TURKISH WATER INSTITUTE
SUEN
TÜRKİYE SU ENSTİTÜSÜ

Supplying Water to a Metropolis

İSTANBUL and WATER

Contents

Introduction

HISTORY

With a history dating back 8.500 years, İstanbul is an ancient city which is simultaneously modern and fresh. Including Roman, Byzantine and the Ottoman Empires, the city functioned as home to many tribes, nomads and civilizations and served as the administrative and religious center of these three empires mentioned.

The first name of Byzantium was Lygos. Byzantion, latinized as Byzantium, was the name after 667 BC. Constantinople "City of Constantine", was the name by which the city became soon more widely known, in honor of Constantine the Great. İstanbul, is the modern Turkish name since taken over by the Ottoman Empire in 1453. Ankara is the capital of the Republic of Turkey while İstanbul is known to be the capital of commerce and culture.

The core of İstanbul has historically been "The Historical Peninsula" surrounded by the Golden Horn on north, the Bosphorus on east and the Marmara Sea on south. Due to its strategic location connecting Europe and Asia, the herein reigning civilizations always played an important role in history. The splendid history made religions, cultures and communities to mingle as such the city has been included into the World Heritage List of UNESCO with four major parts.

GEOGRAPHY and CLIMATE

Covering a surface area of nearly 5.500 square kilometers, İstanbul is geographically unique due to its position as a bridge between Europe and Asia where the watercourse of Bosphorus divides the city. To the south lays the Marmara Sea, and to its north the Black Sea. The western part of the city is in Europe, and the eastern is in Asia. This geographical location brings in characteristics of east and west to the city at the same time.

İstanbul is situated in the Marmara Sea Basin, one of the 25 hyrdological basins in Turkey. The climate in the city is in general similar to the Marmara region which is under the effect of Mediterranean, Black Sea, the Balkans and Anatolian continental climate. İstanbul is a city where four seasons can be experienced. The hottest months are July and August while the coldest months are January and February. Average rainfall is 787 millimeters a year. 35% of the rainfall occurs in winter, 23% in spring, 14% in summer, and 28% in autumn.

POPULATION

İstanbul is the most populous city in Turkey and thus the heart of the country. It is also one of the largest agglomerations in Europe and the fifth largest city in the world in terms of population within city limits. In 2018, İstanbul had an estimated population of over 15 million resulting in a population density of 2.750 people per square kilometer, far greater than Turkey's density of 105 people per square kilometre. The most rapid growth in the city came during the late 20th century, when its population rose from 983.000 in 1950 to 11.076.840 in 2000. The population has grown partly from expanding the city limits, especially in the 1980s, when İstanbulites doubled in number. İstanbul is growing at an average rate of approximately 2%, making it one of the fastest growing metropolitans in the world.

Table 1. Population of İstanbul

Year	Population
2000	11.076.840
2005	12.128.577
2010	13.255.685
2018	15.067.724

ECONOMY

"İstanbul's Economy Alone is Larger than 130 Countries"

As Turkish economy grows with historic records, İstanbul functions as the engine of growth, having $25.000 GDP per capita income to which corresponds more than two times of countries' average. Compared with the year of 2001 level, GDP per capita in İstanbul has grown more than fivefold. The foreign trade volume is approximately $193 billion, where more than 70.000 companies are dealing with international trade in İstanbul.

History of Water Management in İstanbul

Described by the historian Procopius as "the city surrounded by a wreath of water", İstanbul has always boasted an exquisite geographical position.

The water needs of the city during its foundation period was supplied through underground resources. The first notable water facilities in the city were constructed during the Roman Empire. Opening a new era with the conquest of İstanbul, the Turks have established a splendid water civilization considering the conditions of those days. The city population grew further after the conquest and the existing water facilities proved insufficient. With the increase of population over time, water scarcity reappeared and Suleiman the Magnicifent appointed Sinan the Architect to resolve the issues. Many prominent hydraulic structures from aqueducts to fountains were built and are still visible throughout the city.

