

Why does İstanbul need a paradigm shift in water and sanitation management¹

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1.Introduction

Nearly all of İstanbul's drinking water (97%) comes from surface water stored in reservoirs. Its most important water sources are the Omerli-Darlık system on the Asian side and the Terkos-Alibeykoy system on the European side. Both systems consist of dams, reservoirs, water treatment plants, and pipelines. Many of the reservoirs that supply İstanbul are located within the metropolitan area and are exposed to pollution from settlements without adequate sanitation (Figure 1). Water quality is theoretically controlled by conservation zones around the reservoirs which limit construction and industrial activities in four concentric buffer zones with increasingly strict regulations the closer the zones are to the reservoirs^{2,3}

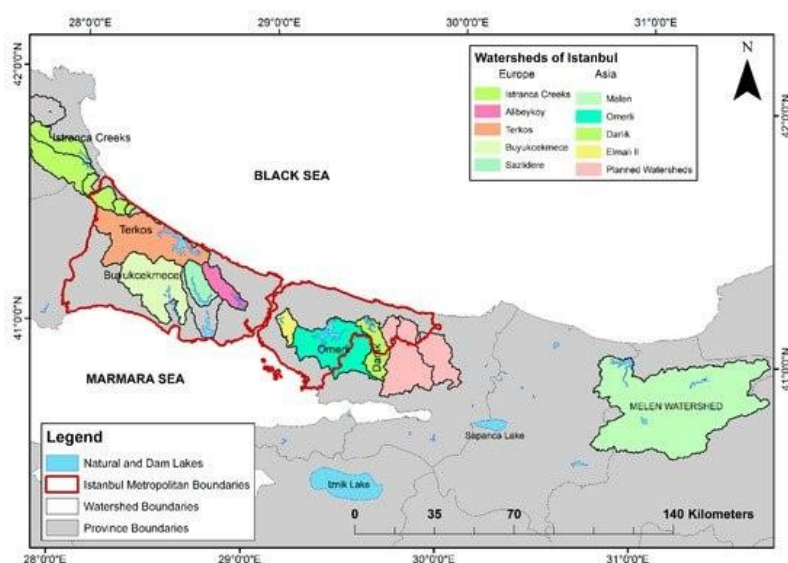


Figure 1. Watersheds of İstanbul

¹ This article was presented as a İstanbul Case Study at the HPA International Webinar on 21st Century, Water and Sanitation in Cities in May 6, 2021

² Ali Demirci and Anya Butt: Historical Overview and Current Trends in İstanbul's Water Supply Development, Globalization And Water Resources Management: The Changing Value of Water, August 6–8, Awra/Iwlr-University of Dundee International Specialty Conference 2001. Retrieved September 14, 2010.

³ German) Şenda Kara and Frank Alleweldt: Trınwasserversorgung und Stadtexpansion: Der Fall İstanbul (Drinking Water Supply and Urban Expansion: The Case of İstanbul), in: Wasser - Abwasser 136 (1995), Nr. 7, pp.)

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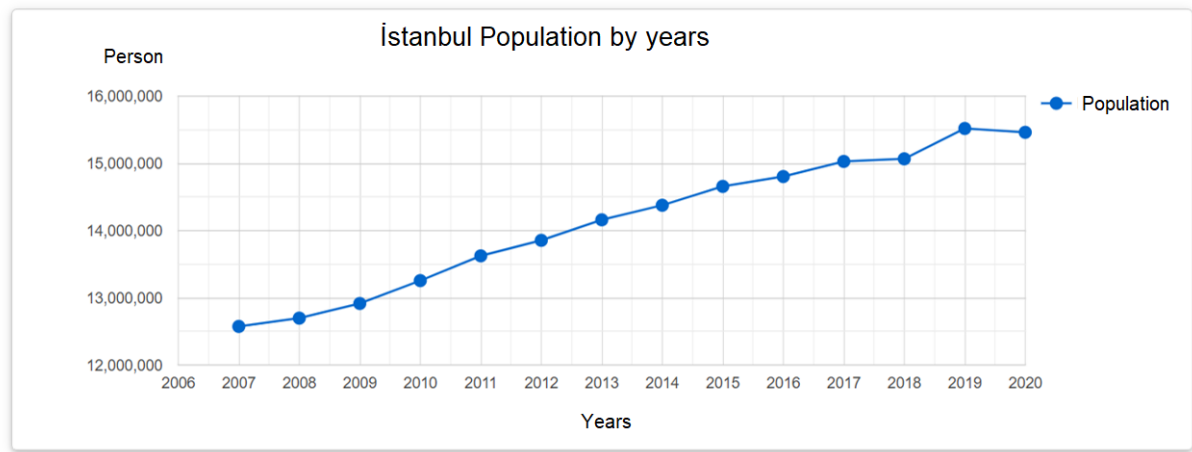


Figure 2.İstanbul Population by years

However, over time, the infrastructure in İstanbul failed to improve and ghetto neighborhoods made the distribution of services harder. The need for a new administration with broader authority and abilities was seen as İSİ failed to meet the increasing population's water and sewerage demands. The name of the new administration founded in 1981 is İstanbul Water and Sewerage Administration (İSKİ).

