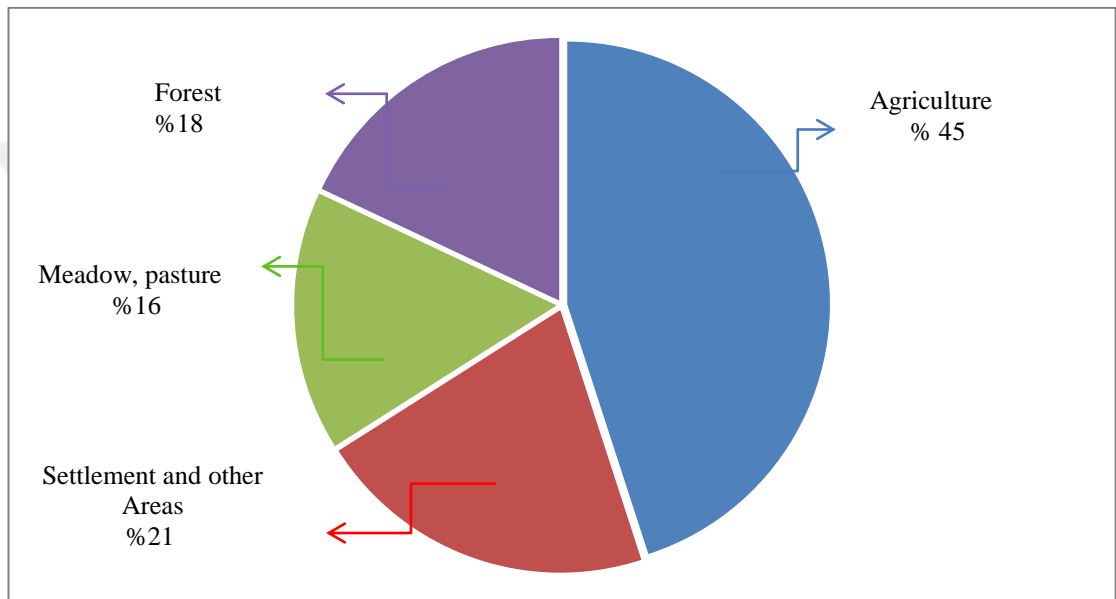


Figure 3.3 Landuse of Ankara province (MAF 2018)

3.1.6 Ankara province water resources

Ankara ranks below the national average in terms of water resources potential. As important water resources, Kızılırmak river basin and its branches and a part and branches of Sakarya basin constitute. Thanks to the dams built on this river and its branches, drinking water, utility water, irrigation water, flood protection and energy uses are used. There are sand quarries on some streams and streams. For example, there are stone and sand facilities on Ova Çay between Kazan and Çubuk districts (Ankara MM 2021). The most important rivers and their tributaries in Ankara are given below:

1. Kızılırmak river and its tributaries Terme Stream, Balaban Stream
2. Sakarya river and its tributaries Aladağ, Nalderesi, Girmir Stream and Ankara Stream
3. Peçeneközü Creek

Among the lakes and surface areas within the borders of Ankara Province, the most important natural lakes are; Mogan, Eymir, Salt Lake and Samsam Lake. As of 2021, the groundwater potential is 286.2 hm³/year (DSI 2022).

3.1.7 Batıkent: Location and General Condition

Batıkent is a district of Ankara Yenimahalle. It is also one of the largest modern housing projects in Turkey. The population of Batıkent constitutes half of Yenimahalle district to which it is connected. The general population consists of people with middle and upper middle income groups. In the 1970s, it started to be created as a solution to the increasing population problem and unplanned urbanization problem in Ankara. The project, which started in the Vedat Dalokay period, has developed considerably, especially with the development of the infrastructure in the Murat Karayalçın period and the completion of the metro network in the Melih Gökçek period (Yenimahalle Municipality 2021). This district, which has the most organized neighborhood structure in Ankara, is in a situation where immigrants are getting more and more every day. According to statistics, Batıkent, which had a population of approximately 175.000 in 2007, exceeded 245.000 in 2021. Considering the location, the region in question is a development area located in the western corridor, 15 km away from the city center of Ankara (Figure 3.4) and forms a border with the Istanbul Road, Ostim Industrial Zone and Eryaman Region. There are industrial areas such as Ostim and İvedik around the region. Batıkent, which is a very important region within the Yenimahalle district, is an important product of the social democrat municipality understanding and has mostly been realized with the understanding of cooperatives. In the region, which completed its construction towards the end of the 1990s, the development process accelerated with the industrial zones moved around the Istanbul Road (Şahin and Gözcü 2017).

