# Biyolojik Çeşitliliğe ve Ekosistem Hizmetlerine Katkı Sağlayan Kentsel Projeler

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**ABSTRACT**

Urban areas are expanding faster than urban populations. This urban expansion will heavily draw on natural resources and often consume prime agricultural land with emissions that affect negatively ecosystems and biodiversity. However, cities' efforts including landscape projects can play a key role to protect and manage vulnerable ecosystems and biodiversity. In the recent years, individual cities have begun to take an increasing responsibility in the management of ecosystem resources and improvement the biodiversity. In this research, it has been tried to determine features and strategies of modern urban projects performed all around the world to find out how their functions address the issue. In this work, through the case analyses, some critical urban approaches for contributing and improving the ecosystem services and biodiversity are summarized which are: to preserve or rehabilitate the wetlands surrounding the cities; to conserve the forest, native green areas, and remote ecosystem; to do urban agriculture and rooftop gardening; to green and plant native plants; to educate environmentally; to connect fragmented ecosystems; to mitigate pollution by waste management. The results of this work can be beneficial for planners, designers and managers of landscape about management, design, and planning strategies in the cities and beyond cities.

**Key Words:** City contribution, Biodiversity, Ecosystem services, Landscape projects, Cities

Kent parkları, medyan yeşil şeritleri ve ağaç dikme çalışmaları, kent sakinlerine daha huzurlu ortamlar sunup ve yaban hayatı için bir sığınak sağlayabilir. Son yıllarda, bireysel şehirler, ekosistem kaynakların yönetiminde ve biyoçeşitliliğin geliştirmesinde, bölgesel ve hatta küresel ölçekte artan bir sorumluluk almaya başlamışlardır. Bu makalenin amacı, ekosistem yönetimine katkıda bulunabilir ve biyolojik çeşitliliğini geliştirebilir kentsel projelere ait bazı tekniklerin açıklanmasıdır. Bu araştırmada, dünya çapında, gerçekleştirilmiş olan modern projelerinin, özelliklerini ve stratejilerini belirlemeye çalışılarak, işlevleri ile meseleyi nasıl ele aldığını ortaya

koymuştur. Örnekler hakkında verileri elde etmek için masa araştırması yanı ikincil veriler olarak, internet, kütüphane, devlet kurumları ve belediyeler tarafından yayınlanan raporlardan yararlanmıştır. Sonunda, ekosistem hizmetlerine ve biyolojik çeşitliliğe katkı sağlamak ve iyileştirmek için bazı kritik kentsel yaklaşımları özetlenmıştır; Kentleri çevreleyen sulak alanların korunması veya iyileştirilmesi; ormanı, yerli yeşil alanları ve uzak ekosistemin koruması, Kentsel tarım ve çatı bahçeciliğin yapılması; yerli bitki yetiştirilmesi; Çevrenin eğitilmesi; parçalanmış ekosistemleri birbirine bağlanması; Atık yönetimi ile kirliliğin azaltılması gibi. Bu çalışmanın sonuçları, planlamacılar, tasarımcılar ve peyzaj yöneticileri için şehir ve şehir dışı yönetim, tasarım ve planlama stratejileri konusunda yararlı olabilir.

