



Urban Water and Management in Sustainable Cities

Tugce Bekar¹

¹Independent Research Author, Istanbul, Turkey

Abstract

The most important basic need in today's cities is water. Population growth in cities, climate change, and decreasing access to water resources make the issue of sustainable city and water relationship more important. In addition to the industry being the sector that consumes the most water, water use is also high in domestic use, agriculture, commercial, and tourism areas. Settlements at risk of water scarcity must take precautions to avoid becoming a waterless settlement in the future. To protect the delicate balance of nature, sustainability in urban areas should be ensured. Environmental pollution should be analyzed and suggestions should be presented for the solution to this pollution. Based on the concepts of sustainable city and urban water cycle, it also mentions how the city and water are and should be in a relationship. It contains concepts that will better express the relations of basic concepts with each other and complement the context. Sustainable use of water also contributes to the protection of natural ecosystems and biodiversity. Water resources management for sustainable cities plays an important role in achieving the goal of creating an environmentally friendly, healthy, and safe living space.

© 2024 The Authors. Published by IEREK Press. This is an open-access article under the CC BY license (<https://creativecommons.org/licenses/by/4.0/>). Peer review under the responsibility of ESSD's International Scientific Committee of Reviewers.

Keywords

Sustainable City, Water Balance, Water Management, Water Resources.

1. Introduction

Today, the rapidly developing and changing structure of cities emphasizes the fact that water is one of the basic needs. Considering that water is the main source of life, sustainable management of water is critical for the future of cities. As the world's population grows rapidly, cities are using water resources more intensively than ever before. Water plays an important role not only in sustaining human life but also in the activities of various sectors such as industry, commerce, agriculture, and tourism. Global climate changes, increasing population, and difficulties in accessing water resources have caused the relationship between sustainable cities and water to become more critical than ever before. If the current situation of the urban water cycle continues, urbanites and nature will be more exposed to disasters brought about by the climate crisis. Therefore, the current situation between the city and water should be examined and measures should be taken, if it is insufficient, it should be improved.

Sustainability is a concept that is of increasing importance today. Factors such as urbanization and population growth require more effective management of water resources. Thanks to this research, findings will be obtained on how the relationship between sustainable cities and water can be improved against the climate crisis. In this study, the relationship between sustainable cities and water; If the current situation of the urban water cycle continues,

how it will affect the citizens in the future, and what can be done to minimize the negative impact of the global climate crisis for water management in sustainable cities will be examined within the framework of the questions.

2. Purpose and Scope of the Study

The aim of this study is to examine the existing relationship between cities and water resources and to develop improvement measures by identifying deficiencies, if any. Examining the relationship between sustainable cities and water resources can provide findings on how to remedy the climate crisis more effectively. In this study, the relationship of sustainable cities with water resources will be discussed, and how it may affect urban residents in the future if the current urban water cycle continues. In addition, steps to be taken to minimize the negative effects of the global climate crisis on water management in sustainable cities will also be discussed. In this context, the study was designed to understand the relationship of cities with water resources and to determine their improvement potential in terms of sustainability.

3. Method of the Study

Within the scope of the study, the concept definitions and current situation analyses made about these issues were investigated through written and numerical sources. Concepts that will complement the context will be examined and suggestions will be made in line with the findings on water management in sustainable cities.

4. Water Use and Problems in Cities

Cities are, in a sense, living beings because they have variable populations and areas and are constantly growing and developing. They have a huge impact on the environment due to the areas and amounts of energy they consume, the natural environments they pollute, and the populations they host. This effect has gained more importance in the current period. These effects can be on a global scale, as well as on a regional or urban scale. Impacts on a global scale; While energy and raw material use and environmental pollution can be given as examples, regional-scale effects; Water basins, natural resources, land use plans, pollution in rural areas, and impacts from development can be given as examples. On the urban scale, effects such as air, water, and noise pollution for the living spaces of the cities, opening up of agricultural areas, water basins, and green and forest areas to settlement can be mentioned (United Nations Development Program, 2007: 69).

The number of urban populations worldwide increased from 746 million in 1950 to 3.9 billion in 2014. By 2045, this figure is expected to reach 6 billion, and 66% of the world's population will live in cities. Accordingly, it is estimated that the populations of cities, especially in developing countries where the urbanization rate is low, will more than double and the population in countries will accumulate in certain regions (Pektezel, 2015). For this reason, original urbanization plans should be made, especially reducing land and energy consumption, the importance of pedestrian-centered, human-oriented urbanization planning for healthy urbanization, the importance of local public transportation, especially rail transportation, protecting green areas and open spaces, reducing resource consumption and taking into account the area. Rather than typical similar cities, a long-term, comprehensive plan is required.

4.1. Natural and Urban Water Cycle

Urban areas represent the environment, which includes all the structures necessary for people to work and live. The built environment of a city consists of structures that serve various purposes, roads that provide transportation, open spaces, and green areas. With the opening of natural basin areas and stream beds to urbanization, the destruction of natural vegetation, and the formation of impermeable surfaces (pavements, parking lots, asphalt roads, etc.), the water, which cannot complete its cycle, passes into surface flow in urban areas (Poletto and Tassi, 2012) (Figure 1). In areas with dense urbanization, the flow level and volume of water flowing on impermeable surfaces continue to increase, while the water cannot seep into the soil and quickly passes into the hill flow (Lau and Mah, 2018). Water flowing in urbanized areas can have negative impacts such as floods, drought, poor water quality, and groundwater. The flowing water is polluted with soil wastes, chemical wastes, fuel wastes, etc., and carries heavy metals to the basins, causing pollution of water resources (University of Arkansas Community Design Center, 2010).

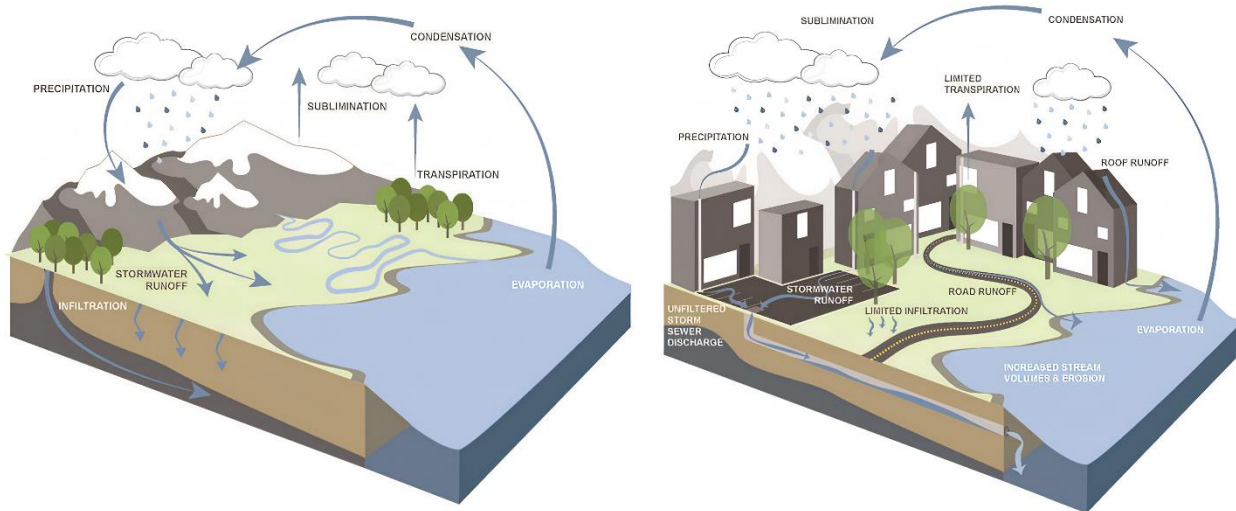


Figure 1: Comparison of the natural water cycle and the water cycle in urban areas (Rutgers, 2016)

The increase in urbanization causes the flow channels of the natural waterways occupied by buildings to change over time, the mass of water passing into the surface flow to increase, and the infiltration surfaces of the soil to decrease. This situation becomes vulnerable to floods and floods due to infrastructure systems in settlements where urban development continues and is not properly planned (Erkal and Topgül, 2020).

