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Streams Under Urban Pressure: Blue-Green Infrastructure Planning and Design Approaches for Bursa Ayvali Creek Corridor*

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Abstract
To prevent adverse effects of rapid urbanization and construction on urban landscapes, protection, and planning of hydrological network systems with open green spaces is a contemporary issue for cities. Within the scope of ensuring the sustainability of water resources and green open spaces, it is necessary to protect the natural water corridors for a sustainable environment, store rainwater, protect and feed the qualities of groundwater, and create permeable surfaces. In many developed countries, blue-green infrastructure solutions are produced respecting the natural structure of the water resources with innovative techniques. Ayvali Creek is an important branch of the Nilufer Stream, which is the mainstream of Bursa. Along this creek corridor under industrial, agricultural, and urban pressures, water pollution is observed and the natural habitat area is damaged. This study aims to categorize the problems and opportunities seen in the differentiating urban typologies along Ayvali Creek, by scoring and prioritizing them with an evaluation matrix. With matrix results, planning and design proposals focused on precipitation water integrated into the existing blue-green infrastructure system for the character of the area have been developed.
Keywords: *Blue-green infrastructure, urban stream, urban pattern, Ayvali Creek, Bursa*

* This study is not included in the study group that requires TR Index ethics committee approval.

1. Introduction

Cities expose to the adverse effects of climate change due to urbanization, pollution, the deterioration of nature, and the unconsciousness of human activities. In recent years, the integrated planning and protection of the urban water systems and the urban open green spaces, have gained importance in order to prevent the pressure on the urban landscape due to the increase in the building stock and population density by the urban and industrial development (Özeren, 2012; Gülçin, 2018; Şen et al., 2019; Dar et al., 2021). In parallel with the increase in urban pressure, the intensity of impermeable surfaces causes an increase in urban surface runoff and pollutes the urban water system (Mitchell, 2006). In urban areas, the deterioration of basin topography and the concrete sections for urban streambeds cause interruptions of the natural water cycle. In addition, the underground and surface water resources cannot feed sufficiently. Due to the adverse effect of global warming and climate change, excessive precipitation regimes cause floods and pollute the urban streams. (Troy & Holloway, 2004; Müftüoğlu & Perçin, 2015; Hepcan, 2019; Hamel & Tan, 2021).

A blue-green infrastructure system, which imitates natural systems, is planned considering natural systems or engineering systems in order to prevent the adverse effects of extreme precipitation regimes in cities due to global climate change and to provide resilient cities. Green infrastructure is planned, implemented, and managed at different scales. In planning, region (river corridors, natural ecosystems), basin, city (city parks, wide tree boulevards, woods), neighborhood (neighborhood and district parks, vegetated streets and avenues), and area (rain gardens, vertical gardens, rainwater vegetation strip) scales can be taken as the basis (Demir & Koç, 2018; Hepcan, 2019; Hamel & Tan, 2021). In addition, the blue-green infrastructure provides several opportunities for clean water supply, climate change adaptation, food production, economic and ecological contribution, and increasing the air quality (Gülçin, 2020; Flores et al., 2021). Urban parks, squares, rain gardens, agriculture areas, cemeteries, vegetated roads, and urban stream corridors, provide components for a blue-green infrastructure system in cities. Urban streams are one of the most significant elements of the blue-green infrastructure with their ecological contribution to urban flora and fauna and providing social amenities as recreational spaces.

Urban stream corridors and permeable flood areas clean the precipitation water by filtering before it reaches the water resources such as lakes, seas, and oceans. In addition, these areas reduce the surface water runoff and feed the underground water resources. Therefore, expropriating the floodplains of streams and lowering the elevations allow water to flow to larger areas and reduce its speed. In this context, the design of the floodplains with the green infrastructure around it, such as parks, sports fields, walking, and bicycle paths, increase the quality of urban life and provides social amenities for the community (Oktay et al, 2016; Hepcan, 2019; Flores et al., 2021; Hamel & Tan, 2021). There are several urban stream restoration projects around the world as Cheonggyecheon River urban renewal (Turgay, 2018), Kallang River-Bishan Park (Kurek, 2015), Isar Plan (Oppermann & Pauleit, 2005; Özalp, 2020), Manzares River (Turgay, 2018). The projects which are mentioned aim to restore the urban streams which have lost their natural characteristics.