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## ÖZET

Kentsel alanlar, kent nüfusundan daha hızlı genişmektedir. Bu kentsel genişleme, doğal kaynakları büyük oranda etkilemekte ve başlıca tarım arazilerini tüketmektedir, dolaysıla emisyonları, ekosistemleri ve biyoçeşitliliği olumsuz yönde etkilemektedir. Ancak, şehircilerin çabaları ve peyzaj projeleri, savunmasız ekosistemlerin ve biyolojik çeşitliliğin koruması ve yönetmesi için önemli bir rol oynayabilir. Kent parkları, medyan yeşil şeritleri ve ağaç dikme çalışmaları, kent sakinlerine daha huzurlu ortamlar sunup ve yaban hayatı için bir sığınak sağlayabilir. Son yıllarda, bireysel şehirler, ekosistem kaynakların yönetiminde ve biyoçeşitliliğin geliştirmesinde, bölgesel ve hatta küresel ölçekte artan bir sorumluluk almaya başlamışlardır. Bu makalenin amacı, ekosistem yönetimine katkıda bulunabilir ve biyolojik çeşitliliğini geliştirebilir kentsel projelere ait bazı tekniklerin açıklanmasıdır. Bu araştırmada, dünya çapında, gerçekleştirilmiş olan modern projelerinin, özelliklerini ve stratejilerini belirlemeye çalışılarak, işlevleri ile meseleyi nasıl ele aldığını ortaya koymuştur. Örnekler hakkında verileri elde etmek için masa araştırması yanı ikincil veriler olarak, internet, kütüphane, devlet kurumları ve belediyeler tarafından yayınlanan raporlardan yararlanmıştır. Sonunda, ekosistem hizmetlerine ve biyolojik çeşitliliğe katkı sağlamak ve iyileştirmek için bazı kritik kentsel yaklaşımları özetlenmıştır; Kentleri çevreleyen sulak alanların korunması veya iyileştirilmesi; ormanı, yerli yeşil alanları ve uzak ekosistemin koruması, Kentsel tarım ve çatı bahçeciliğin yapılması; yerli bitki yetiştirilmesi; Çevrenin eğitilmesi; parçalanmış ekosistemleri birbirine bağlanması; Atık yönetimi ile kirliliğin azaltılması gibi. Bu çalışmanın sonuçları, planlamacılar, tasarımcılar ve peyzaj yöneticileri için şehir ve şehir dışı yönetim, tasarım ve planlama stratejileri konusunda yararlı olabilir.

**Anahtar Kelimeler:** Kentin katkısı, Biyolojik çeşitlilik, Ekosistem hizmetleri, Peyzaj projeleri, Kentler,

## 1. INTRODUCTION

Urban growth are increasing faster than urban populations and urbanization will triple till 2030 (1). With this extreme urbanization and cities' demand for natural sources and ecosystem services, the ecology and natural ecosystem of the planet is affected by human activities. In fact, urban growth is associated with occupying the natural environments like wetlands, lake and

forests with buildings, routes and other constructions besides extreme change of natural landscape (2).

The cities' expansion has also caused the loss of biodiversity through degradation, fragmentation and destruction of natural habitats on earth (3; 4); urban heat islands, increased temperatures, water runoff posed by impervious surfaces, and emission of carbon dioxide (5, 6); and isolation of natural habitats (7). However, cities can contribute to improve ecosystem services (ES) and support rich biodiversity.

The ecosystem services emphasize the benefits that ecosystems provide to human wellbeing and health both directly and indirectly (8). Ecosystems have the potential to provide food and energy, protect against natural hazards, regulate climate and disturbance regimes, support agriculture, prevent soil erosion, and create esthetics values and recreational opportunities (9). Urban ecosystem services are generated in diverse habitats including green spaces, gardens and urban forests, vacant lots, campus areas, cemeteries, brownfield, landfills; blue lands such as urban wetlands, streams, lakes, ponds. Table 1 contains examples of important services provided by green and blue ecosystems in urban areas.

**Table 1:** Ecosystem services provided by green and blue ecosystems in urban areas (10)

| | |
|---|---|
| Microclimate regulation | • To reduce the urban heat island effect by the city parks and its greenery<br>• To decrease energy use of fossil fuels<br>• To absorb carbon by trees and green covers |
| Water regulation | • To catch rainfall by plants and permeable surfaces and soil<br>• To reduce surface water flooding and subsequently reduce the pressure on the drainage system |
| Pollution reduction and health effects | • To improve inequity in human health (both physical and mental) among urban socio-economic groups and improve general health of human<br>• To improve air quality by urban vegetation and cooling the air<br>• To reduce mortality in green area |
| Habitat | • To have diversity of plant and animal species and various habitats and contribute to reduce biodiversity loss |

| | |
|---|---|
| Cultural and Social services | • To help human health by the psychological benefits of green areas<br>• To increase value of properties regarding proximity to green areas.<br>• To provide design features for architecture and urban planning to create eco-design and bio-mimicry<br>• To consolidate sense of place and sense of identity in cities.<br>• To provide opportunities for education and cognitive development of young children. |

Cities operations and activities may contribute to the biodiversity improvement as well. Biodiversity according to the Convention on Biological Diversity (CBD), means the variability among living organisms from all sources including terrestrial, marine and other aquatic ecosystems and also diversity within species, between species and ecosystems' (1). Food provision, clean water, medical stuff, and quality of life are some of the services which biodiversity offers to cities (11).