4.2. Water Resources and Utilization

97.5% of the water presence is found in the oceans as salt water, and only the remaining 2.5% is fresh water. 68.7% of the fresh waters, which have a volume of approximately 35.2 million km³, are found as glaciers, 0.8% in the frozen soil layer, and 30.1% as groundwater. The remaining 0.4% is surface atmospheric waters. (UNESCO, 2006) In addition to the fact that the conversion of salt water into potable/drinking water is an expensive process, the uneven development of freshwater resources, population, and economic activities in the world are the main reasons for the increasing competitive pressure on water (Gunaydin, 2009).

Table 1: Water Resources and Withdrawal, 2000 (km³ / year)
Source: UNESCO UN Water, Water in a Changing World, Londra, 2009, s.99.

Region	Renewable Water Resources	Total Water Shoot	Renewable Resources Water Draft in %
Africa	3936	217	5.5
Asia	11594	2378	20.5
Latin Amerika	13477	252	1.9
Caribbean	93	13	14.0
North America	6253	525	8.4
Oceania	1703	26	1.5
Europe	6603	418	6.3
WORLD	43659	3829	8.8

As can be seen, there are great inequalities in the distribution of renewable water resources across the continent. Latin America, which has the most renewable water resources, has the lowest ratio of total water withdrawal to renewable water resources, slightly more than Africa, which has one-third of its water resources. The Asian continent, which has a similar value to Latin America in terms of renewable water resources, consumes almost 10 times more water than Latin America. On the other hand, North America and Europe stand out for their similar relationship with water resources, total water withdrawal, and renewable resources. This disparity in water availability between continents is reflected in every country. Demographic developments often lead to a deepening of inequality.

Table 2: Amount of Usable Water Per Capita in the World

Source: DPT, Su Havzaları Kullanımı ve Yönetimi OIK Raporu, DPT Yayın No: 2555, OIK: 571, Ankara, 2001, s. 28. (DPT, Water Basins Use and Management Report, DPT Publication No: 2555, OIK: 571, Ankara, 2001, p. 28.)

Country / Continent	Annual Average (m3)
Syria	1200
Lebanon	1300
Turkey	1430
Iraq	2020
Asia	3000
Western Europe	5000
Africa	7000
South America	23000
World	7600

As you can see in the table above, the average amount of water per capita in the world is 7,600 cubic meters, while this average triples in South American countries and drops six times in the Middle East. Countries with an annual usable water consumption per capita above 8,000 to 10,000 m³ are classified as water-rich countries, countries with a risk of water scarcity below 2,000 m³, and countries with less than 2,000 m³ are classified as countries with water scarcity. When you think about it, the value of water becomes even clearer. 1,000 m³ is classified as water-rich and is considered a water scarcity.

It is generally accepted that a person should consume at least 25 liters of water per day to meet their biological needs and survive. However, considering the water to be used for purposes such as drinking, cooking, washing, and laundry, which are required for a modern person to live in a healthy way, the average urban water consumption standard per person per day is considered to be 150 liters. While the amount of daily water consumption per capita is 266 liters in industrialized countries; It is around 184 liters in Latin America, 158 liters in Arab countries, 143 liters in Asia, 111 liters in Turkey, and 67 liters in Africa. While this amount reaches 350 liters in North America and Japan, it drops to 10-20 liters in Sub-Saharan Africa. (Gunaydin, 2009)

In addition to population growth, climate change, socio-economic factors, technological developments, developments in water policy, and new legal and financial management approaches increase the pressure on unevenly distributed water resources around the world. Sectoral water use systems create more competition for water resources. The table below shows water consumption by sector and by continent.

Table 3: Sectoral Water Use in the World (kilometer³ / year)
Source: UNESCO, Water in a Changing World, Londra, 2009, s.99.

Region	Draft					
	Agriculture		Industry		Urban	
	Quantity	Percent	Quantity	Percent	Quantity	Percent
Africa	186	86	9	4	22	10
Asia	1,936	81	270	11	172	7
Latin Amerika	178	71	26	10	47	19
Caribbean	9	69	1	8	3	23
North America	203	39	252	48	70	13
Oceania	18	73	3	12	5	19
Europe	132	32	223	53	63	15
WORLD	2,663	70	784	20	382	10

As can be seen, 70% of the total water consumption on a world scale is used in agricultural irrigation. Although this rate is 30% in developed (high-income) countries; It rises to over 80% in underdeveloped (low and middle-income) countries. In the industrial use of water, central countries have a share of 50% and peripheral countries have a share of 10% (Gunaydin, 2009).

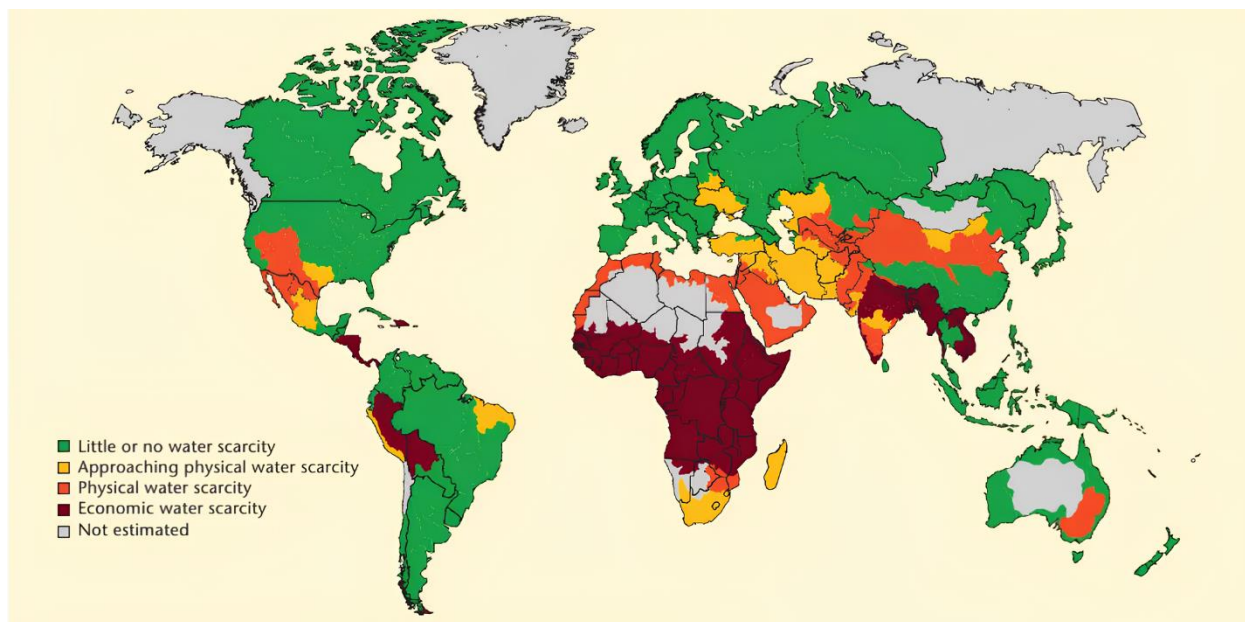
4.3. The Extent of Water Shortage in the World

At the beginning of the 20th century, a large number and species of life, including 6 billion people, are facing a serious water crisis, despite recent steps being taken in the right way (UNWWDP: 2012; 4). While 800 million people living in our world lack safe drinking water, 2.5 billion people live without adequate sanitation. The negative

effects on water resources are increasing and becoming continuous (USIAD, 2009: 6). The world's population is constantly increasing. With the effect of industrialization, unplanned urbanization, and drought caused by global climate change, the supply of potable water resources is decreasing, while the demand is increasing (2007 Annual Report, 2008: 7). According to the projections of the World Bank and the UN, it is estimated that 2.5 billion people will face water scarcity in 2025 (World Water Forums, 2009: 11). The pressure on water resources is a problem that affects the whole world. Just as infectious diseases can become a global threat, water scarcity can cause water wars and ultimately disrupt world peace.