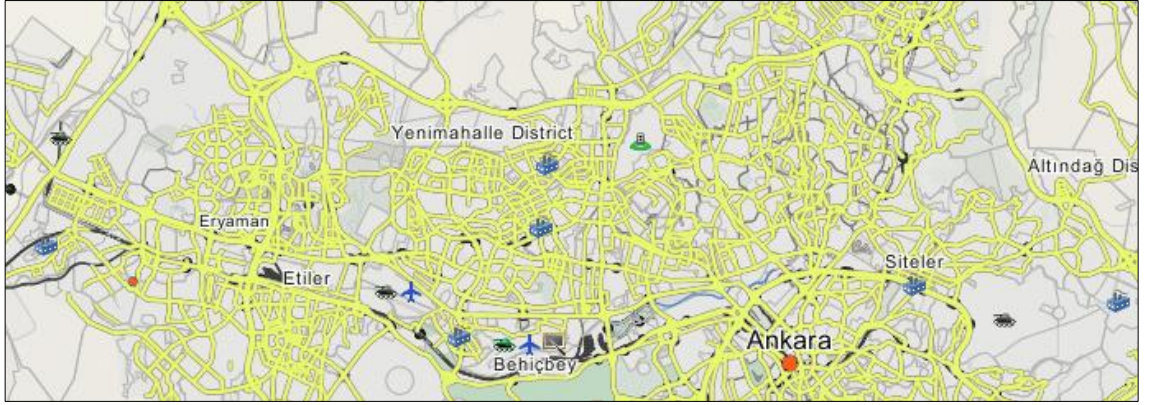


Figure 3.4 Location of Batikent in Ankara province (Google 2023b)

Batikent region has 8 neighborhoods in itself (Figure 3.5 and 3.6). The Batikent region is a region that is intended to be built in a planned and orderly manner within the province of Ankara and is aimed to be developed with a European model plan approach. It continues to develop day by day. When the open and green space arrangements made over the years are examined, it has been seen that the open and green spaces for our study area, which is located within the borders of Yenimahalle municipality, differ in many points such as the qualities, usage purposes and regulations.



Figure 3.5 Location of Batikent quarters (Yenimahalle Municipality 2023)



Figure 3.6 Quarters of Batıkent (1: İnönü, 2: Turgut Özal, 3: Karacakaya, 4: Ergazi, 5: Yuva, 6: Ostim, 7: Kardelen, 8: Uğur Mımcu) (Google 2023c).

The Batıkent Project, the preparations of which started in 1974, started as a housing project targeting middle and lower income families, after Vedat Dalokay became the mayor. On the other hand, by directing the rapidly increasing urbanization in the 1970s to the western corridor, it was targeted as the first satellite city against unplanned urbanization and slums (Günay 2005). The master development plan, prepared by Suavi Akansel and his team in 1979, specified the basis of macroform for Batıkent (Figure 3.7). The said plan was created to provide housing for 5000-7000 people. There are centers and sub-centers according to the plan (Keskinok 2005).

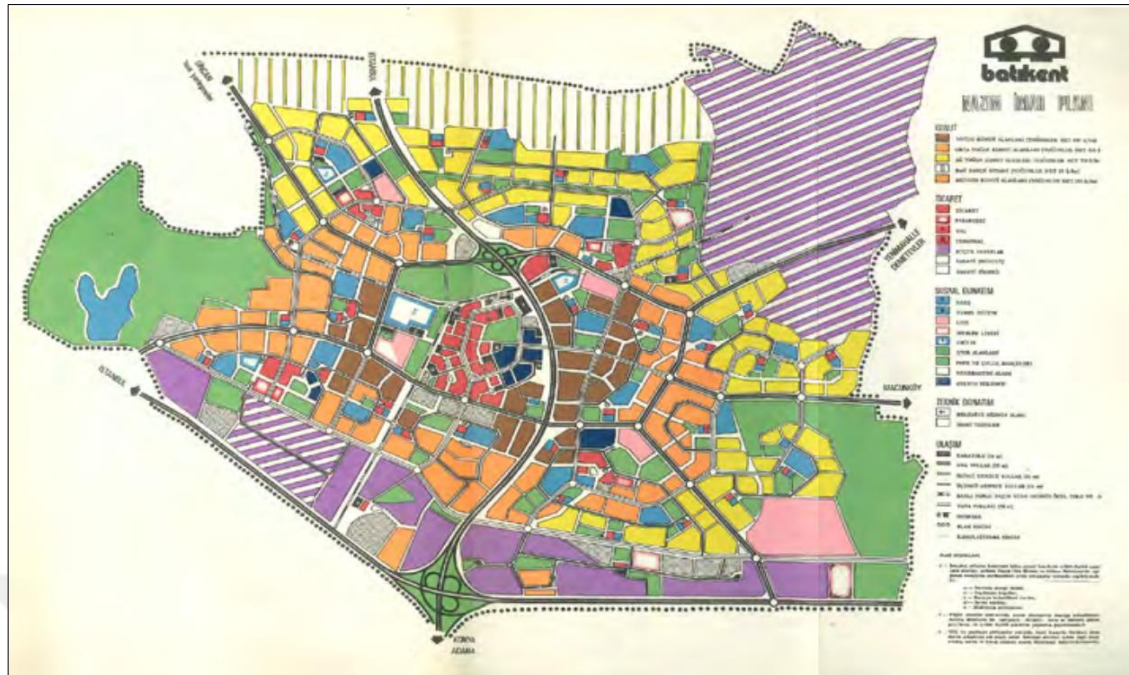


Figure 3.7 Batikent 1979 master development plan (Keskinok 2005)

The area specified as Batikent and its surroundings was defined as the "Western Corridor" in the 1990 Ankara Master Plan. Mass housing areas envisaged as urban development in this area are concentrated in Eryaman, Batikent, Fatih, Etimesgut and Sincan campuses. It is stated that this axis, which is connected with the city center via the Ankara-Istanbul Highway, will provide a faster urbanization. When the land use of the area is examined in 2005, residential uses mainly occupy a place among the urban areas in the region (Figure 3.8 and 3.9). This is followed by work and recreation areas. Small industrial sites adjacent to Batikent region and Sincan Organized Industrial Zone constitute the largest working area of the region. In addition to these industrial areas, OSTİM, İvedik Organized Industrial Zone and Istanbul Yolu-Kazan Urban Work Line provide significant employment in the region.