In the projects implemented in Europe, America, and the Far East, it has been carried out to improve the creeks, to provide their natural features, and to serve the city for both ecological and recreational purposes, and to reduce the impact of climate change in urban areas. In this context, together with the restoration works carried out, blue-green infrastructure techniques that develop rational and natural solutions were used and the natural process of water was integrated into the city. Before these projects are carried out, it is determined that water is generally polluted with domestic, agricultural, and industrial wastes in all study areas, the riparian zone is changed, its natural bed is deteriorated, water is taken into concrete blocks, the connection between water and land is broken, the biological diversity on the waterfront decreases, and flood problems increase and the ecology of the city is damaged (Kurek, 2015; Turgay, 2018; Hamel & Tan, 2021). In order to find solutions to the ecological, economic and social problems that occur in these areas where the water dynamics are disturbed, approaches such as repairing the hydrological and

morphological structure of the stream that has lost its function, to increase the water quality, to control the precipitation water flow, to create a recreationally oriented water edge, to improve the air quality, to improve the biological diversity, creating habitats, providing the opportunity to experience nature in the city, reducing the risk of erosion, increasing its resistance to urban pressures, and bringing water back to the urban ecosystem have been developed. In order to achieve this goal, it is aimed to establish a holistic green network system supported by green corridors, which provides the integration of water with the green areas in the city, meets the different recreational needs of the population, and provides a natural living environment for fauna and flora (Kurek, 2015; Turgay, 2018; Flores et al., 2021). In this context, green infrastructure techniques supported by stormwater management were used. With these landscape restoration projects, the natural river landscape has been improved, recreational opportunities have been brought, water and green areas have been integrated horizontally and vertically, biodiversity has been increased, vehicle traffic has been reduced, and flood resistance has been gained, thus creating a multi-purpose blue-green a system was created.

Blue-green infrastructure system techniques, which take into account the natural drainage pattern and are built in accordance with the water cycle in order to control the flowing water and direct it to water resources with nature-based solutions, can be provided. In this context, Troy and Holloway (2004), Oppermann and Pauleit (2005), Zhang and Browb (2005), Özeren (2012), Wang (2014), Müftüoğlu and Perçin (2015), Hepcan (2019), Özalp (2020); Dar et al. (2021) studies have been examined. Using natural systems or using green roof/roof gardens, rain gardens (bio-retention areas), permeable (porous) flooring, vegetated depression areas (vegetable water areas), structured wetlands, rain tanks, rain ditch, rainwater typologies for blue-green infrastructure systems. Although these techniques, whose purpose is to control and store precipitation water, are similar to each other, they also have minor technical differences. In this context, Chicago Green Stormwater Collection Project, USA, Quinli Stormwater Park, Ha'erbin, CHINA, Upton, Northampton, UK, Ruwenbos, Enschede, Netherlands, Postdamer Platz, and Herman Miller Factory Project, Berlin, GERMANY, 12th Street Green Street Application, Portland OREGON, USA, Mount Tabor Secondary School Garden, Portland, OREGON, USA, Mount Tabor Secondary School Garden, Portland, OREGON, USA, ITU Maslak Yeşil Campus, İstanbul, Adaptation to Climate Change through Rain Harvest Project, Ankara projects examples of green infrastructure were searched from literature considering these concerns (Oppermann & Pauleit, 2005; Zhang & Browb, 2005; Özeren 2012; Wang 2014; Müftüoğlu & Perçin, 2015; Ünal & Akyüz, 2017; Demir & Koç, 2018; Hepcan, 2019; Özalp, 2020; Dar et al., 2021; Flores et al.,2021). In Turkey, the amount of freshwater needed is more than the annual precipitation amount due to climate change and drought. By providing additional water supply, it is significant to store the precipitation water with sustainable nature-based approaches.

In order to ensure the sustainability of water resources in Turkey, water management strategies should be integrated into the urban planning process (Saygın & Ulusoy, 2011). The Integrated Water Resources Management approach, an ecologically-based approach supported by the European Union Water Framework Directive, aims to plan the use of water resources in accordance with social, economic, and ecological purposes. This approach deals with freshwater, wastewater, and rainwater at the basin scale. With this water resources management, it is aimed to protect the aquatic ecosystems, especially freshwater ecosystems which provide drinking water, and to restore the deteriorated natural process of the water cycle (Muluk et al., 2013; Demir & Koç, 2018). The regulation on the protection of wetlands on a national scale, the flood and sediment control regulation, the regulation on rainwater collection, storage, and discharge systems, the creek beds and floods circular, the planned areas zoning regulation, carry out at the municipal scale for the collection of rainwater, the importance of water resources on the ecosystem. It consists of increasing the water quality, preventing surface water runoff, and restarting the deteriorated natural water cycle.