Recent research has shown that global water problems are:

- a) 1.6 billion people do not have access to water due to economic negativities.
- b) In a study conducted by the UN Development Programme (UNDP), it was stated that people living in the shade of slums spend 5-10 times more money to benefit from municipal water.
- c) 3,000 children die annually due to polluted water (Firidin, 2015).



Map 1: World Water Scarcity Analysis

Source: The United Nations World Water Development Report 3; 2009: 128

Economic water scarcity (Map 1) refers to technological competence that can hinder water delivery, unequal wealth distribution, and politicians' policies that negatively affect water accessibility (UNWDR; 2019: 167). When the map is examined, it can be seen that economic water scarcity is encountered in countries that do not have a good income situation in the world. For example; It can be considered that political stability has not been fully achieved, such as Western China and East India, some countries in Central America, and almost all Central African countries. It can be said that there is a physical shortage of water in the desert-covered and extremely arid regions of the world. For example; The Gobi, Karakum, and Takla Markan deserts in the harsh continental regions of Central Asia, the Arabian Desert and the Great Sahara in North Africa and the Arabian Peninsula, the Kalahari Desert in South Africa, and the deserts of Nevada and Arizona in South Africa. America and Australia.

It can be used in Turkey, which is called the Great Sand Desert. Our country, along with our neighbors to the east and south, is one of the countries that is physically threatened by water scarcity.

4.4. Causes of Water Shortage

In general, water resources are more likely to be under pressure from man-made disasters than natural disasters. Global environmental pollution has made the need to protect water resources increasingly apparent. Water pollution is the condition in which water becomes harmful to humans and other living things due to the effect of pollutants.

This situation can occur not only as a result of human activity but also as a result of biological activity and natural causes. There are many reasons for the water scarcity we are experiencing.

We can list these reasons as follows:

- a) Natural Factors: Water resources are not evenly spread around the world, water is scarce and some parts of the world are arid.
- b) Demographic Factors: The rapidly increasing population and the resulting negativities in terms of the quality and quantity of water.
- c) Social and economic factors: The problem of access to water for the poor, social and cultural characteristics.

There are several problems in the protection and effective use of water resources. Some of these problems are linked to damage to the environment. These negative effects can be grouped under three headings (Çolakoğlu, 2008: 52):

- a) Water shortage caused by population growth: The world population is increasing rapidly. The average population growth per year is around 90-100 million. Considering that the water resources and amount are constant, there may be problems with the amount of water sufficient for the increasing population.
- b) Water pollution caused by agriculture, industry, and urbanization: Water pollution is the pollution of surface and underground water resources. Factors that cause this; can be listed as the mixing of pesticides used in agriculture with water, the mixing of industrial wastes with water, and the mixing of urban wastes with water. In addition, hospital waste poses a significant danger. When hospital wastes are mixed with domestic wastes without a separate process, urban wastes can be more harmful (Keleş et al., 2005: 124).
- c) Negative effects of global warming on water: Global warming negatively affects the whole world. One of the factors that negatively affect the water cycle and water quality is extreme temperature and extreme cold.

Climatic events such as droughts and floods caused by global warming affect the quality of water.

Table 4: Pressures on the Freshwater Ecosystem
Source: The United Nations World Water Development Report: 2012; 14.

Human activities	Potential impact	Risk function
Growth of population and consumption	Recovery of cultivated areas through the withdrawal of water from wetlands and, as a result, an increase in water consumption	Functions of almost the entire ecosystem, including settlements, production, and regulation functions
Infrastructure development (dams, waterways, edge embankments, variants, etc.)	Loss of occupancy leads to changes in the amount and increase of river flow, water temperature, nutritional value, and sediment transfer, and thus delta formation prevents fish migrations.	Quantity and quality of water, habitats, floodplain production, fisheries, river delta Economies
Land transformation	It is important to note that the key components of the aquatic environment are pure remains outside; loss of function, integrity, habitats, and biodiversity, change in building flow, inhibition of natural regeneration, intermittent water source propagation	Natural flood control, habitat for fisheries and waterfowl, regeneration, water reserve, water quality and quantity

Overconsumption and waste	Depletion of life resources, ecosystem function, and biodiversity (depletion of groundwater, collapse of fisheries)	Food production, water reserves, water quality and quantity
Extermination of exotic species	It causes a loss in the amount of biodiversity of native species	Food production, wildlife habitats, and regeneration
Emission of pollutants into soil, air, or water	Contamination of water sources alters the ecology and chemistry of wetlands, lakes, and rivers; Greenhouse gas emissions affect the amount and pattern of precipitation	Water resources, habitats, water quality, food production, and climate change can also affect hydropower, irrigation capacity, transportation, and flood control
Overconsumption and waste	Depletion of life resources, ecosystem function, and biodiversity (depletion of groundwater, collapse of fisheries)	Food production, water reserves, water quality and quantity
Extermination of exotic species	It causes a loss in the amount of biodiversity of native species	Food production, wildlife habitats, and regeneration
Pollutants in soil, air, or water Spread	Contamination of water sources alters the ecology and chemistry of wetlands, lakes, and rivers; Greenhouse gas emissions affect the amount and pattern of precipitation	Water resources, habitats, water quality, food production, and climate change can also affect hydropower, irrigation capacity, transportation, and flood control

When we examine the table above, we see that many factors, from excessive population growth to the introduction of pollutants into water, have a direct or indirect negative impact on the quality and existence of water resources. The lives of species that depend on water resources for their survival and gradually depend on water are also at risk. This situation violates the right of living things to exist. At the same time, problems in river flows and lake structure can cause serious damage to local and national economies. In addition to environmental problems, there are also many human factors that increase the negative pressure on water resources. This can also be seen as people's lack of interest in environmental problems. In this context, people are ignorant about the causes and solutions of these problems, there are no financial resources necessary to combat environmental problems, and as a result, government institutions and information confusion emerge. In this environment, it is accepted that national efforts to protect water resources are insufficient, and international efforts are needed. Because environmental problems affect according to the principle of integrity. As a result, any damage to the ecological order causes direct or indirect negative effects on water resources. All living things that depend on water resources will be affected equally.

4.5. Urban and Water-Related Problems

Since the river beds in urban centers are narrowed and turned into canals and some of them are covered, the natural flow systems of the waters are disrupted. Asphalted roads in cities, extending them in certain directions, and dividing them with residential areas reduce the time between the time of precipitation and the time of transition of precipitation to surface runoff and cause floods (Marcus and Detwyler. 1972: 99). Rapid and unplanned urbanization increases surface runoff coefficients in urban areas, resulting in more runoff and shorter-term flooding at the same rainfall intensity. In addition, the destruction of vegetation in and around cities, improper agricultural practices, and the removal of sand from riverbeds cause significant changes in river morphology and prepare soils for flooding. Urban asphalt and construction. Rain and snow drain meltwater as soon as possible without stagnation. Urban development changes the natural direction of surface drainage by increasing the amount of water flowing into rivers. In particular, the increase in urban settlements and impermeable soils in the basin gives the direction of the natural flow and the characteristics of the amount of water entering the surface runoff that can lead to flood and flood disasters. Here, too, the long bridge built over the river acts as a dam, closing the river bed, providing its drainage, preventing the flow of water, and swelling backward, causing flooding.