2.Increasing in water demand

Because of the rapid population increase in İstanbul(Figure 2), additional water resources were needed. Therefore the Melen System was developed to cover the long-term water demand of İstanbul. The first stage supplying 268 million m³ was completed in 2007. A second and third stage is expected to bring a total of 1,180 billion m³ for all three phases to meet the water demand of the city until the year 2040, doubling the amount of water supplied before the Melen system.

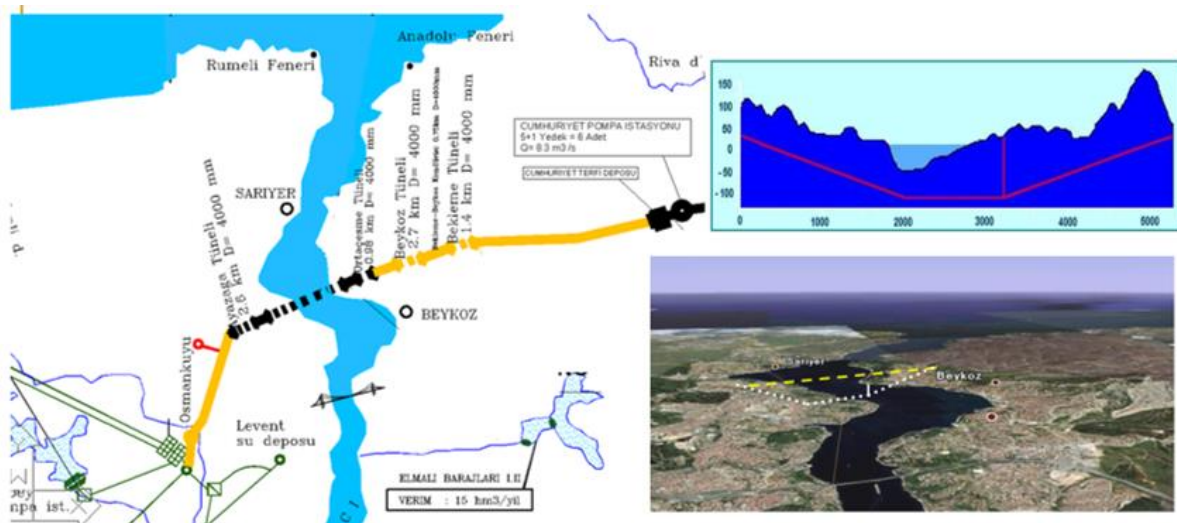


Figure 3. Bosphorus Tunnel part of the Melen Water Supply System

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Also, a 5.5 km long [tunnel under the Bosphorus](#) transfers water to the European side⁴ (Figure 3). According to monitoring by four metropolitan agencies drinking water quality is good, reportedly surpassing Turkish as well as EU standards. According to a 2004 survey, 35% of customers stated that they drink water from the tap, up from only 10% in 2000. During that period water quality had improved due to network repairs and the completion of new drinking water treatment plants.⁵

3. Two-year droughts problem

Although the data do not indicate a clear long-term declining trend in rainfall, extreme events – especially two-year droughts – seem more pronounced than in the past. In 2006, rainfall was the record low for the previous 50 years. Furthermore, the water level in reservoirs serving the city plummeted to around 25% of full capacity in 2007 and 2008. In 2020, rainfall was under the normal level and it continued in the 2021 water years resulting out of use of some dams in the European side of İstanbul. The total water volume rate in the dams dropped as of % 19.