To meet the surging water demand of the city driven by population growth, as well as to provide pressure water to new modern buildings, "Dersaadet Anonim Su Şirketi (Water Inc.)" was chartered to a French company in 1868 by Sultan Abdulaziz. The company had the duty to supply water to the city from Terkos Lake and collect other spring, underground and stream waters to transfer upon treatment. In time, the companies with privileges were seen to underperform their duties while enjoying many rights and the public opinion was that water services could not be effectively delivered by these companies. As a result, in 1932, Terkos company and in 1937, Kadıköy-Üsküdar water company were purchased and transferred to İstanbul Water Administration (İSİ) which evolved over time to include wastewater services with the current name of İstanbul Water and Sewerage Administration (İSKİ) since 1981.

In the year 2004, the service area of İstanbul Metropolitan Municipality, and so that of İSKİ, was expanded to cover the entire provincial administrative area including villages and small towns outside the city periphery. This reform was primarily to benefit more from economies of scale and was applied in the course of time to other 29 cities in Turkey.

Mağlova Aqueduct, *built by Sinan the Archtitect in 1554-1565*

Water Governance

Central Governmental Institutions

Ministry of Agriculture and Forestry

One of the mandates of the Ministry of Agriculture and Forestry, through the GD of Water Management, is to conduct the necessary coordination for the generation and implementation of river basin management plans. Chaired by the Governor and with the participation of all relevant stakeholders, the GD of Water Management coordinates the Marmara Basin Management and İstanbul Provincial Water Management Committees where basin and provincial water-related matters are discussed and resolved.

State Hydraulic Works (DSİ)

The State Hydraulic Works (DSİ) under the Ministry of Agriculture and Forestry plans and constructs large-scale hydraulic facilities (e.g. dams, transmission lines) and transfers these to the Water and Sewerage Administrations for operation and maintenance. Through its regional directorate headquartered in İstanbul, DSİ has thus far built the major hydraulic structures of the city and transferred them to İstanbul Water and Sewerage Administration (İSKİ). DSİ is currently undertaking the Melen Dam project with a total impoundment capacity of 694 million m^3.

Ministry of Environment and Urbanization

Through its İstanbul Provincial Directorate, the Ministry of Environment and Urbanization audits the compliance of wastewater quality standards. The Ministry has broad authority in wastewater control including processing fines in the case of non-compliance.