Flooding and inundation events are not only caused by meteorological factors. Especially the settlements in the river basins develop over time and change the land cover and land structure of the region. Improper land use increases flooding and inundation. Floods not only lead to deaths but also damage many man-made structures such

as farmland, villages, roads, bridges, etc. Areas that are flooded due to floods and floods temporarily become lakes or swamps. For example, on May 15-16, 2014, 4 people lost their lives, 600 houses were flooded, more than 6 thousand people were evacuated from their homes and 300 thousand houses were left without electricity for a while in the flood that occurred in the city of Maglay due to heavy rainfall in Bosnia and Herzegovina. River floods occur mostly in Southeast Asia, especially in China and India. Due to excessive rainfall and geomorphological factors in Turkey, floods and floods occur in many cities, especially in Balı-kesir, Antalya, Izmir, Rize, Muğla, Edirne, and Kars. Sea swells and giant waves due to storms and earthquakes are also a threat to coastal cities. In 1228, 100 thousand people lost their lives due to the sea swell that occurred in Friesland in the Netherlands, and in 1642, the embankments collapsed in the sea swell that occurred in China and 300 thousand people died (Özey, 2009). The tsunami that occurred in Southeast Asia on December 26, 2004, affected fourteen countries, especially Indonesia, and more than 230 thousand people lost their lives. (Pektezel, 2015)

5. The Relationship Between Water and Sustainable Cities

5.1. Sustainable City Concept

A Sustainable city is a concept that aims to maintain the development of urban areas in a way that does not threaten human and environmental health. The sustainable city approach aims to balance economic growth, environmental protection, and social welfare. This approach emphasizes that cities should be planned and managed by taking into account not only the needs of today's generations but also the needs of future generations. At the same time, it aims to continue the development of urban areas without disturbing the ecological balance. Water, on the other hand, is vital not only for human life but for all ecosystems. However, water resources are limited and these resources should be used in a balanced and effective manner by the principle of sustainability. Water management of sustainable cities, on the other hand, requires not only the efficient use of water but also balancing environmental, economic, and social factors. In this context, one of the most important concepts of sustainable water management is to ensure that water is used in a balanced way. To achieve this goal, concepts such as green spaces, blue corridors (waterways), and permeable areas play a key role in the sustainable management of water.

Water management of sustainable cities includes not only environmental but also economic dimensions. Water conservation and efficient use reduce water costs and increase the capacity of water to meet future demands. At the same time, preventing contamination of water resources reduces treatment costs and lowers health expenditures. It directly affects the quality of life and environmental health in the future. Bringing together elements such as water efficiency, technology, social participation, and climate change is essential for the success of the relationship between sustainable cities and water.

Urban planners are one of the key movers of sustainable water management. Planners need to develop strategies to ensure the effective use of water resources, to meet future water needs, and to protect water resources. These strategies should include issues such as the development of green infrastructure, the promotion of efficient use of water, and the recycling of wastewater. In addition, it is important to integrate the water management dimension into urban planning processes.

5.2. The Role of Sustainable Cities and Future Prospects

Sustainable cities must play a leading role in water management. These cities can set an example for other regions by promoting the efficient use of water. Future prospects are even more important. With the increasing pressure on water resources, sustainable water management will become even more critical. Technological innovations can help collect, store, and distribute water more effectively.

5.3. Protection and Sustainable Use of Water Resources

The use of water resources above their capacity leads to global warming and water pollution. It affects the quality, natural distribution, and quantity of water resources suitable for use in the world landscape. The protection and sustainable use of water resources is of global importance. The use of water resources in cities and the geographical distribution of water consumption vary depending on the level of regional development.

Generally, while the daily water consumption per capita in developed countries is 266 liters, this value is 67 liters in Africa. While the average water consumption in the world is 150 liters/day/person, this value is 111 liters/day/person in Turkey (Aliağaoğlu and Uğur, 2010). However, water consumption in cities varies in residences, public institutions, industrial facilities, and touristic facilities. According to the results of a study conducted for the city of Antalya, the current water consumption status was determined as 112 lt/day/person in residential areas, 28 lt/day/person in public institutions, and 225 lt/day/person in touristic facilities (Aliağaoğlu and Uğur, 2010).

The geographical distribution of water consumption in cities; varies according to the quality of water, the presence and variety of water resources, the price of water, water usage habits, and cultural structure. Unplanned use of water resources often leads to irreversible consequences. For example, excessive use of the streams that feed the lakes to irrigate agricultural lands reduces the water in the lakes and causes them to dry up (Aral Sea, Lake Chad, Akşehir Lake, etc.). Water resource management projects improve the quantity and quality of water. An example of these projects is the closed Konya Basin in the Central Anatolia region of our country. Konya Basin is a closed area covering 17% of the country's territory. Consisting of eight lakes and three reedbeds, the area is a designated natural heritage site, nature reserve, and private reserve. These wetlands within the basin were at serious risk due to improper land use and agricultural irrigation practices. With the "Towards the Rational Use of the Konya Closed Basin" project launched in 2003, more effective and sustainable use of the limited water resources in the basin has been ensured. (Pektezel, 2015)

6. Climate Change and Water Management

6.1. Water Management

Water resources management covers groundwater and surface waters, soils, upper and lower basins within the boundaries of the basin, those who need water for various purposes, those who provide water, and the entire ecosystem that needs water. Relevant management and institutional structures are also built within this framework. However, the level of development, and historical, cultural, and geographical conditions of a country also affect and differentiate its organization.

6.2. Sectoral Structure of Water Use

Unlike other living things, human beings use water not only for physiological needs but also in various ways for social, economic, and cultural, that is, in all areas of life. The history of human beings using water for other purposes dates back to ancient times. About 9,000 years ago, water was used to irrigate fields, while 2,000 years ago, water was used to run factories. Today, water is used in a wide variety of areas, from electricity generation to heating and cooling to cleaning. Today, the areas where water is used can be divided into three groups: agricultural, industrial, and urban. Industrialization is a development that directly and indirectly increases water consumption.

Theoretically, food production in the world is enough for everyone, but sharing and distribution problems create great imbalances in food production and sharing. The average daily calorie consumption per person across the world's population is 2,700 calories, but 800 million people worldwide consume significantly fewer calories than this average. In other words, a significant part of the world's population cannot get the nutrients that a normal person needs. This number decreases in proportion to the increase in the world's population, but the amount remains approximately the same. In fact, the cause of these problems lies in the uneven distribution of water resources. Because 40% of food production is obtained from irrigable lands (16%). The expansion of arable areas and the increase in yield is an event that directly depends on the amount of water. The fact that 2/3 of the products produced by irrigated agriculture are wheat and rice reveals the importance of water in nutrition. Today, the production of China, South-Southeast Asian countries, and North African countries is largely dependent on water. 4/5 of the grain yield in China, more than 1/2 in India, and 1/5 in the USA are obtained from irrigated lands. (Brown, 2006)

Table 5: Amount of water used in various places
Source: (WWF, 2006: 1)

Uses of Water	Amount of Water Used
Water needed for a healthy person	100 Liter
For shower	40 Liters
For toilet	12 Liter
Water spent on 1 cup of coffee and tea (from production to consumption)	140 and 35 Liters
250 mlt beer, 200 mlt, for apple production	75,200,190 Litres
For the production of 1 kg of cotton	20,000 Liters
For the production of 1 kg of rice, wheat, corn	3,000, 1334, 900 liters
For the production of 1 kg of steak	16,000 Liters
For a pair of leather shoes	8,000 Liters
Water needed for daily breakfast	135 Liters
Clean water flowing down the drain from the tap daily	17 Liter
Water used for the manufacture of a car	450,000 Liters
Water needed for a salad for one person	133 Liters
Water spent for 18 golf courses per year in Spain (as much as the water requirement of a city with a population of 15 thousand)	700,000 cubic meters

Since the 1960s, there has been an important development in agriculture that has increased production and is called the "green revolution". The amount of water used in this production increase has also increased to that extent and production has become directly dependent on water use. For example, the water that should be used for one ton of wheat is 1000 tons (Neubert, 2001). The amount of water that should be used for some products in the agricultural sector is shown in Table 5.

The amount of water consumed varies according to the economic structure of the countries, place, and time. In regions with dry climates, the water requirement is higher than in rainy regions. There are also differences between developing and industrialized countries. For example, although water has a usage rate of 69-70% in the agricultural sector in general, the share of the agricultural sector reaches 80% in China, India, Pakistan, and North African countries where intensive irrigation is carried out. Although the world average of the amount of water used in industry is 23%, there are significant differences between countries. While this rate goes up to 60-80% in industrialized countries, it decreases to 10-30% in developing countries. In the industrial sector, there is an intensive use of water in sectors such as electricity, oil production, metal, and chemical industries.

Although the average of water used in homes is 8% worldwide, it varies according to the country and place of residence, just like in the industry. In terms of the amount of water used in households, there are differences between rural settlements and cities, and between developing countries and industrialized countries. The emergence of megacities has been a development that has increased water shortage (Klaphake and Scheumann, 2001). There are also large differences between countries in terms of water consumption per capita. Water consumption per capita per day is as low as 700 liters in the US, 130 liters in Germany, and 30 liters in water-stressed parts of Africa. In terms of water consumption among the continents, Asia stands out, as can be seen in Table 3. Undoubtedly, the most important reason for this is that the population living on this continent is higher than the population on other continents of the world (Spiller, 2003).