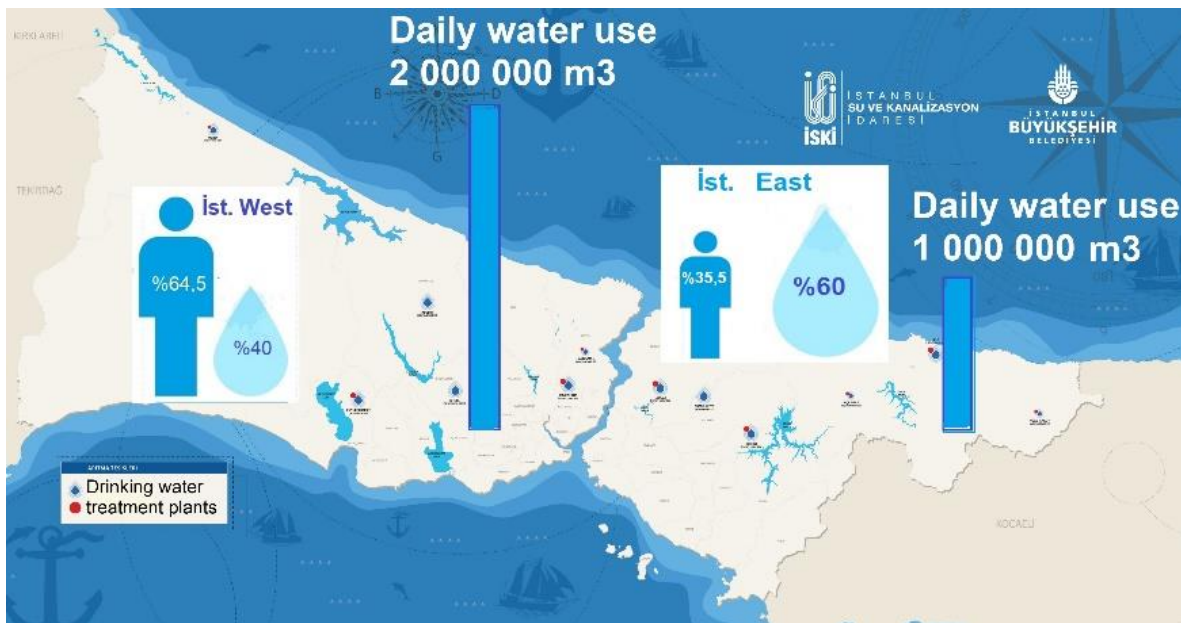


Figure 4. Water potential, population and average daily water use in Istanbul East and Istanbul West

Population and water resources are unevenly distributed throughout Istanbul. About 60% of the water in Istanbul is on the Asian side. However, 65% of the population lives on the European side of the city. Due to the increase in population and changes in precipitation rates, the need for water has increased in recent years. (Figure 4).

⁴ XIVst Regional Directorate of State Hydraulic Works -Istanbul. Retrieved September 14, 2010.

⁵ Altınbilek, Dogan. "Water Management in Istanbul". International Journal of Water Resources Development. 22 (2): 241–253. doi:10.1080/07900620600709563.

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4. Melen Water Supply System



Therefore, the idea of the Melen project was developed at the beginning of the 2000s. It was aimed to bring water from Melen Creek, which is about 180 km away from Istanbul. The first water in Istanbul was launched in 2007 with the Melen Project. The Greater Melen Project (GMP) is a large-scale interbasin water transfer project that provides domestic and industrial water requirements of Istanbul for 2040.

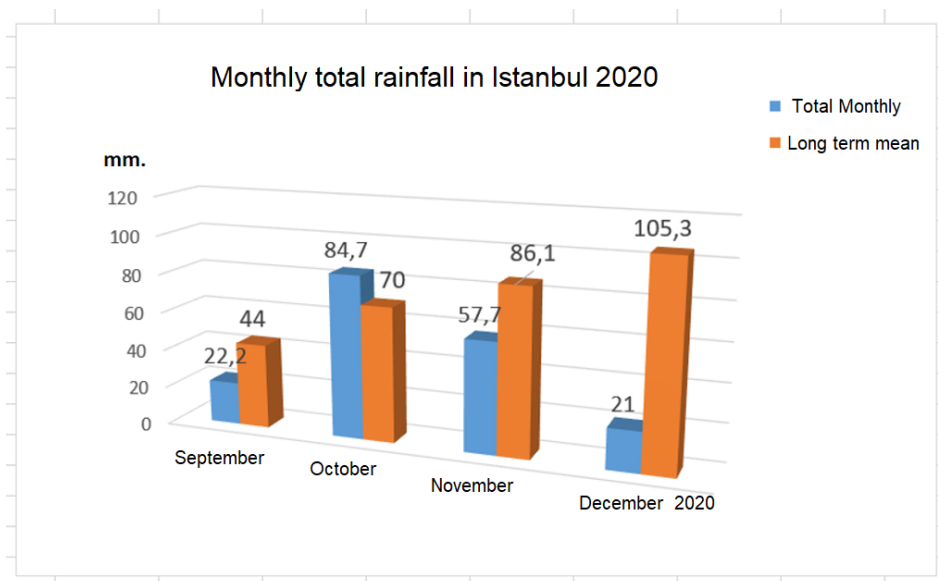


Figure 6. Sharp decrease in the monthly rainfall in İstanbul in 2020

5. Drought Periods in Istanbul

Due to the increase in population and changes in precipitation rates by years, Istanbul faced a water shortage threat in 2007, 2014. But partially completed Melen Project helped İstanbul to overcome these critical periods. In the year 2019, annual total rainfall was lower than the mean value in İstanbul. This meteorological drought period has continued in 2020 and Istanbul entered the new water year 2021 with a very low water storage rate in the dam's reservoir