This study aims to evaluate the problems on changing urban typologies of the Ayvali Creek urban stream corridor considering their impact. The method of the study was structured in two stages. In the first stage

of the study, a field trip and site observations, and SWOT analysis were carried out. In the second stage, a matrix was proposed over the SWOT analysis and scoring was made according to the impact values. The results of the study will be thought to be a base for blue-green infrastructure projects for Ayvali Creek and its surroundings.

2. Material and Methods

2.1. Material

Ayvali Creek, which is investigated within the scope of the study, is located in the city of Bursa. Bursa is a city with rich underground and surface water resources. All the natural qualities of the city, together with its water resources, have become an identity value (Muluk et al., 2013; Bayramoğlu & Demir, 2018, Demir & Koç, 2018). Especially Nilufer Stream, to which Ayvali Creek is connected, is one of the important parts of Bursa's ecological system. The fact that it is the main river corridor of the city and that it has a place based on the past for the city emphasizes the importance of the stream. Ayvali Creek, one of the important branches of the Nilufer Stream in the urban context, is a stream of the Nilufer district (Figure 1). The creek collects the water of Çalı and Kayapa Creek and, after passing the Özlüce canal, takes the name Ayvali Creek in the north of Özlüce village. Afterward, it passes through Çayırköy Plain and pours into Nilufer Stream. According to the Surface Water Quality Regulation, The water quality of Ayvali Creek, which is very close to the settlement areas, is III. and IV. class (highly polluted) water quality. The biggest reason for this is the use of cyanide by the factories operating in the industrial zone, producing coatings, paints, synthetic rubber, and plastic, and these cyanide-containing wastes are discharged in areas close to the stream (Akay et al. 2019).

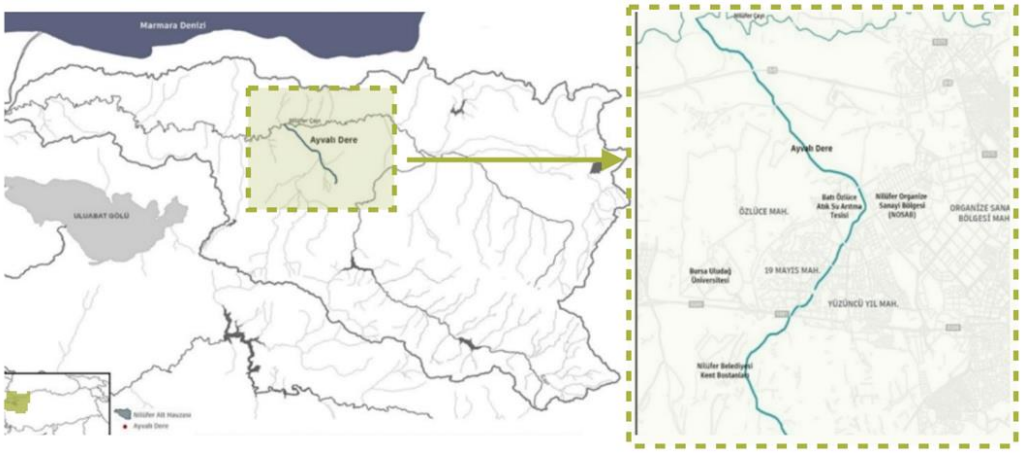


Figure 1. Location of Ayvali Creek

Moreover, according to the samples taken from Ayvali Stream, the intense presence of nitrogen derivatives and the high level of NH4+–N ions indicate that the sewage wastes in the settlement area and animal wastes are mixed into the water of the stream (Akay et al. 2019). In addition to the pollution load arising from the wastewater discharge of the Nilufer Organized Industrial Zone and the Western Treatment Plant, the domestic and industrial pollution loads with the wastewater discharged by the individual production facilities without treatment were also determined (Karaca & Taşdemir, 2014). Besides the pollution, the decrease in the water of Ayvali Creek is one of the important problems for both the ecological continuity of the stream corridor and its surroundings. The water of Ayvali Creek is decreasing as a result of the activities of the Western Treatment Plant and the seasonally changing precipitation graph. Especially in the summer season, since the precipitation decreases, the water of the stream, which cannot be fed with rainwater, is completely wastewater (Karacaoğlu & Dalkıran, 2017). Agricultural areas are irrigated with the water of the stream, which is polluted by wastewater, and it causes an increase in the salt rate in the soil. In this way, the agricultural products grown here and sold in