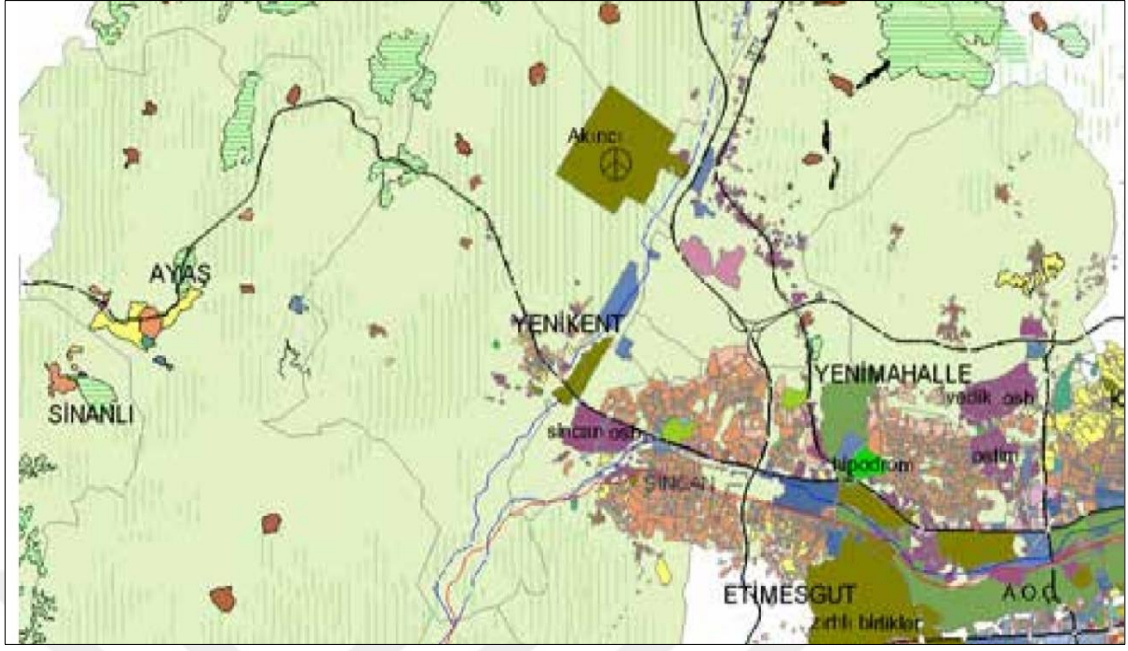


Figure 3.8 Batıkent 2005 western corridor landuse (Keskinok 2005)