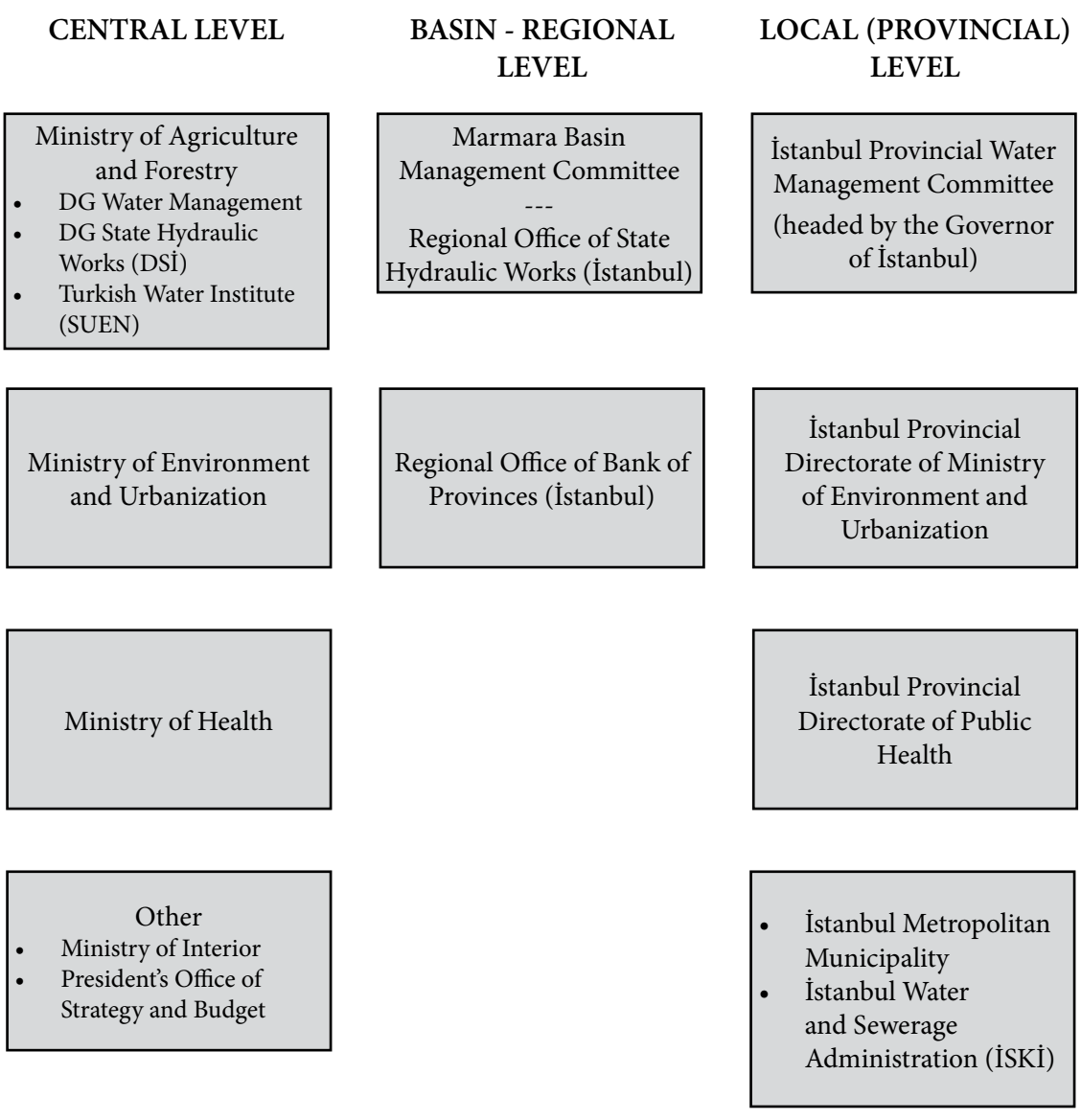
Ministry of Health

In line with the By-Law on the Quality of Water Intended for Human Consumption, the Ministry of Health, through the İstanbul Provincial Public Health Directorate, controls the drinking water standards throughout many points in the city.

Turkish Water Institute (SUEN)

Turkish Water Institute (SUEN) is a national think tank situated in İstanbul with the goal to develop short and long-term strategies and national policies for the good governance of water. SUEN provides technical assistance and training programs to the experts working in water and sanitation.

Figure 1.
Key Governmental Organizations in Water Management in İstanbul



Basin and Local Authorities

Marmara Basin Management Committee

Covering several provinces including İstanbul, the Marmara Basin Management Committee gathers periodically to discuss basin-level water issues in the chairmanship of the Governor or Deputy Governor of İstanbul with different stakeholders including NGO's.

İstanbul Provincial Water Management Committee

The İstanbul Provincial Water Management Committee meets periodically to ensure the coordination among institutions related to water management in İstanbul. The meetings are chaired by the Governor or Deputy Governor of İstanbul.

İSKİ (İstanbul Water and Sewerage Administration)

Founded in 1981 pursuant to İSKİ Law No. 2560, İSKİ is a public utility affiliated to the İstanbul Metropolitan Municipality with an independent budget approved by the Metropolitan Municipal General Assembly. The Administration is mandated to supply water to households and other consumers and collect and treat wastewater of the entire city. As the first established water and wastewater administration, İSKİ has always been the pioneer among the country water and wastewater administrations.

Providing water and wastewater services to over 6 million customers, İSKİ has a total staff of more than 12.000 including workers employed in outsourced works. The total budget of the administration is more than 1,5 billion USD of which more than one third is allocated to investments. The largest share of income is generated from water sales. Water consumption is fully metered mechanically or electronically.