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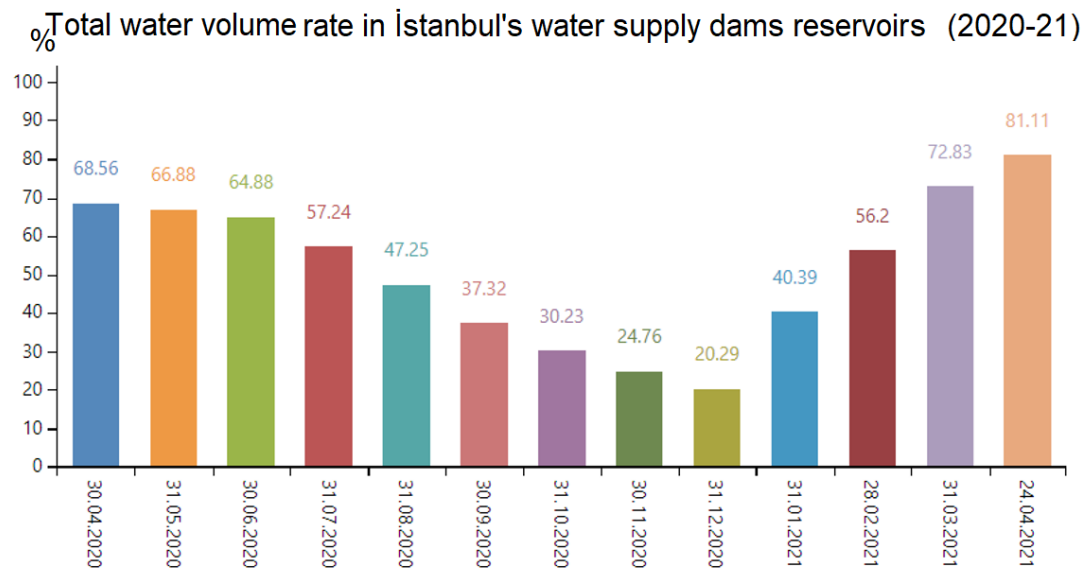
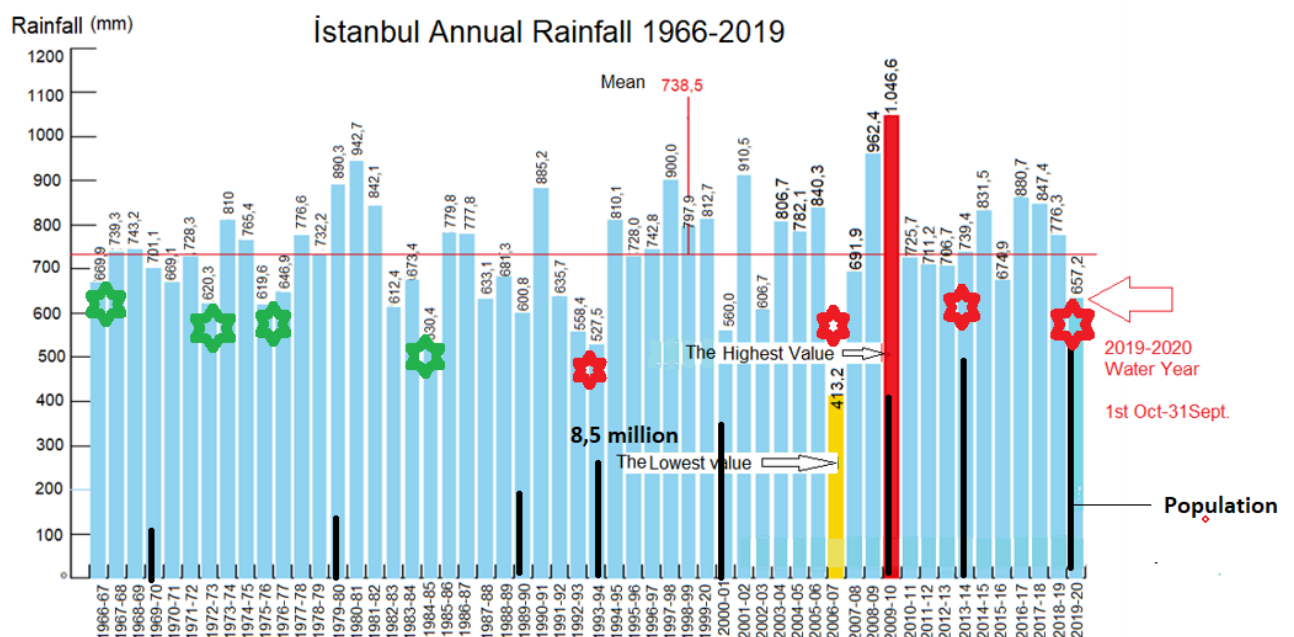