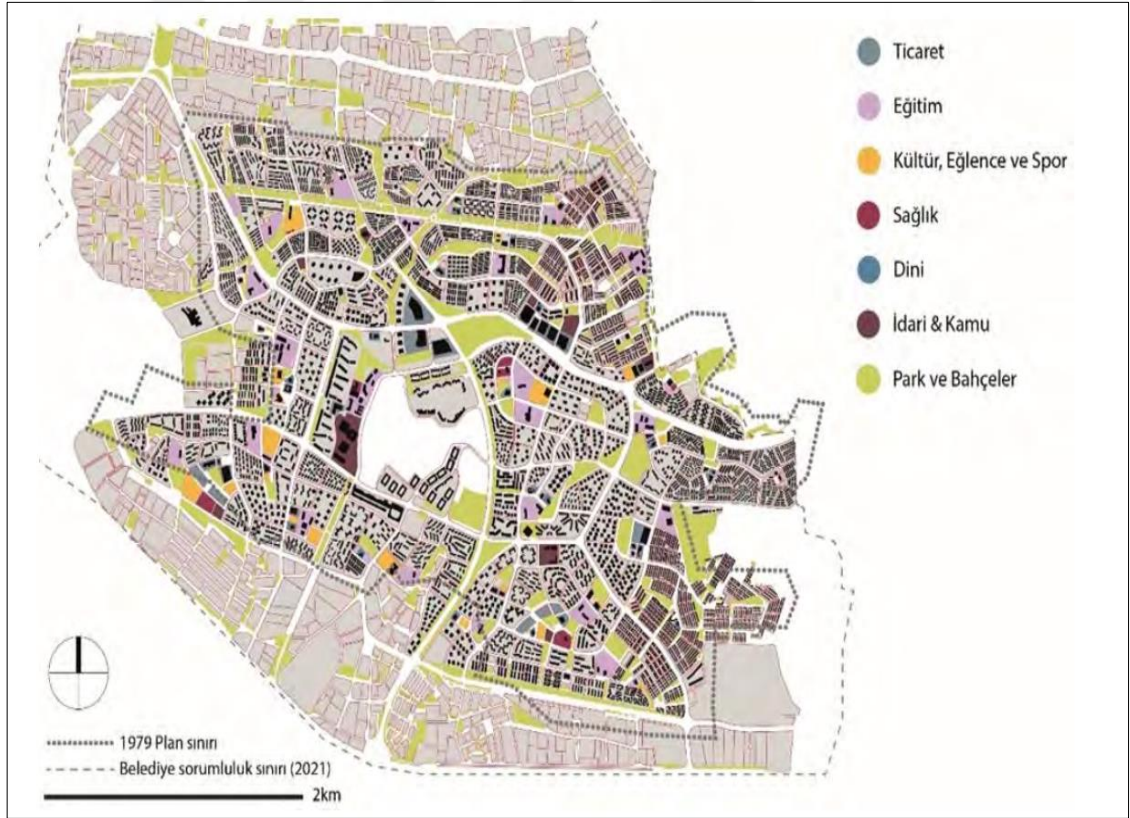


Figure 3.9 Batıkent landuse plan (Kürelı 2021)

3.2 Methods

The method used in the research was created by developing the methods in the studies examined in the theoretical foundations and literature review section. When the research were examined, there are not many studies on blue and green infrastructure in our country. Within the scope of the study, open, green areas and water surfaces were examined in situ in Batikent. In addition, the necessary zoning plans and ready-made plans were obtained, and verbal interviews were provided by negotiating with the responsible municipality and the metropolitan municipality. All these data were processed through Google Earth, Netcad, Yenimahalle municipality zoning application, and Photoshop programs. If we examine in detail, the methods we followed during our study are given in Figure 3.10.

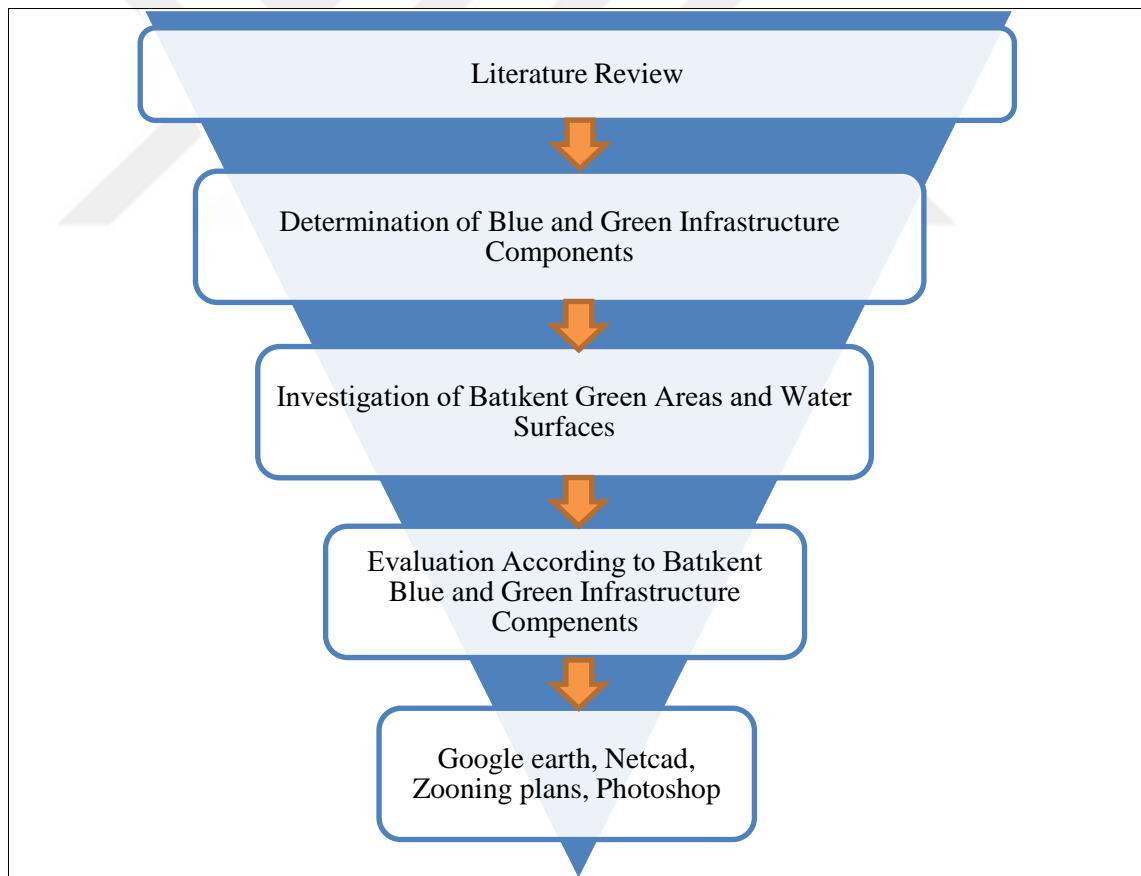


Figure 3.10 The method flow chart used in this study (Original 2023)

Considering the literature reviews and the case studies examined, 7 basic components were determined within the scope of blue-green infrastructure and are given in Table 3.2. The Batkent region of the Yenimahalle district, which we determined as the study area, was examined in terms of the following components.