The Board of Members of the Administration where the Mayor of İstanbul is the Chairman is highest executive body of the organization. The Director General of İSKİ acts as the Vice Chair of the Board with 6 members including the most senior Deputy Director General. The Director General of İSKİ is appointed upon the proposal of the Metropolitan Municipality Mayor and approval by the Minister of Environment and Urbanization.

Table 2. İSKİ in Numbers (2018)

Population Served	15.067.724
Total Area of Service	5.461 km^2
Number of Customers	6.464.453
Length of Water Network	19.146 km
Length of Transmission Lines	2.602 km
Yield of Water Resources	1,7 billion m^3/year
Average Daily Water Supply	2.733.388 m^3/day
Number of Drinking Water Treatment Plants	21
Capacity of Drinking Water Treatment Plants	4.428.860 m^3/day
Number of Water Storage Tanks	150
Volume of Water Storage Tanks	1.727.080 m^3
Total Length of Sewers	16.106 km
Length of Collector Lines	1.140 km
Length of Tunnels	202 km
Number of Wastewater Treatment Plants	88
Capacity of Wastewater Treatment Plants	5.815.910 m^3/day

Water and Wastewater Tariffs

Proposed and collected by İstanbul Water and Sewerage Administration (İSKİ), the water and wastewater tariffs are approved by the Municipal General Assembly. İSKİ differentiates the tariffs per customers groups and applies a gradual block tariff system where the unit prices rise after a higher block of domestic consumption. By this, excessive consumption is aimed to be minimized.

Table 3. İSKİ Water Tariffs

Domestic Water Tariffs (including wastewater) (as of 01.06.2019)	
Consumption Blocks	**Unit price per m^3**
0-15 m^3/month	$0,7
>15 m^3/month	$1,05

Basilica Cistern (527-565)

Water Resources and Consumption

Water Resources

98% of the water resources of İstanbul are surface water resources. 60% of the water resources are in the Asian part of İstanbul while 40% is within the European part. In contrast, 60% of the population reside in the European section of the city whereas the rest live in the Asian part necessitating transmitting water from Asia to Europe.

Water from rainfall times are impounded in dams and regulators, and then supplied to the city following necessary treatment processes. To meet the growing water demand in İstanbul due to population increase and geographical expansion of service areas, potable water is provided from a long range of sub-basins extending from Tekirdağ province in Europe to Düzce province in Anatolia.

Water Use

In the year 2018, an average of over 2,7 million m^3 of water was consumed in İstanbul in a day. This amount was 1,95 million m^3 in 2010. In the summer season, the city water demand peaks and exceeds 3 million m^3 per day.

Melen, which is among the major water resources of İstanbul, is a tributary of the Sakarya River. The rough terrain of the city and conveying water from far distances lead to high energy consumptions for pumping.

Table 4. Total Average Water Consumption

Year	m^3/day
2010	1.968.073
2012	2.385.072
2014	2.532.736
2018	2.733.388

Table 5. İstanbul Water Resources

Water Resource	Annual Yield (million m^3)	Max. Impoundment Volume (million m^3)	Year of Opening
Ömerli	220	235.371	1972
Darlık	97	107.500	1989
Elmalı 1 & 2	15	9.600	1893-1950
Terkos	142	162.241	1883
Alibeyköy	36	34.143	1972
Büyükçekmece	100	148.943	1989
Sazlıdere	55	88.730	1998
Istrancalar (Düzdere, Kuzuludere, Büyükdere, Sultanbahçedere, Elmalıdere)	>75	6.231	1995-1997
Kazandere	100	17.424	1997
Pabuçdere	60	58.500	2000
Yeşilçay	145	-	2004
Melen	575	-	2007-2014
Yeşilvadi Regulator & Şile Caisson Wells	10	-	1992
Water from Wells and Springs	40	-	1994-2006
Sakarya Regulator	150	-	2014
Total	1.820	868.683	

Ömerli Reservoir

Water Infrastructure

Water is collected in dams and natural lakes, then transferred to treatment plants via tranmission lines. There are 17 surface water resources in İstanbul, including 1 natural lake, 8 dams and 7 regulators. Furthermore, there are 145 potable water wells with an annual capacity of 37.320.000 m^3 feeding the regions of Silivri and Çatalca. The annual yield of potable water resources equals to 1,7 billion m^3. Water catchment basins reach up to 6.157 km^2 together with the Melen Basin.