Figure 7. Total water volume rate in İstanbul water supply dams by months in 2020-2021

In contrary to expectations, the meteorological drought period has continued in the last four months of the last year (Figure 6). The total amount of water in the dam's reservoir was decreased by 20% in total (Figure 7). Fortunately, precipitation started with a delay of 3 months and the amount of water in the dams started to increase in February 2021.

With this population and water use trend, İstanbul falls to water shortage when annual rainfall is lower than average level during consecutive two years.



Source: Annual Activity Report 2019 .İSKİ

Figure 8. İstanbul Annual Rainfall by years

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But it should be noted that, although the amount of rainfall in various years until 1994 was very low, it did not cause a serious water shortage (Figure 8). The water shortage occurred in 1994 due to increased population with 500 mm of precipitation for 2 consecutive years. Later, due to the rapid increase in the population and the low annual precipitation, water shortages occurred again in 2007, 2014, and 2020. However, the total occupancy rates in the dams increased up to 81% in April 2021, it was observed that this accumulated water volume rate tended to decrease over the previous years.

6. Deficiency of water budget in Istanbul West

During these drought periods deficiency of water budget has always and firstly occurred in İstanbul West. The deficiency in the water budget of İstanbul West was provided from İstanbul East, Melen and Yeşilçay systems since 2007.

Water has transferred to the European side with a 6 m diameter tunnel that goes 135 m below sea level crossing the two continents. This tunnel has a capacity of 3 million m³ of water per day.

Melen and Yeşilçay System has partially served İstanbul since 2007. Since then most of the years' one-third of annual water demand was supplied by Melen and Yeşilçay System to İstanbul. But this rate was increased by 50 % in 2020.

6.1. Melen Dam Case

The last part of the Melen Water Supply system, Melen Dam was expected to be completed by the end of 2017. It would have a huge storage capacity of 694 million-cubic-meter that equals 75 percent of the total capacity of all İstanbul Dams



Figure 9. Cracks in the Melen Dam Body and its strengthening project

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Although the dam construction to a large degree was completed in 2019, due to cracks as a result of insufficient ground reinforcement work, filling of the dam reservoir couldn't be started (Figure 9). Therefore the waters taken from Melen River need to continue to be pumped with a large number of pumps, each having a maximum pressure height of 220 meters (Figure 10).



Figure 10. Melen Dam, Melen Regulator and Pumping station

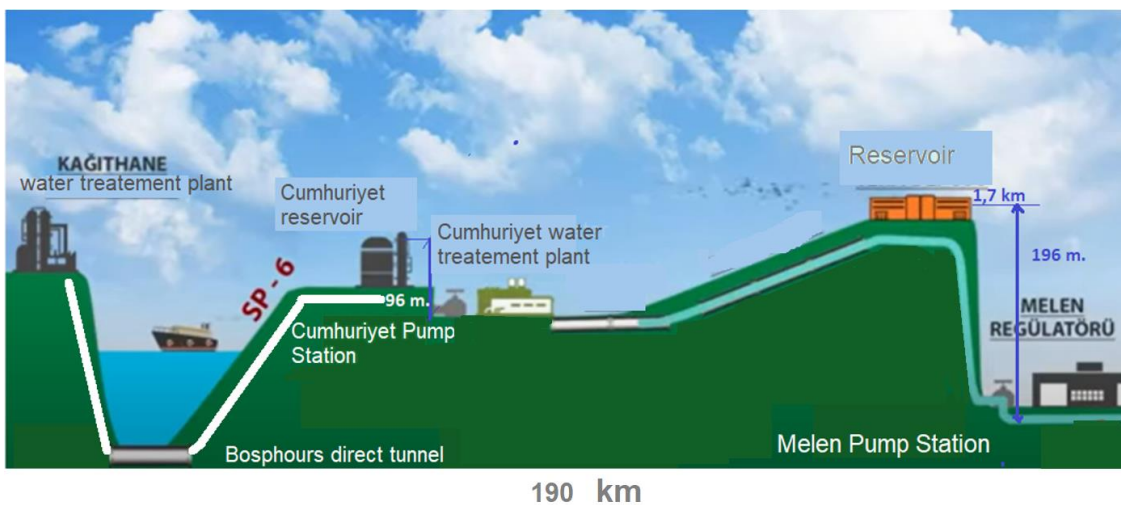


Figure 11. Existing Melen Water Supply system

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The total pressure height needed to transfer 1,2 million m³/day from Istanbul East to West is about 300 m (Figure 11).