the local markets pose a danger to human health. Moreover, problems such as bad odor, pollution, and mosquitoes spread by the stream in residential areas also have the potential to cause health problems (Kocaer & Başkaya, 2004). In addition to its potential negative effects on human health and the pollution it causes in its immediate surroundings, it is one of the main factors causing the pollution of the Nilufer Stream, which is the main source of Ayvali Creek. Therefore, any positive or negative intervention for Ayvali Creek will affect the Nilufer Stream, that is, the entire river corridor system of Bursa.

2.2. Methods

Management of green infrastructure includes mapping green areas, determining biodiversity, identifying diseases and problems and developing solutions, as well as maintenance and monitoring stages. In this context, rules on the maintenance and management of urban green infrastructure components are defined and guidelines containing these rules are prepared (Dar et al., 2021; Flores et al., 2021). In order to develop a holistic green-blue infrastructure planning and design strategies for the Ayvali Creek corridor, firstly, the problems in the corridor should be identified and then the potentials in the corridor should be revealed. For this reason, a detailed SWOT analysis was conducted for the Ayvali Creek corridor. SWOT analysis was carried out in two stages.

The first stage was carried out in the study area. Along the Ayvali Creek corridor, on the junction points of the streams, especially the bridges, and the points with changing landscapes were stopped, point data was taken with GPS Magellan, the point taken on the current plan was marked. At the end of the site visit, 19 points were determined as reference points (Figure 2). Points between 1-6 located in the agriculture context, points between 7-15 located in the urban and industrial context and points between 16-19 located in the agricultural context. For these 19 points, notes were taken and free photos were taken from different angles of the problematic and potential areas of the area (Figure 3),(Figure 4).