20 targets have been made as a part of the CBD's Strategic Plan for Biodiversity 2011–2020 in which conservation of biodiversity, the sustainable use of its components, and the fair and equitable sharing of the benefits from using genetic resources are main goals (12).

Biodiversity in cities is the richness and variety of living organisms (including genetic variation) and also variety of landscapes and habitats which contains:

- Natural landscapes remaining in the cities like leftovers of primeval forests.
- Traditional agricultural landscapes such as meadows.
- Urban–industrial landscapes such as residential areas, city centers, urban parks and gardens, industrial parks, railway areas, and brownfields (9).

Recognizing the importance of biodiversity and healthy ecosystems for cities survival, today, cities initiate many operations to conserve natural sources and ecosystem services. Even though it has been studies how urbanization affects biodiversity and human well-being, there is a need for

research on how this knowledge is utilized in landscape practices and urban projects. This research makes attempt to identify and introduce some ways in which modern cities could improve the ecosystem services and contribute to biodiversity improvement. It introduces some projects, their features and strategies used in order to increase biodiversity and ecosystem services from all around the world.

## 2. METHOD & MATERIALS

In this research, by investigation of the various urban websites, government agencies, published reports, and documents, some significant urban and landscape projects are explained with a focus on their functions for increasing biodiversity and ecosystem services. The cases discussed in this work have been chosen from successful urban and landscape projects. In this way, some of the implemented projects have been analyzed to identify how modern cites could address the issue and which initiatives have been performed to offset biodiversity loss and maintain ecosystem services.

### 2.1. Eco-Links and Green Ways

Eco-links are underground tunnels and vegetated overhead bridges that connect the green areas and provide a way of movement for mammals, insect, and other species (9). There are various crossing structures established in European countries including the Netherlands, Switzerland, Germany, and France to mitigate the conflict between wildlife and roads and protect wildlife such as: amphibians, badgers, ungulates, invertebrates, and other small mammals (Figure 1).

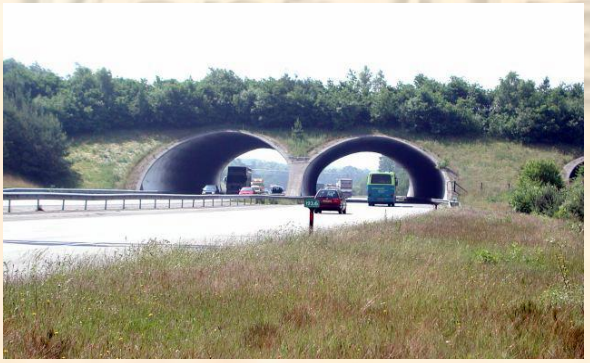

Figure 1: Highway A50 in Netherlands (13)

In the urban environments, greenways can be found in the forms of green sideways, green wedges or streams which penetrate in urban structures and connect the urban green spaces like parks and garden. Rua Gonçalo de Carvalho in Porto Algre/ Brazil is an example of natural urban ecolink (Figure 2). Although the trees occasionally cause power outages when it rains, it has benefits for the residents. In addition to serving as an ecolink, improve air quality, the trees decrease the urban heat island effect, minimize the impact of rain and flooding, and increase property values.