Table 3.2 Basic components within the scope of blue-green infrastructure in Batkent

	BASIC COMPONENTS
1	Urban open and green spaces
2	Green corridors
3	Green roof
4	Urban water surfaces
5	Rainwater use systems
6	Natural wetlands
7	Mixed-used areas

4. RESULTS AND DISCUSSION

Seven basic components determined within the scope of blue-green infrastructure in Ankara Batıkent region were evaluated, respectively.

4.1 Urban Open and Green Spaces

Open and green spaces greatly affect livability in cities. These areas, other than architectural structures and transportation areas, play a very important role in improving urban living conditions. According to the regulation published by the Ministry of Environment and Urbanization as of 2022, the amount of green space required per person is at least 15 square meters. The amount of green space specified by the World Health Organization is at least 9 square meters per person. In Batıkent, which is our study area, this amount is 23% per person. square meters. There are more than 64 parks in the study area. While most of the open and green areas in the area are affiliated to Yenimahalle Municipality, some large areas that function as regional parks are affiliated to Ankara Metropolitan Municipality (Figure 4.1).



Figure 4.1 Batıkent open and green spaces systems (Netcad 8.5.2)

The West Park, located in the area specified as the Batı Sitesi neighborhood, is under the responsibility of the Ankara Metropolitan Municipality. Unlike many parks in the region, there is a skateboarding track in the west park (Figures 4.2 and 4.3).



Figure 4.2 Open and green areas of western region (Netcad 8.5.2)



Figure 4.3 West park skateboarding track and green area (Original 2023)

Erol Kaya Walking Park (Figure 4.4), located in İnönü neighborhood (Figures 4.5) is a park belonging to the Ankara Metropolitan Municipality. The biggest feature that distinguishes this park from other open and green areas is that it creates a barrier that

supports the green corridor in the area. In addition, it is separated from the parks in studied area with a 2506 m² running and walking path.



Figure 4.4 Erol Kaya walking park (Orijinal 2023)



Figure 4.5 Ergazi and İnönü neighborhoods open and green areas (Netcad 8.5.2)

Although İsmail Hakkı Tonguç Park, located in İnönü district, is a neighborhood-scale park under the responsibility of Yenimahalle municipality, it has differentiated itself from other open and green spaces with its monumental elements (Figure 4.6).



Figure 4.6 İsmail Hakkı Tonguç park (Orijinal 2023)

Kentkoop and Uğur Mumcu districts are centrally located in the Batkent region, which is our study area, and are the first settlement areas of the region. There are many parks qualified as regional parks in these areas (Figure 4.7).



Figure 4.7 Kentkop and Uğur Mumcu open and green areas (Netcad 8.5.2)

Vedat Dalokay Park, located in Uğur Mumcu neighborhood, is a regional park belonging to Ankara Metropolitan Municipality. Many concerts and activities are held frequently in the 40.800 m² park (Figures 4.8 and 4.9).



Figure 4.8 Vedat Dalokay park (Google 2023d)



Figure 4.9 Vedat Dalokay park (Google 2023e)

Haydar Aliyev park was built by SOCAR, the State Oil Company of Azerbaijan, in 2012 and given to the use of Ankara Metropolitan Municipality. The park, which has an area of 97.400 m², has monumental sculptures, a ceremonial area, two pools, a 1500-person amphitheater, sports fields, locker rooms, children's playground, fitness area, cafe, walking paths, camellias and resting areas (Figures 4.10 and 4.11).



Figure 4.10 Haydar Aliyev park (Google 2023f)



Figure 4.11 Haydar Aliyev park (Google 2023f)

There are more than 64 parks in our study area, along with some of the open and green areas mentioned above. In addition to these park areas, there are large recreation areas in the project phase. Currently, it is planned to construct two regional parks, one for which the foundations have been laid during the negotiations with the municipalities, and one at the project drawing stage and one more than 650.000 m².

According to the statement published by the Federal Nature Protection Agency (BNF 2017), the existence and systematic creation of open and green areas is an important issue for the blue and green infrastructure system. Parks have a serious place among the basic elements that make up the green infrastructure.

In this context, it can be said that the open and green space systems regarding the study area are in a highly developed and orderly condition. Open and green areas, which are planned to serve different groups and at different scales have different elements (Table 4.1).