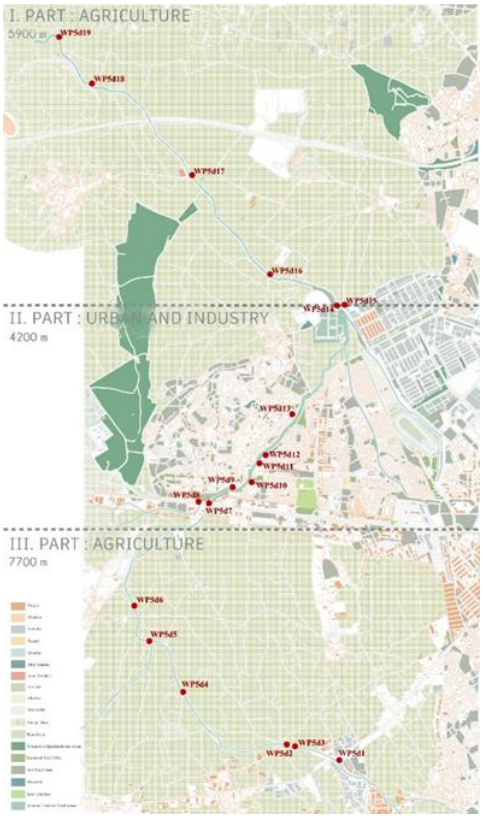


Figure 2. 19 Points from, Ayvali Creek

Figure 3. Photos from Problematic Areas, Ayvali Creek

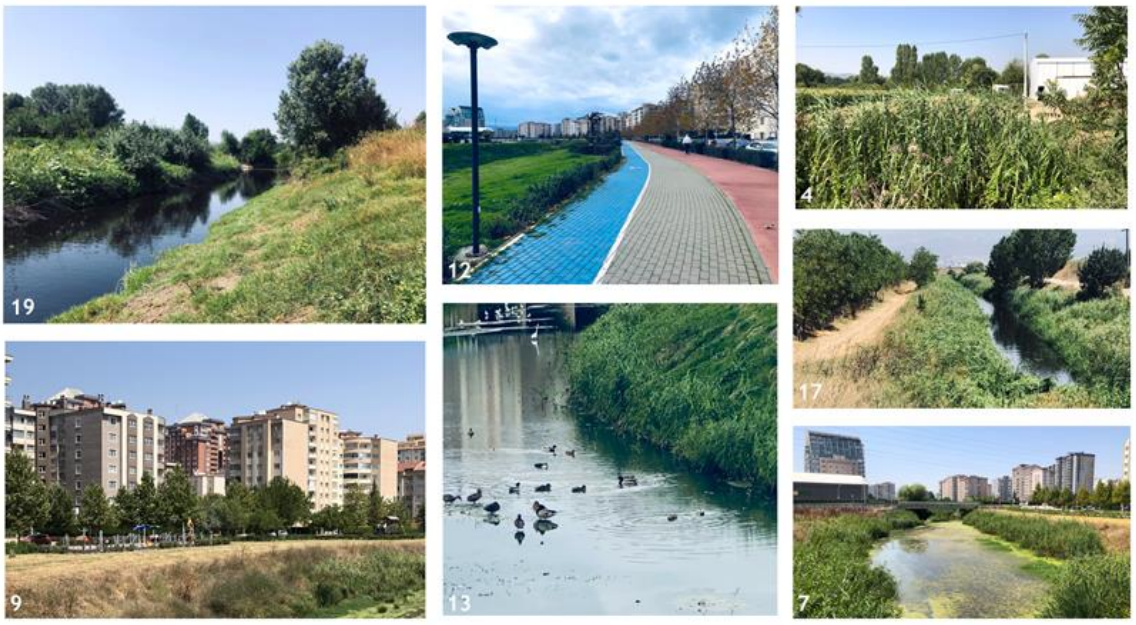


Figure 4. Photos from Potential Areas, Ayvali Creek

In the second stage, as a result of field studies and literature review on the stream corridors, the strengths and weaknesses, opportunities, and threats reflecting the internal and external factors of the area were analyzed. In this context, a SWOT analysis was carried out with respecting the dynamics and characteristics of the Ayvali Creek (Table 1).

After the SWOT analysis, two matrices were structured by overlapping the SWOT analysis with the points taken along the Ayvali Creek urban stream corridor. In the first matrix, the weaknesses and threats in the SWOT analysis were linked to the points and 1 point was given to the points for each corresponded characteristics. In the second matrix, the strengths and opportunities of the field and the points were linked, and in the same way, 1 point was given to each correlation. The existing problems in the Ayvali Creek corridor have been found in detail and the most problematic point in the creek corridor has been determined. With the second matrix, the existing appropriate applications and potentials in the area are revealed. It is aimed to be a guide for the planning and design proposals to be developed for the Ayvali Creek corridor.