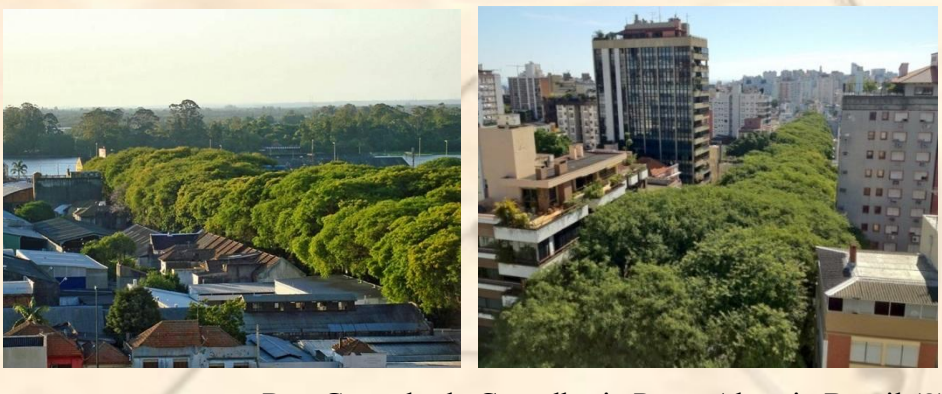

Figure 2: Rua Gonçalo de Carvalho in Porto Algre in Brazil (9).

### 2.2. Restoring Biodiversity in Mayesbrook Park/ London

Mayesbrook Park is located in a densely urban area of East London. It is considered as an ecological project designated to produce the UK's first climate change adaptation public park.

It is a cooperation of public-private organization with a goal of rehabilitating the Mayesbrook and creating a new floodplain that can naturally and safely store floodwater (Figure 3). Rehabilitation of three rivers in a habitat-depleted park can be a good example of an approach that combines biodiversity enhancement with flood storage (14). With planting new shrubs and trees provided shade, enhancing habitats for wildlife, adding new footways and signage, the public are able to use better the park (14). This project has led to reducing flood peaks and reconnects the brook with its natural floodplain.

Figure 3. View of one of the lakes restored in the park. Source: Thames Rivers Trust (15)

## 2.3. Managing natural wetlands in Nakivubo Swamps/ Uganda

The Nakivubo swamp characteristics and its location have provided an important set of services to the Kampala's dwellers. It has been receiving wastewater from Kampala for over 30 years. This swamp consists of floating root mat co-dominated by the sedges Cyperus papyrus and Miscanthidium violaceum. The partially treated wastewater flows beneath the floating mat into Lake Victoria via the Murchison Bay (Figure 3). This swamp can remove the nutrients and pathogens from wastewater in a sustainable way, however it maintain the ecological quality and biodiversity for future functionality of to the city (16).

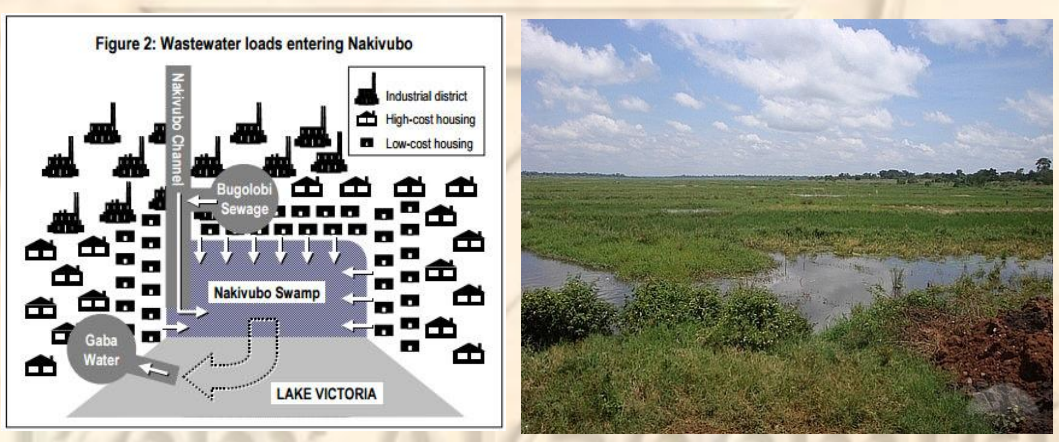


Figure 3: Nakivubo's swamp functions as a buffer that through it, the city's industrial and domestic wastewaters pass before being discharged into Lake Victoria at Murchison Bay (16).

## 2.4. Biodiversity Recovery in Greater Sudbury, Ontario/Canada

Past mining activities have produced a high level of atmospheric Sulphur dioxide and resulted in the disappearance of most of the area's vegetation in the Ontario. In 1978, the city initiated an

environmental clean-up and re-greening program (17). The program has resulted in planting of millions of trees and shrubs on vast areas of land. Together with the mining companies, the city also developed a Biodiversity Action Plan.