Water collected in the resources is delivered to drinking water treatment plants via transmission lines up to 3 m in diameter. Reaching a total length of 2.600 km; 823 km of the transmission lines is steel, 598 ductile iron, 20 km polyethylene and the rest (in tunnel, channel and galleries) is made of other materials.

The rough geography and distance of water resources to the city brings about a large energy requirement. In every stage between the water resource and house taps, pumping systems are installed to enable pressure supply. Pumps of various capacities in 115 pumping stations all around İstanbul provide water to all corners of the city. The installed capacity of all potable water pumping stations is 308.805 kVA and the annual energy consumption is on average 757.805.995 kWh.

Raw water in the drinking water resources reach to the water treatment plants via transmission lines for the required treatment processes. There are 21 water treatment plants in İstanbul. Ozonation technology is adopted in these facilities with a total capacity of over 4,4 million m^3/day to enable provision of drinking water complying with national and international standards.

There are 150 water storage tanks of various sizes in different parts of İstanbul. Constructed to provide water consumption balance, save energy and minimize water cuts that may occur due to breakdowns and energy cuts, the total capacity of these tanks amounts to 1.727.080 m^3. Upon treatment, the water is supplied to the city via transmission lines and eventually through the drinking water distribution system. The drinking water network is made of ductile iron pipes. The length of this pipe type-selected due to its resistant, leak-proof and long-lasting aspects- is estimated to be 19.146 km.

Laboratory Services

The quality of water is analyzed at the laboratories in the same plants. Starting from the intake of raw water into the plant through the whole treatment process, the analyses conducted provide continuous monitoring of the quality of water supplied to the drinking water distribution system. Over 80 parameters, including chemical, bacteriological and aesthetic ones, are monitored in the process. An average of minimum 150-200 samples per day are taken from miscellanous points and analyzed in the state-of-art labs. The results of these analyses are accessible monthly over the web page of İSKİ.

SCADA

İSKİ has modernized the SCADA (Supervisory Control and Data Acquisition) system used for drinking water distribution with the state-of-the-art system ensuring the most rapid response to the requirements of the growing population. This new system provides secure and high performance, and is controlled via satellite covering a vast area independent of land lines. Through satellite communication, water distribution system of an area with different terrain conditions and vast space between Istrancalar and Melen can be easily controlled via data flow that is updated instantly.

In virtue of the modern system, the water increase level in dams during/after rainfall can be swiftly measured, and water loss is prevented as foreseeing and addressing to probable breakdowns is possible. It is also easier to detect the unaccounted for water (i.e. the difference between water supplied and billed).

The SCADA system enables monitoring of the data on water levels, pressures, flows, water quality, etc. in dams, main transmission lines, pumping stations and water storage tanks at the SCADA center in Kağıthane headquarters. Furthermore the cameras at the stations provide instant monitoring while the system also enables easy access to data and response to cases of disasters.

Figure 2. Water Treatment Plants in İstanbul

Melen System

Greater İstanbul Water Supply Project

Uniting Two Continents through an Undersea Tunnel

40% of İstanbulites live in the European part of the city while the rest reside in the Asian part. Yet, the case is the opposite when it comes to water resources. For this very reason, transferring water between the continents has become inevitable.

Considering the population expected to top 20 million in the future, the Greater İstanbul Water Supply project has been undertaken by the State Hydraulic Works (DSİ) under the Ministry of Agriculture and Forestry to supply the city's ever-growing water needs. In an inter-basin and inter-continental manner, water is taken from the Melen Creek in another province, Düzce, from a distance of 170 km.