Table 1. Ayvali Creek Corridor Swot Analysis

Ayvali Creek Corridor Swot Analysis	
Strengths	**Weaknesses**
● The cross-section of the stream preserves its natural form at many points. ● Protection of natural sounds due to the fact that the creek is in a more natural form. ● Variety of natural plants that can grow on and near the creek. ● The surrounding stream is generally covered with agricultural lands. ● The stream bed has different elevations. ● Less urban pressure ● Using duckweed as a natural cleaner in the stream. ● Richer fauna in the urban part of the stream (herons, ducks, geese, turtles, frogs, and insects). ● Having recreational potential. ● Fauna and flora in the creek section and the surrounding create colorfulness in both visual and auditory landscapes. ● The junction point of Ayvali stream to Nilufer Stream and its close surroundings are covered with agricultural lands (away from the pressure of urbanization)	● Water pollution is seen and increasing along the route. ● Withdrawal of water from the stream to agricultural fields. ● The general neglect of the creek. ● Excessive drying in the creek bed in the summer season due to the irregular water withdrawal. ● The narrow cross-section of the stream. ● Ignoring the flood border. ● Mosquito problem ● Noisy production by factories near the stream causes natural elements such as bird species to escape from the area. ● Lack of recreation and nature theme. ● In the urban part, while one side of the stream is used for recreation in some areas, most of the other sides are vacant. ● Interference with the section of the stream in some parts of the corridor. ● Lack of pedestrian bridge over the creek. ● The sight of the discharge points of the sewer lines to the stream and the bad odor it creates. ● Lack of fauna and less vegetation diversity in the industrial part of the stream corridor. ● Irregular garbage and rubble spill. ● Grown in agricultural areas irrigated by polluted water negative effects of agricultural products on human health.
Opportunities	**Threats**
● The willingness of the relevant stakeholders to solve the problems. ● Bringing the river problems to the agenda and aiming to solve the problems with the planned projects. ● Presence of previous studies on the water pollution of the stream. ● The support of the zoning plan in keeping the creek area as an agricultural area in some parts. ● The support of the zoning plan in keeping the creek area as a recreational area in some parts. ● There are areas in the region where buffering or masking can resolve the concept of noise/sound environment. ● Regarding mosquitoes by the municipality regular spraying. ● Cafes and restaurants near the stream have the potential to divert people to the creek so that the area is likely to become a more inhabited place with the creek	● There is a high voltage line near the creek. ● Establishment of a small number of industrial establishments in the environment, which is generally used as an agricultural area, and discharge of polluting wastes into the stream. ● Irregular garbage and rubble dump. ● The creek flood analysis was not done and the flood border is undefined. ● Bullet sounds originating from the Bursa Special Operations Forces Branch Directorate Shooting and Training Center near the area where Ayvali Stream connects to Nilufer Stream ● Excessive pollution of the stream by Nilufer Organized Industrial Zone (NOSB) wastewater despite the treatment system. ● Inadequacy of Batı Özlüce wastewater treatment plant. ● The management organization problem and lack of coordination of many institutions related to water management. ● Problems with the speed limit of vehicles passing by the stream. ● Accessibility problem.

3. Findings & Results

When the beginning zone of Ayvali Creek was observed, it was determined that the section of the stream is narrow and unmaintained, the water is stagnant and there is no water in places (from point 1 to point 8). Although there are several factories and waste around, no obvious bad odor and any deterioration of water color were observed in the stream. When it comes to the zone where the residential pattern is concentrated (from point 9 to point 13), it has been determined that the sewage mixes with the stream. Therefore, there is a serious sewer smell coming from the water.

Especially in areas where social facilities are concentrated, there is a park, bicycle, and pedestrian path by the stream, yet one side of the stream is always idle. At the same time, the sounds coming from the power line passing through the neighborhood suppress the natural sounds in the environment and create noise pollution.

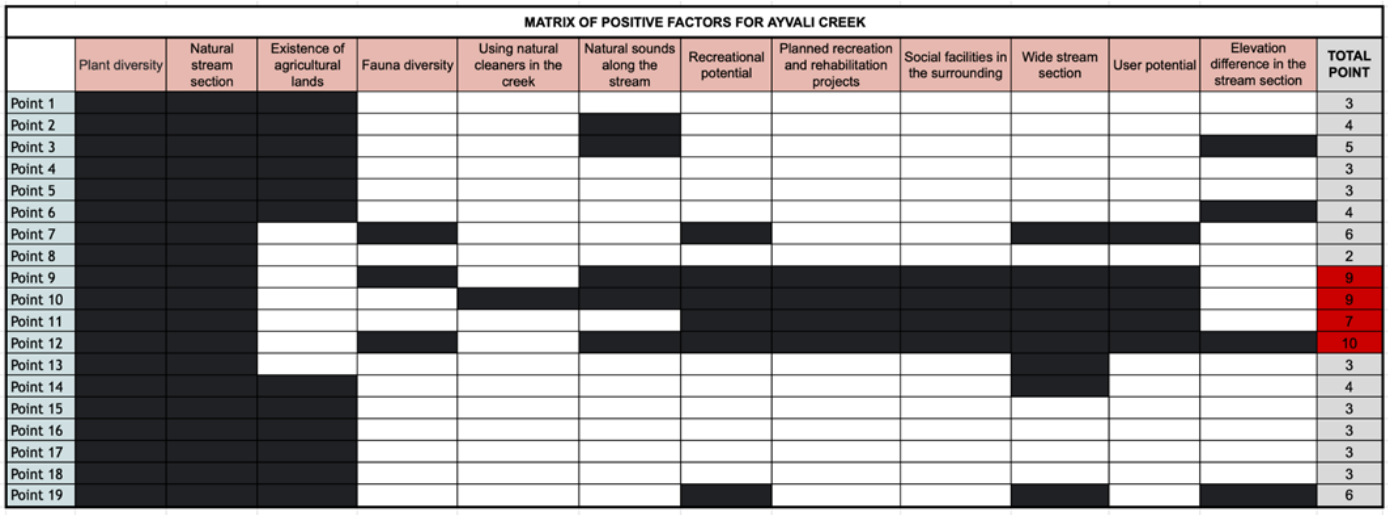
According to the matrix, the most problematic zone of the creek and the zone with the highest score (from point 14 to point 17) corresponds to the area where industrial and agricultural areas are located (Figure 3). The discharge of factory wastes operating in the industrial zone into the stream, the discharge of sewage water into the stream and the use of the streamside to dump garbage cause the stream water to be seriously polluted, the color of the water to turn black and the environment to emit an intense bad odor. In addition, the presence of agricultural lands around such a polluted creek corridor also poses a severe threat to agricultural products and human health. Locals who draw water from the stream to irrigate their agricultural lands cause both the decrease in the water in the stream and the deterioration of the structure of the agricultural lands. In addition, they are exposed to the invasion of mosquitoes, which is a result of dirty water and to the wounds in various parts of their bodies by contacting the water of the stream.