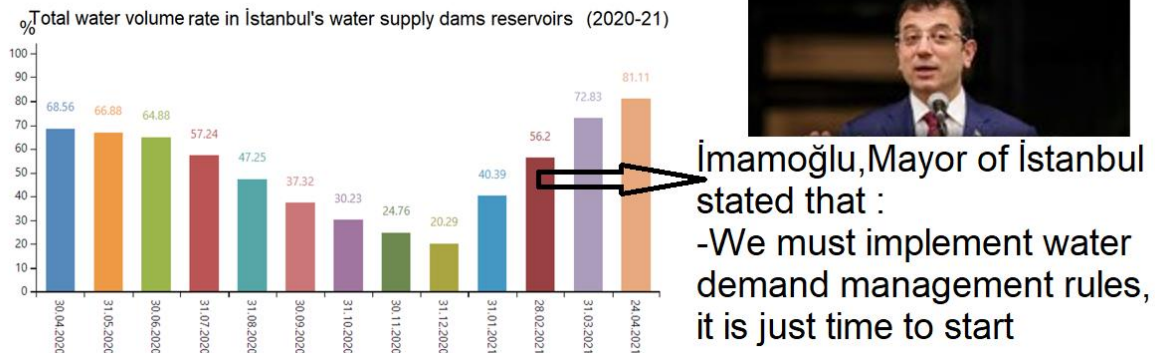


Figure 13. Water volume in the dams by months

Although the water level was rising in the dams in February 2021, the Mayor of İstanbul Mr. İmamoğlu made a statement saying that we must implement water demand management rules, it is just time to start. But it was not executed properly.(Figure 13).

6.2. İstanbul Canal Project

While İstanbul is waiting for the completion of the Melen dam to avoid the threats of possible dry periods in coming years, other challenges come out.

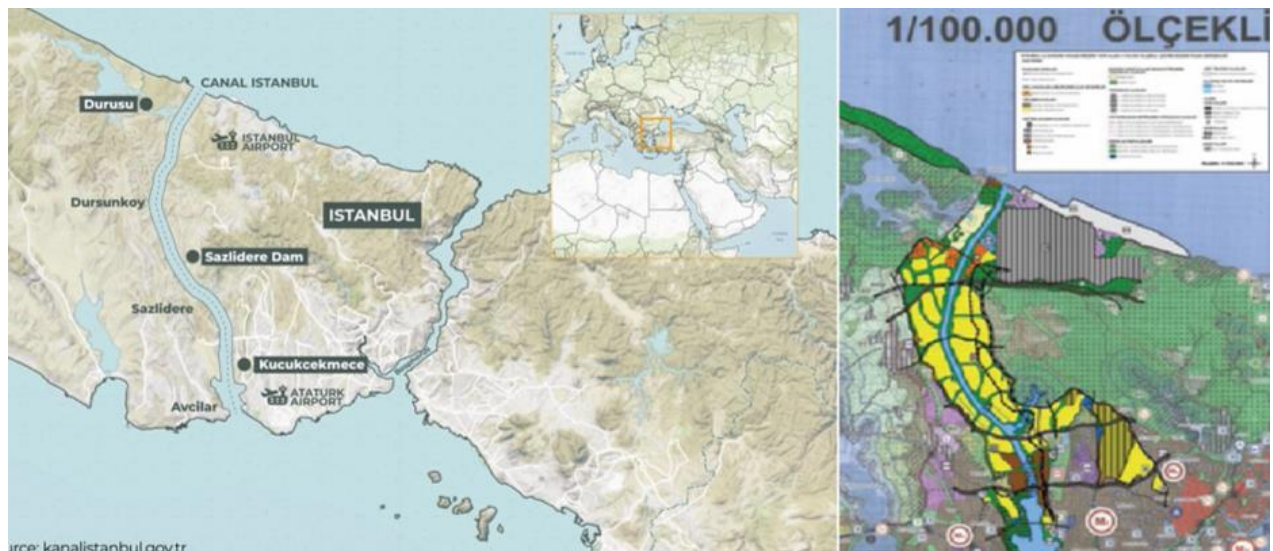


Figure 14. İstanbul Canal Project and new zoning plan

If İstanbul Canal Project will be implemented, It will largely and seriously affect the İstanbul West water supply plan. Many existing water infrastructure and facilities will be disabled and rebuilt due to the construction of the İstanbul Canal (Figure 15).