Table 6: Distribution of Water Consumption Across Continents (1900 – 1990)
Source: (McNeill, 2005: 139)

	Rivers in the World Distribution %	Freshwater Around the World Consumption Rate %		
		1900	1950	1990
Asia	32	71	63	60
Europe	7	12	13	13
North America	18	10	17	18
Africa	10	5	5	6
South America	26	2	2	4
Australia	5	-	1	1

In parallel with the social and economic developments in the world, more water is needed in households, industry, and agriculture. Water is also the source of energy production and is of great importance for the construction and development of industry. As a result, surface water management efforts have accelerated. As a result, issues of water sharing and access are increasingly at the forefront of global politics. Countries such as China, Turkey, and Egypt are looking for ways to increase existing water resources and generate electricity through various dam projects. To achieve this goal, large-scale dam projects were implemented to control the water in the country's rivers. Efforts in this direction have created other problems. Large-scale investments in water can lead to differences and conflicts between countries in terms of water use. These large-scale projects have significant economic, social, environmental, and cultural costs. Indeed, many artifacts that are important for human history will be lost, and settlements and agricultural lands will be flooded. The expected benefits from the construction of dams should be carefully calculated due to the damage it causes to flora and fauna.

Climate change further affects water resources. It is an important factor influencing the future use of water resources. Rising temperatures cause water resources to evaporate faster, while heavy rainfall can increase the risk of flooding. Rising temperatures increase the risk of drought, while heavy rainfall can also increase the danger of flooding. Therefore, the water management strategies of sustainable cities should also take into account climate change scenarios. Smart water management can help water resources adapt to changing conditions.

6.3. Sustainable Water Management and Social Participation

Sustainable water management should be supported not only by technological solutions but also by community participation. Society's sensitivity to water resources and adopting water-saving habits can make sustainable water use more effective. In this context, educational campaigns, seminars, and projects involving the community in water management are important.

6.4. Water Pollution and Solutions

The most important water-related problems in cities are the pollution problems of sea, lake, river, and groundwater. Water resources are polluted in cities where population growth, unplanned urbanization, lack of infrastructure, and unplanned industrialization are side by side and intertwined. For this reason, in some cities today, watershores are not preferred for settlement due to pollution. Streams, lakes, and sea shores, whose waters are extremely polluted and smelly, constitute a disadvantage in terms of settlement. The main source of water pollution in urban centers is the sewage systems of cities. The amount of organic matter in urban waste is too high, causing bad odors. The use of water for cooling purposes in industrial centers, and nuclear and thermal power plants and its discharge back as hot water increases the biological and chemical reactions in the water and reduces the amount of dissolved oxygen. As a result, waste hot water prepares the environment for the development of harmful algae in streams and lakes and accelerates lake eutrophication (phosphate pollution). In new and rapidly developing cities, garbage piles also pollute the waters. In small and medium-sized cities of backward and developing countries, garbage is collected and dumped on vacant lands. Solid and flowing garbage accumulated in wild landfills mixes with the surrounding streams, drinking water, and groundwater and pollutes these waters. (Pektezel, 2015).

6.5. Urban and Groundwater Pollution

In areas with high urban pressure, excessive amounts of water are withdrawn from groundwater. The content of the water of groundwater, from which more water is withdrawn than the amount of feeding, decreases and deepens. Especially in coastal areas, when too much water is withdrawn from groundwater, fresh and saltwater mix with each other. Asphalt and construction work in urban areas prevent rain and snow meltwater from seeping into the ground. As a result, the amount of water in the groundwater table in urban areas is decreasing. In many historical fountains in the city center, water is no longer flowing due to the decrease in the water level.

6.6. Urban and River Pollution

Today, many rivers passing through cities are so polluted that they cannot be used even in agriculture and industry. The wastes of industrial establishments established in river basins, liquid wastes of river vehicles, pesticides, solid and liquid wastes of houses, and wastes of mines pollute the rivers. The industrial establishments that pollute the rivers the most; are weaving, leather processing, meat combines, and laundry facilities. These streams are covered

in order to remove the stench of the streams passing through the city centers and with high pollution levels. Again, in order to gain land in urban centers, river beds are narrowed and turned into canals. These human pressures on river systems cause the deterioration of the existing ecological integrity in the river basin. (Pektezel, 2015)

Water pollution is a serious threat to the water relationship of sustainable cities. Factors such as industrial waste, household waste, and pesticides can contaminate water supplies. Therefore, environmentally friendly technologies should be used in wastewater treatment systems and water treatment. In addition, effective control mechanisms are necessary to identify and prevent sources of pollution.

7. Conclusions

Based on the findings obtained from the research, conclusions have been drawn. Solutions proposals have been detailed under headings and items.

7.1. Findings

This study deals with water use in cities and the problems that arise due to this use. With the acceleration of the urbanization process, the pressure on water resources is increasing, and effective management and sustainable use of water resources are gaining importance. Our findings lead us to the following main conclusions:

- **Urbanization and Impacts on Water Resources:** The continuous growth and development of cities put increasing pressure on water resources. In particular, land use and infrastructure development negatively affect the quality and quantity of water resources by affecting the natural water cycle. The demand for water resources is increasing around the world and water consumption is at high levels, especially in urban areas.
- **Water Use and Water Resources:** The majority of water resources are found in the oceans as salt water and freshwater resources are limited. Population growth, climate change, and economic factors increase the pressure on water resources. In particular, sectors such as agriculture, industry, and urbanization play an important role in water consumption. The unequal distribution of water resources deepens the problem of water scarcity around the world and leads to economic, social, and environmental impacts
- **Water Scarcity and the Size of the Problems:** Water scarcity is a serious problem worldwide. Millions of people lack safe drinking water and inequalities in access to water resources. The economic, social, and environmental impacts of water scarcity are increasing.
- **Urbanization and Water-Related Problems:** The urbanization process shows an increasing trend around the world. The urban population increased from 746 million in 1950 to 3.9 billion in 2014 and is expected to reach 6 billion in 2045. The acceleration of urbanization complicates the effective use and management of water resources. In particular, unplanned urbanization and infrastructure deficiencies lead to problems such as floods. In addition, the deterioration of natural flow systems in cities causes pollution of water resources and flooding. The natural flow of the water cycle in cities is greatly disrupted. Increased runoff increases the risk of flooding and flooding.
- **Water Management and Sectoral Water Use:** Water management strategies need to be developed for effective management and sustainable use of water resources. In different sectors such as agriculture, industry, and urban use, it is important to use water in a balanced and equitable way.

As a result, global cooperation and solution-oriented policies need to be implemented for the sustainable use and management of water resources. Water use and water-related problems in cities should be handled with a multidisciplinary approach and long-term solutions should be studied. This is vital in order to leave a livable environment for future generations.

7.2. Results

Urbanization has led to an increase in pressures on water resources and the water cycle in cities, resulting in issues such as floods, overflows, and water scarcity. To address these challenges, it is crucial to prioritize sustainable water resource management in urban planning. This includes investing in water-saving technologies and renewable

resources, implementing effective measures to prevent water pollution, and promoting environmental awareness and education. Additionally, policy and legal arrangements should be established to ensure equal access to water resources and fair utilization. To ensure the long-term sustainability of cities, it is necessary to reduce water pressures and implement efficient management strategies. The participation and cooperation of stakeholders are crucial in achieving these goals.

- With the effect of the urbanization process, the pressures on water resources and the water cycle in cities are increasing. This makes problems such as flooding, flooding, and water scarcity even more common in urban areas.
- Sustainable management and use of water resources should be at the center of urban planning processes. Investments in water conservation and renewable water resources should be increased.
- Effective measures should be taken to address the problem of water pollution in urban areas and environmental awareness and education activities should be carried out to protect water resources.
- Policies and legal arrangements should be made at national and international levels in order to eliminate inequalities in access to water resources and to distribute water use fairly.
- For the future sustainability of cities, it is necessary to reduce the pressures on water resources and develop water management strategies. Stakeholder participation and collaboration are important in this process.