Table 4.1 Elements in parks of Batıkent region

PARK NAME	ELEMENTS IN BATIKENT PARKS
The West	Skateboarding track
Erol Kaya Walking	Barrier that supports the green corridor Running and walking path, 2506 m ²
İsmail Hakkı Tonguç	Differentiated itself from other open and green spaces with its monumental elements
Vedat Dalokay	Many concerts and activities are held frequently in the 40.800 m ² park
Haydar Aliyev	An area of 97.400 m ² , has monumental sculptures, a ceremonial area, two pools, a 1500-person amphitheater, sports fields, locker rooms, children's playground, fitness area, cafe, walking paths, camellias and resting areas

4.2 Green Corridors

Green corridors; These are corridors that provide the connection of natural corridors such as rivers and valleys, as well as areas such as parks, recreation areas, cultural objects and historical settlements. It can also be defined as the whole of open spaces created to plan, protect and connect ecological, recreational and cultural uses (Arslan *et al.* 2004).

In addition to the green corridors created by parks and recreation areas in our study area, large green areas, which are considered as medians in the transportation network, and green corridors have been created. Thanks to the planned construction of the area, the vast majority of open and green areas provide continuity. For example, there is a 2730-meter-long park, an area to be afforested, and a green corridor created with recreation areas in our area. There are green corridors as a buffer zone between the OSTİM industrial zone adjacent to our study area and the residential areas (Figure 4.12 and 4.13).

Within the green infrastructure system, it is important to create a greenway or green corridor system that will enable different open green areas to be associated with each other in a comfortable and active way (Demiroğlu *et al.* 2019).

In the Batıkent region, which is our study area, when we examine the concept of green corridor, a green corridor system is planned in which parks and recreation areas of different scales are connected by highway and pedestrian axes. However, in this corridor, the relationship of these areas with each other exists only on the plan, and a sufficient and regular relationship could not be seen in place.



Figure 4.12 Satellite image of Batıkent region green corridor example (Netcad 8.5.2)

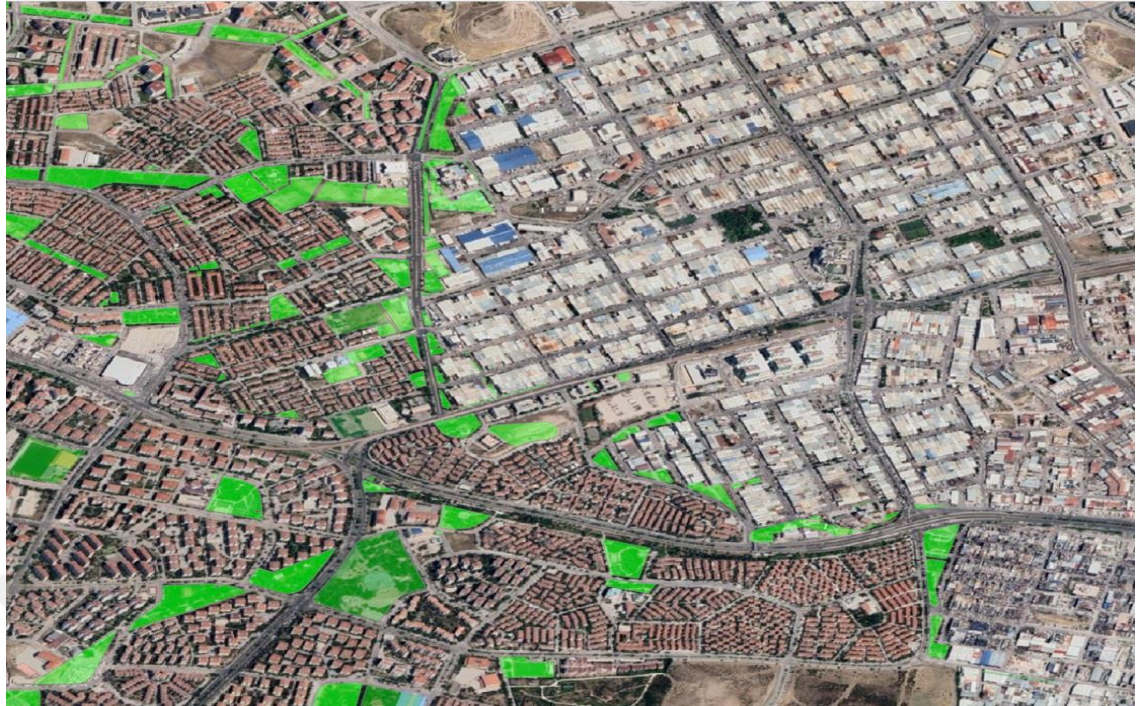


Figure 4.13 Green corridors between Batkent and industrial zone (Netcad 8.5.2)

4.3 Green Roof

Green roofs are defined as "vegetated roof technology", "living roofs" or "eco roofs". The concept of green roof basically includes all kinds of planting applications on the roof surface and refers to the area covered with a waterproof layer of the surface area and covered with soil and vegetative elements above it, which is specially designed to provide and balance local, social and ecological benefits at the highest level (Peck and Kuhn 2003). Although this system is frequently applied in Istanbul in our country, a similar design has been encountered in the construction known as Gala Houses in our study area, although it is not a complete green roof application (Figure 4.14).

Green roof applications are a method that has many positive effects such as regulating the temperatures of buildings used in crowded urban areas and large industrial areas where land values are high, ensuring the use of rainwater, increasing urban biological diversity (EPA 2023).