### 2.5. Water Supply, Sewerage, and Environmental Clean-Up in Cartagena /Colombia

This project is a 20-year project (2005-2025) in order to expand the water supply and sewerage for the city of Cartagena in Colombia. It has also provided opportunities for the sustainably dispose of wastewater, restoration of an important coastal wetland, improvement of sanitation, and accessibility to clean water for the city's residents. This work demonstrates how the needs of local communities and biodiversity can be united in a mutually beneficial way (18). Through this project, not only sanitary conditions is improved, but the expansion of water-supply services will increase land values (Figure 4).

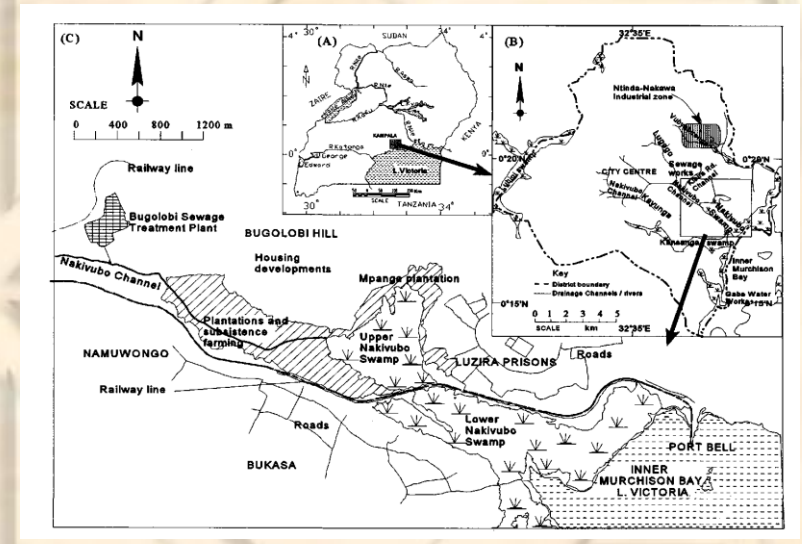


Figure 4. Map showing location and extent of the Nakivubo channel and swamp (19).

### 2.6. Biodiversity Education in Mexico City's Zoological Parks

In Mexico City, three zoological parks have been operated: Chapultepec Zoo, San Juan de Aragón Zoo, and Los Coyotes Zoo. In recent decades, these parks have evolved into protection and conservation projects for their locally and nationally unique species. Educational programs as an essential step of biodiversity conservation in the parks focus on water conservation, climate change, or habitat protection (9). So, Mexico City's zoological parks creates the opportunity for improving public awareness about biodiversity conservation toward resilient and sustainable future (**Figure 5).**

**Figure 5.** San Juan de Aragón Zoo in Mexico City (20)

## 2.7. Greenery in Slums; Bangalore/ India

In many slum areas, the presence of trees and plants that have healing benefits is extremely vital, as traditional medicine is the most economical, trusted, and available form of health care in such settlements. In Bangalore, around 30-40 percent of the population lives in slums. Slums in Bangalore have an average of 11 trees per hectare, versus 28 trees per hectare in other residential areas. The dominant species in the areas are of high medicinal and nutritional value that can be used as sources of primary health care (21). The trees also offer many socio-cultural services. Daily chores such as cooking and washing are carried out under tree covers (**Figure 6).**