8. Strategies for Sustainable City and Water Management Proposal

The concepts that play an important role in the creation of sustainable cities and water management strategies are sustainability, efficiency, and ecology. Sustainability, efficiency, and ecology are fundamental concepts in understanding and managing the water relationship of sustainable cities. At the same time, when set out within the framework of these concepts, it can be ensured that the water balance in the city is maintained and the effects of the climate crisis, which are getting tougher day by day, are reduced to tolerable levels. These concepts determine how the relationship between the city and water should be.

8.1. Sustainability

Sustainability aims at the long-term use and protection of water resources. This approach aims to leave a transferable and livable environment for future generations by ensuring the efficient use of water. While sustainable water management requires the balanced use of water resources, it aims to protect the quality of water, increase the resilience of water resources against climate change, and ensure the sustainability of green areas. In addition, reducing pollutants and treating water with environmentally friendly methods are also part of the sustainability principle.

8.1.1. Sustainable Cities and Environmental Impacts

Sustainable cities should also consider environmental impacts in terms of water resources management. Pollution is an important factor affecting the quality of water. Therefore, solutions should be developed in areas such as wastewater treatment systems and industrial waste management. However, natural and artificial infrastructures that regulate the flow of water must also be taken into account to maintain the quality of the water.

8.1.2. Sustainable Cities and Social Impacts

Sustainable water management must also include societal impacts. Equitable and equitable distribution of water in water-stressed regions is critical to ensuring social stability. Additionally, community initiatives such as water conservation and awareness campaigns can help promote sustainable water use.

8.2. Efficiency

Efficiency aims at the best use of water. Efficient use of water in sustainable cities prevents water from being wasted, while at the same time optimizing the use of water for different purposes. Less consumption of water resources is critical for water to meet future demands.

Water efficiency is an approach that allows water to be used more effectively. This approach includes technological innovations for the efficient use of water. Smart irrigation systems prevent waste of water while ensuring that water is used according to needs. In addition, technologies such as wastewater treatment and recycling contribute to the sustainable use of water resources.

Technologies that save water in sustainable cities support the efficient use of water. Smart irrigation systems save water by directing water to areas where it is needed. At the same time, technologies such as low-flow faucets, water-saving shower heads, and devices that regulate water flow help in reducing water consumption. Various arrangements can be made in infrastructure systems to ensure water savings in sustainable cities. Infrastructures such as water tanks where rainwater is collected, and irrigation systems for the use of water in agricultural areas enable more effective use of water.

Technology and innovation play an important role in the water management of sustainable cities. Smart meters are used to monitor and manage the consumption of water, while water purification technologies help make water reusable. In addition, with data analytics and sensor technologies, water leaks can be detected and water losses can be reduced. By integrating new technologies, urban planners can make water management more efficient.

8.3. Ecology

The concept of ecology emphasizes the environmental impacts of water and its interaction with ecosystems. Sustainable management of water resources contributes to the conservation of ecosystems and biodiversity. For example, the reintroduction of polluted water into the water cycle causes profound effects on aquatic ecosystems, agricultural crops, and habitats. For this reason, it is important to use water by considering the ecological balance in order to protect the natural balance.

Creating green infrastructures is of great importance for the protection and sustainability of water resources in sustainable cities. Solutions such as green roofs, water-permeable surfaces, and natural wetlands support the collection of rainwater and the stabilization of groundwater levels. At the same time, these green spaces improve the aesthetic appearance of the city and increase biodiversity. Urban planners support the sustainable use of water resources by providing leadership in the planning and implementation of green infrastructure.

9. Auxiliary Concepts

The water relationship of sustainable cities is shaped around the basic concepts of sustainability, efficiency, and ecology. When it comes down to sub-diffractions, it also includes concepts such as recycling, sociology, and clean environment. Recycling refers to the disposal of water and waste that affects water through recycling systems and filters. Sociology involves increasing public awareness so that society's relationship with the environment is more harmless. A conscious and sensitive society contributes to the formation of sustainable cities. A clean environment, on the other hand, aims to ensure that all uses in the city do not cause environmental pollution. A clean environment refers to an environment where pollution is minimized or absent.

9.1. Sustainable Water Management

Sustainable water management strategies aim to meet future water demands while also protecting natural water resources. Based on the concepts, various strategies can be developed for the successful management of the water relationship of sustainable cities. These strategies aim both to ensure the efficient use of water and to protect water resources.

These strategies may include:

9.1.1. Urban Green and Blue Items

Green areas are reserved for the protection and development of natural ecosystems in the city. These areas both help to keep water in the soil and contribute to a healthier environment. At the same time, green spaces offer city residents places where they can breathe, relax, and be in touch with nature. Blue corridors, on the other hand, aim to protect and effectively use waterways. Thanks to these corridors, the natural flow of water is ensured, water pollution is prevented and the sustainability of water resources is supported. Blue corridors also help reduce the risk

of water flooding. By rehabilitating the river beds passing through the residential areas, both types of pollution should be prevented and the risk of flooding should be prevented. However, while rehabilitating the stream beds in urban centers, their water-carrying capacity should not be reduced by narrowing them.

9.1.2. Green Buildings, Collection and Utilization of Rainwater

Green buildings are buildings designed to save energy and water. These buildings may have systems where rainwater is collected and water is recycled. Likewise, green infrastructures feed underground water resources by allowing water to seep under the ground.

Rainwater collection and reuse are examples of efficient use of water. Collecting rainwater and using it for urban, agricultural, or industrial use contributes to less consumption of water resources.

9.1.3. Dissemination of Water Permeability and Prevention of Waterborne Risks

Increasing water permeability in cities allows water to seep underground. Thanks to these areas, rainwater penetrates the soil, feeds groundwater resources, and contributes to the natural cycle of water. Permeable areas also prevent erosion and allow water to mix with the soil without contamination.

While planning the social and economic development of cities, hydrographic environmental components should always be protected. Infrastructure, such as dam embankments or water collection tanks, can help reduce waterborne risks and threats. Special protection measures should be taken and implemented for streams, lakes, dams, and groundwater from which drinking and utility water is supplied.

9.2. Reduction of Environmental Pollution and Water Recycling Systems

Maintaining the quality of water in sustainable cities is also of great importance. Elements such as industrial waste, household waste, and pesticides can cause water pollution. Therefore, strict inspections and proper treatment systems are necessary to reduce environmental pollution. Seas, lakes, rivers, and groundwater in urban centers and their immediate surroundings should be protected and improved and pollution should be prevented.

By recycling water in infrastructure systems, the service life of water can be extended. Wastewater treatment plants should be installed in sewers in urban centers and checked regularly. After the wastewater is treated, it should be reused for irrigation purposes.

9.3. Adaptation to Climate Change

Seasonal stream beds and flood crevices passing through urban centers should not be filled and closed but should be protected in a way that can work as drainage channels. In urban planning, the natural conditions of surface flow must be taken into account. Sustainable water management strategies aim to minimize the effects of climate change on water resources.

9.4. Increasing Community Awareness

The importance of the concept of sociology emerges at this point. Society's awareness of environmental awareness and water use should be increased. Public awareness of water can be increased through educational campaigns, seminars, and awareness-raising projects.

10. Assessment

The relationship between sustainable cities and water is important for future generations to maintain a healthy life in a livable environment and has become a global priority. It is also a critical issue that affects the quality of life and environmental health in the future. The fact that water is a limited resource and the rapid growth of cities causes this relationship to become even more complicated. However, the principle of sustainability serves as a guide to overcome these challenges. Effective use of water resources, environmental protection, social participation, and technological innovations are the basic components of the water relationship of sustainable cities.

Water management of cities should not only be limited to the efficient use of water, but should also include multidimensional elements such as ecological balance, social awareness, and environmental protection. For this purpose, concepts such as green areas and blue corridors guide the sustainable management of water, while basic

concepts such as sustainability, efficiency, and ecology emphasize the meaning and necessity of this relationship. The relationship between sustainable cities and water is an important issue that affects the quality of life and the sustainability of the environment not only for today but also for future generations. Therefore, effective and fair management of water resources is the cornerstone of the creation of sustainable cities.