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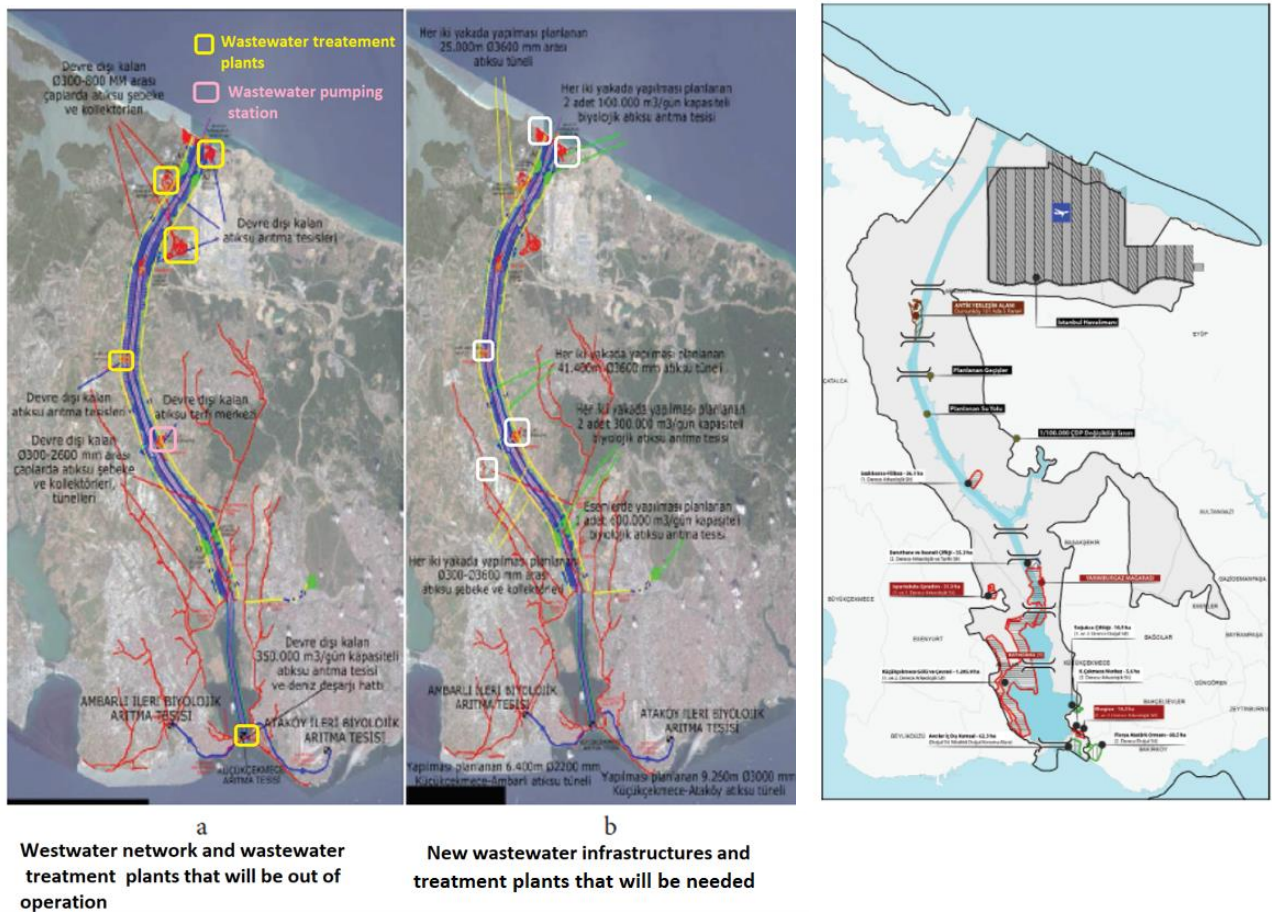


Figure 15. Existing wastewater infrastructure and facilities that will be out of operation and rebuilt after İstanbul Canal

In addition, it is estimated that the additional population that will come to the residential areas in the zoning plans will reach 1.5 million people.

Authorized organizations planned some more dams on both sides of İstanbul to provide drinking water for rising demand.