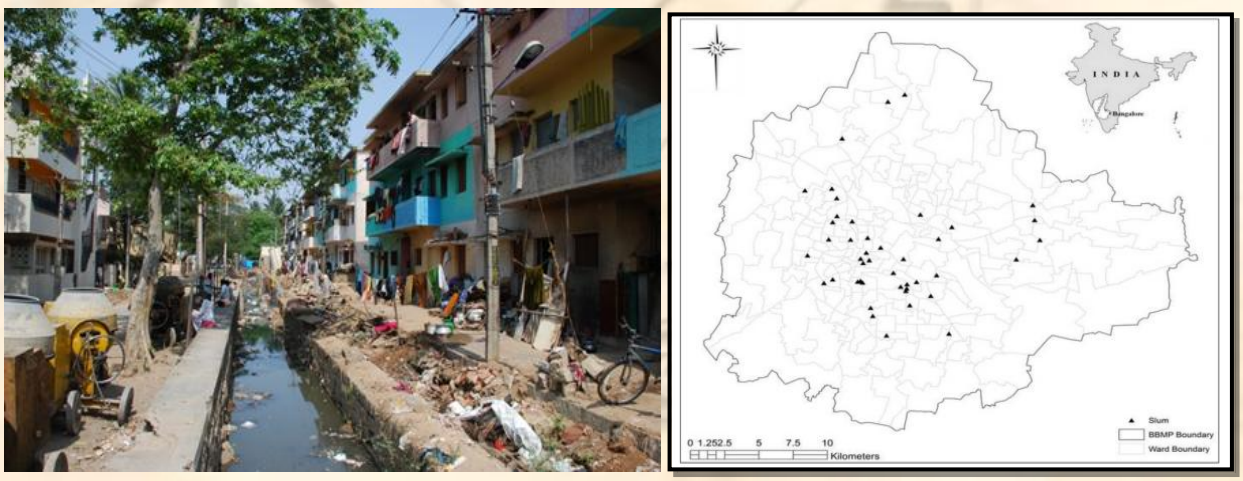


Figure 6. Location of surveyed slums in Bangalore (21).

## 2.8. Curitiba's Innovative Approach to Waste Management, Brazil

**2.9.** The population of Curitiba, Brazil, exploded from 120,000 to more than 1.7 million between 1942 and 2012 and faced with a challeng to provide food, water, and sanitation services for its residents. By the early 1970s, poverty, waste, and disease were rampant in the city's slums. Today, Curitiba is known as "Brazil's green capital" and a prime example of a green economy in a developing country (22). The Green Exchange Programme encourages slum dwellers to clean up their surroundings and improves public health by offering fresh fruit and vegetables in exchange for garbage and waste brought to neighborhood centers (Figure 7).

Figure 7. Slum dwellers were getting fresh fruit in exchange for garbage (9).

### 2.10. More Trees, Less Childhood Asthma, New York City

Rates of childhood asthma in the USA increased by 50 percent between 1980 and 2000, with the highest rates reported in poor urban communities. Researchers studied the correlation between numbers of trees on residential streets and incidences of childhood asthma. They found that as the number of trees rose, the prevalence of childhood asthma tended to fall (23). Trees help remove pollutants from the air and may be lead to lower exposure to allergens that trigger asthma. Furthermore, leafy neighborhoods encourage children to play outdoors; where they are exposed to microorganisms that help their immune systems develop properly. New York City is currently in planting a million new trees.

### 2.11. From Open Dump to Greenery: Mumbai's Gorai Dump Closure Project /India

The city of Mumbai, India, generates about 6,500 tons per day of municipal solid waste and about 2,400 tons per day of construction waste. For almost 40 years, all of that waste went to Gorai Dump—a 20-hectare open site in Mumbai's western suburbs. Located next to a creek and close to the residential areas, the dump had caused significant environmental damage. So, the area has been known as one of the unhealthiest places in Mumbai. Following the site closure in 2009, the site was covered with impermeable surfaces, and converted into a high-quality green area (Figure 8). The next step will be installing a power plant at the site that can run on methane gas from the decomposing garbage and produce electricity as well as reducing greenhouse gas emissions (24).

Figure 8: the site have got a beautiful new green space to enjoy, air and water quality have improved, breeding flies and rodents have been eliminated, and property values in the area have increased fivefold (24).

### 2.12. Project of Plant, Harvest and Eat, Istanbul/Turkey

Istanbul is a metropolitan where greenery is disappearing while demands for sources and agricultural crops in particular are increasing. However, there is one small garden as a part of a restaurant on one of the crowded streets of Istanbul (Taksim), which grows its own fruits in the dense structure of the city. The project aims to create an ecosystem and a publicly open area in Istanbul to emphasize how gardens can be used as venues for gathering people to work together and share ideas (Figure 9). It focuses on topics such as public access, education and business models as well as creating conditions for growing plants. In the designed indoor and outdoor dining environment, there is a meeting room, training and information area, and a restaurant that offers products grown in the enterprise itself. This project provides cheapness, sustainability and a new ecosystem for the gathering people (25).