In order to meet the increasing water, need in the future, excess surface water can be stored in underground water tables - aquifers. This method has little danger of evaporation and contamination and is inexpensive and natural. In addition, it is thought that this method can be used to solve water problems in terms of preventing the mixing of salt and fresh water in coastal areas, controlling floods, and evaluating wastewater treated in urban centers. For this, excess surface water can be given to wells or surface water can be transferred to groundwater tables by spreading water over a wide area in permeable areas.

Considering the information obtained during the studies, it has been revealed that the pressure of human factors affecting the urban water cycle on water resources can be reduced by their agricultural and sectoral use. Breaking the continuity of negative effects on water resources will be the most important step. If the necessary investments are made around "sustainable water management" strategies with the right stakeholders, we can avoid the worst-case scenario. At this point, there are multiple elements that we can prevent and that we have at our disposal. First of all, raising the awareness of the citizens; will be the beginning of recycling and savings that can be made on a micro scale. In addition, all segments of society should be informed about the necessary training for water conservation. Awareness-raising and other sustainable urban activities should be encouraged by competent authorities such as states and non-governmental organizations. It is necessary to examine every production made on the path to be followed, to limit water consumption, and to support it with sustainable solutions and renewable energies.

Acknowledgment:

The abstract of this paper was presented at the Urban Planning and Architectural Design for Sustainable Development (UPADSD) Conference—8th Edition, which was held on the 24th - 26th of October 2023.

Funding Declaration:

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Ethics Approval:

Not applicable.

Conflict of interest:

The authors declare there is no conflict.

References

- Alpaslan, M.N., Tanık, A., Ve Dölgen, D., 2008. Türkiye'de Su Yönetimi: Sorunlar Ve Öneriler, Tüsiad Yayınları, N. T/2008-09/469, İstanbul, 215pp [Water Management In Turkey: Problems And Suggestions, Tusiad Publications, N. T/2008-09/469, İstanbul, 215pp] retrieved from https://tusiad.org.tr/yayinlar/raporlar/item/download/3498_a1f91fd58001d6767c7e2c4ec20c9b0c
- DSİ (2007), "Toprak Ve Su Kaynakları" ["Soil And Water Resources"] retrieved from <https://www.dsi.gov.tr/sayfa/detay/754>
- Günce Dergisi (2010), Su Kaynakları Yönetimi, Sayı 20. [Günce Dergisi (2010), Water Resources Management, Issue 20.] retrieved from https://www.tuba.gov.tr/upload/files/gunce/40_042010_1302-9541.pdf
- İzmir Büyükşehir Belediyesi, 2019, İklim Değişikliğine Dirençli Kentler İçin Bir Çerçeve: Yeşil Odaklı Uyarılama Kılavuzu, [Izmir Metropolitan Municipality, 2019, A Framework For Climate Change Resilient Cities: Green-Oriented Adaptation Guide] retrieved from https://direnclikent2019.izmir.bel.tr/YuklenenDosyalar/Dokumanlar/YESIL_ODAKLI_UYARLAMA_KILAVUZU.pdf
- Karadağ, Aybike Ayfer (2006), "Avrupa Birliği Su Politikaları Çerçevesinde Türkiye'deki Su Kaynakları Yönetiminin Değerlendirilmesi", TMMOB Su Politikaları Kongresi, Cilt.1 İçinde (210-218) Ankara: TMMOB Yayınları. ["Evaluation Of Water Resources Management In Turkey Within The Framework Of European Union Water Policies", In TMMOB Water Policy Congress, Vol.1 (210-218) Ankara: TMMOB Publications.] retrieved from <https://eskivan.imo.org.tr/resimler/ekutuphane/pdf/9127.pdf>
- Konyalı, C. & Çay, R. D. (2020). Sürdürülebilir Yağmur Suyu Yönetimi Kapsamında Yeşil Altyapı Sistemlerinin Değerlendirilmesi: Edirne İli Örneği . Kent Akademisi , 13 (4) , 668-687 . [Evaluation Of Green Infrastructure Systems Within The Scope Of Sustainable Rainwater Management: The Case Of Edirne Province. Urban Academy, 13 (4), 668-687.] DOI: 10.35674/Kent.822454 retrieved from <https://doi.org/10.35674/kent.822454>