6.3. Additional dams planned



Figure 16. Additional dams that planned in both sides

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In contrary to the rising water demand part, additional dams planned in İstanbul west has a storage capacity of 120 million m³ while İstanbul east has 422 million m³ (Figure 16).

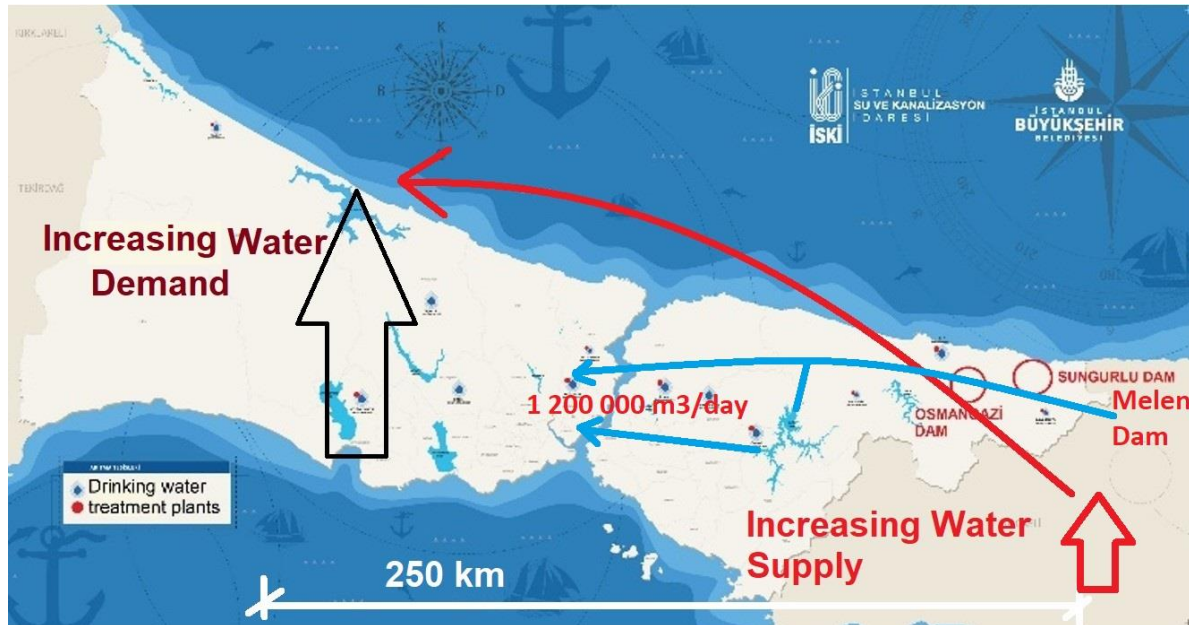


Figure 17. Bulk Water transfer from İstanbul East to İstanbul West

Not only in İstanbul but also several metropolitan cities in the world, transferring their additional water demand from other river basins are common (Figure 17).

But this global trend likely to create water allocation disputes between cities and regions. That means that in addition to international hydropolitics subnational hydropolitics will be needed soon

Sanitation

In 2021 İstanbul's wastewater system consisted of 14 990 km of sewers, 17 pumping stations, 67 [wastewater treatment](#) plants. 95% of the wastewater collected was being treated. Treated wastewaters are discharged into the [Bosphorus](#). They are discharged into the lower layer, where the flow is towards the Black Sea in the North.

As of 2021, %, 2,5 percent of treated wastewater is reused in İstanbul.

Lessons Learned

- İstanbul sets a good example to the challenges faced in water supply in heavily populated cities,
- Right in time measures in water management are vital to managing future risks
- Problems caused by lack of implementation of water demand management could be compensated by some expensive engineering solutions
- Water demand management needs to be implemented when water is available

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- Even though Istanbul has had water supply problems periodically, sustainable water governance to Istanbul has not been the subject of scientific and innovative management concepts.
- The most important reason for this has been the policy of providing water to the rapidly increasing population.
- The Istanbul Metropolitan Municipality has tried to meet the water demand of the increasing population with only a supply management concept
- It resulted in water transfer from other river basins with higher cost
- **In İstanbul rising water demand and supply management trends point towards unsustainable use of water**
- This paradigm needs to be shifted

The Reuse, Reduce, Recycle, Recover approach is needed

Istanbul Canal Project, frequent meteorological drought periods, developed smart water technologies, and new water management concepts force paradigm shift in İstanbul's water and sanitation management

Considering innovative smart water management concepts Istanbul Water and Sanitation Governance can be replanned as East and West İstanbul taking into account **REUSE, REDUCE, RECOVER, RECYCLE** of current water potential of this metropolitan city