MATRIX OF NEGATIVE FACTORS FOR AYVALI CREEK

	Water pollution	wastewater discharge	Sewer smell	Industrial waste	Pollution in the riverbank	Dark water	Neglect	Still water surface	Extinct fauna	Uncontrolled water	Intervened stream	High Voltage Line	TOTAL POINT
Point 1					■		■	■					3
Point 2							■						1
Point 3							■	■					2
Point 4							■	■					2
Point 5								■					1
Point 6					■			■					2
Point 7	■	■	■				■						4
Point 8	■		■		■		■	■					5
Point 9	■	■											2
Point 10		■								■		■	3
Point 11												■	1
Point 12							■				■	■	3
Point 13							■					■	2
Point 14	■	■	■	■	■	■	■		■	■			9
Point 15	■	■	■	■	■	■	■		■	■			9
Point 16	■	■	■	■	■	■	■		■	■			9
Point 17	■	■	■	■	■	■	■		■	■			9
Point 18	■		■		■	■	■		■				6
Point 19	■		■		■	■	■		■	■			8

Figure 5. Matrix of negative factors for Ayvali Creek

When the favorable characteristics of the Ayvali Creek urban stream corridor were examined pointwise, it was determined that the zone with dense urban fabric received a higher score (Figure 4). Despite mixing sewage water with the stream water in this zone, the continuation of the plant diversity and the visible increase in the fauna reduce this effect. The use of duckweed, which is a natural cleaner especially in the section of the stream, also reduces the pollution in the stream. However, the recreation potential of the area and applications ensure that this part of the corridor is in a better condition compared to other regions (from point 9 to point 12). The dense housing pattern in the region and the presence of social facilities such as cafes and restaurants by the creek increase the user potential.



MATRIX OF POSITIVE FACTORS FOR AYVALI CREEK													
	Plant diversity	Natural stream section	Existence of agricultural lands	Fauna diversity	Using natural cleaners in the creek	Natural sounds along the stream	Recreational potential	Planned recreation and rehabilitation projects	Social facilities in the surrounding	Wide stream section	User potential	Elevation difference in the stream section	TOTAL POINT
Point 1	■	■	■										3
Point 2	■	■	■			■							4
Point 3	■	■	■			■						■	5
Point 4	■	■	■										3
Point 5	■	■	■										3
Point 6	■	■	■									■	4
Point 7	■	■		■			■			■	■		6
Point 8	■	■											2
Point 9	■	■		■		■	■	■	■	■	■		9
Point 10	■	■			■	■	■	■	■	■	■		9
Point 11	■	■					■	■	■	■	■		7
Point 12	■	■		■		■	■	■	■	■	■	■	10
Point 13	■	■								■			3
Point 14	■	■	■							■			4
Point 15	■	■	■										3
Point 16	■	■	■										3
Point 17	■	■	■										3
Point 18	■	■	■										3
Point 19	■	■	■				■			■		■	6

Figure 6. Matrix of Positive Factors for Ayvali Creek

In addition, during the field trip, it was determined that the locals were aware of the current state of the creek during the interviews. In particular, people who know the uses of the creek 20-30 years ago will play a positive role in supporting the projects to be made for Ayvali Creek. On the other hand, the recreational potential provided by the corridor and accordingly the wastewater cleaning applications in this part of the creek at certain times set an example for the design strategies that should be established for the problematic areas of the urban stream corridor. It is significant to increase the variety of uses of the stream and user profile to develop the urban stream corridor.