Figure 9. The restaurant has an exciting place for growing plants that are used and consumed in the place itself (25).

## 2.13. Green superlatives, Zorlu Center Istanbul /Turkey

With approximately 14 million inhabitants, Istanbul is one of the most densely populated cities in the world, located on a unique transition across the Bosphorus; the strait between the Mediterranean and the Black Seas. Fast urbanization of Istanbul with high demands for the land sources requires new imaginative solutions in the use of space (26). Zorlu Center is a mixed-used center with a modern environment and functions that can be considered as a

collaborative green project executed by the architects, engineers and landscape designers in Istanbul. The general design is based on four distinctive towers arranged to form a ring and enclose a central plaza and a 12,000 m² open-air park. The main green part of this project generates a total 72,000 m² of extensive roof gardens. The Zorlu green roofs improve the microclimate by filtering dust and pollutants from the air. It includes 120,000 m² of green area (almost 60 % of the total area) located on the roofs which rise from ground level up to 33 meters in height.

**Figure 10.** Green superlatives, Zorlu Center Istanbul –Turkey (26).

There are over 200 different plant species, including 68 tree species with total height of 30 to 600 cm in the roof gardens. In order to maintain the plants from wind, some techniques were used such as fitting with special clamp and anchoring systems and planting into the steel structures of the roofs. Furthermore, the facade itself is equipped with evergreen plants at many levels (26). All roof gardens and green spaces on the ground floor have an automatic irrigation system. Rain water is stored in large tanks and is carried to the plants by drip irrigation and sprinklers.

## 3. DISCUSSION

According to the various programs explained in this research, cities have found various strategies to create or improve the urban ecosystems and contribute to the biodiversity improvement. The most critical approaches to keep and improve ecosystem services and biodiversity in the modern cities are;

- To preserve or rehabilitate the wetlands surrounding the cities, which supports the provision of a range of ecosystem services.
- To conserve the forest, native green areas, and remote ecosystem in the cities especially those that contains biodiversity hotspots in the world.
- To do urban agriculture and rooftop gardening which generate biodiversity in agricultural crops by using urban waste as an input. It can save rural marginal agricultural land and rain forest. It also produces food and energy crops close to the market demand, as well as reducing traffic, storage, and packaging as sources of the pollution that hurts biodiversity.
- To green and use the native plants in parks, roadsides, gardens, vertical and rooftop gardens, and other such areas, which will diversify the environment to support native mammals, birds, reptiles, amphibians, and insects.
- To educate residences to valuates their environmental assets and enhance public environmental awareness.
- To connect fragmented ecosystems in order to increase ecological functionality as a whole and therefore to maximize the ecosystem services.
- To mitigate pollution by creating a cooperative way for the resident's participation in the waste management programs which can offer direct benefits to the volunteers and motivate them to keep participating.

## 4. CONCLUSION

In the most cases explained in this article, greening approaches are seemed the first priority for the landscape experts to contribute the ecosystem improvement and biodiversity. Street trees, parks, reserves, green corridors and roofs are the common operations which offer a range of social and ecological benefits and enhance biodiversity. However, it seems more essential to think how to address the current ecological issues of the cities beyond just planting and conservation approaches as the usual solutions.

As a landscape or urban planner, the first step to improve the urban ecosystem is to recognize the major ecological possibilities or ecological challenges in the city. Then, it should be though about an innovative urban plan and management that can recover the dynamic pattern of the urban ecosystems, conserve the natural treasure, or solve the ecological issues as well as meeting the

resident's needs and increasing ecosystem services. Urban and environmental planning should provide opportunities that integrate the protection of biodiversity into the urban design, zoning and spatial plans.

In the most successful environment projects of the cities, the communities' participation has had intensive influence to proceed the projects. Particularly, in the fast-growing, low-income cities, biodiversity and ecosystem related decisions have to be made regarding the public interest and in a collaborative ways. So, the residents will be provided by opportunities to cooperate in the project and perceive the direct ecological interests as well as improving their ecological knowledge.

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