Among the 4 phases of the multi-billion Turkish liras project, the Bosphorus Crossing Tunnel section covered a subsea tunnel, bored with high-technology machinery, with a diameter of 5.820 mm and length of 5.550 m at 135 m below sea level. The construction of the tunnel, with a capacity to convey nearly 3 million cubic meters per day between continents, was completed in 1.200 days. The average advancing speed of the TBM used for the tunnel section was 8 m per day, with a maximum speed of 20,4 meters per day. The steel tube of 4 m in diameter inside the hard-rock type tunnel resists a pressure of 14 bar.

Besides the tunnel section, the Greater İstanbul Water Supply project to secure the drinking water supply to İstanbul until the year 2060, includes the Cumhuriyet Water Treatment Plant (capacity of 720.000 m^3/day), the Melen Transmission Line (3.000 mm in diameter steel pipe for a length of 170 km) and pumping stations, the Melen Dam (total impoundment volume of 694 million m^3) and Regulator and the Sungurlu Dam. The completed facilities (Cumhuriyet Water Treatment Plant, Melen Transmission Line and Bosphorus Tunnel) have been transferred to İSKİ for operation and maintenance.

Melen Bosphorus Tunnel

Wastewater Infrastructure

Roughly 50% of İSKİ's total investments are spent for wastewater infrastrucutes. All wastewaters are collected through the sewerage systems where concrete materials are in general preferred. The wastewater subsequently are conveyed through main sewers and tunnels. As high as 2,20 m in diameter, the main sewer materials are reinforced concrete and corrosion resistant. Tunnel systems have been built in locations considering traffic density and ground conditions. The coasts of İstanbul are in large parts surrounded with wastewater tunnels up to 3 m in diameters and main sewer collectors. No-dig technologies and robotic systems are utilized in the rehabilitation and cleaning of the sewage networks.

The total wastewater treatment capacity of the city is more than 6 million m^3 a day. Many advanced wastewater treatment plants have been built taking the sub-basin characteristics into account. Given the two-layer flow structure of the Bosphorus watercourse, the plants were planned as preliminary treatment along the Bosphorus and other plants on the Marmara coastal areas have been built with advanced biological treatment specifications. Part of the biologically treated effluent is used for the irrigation of recreational areas (parks) as well as for industrial purposes. Significant energy is generated from the treatment plants as well.

Figure 3. Wastewater Treatment Plants in İstanbul

Ataköy WWTP

International Activities

İstanbul International Water Forum

As the hub for international conferences, miscellaneous international water and environment related events take place in İstanbul.

One of them is the İstanbul International Water Forum, shortly IIWF, organized every three year bringing the world water community together. Organised one year prior to the World Water Forums, IIWF is the flagship event of the Turkish Water Institute (SUEN) under the Ministry of Agriculture and Forestry.

The last organized IIWF, 4th İstanbul International Water Forum, was held between 10-11 May 2017 at the İstanbul Lütfi Kırdar International Convention and Exhibition Center. The Forum was jointly organised by the Turkish Water Institute and State Hydraulic Works welcoming around 2.000 registered participants from 64 countries all over the world. Considering that Turkey hosts more than 3,6 million Syrian refugees and İstanbul approximately 500 thousand, the Forum focused on the issue of refugees under the central theme of "Water and Peace".

By emphasizing that refugee crisis has become a global concern, the 4th Forum's main message was that refugee crisis is not an issue to be dealt alone by host countries and the responsibility should be shared by the international community through new international funding mechanisms.

Technical Assistance and Capacity Building Programs

İstanbul Water and Sewerage Administration (İSKİ) under the Metropolitan Municipality of İstanbul provides significant technical and financial contributions to the countries in need. A great amount of equipment has been granted and thousand of experts are hosted in the city to be acquainted with the good practices in water management.

Turkish Water Institute under the Ministry of Agriculture and Forestry located in İstanbul, has carried out numerous capacity building programs to the benefit of more than 1.200 water and sanitation experts from over 30 countries in cooperation with İSKİ and the Turkish Cooperation and Coordination Agency (TİKA).

Sources

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For Your Notes

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