Figure 4.14 Green roof examples of Gala Batıkent residences (Google 2023g)

In our area, the green roof application is located in one building block. And it has been seen that the application is designed to provide an active area of use and gain from the area, rather than a sustainable effect such as the use of rainwater.

4.4 Urban Water Surfaces

Urban open and green spaces are breathing spaces for cities. And these places are very important for cities. In order to ensure the quality of the open and green spaces and the elements that define the space, the water element has an increasing effect on the livability of the spaces (Kürkçükoğlu 2009). Many of the open and green areas in our study area have a water element. The majority are located in public parks and recreation areas. In some residential areas, the water element is also used in the common areas. However, there is no natural water surface in the area (Figure 4.15). The water element has a very important place in the arrangement of urban open spaces, which have an important place in urban areas. The use of water in urban open and green spaces is very effective in terms of quality, usability and livability of the space (Kürkçüoğlu 2009). Among the open and green areas in the Batıkent region, the water element is frequently encountered in the areas that have the nature of a regional park and are frequently preferred. This showed that open and green areas where the water element is used are more preferred.



Figure 4.15 Examples of Batıkent public space urban water surface (1. Yekta Göngör Park (Google 2023h), 2. İsmail Hakkı Tonguç Park (Google 2023i), 3. Haydar Aliyev Park, 4. Vedat Dalokay Park) (Google 2023j)

4.5 Rainwater Utilization Systems

Water, which is the most basic need of people at all times, has been consumed unconsciously due to rapidly increasing industrialization and population. This unconscious consumption and insufficient natural resources have pushed people to seek other water sources. For this purpose, rainwater collection and storage systems have been developed. Rainwater harvesting is the collection of water from precipitation with different methods and systems. Sustainable water is one of the alternative sources of management. Rainwater harvesting is achieved by directing the rain flowing from roofs and surfaces during precipitation to suitable storage areas (Can 2021). While some of the public spaces in the open and green areas in Batıkent, which is our study area, are affiliated to Yenimahalle District Municipality, some are affiliated to Ankara Metropolitan Municipality. As of 2021, most of the open and green areas under the responsibility of the Metropolitan Municipality are irrigated by the resources created by the storage of rain water. In order to prevent flood risks in urban areas, to support

natural water resources, and to ensure sustainability, the analysis of rainwater use and management is important for the concept of green infrastructure (Çay 2020). In the Batkent region, there are no serious stormwater management policy actions to support the blue and green infrastructure.

4.6 Natural Wetlands

Wetlands can be defined as all non-artificial water bodies, natural or artificial, permanent or temporary, brackish, fresh or salty. This includes marshes, reeds, wet meadows and parts of the sea up to six meters deep (DKD 2023). There is no natural wetland in our study area that we can evaluate within the framework of the definition mentioned above. Within the concept of blue and green infrastructure, nature-based solutions and solutions supported by nature are used for sustainable water management. The presence of natural water resources in the first step in the urban water cycle emphasizes how important these resources are (Haase 2015). There is no natural water source in our study area. For this reason, applications such as semi-natural drainage systems, small channels and culverts should be developed in order to ensure a healthy water cycle within the scope of the blue and green infrastructure concept.

4.7 Mixed Uses Areas

Due to the increasing rate of urbanization, an approach known as mixed-use area has been adopted, aiming to use various land uses together in order to create a sustainable and environmentally friendly, livable city structure. This approach can be defined as regions where many types of land use such as housing, commerce, official institution areas, health facilities, social and cultural facilities, green areas, and educational facilities are located together (Çubukçu 2022). With the mixed use of the land, carbon emissions are reduced by minimizing the use of private vehicles. At the same time, a sustainable approach is provided in many social and environmental issues such as the use of different functions together and the elimination of the security problem (Çetinkaya 2016). Mixed use areas have been planned and created quite effectively in our study area. In our area, there are mixed uses of different sizes from neighborhood scale to regional scale. To explain with examples, there are large shopping centers and

markets in the area defined as the central business area in the Batıkent region (Figure 4.16), which is our study area. These commercial functions are also complemented by sports fields, large open and green spaces and educational units. On the other hand, in smaller areas formed by the merging of neighborhoods or several sites, these mixed-use areas are composed of commercial functions, primary schools, health centers and small-scale parks to meet daily and basic needs (Figure 4.17-4.19).



Figure 4.16 Batıkent central business area (ATLANTIS) (Google Earth 2023d)



Figure 4.17 Relationship between Atlantis AVM and open green space (Google Earth 2023e)



Figure 4.18 Relationship between Atlantis and open green space (Original 2023)