- Lotze-Campen, Hermann 2006, Wasserknappheit und Ernährungssicherheit. *Aus Politik und Zeitgeschichte*. ["Water Scarcity And Food Security", *From Politics And Contemporary History*, Water, 19 June, Apuz 25/2006, Pp.8-13.] retrieved from <https://www.bpb.de/shop/zeitschriften/apuz/29693/wasserknappheit-und-ernaehrungssicherung/>
- Ormançılık ve Su Şurası, Su Kaynaklarının Geliştirilmesi ve Hidroloji Çalışma Grubu Raporu, 2021 [Forestry And Water Council, Water Resources Development And Hydrology Working Group Report, 2021] retrieved from https://cdnys.tarimorman.gov.tr/api/File/GetFile/467/Sayfa/1497/1861/DosyaGaleri/su_kaynaklarinin_gelistirilmesi_grubu_calisma_belgesi.pdf
- Öztopcu, A., & Salman, A. (2019). Sürdürülebilir Kalkınmada Akıllı Kentler. *Karadeniz Uluslararası Bilimsel Dergi*, (41), 167-188. [Smart Cities In Sustainable Development. *Black Sea International Scientific Journal*, (41), 167-188.] retrieved from <https://doi.org/10.17498/kdeniz.476335>
- Phil Dickie, Rich Countries Poor Water, WWF, Avustralya, 2006, S. 6 retrieved from <https://assets.wwf.org.uk/downloads/richcountriespoorwater.pdf>
- Şahin, Yusuf (2011), Kentleşme Politikası, Murathan Yayınları, 2. Baskı, Trabzon. [Urbanization Policy, Murathan Publications, 2. Printing, Trabzon.]
- Tema Vakfı, Su Kanunu Tasarısı, Aralık 2014, İstanbul, [Tema Foundation, Draft Water Law, December 2014, İstanbul] retrieved from https://cdn-tema.mncdn.com/Uploads/Cms/tema-vakfi-su-kanunu-tasarisi_1.pdf
- TUĞAÇ, Ç. (2018). Uluslararası sürdürülebilir kent ölçütleri bağlamında Türkiye için bir değerlendirme. *Kent Akademisi*, 11(4), 703-740. [An Assessment For Turkey In The Context Of International Sustainable City Criteria. *Urban Academy*, 11(4), 703-740.] retrieved from <https://dergipark.org.tr/en/download/article-file/630000>
- Turoğlu, H. (2010). Yapılaşmanın Doğal Akım Yönü ve Akım Birikimi Üzerindeki Etkileri. A. Ü. Türkiye Coğrafyası Araştırma ve Uygulama Merkezi (TUCAM), VI. Ulusal Coğrafya Sempozyumu 2010, 03–05 Kasım 2010 Bildiriler Kitabı: 29 -36. [The Effects Of Construction On Natural Flow Direction And Current Accumulation. A. U. Turkish Geography Research And Application Center (TUCAM), VI. National Geography Symposium 2010, 03–05 November 2010 Proceedings Book: 29-36.] retrieved from http://tucaum.ankara.edu.tr/wp-content/uploads/sites/280/2015/08/semp6_5.pdf
- USİAD (2009), 5. Dünya Su Forumunda, Mevcut Eğilimler Su Sorununu Artıracaktır, No:37, USİAD Yayınları [5. At The World Water Forum, Current Trends Will Increase The Water Problem, No:37, USİAD Publications.]
- Walsh, C.J., Booth, B.D., Burns, M.J. and others, 2016. Principles For Urban Stormwater Management To Protect Stream Ecosystems, The Society For Freshwater Science. retrieved from https://faculty.washington.edu/dbooth/Walsh%20et%20al%20Principles%20for%20urban%20stormwater_Freshwater%20Science%202016.pdf
- Aliagaoglu, A. Ve Uğur, A., (2010). Şehir Coğrafyası, Nobel Yayın Dağıtım. ISBN, 978 (605), 395. [*Urban Geography*, Nobel Publication Distribution. ISBN, 978 (605), 395.]
- United Nations Development Program, (2007) "Urbanization Perception Within The Scope Of Integration Of Sustainable Development Into Sectors Project", File, Issue 51, 69-71. retrieved from <http://www.undp.org/sites/g/files/zskgke326/files/publications/UNDP-in-action-2007-en-.pdf>
- Brown, Lester R., Dünyayı Nasıl Tükettik, Türkiye İş Bankası Yayınları, İstanbul, 2006 [*How We Consumed The World*, Türkiye İş Bankası Publications, İstanbul, 2006]
- DPT, Su Havzaları Kullanımı Ve Yönetimi ÖİK Raporu, DPT Yayın No: 2555, ÖİK: 571, Ankara, 2001, S. 28. [Water Basins Use And Management Report, DPT Publication No: 2555, ÖİK: 571, Ankara, 2001, P. 28.] retrieved from <https://www.sbb.gov.tr/wp-content/uploads/2022/08/Sekizinci-Bes-Yillik-Kalkinma-Plani-Su-Havzaları-Kullanimi-ve-Yonetim-OIK-Raporu.pdf>
- Dünya Su Forumları Bülteni (2009), 5. Dünya Su Forumu Günlük Raporu, No. 16 İİSD Yayınları, İstanbul. [World Water Forums Newsletter (2009), 5. World Water Forum Daily Report, No. 16 ISD Publications, İstanbul.] retrieved from <http://enb.iisd.org/tr/daily-report-16-march-2009>
- Firidin, E. (2015). Su Sorununun, Su Hakkı Ve Su Etiği Çerçevesinde Değerlendirilmesi. *Aksaray Üniversitesi İktisadi Ve İdari Bilimler Fakültesi Dergisi*, 7 (2) , 43-55. [Evaluation Of The Water Problem Within The Framework Of Water Rights and Water Ethics. *Aksaray University Journal Of The Faculty Of Economics And Administrative Sciences*, 7 (2), 43-55.] retrieved from <http://aksarayiibd.aksaray.edu.tr/tr/pub/issue/47830/604157>
- Günaydın, G. (2009). Suyun Piyasalaştırılması, Küresel Tarım - Su İlişkisi. *Memleket Siyaset Yönetim*, 4 (10) , 33-58. [Marketization Of Water, Global Agriculture - Water Relationship. *Hometown Politics And Management*, 4 (10), 33-58.] retrieved from <https://dergipark.org.tr/en/pub/msydergi/issue/75923/1254124>
- Kaya, H. E., & Susan, A. T. (2020). Sürdürülebilir Bir Kentleşme Yaklaşımı Olarak, Ekolojik Planlama Ve Eko-Kentler. *İdealkent*, 11(30), 909-937. [As A Sustainable Urbanization Approach, Ecological Planning And Eco-Cities. *İdealkent*, 11(30), 909-937.] retrieved from <https://doi.org/10.31198/idealkent.533730>
- Kılıç, S. (2008). Küresel İklim Değişikliği Sürecinde Su Yönetimi. *İstanbul Üniversitesi Siyasal Bilgiler Fakültesi Dergisi*, 0 (39) , 161-186. [Water Management In The Process Of Global Climate Change. *Istanbul University Journal Of The Faculty Of Political Sciences*, 0 (39), 161-186.] retrieved from <https://dergipark.org.tr/en/pub/iusiyasal/issue/597/6016>
- Kibaroglu, Aysegül ve Diğerleri, "Türkiye'nin Su Kaynakları Politikasına Kapsamlı Bir Bakış: Avrupa Birliği Su Çerçeve Direktifi ve İspanya", TMMOB Su Politikaları Kongresi 21-23 Mart 2006, TMMOB, Ankara, s.184-194. ["A Comprehensive View Of Turkey's Water Resources Policy: The European Union Water Framework Directive And Spain", TMMOB Water Policy Congress 21-23 March 2006, TMMOB, Ankara, P.184-194.] retrieved from https://www.academia.edu/327033/T%C3%9CRK%C4%B0YEN%C4%B0N_SU_KAYNAKLARI_POL%C4%B0T%C4%B0KASINA_KAPSAMLI_B%C4%B0R_BAKI%C5%9E_AVRUPA_B%C4%B0RL%C4%B0C%C4%9E%C4%B0_SU_%C3%87ER%C3%87EVE_D%C4%B0REKT%C4%B0F%C4%B0_VE_%C4%B0SPANYA_%C3%96RNE%C4%9E%C4%B0

- Klaphake, Axel And Scheumann, Waltina 2001, "Political Responses To The Global Water Crisis: Trends And Conflicts, *From Politics And Contemporary History*", Apuz B8 – 49 /2001, Pp.3-12. retrieved from <https://www.bpb.de/shop/zeitschriften/apuz/25861/politische-antworten-auf-die-globale-wasserkrise-trends-und-konflikte/>
- Marcus, M.G. & T.R. Detwyler. (1972). Urbanisation And Environment In Perspective, P.3-25. In T.R. Detwyler & M.G. Marcus (Eds.), *Urbanisation And Environment - The Physical Geography Of The City*, Duxbury, Belmont, 287p.
- Mcneill, John R. (2005), *Blue Planet*, The History Of The Environment In The 20th Century, Federal Agency For Civic Education, Bonn.
- Oktay, H. E. , Erdoğan, R. & Oktay, F. B. (2015). KENT VE SU, İnönü Üniversitesi Sanat ve Tasarım Dergisi , 5 (11) [City And Water, İnönü University Journal Of Art And Design, 5 (11)] retrieved from <https://dergipark.org.tr/pub/ijad/issue/8730/614918>
- Özey, R. (2009). Çevre sorunları, İstanbul: Aktif Yayınevi [Environmental Issues, İstanbul: Aktif Publishing House]
- Pektezel H. 2015, "Kent ve Su Kaynakları". Eds. M. Karakuyu, A. Keçeli & Ş. Çelikoğlu, Kent Çalışmaları II. Pegem Akademi yayınları, Ankara ["Urban And Water Resources", Urban Studies II. Pegem Academy Publications, Ankara] retrieved from https://www.researchgate.net/profile/Halid-Pektezel/publication/304900788_Kent_ve_Su_Kaynaklari/links/577cf06108aec3b74337e9f7/Kent-ve-Su-Kaynaklari.pdf?tp=eyJjb250ZSh0Ijpb7lmZpcnN0UGFnZSI6InB1YmxpY2F0aW9uIiwicGFnZSI6InB1YmxpY2F0aW9uIn19
- Pınarcıoğlu, N. Ş., & Kanbak, A. (2020). Sürdürülebilir Kent Modelleri. [Sustainable City Models. IJOPEC PUBLICATION.] retrieved from http://www.ijopecc.co.uk/wp-content/uploads/2021/01/2020_25.pdf
- Samanlı, V. Kentlerde Sürdürülebilir Su Kaynakları Sistemleri. 27. Kentsel Tasarım Ve Uygulamalar Sempozyumu, 167. [Samanlı, V. Sustainable Water Resources Systems In Cities. 27th Symposium On Urban Design And Applications, 167.)
- The United Nations World Water Development Report: 2014; 14. retrieved from <https://unesdoc.unesco.org/ark:/48223/pf0000225741>
- UNESCO, The United Nations World Water Development Report 2 - Water, A Shared Responsibility, 2006, S. 121-122. retrieved from <https://digitallibrary.un.org/record/3894442?v=pdf>
- UNESCO UN Water, Water In A Changing World, Londra, 2009, S.99. retrieved from <https://digitallibrary.un.org/record/3894442?v=pdfhttps://www.unwater.org/publications/un-world-water-development-report-2009>
- WWF (2006), "Hätten Sie's gewusst? Erstaunliche Fakten zu unserem Wasserverbrauch", Hintergrundinformation Frankfurt, August ["Did You Know? Amazing Facts About Our Water Consumption", Background Information Frankfurt, August]