4. Conclusion & Suggestions

According to the results of the SWOT for the Ayvali Creek urban stream corridor, it is significant to develop a holistic and flexible design and planning strategies in accordance with the differentiated dynamic characteristics of the area. A three-stage design and planning proposal has been developed based on landscape repair, water management, and green-blue infrastructure and recreation in order to solve every problem situation or to increase the existing potentials.

The landscape repair stage (1) is recommended in both the landscape planning and design processes for this study. As is well known, water sources are polluted in two ways as point and diffuse sources. It is easier to control pollution from point sources such as wastewater discharges of domestic and industrial establishments. Stream beds feeding the water and aquatic plants in flood areas significantly reduce the pollution carried by precipitation water and surface flow. With natural methods, the cost of which is lower than conventional treatment methods, pollutants originating from diffuse sources can be treated more easily with lower cost and lower energy. Especially for the corridor that is exposed to intense pollutants in the industrial zone; It can be recommended to remove pollutants from stream banks, to carry out waste cleaning works from the waste exit point of industrial facilities that cannot be transported, to eliminate pollution with lower cost and higher efficiency by using bioremediation techniques, to clean stream beds from accumulated solid wastes and plants that may prevent the flow of water. As Meles Delta Restoration project sample in İzmir consists of the elimination of industrial pollutants by using bioremediation techniques, it should be constructed for point 14, 15, 16 and 17 which have been highly polluted by industrial facilities.

Water Management and Green-Blue Infrastructure stage (2) is one of the important design and planning proposals for Ayvali creek. Multi-purpose urban open green spaces should be designed and integrated urban blue-green infrastructure systems in order to improve visual, social, cultural, and ecological values in urban areas which are integrated into the urban stream as in a sustainable urban model. For the supply of clean water resources, it is very important to feed the receiving water resources with clean water.

Therefore, controlling the water that passes into the surface flow is a very essential point in terms of clean water going to the receiving sources. In Turkey, the amount of freshwater needed due to the drought issue caused by climate change is more than the annual precipitation amount. In order to close this gap and meet the lack of water, it is necessary to store the precipitation water before it reaches the surface flow and delivers it to water resources with sustainable nature-based solutions. In this sense, it is necessary to collect the rain water or runoff water to reach the section from point 1 to point 8 where the water is quite low in the stream section. In addition to this, with the aim of connecting the blue and green infrastructure, rational solutions such as green roof/roof gardens, rain gardens, permeable (porous) flooring, vegetated depressions (vegetable water arcs), structured wetlands, rain tanks, rain ditch, and rainwater plant strip were suggested as the most frequently used green infrastructure techniques by using natural systems or imitating natural systems with engineering systems.

Recreation stage (3) is recommended in order to provide visitor management and area management in this planning and design processes of the study area. In order to use the recreational potential in the area correctly, it may be suggested to determine the visitor potential according to the population profile and to create a natural corridor that includes water-based activities that will attract different age groups accordingly. In this sense, this stage is particularly significant for areas with recreational potential such as points 9, 10, 11 and 12. As in the project samples of Isar Plan (Oppermann & Pauleit, 2005), Kallang River-Bishan Park (Kurek, 2015), Manzares River (Turgay, 2018) and Melta Delta Restoration (Özeren & Kaplan, 2013), developing the recreational use of the area in addition to its ecological context will intensely effect its contribution to urban life.

Finally, in the context of the planning and design approaches revealed by the study, it is predicted that holistic blue-green infrastructure strategies can be developed against the observed problems in the Ayvali Creek urban river corridor. Integrating the implementation approaches of successful project examples as Isar Plan in Munich, Cheonggyecheon River Restoration in Seoul, Manzares River in Madrid, Kallang River Restoration-Bishan Park in Singapore into the water management processes in Turkey and particularly implementing them in cooperation with local governments will support the sustainable reintroduction of rivers into cities.

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