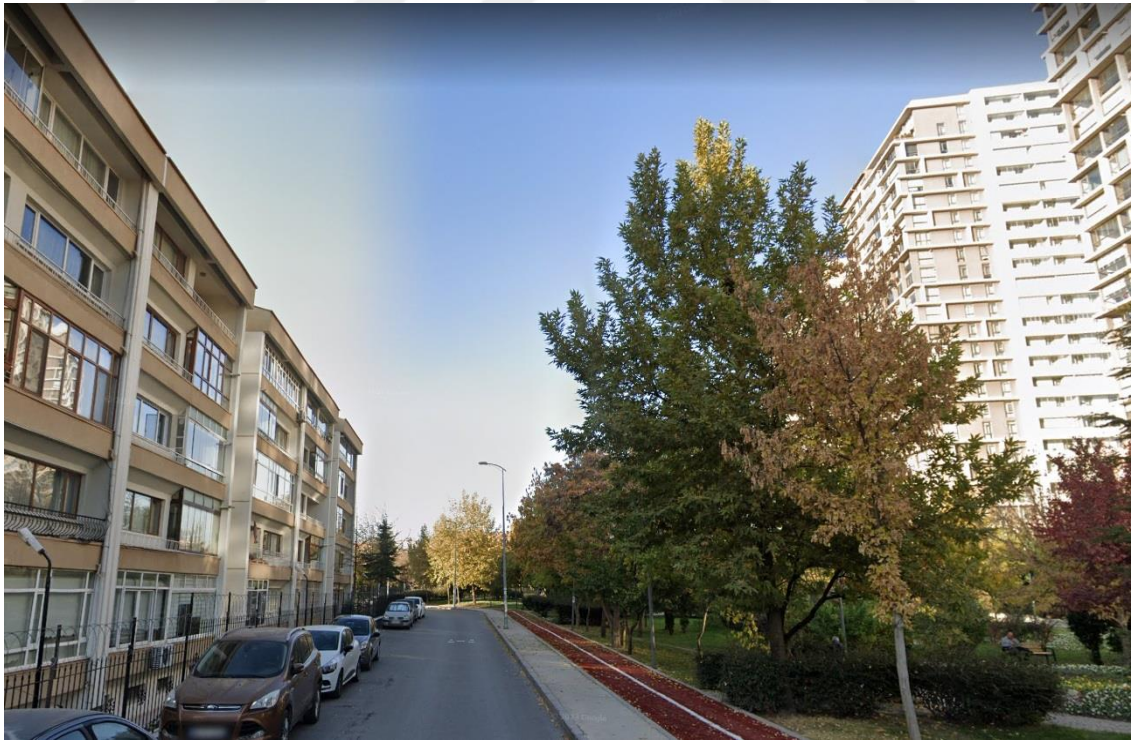


Figure 4.19 Relationship between housing and parking space (Original 2023)

5. CONCLUSION AND RECOMMENDATION

Blue-green infrastructure planning is one of the basic elements of planning within the scope of ecological sustainability. Blue-green infrastructures, which are the structures created by integrating urban green structures with water elements, are not only ecosystems but also planning that provides benefits in many environmental, social, and economic areas. Therefore, considering the effects of climate change, which is an important process today, it has become imperative to realize climate-compatible and sustainable urban planning. In this regard, blue-green infrastructures, which is an application that strengthens urban ecosystems, is becoming more and more common with different examples in the world. However, studies on blue and green infrastructure in Türkiye are very rare. In this study, the blue and green infrastructure system setup was examined within the borders of the Ankara Batıkent region.

In Batıkent region, which is study area, the park areas, which we describe as open and green areas, are of sufficient density, but there is no sustainable system in these areas. However, it will be the wrong approach to consider only park areas as a green infrastructure quality. Therefore, under the titles of urban open and green spaces, green corridors, green roofs, urban water surfaces, rainwater usage systems, natural wetlands, and mixed-use areas in Batıkent were evaluated within the scope of blue-green infrastructure.

Firstly, theoretical foundations were examined, literature reviews were done, and blue-green infrastructure applications in the world were evaluated. Then, open, green areas and water surfaces were examined in situ in Batıkent. In addition, the necessary zoning plans and ready-made plans were obtained, and verbal interviews were provided by negotiating with the responsible municipality and the metropolitan municipality. All these data were processed through Google Earth, Netcad, Yenimahalle municipality zoning application, and Photoshop programs.

There are more than 64 parks in the study area. Open and green areas in Batikent were planned to serve different groups with different activities. They include elements such as skateboarding track, green corridor, running and walking path, monumental sculptures, ceremonial areas, pools, amphitheater, sports fields, locker rooms, children's playground, fitness area, cafe, walking paths, camellias, and resting areas. In addition, they were located at a minimum walking distance, continuously, and at different scales.

A green corridor system is planned in which parks and recreation areas of different scales are connected by highway and pedestrian axes. However, this existed only on the plan, in addition, a sufficient and regular relationship could not be seen in place. The green roof application is located in one building block, it was designed only to provide an active area of use and gain from the area. Moreover, sustainable approaches such as green roofs were not applied in many sites and also quite lacking in the study region. Open and green areas where the water elements are more used are preferred in the region. However, in the study region, water elements are only used as ornamental pools, and there is no available study within the scope of the sustainability principle. There is no stormwater management policy system or natural water source in our study area. However, for a sustainable and efficient water cycle for open and green spaces, it needs to be developed semi-natural drainage systems, small channels and culverts applications.

Considering the examples of blue-green infrastructure applications that are widely used around the world, it is seen how inadequate such applications are in our country. With this study, it was also desired to draw attention to the importance of filling an important gap on the subject. For this reason, it is suggested that new blue-green infrastructure applications that can be realized in a planned and sustainable way should be increased.

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