

# ANCIENT WATER WORKS IN ANATOLIA

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**Abstract:** Since the Anatolian peninsula has been at the crossroads of many civilizations, which have left many ancient ruins during the last 4000 years, Turkey is a rich country in term of cultural heritage. Archeological remains, dating from the Hittite period in Central Anatolia, from the Urartu period in Eastern Anatolia, from the Hellenistic-Roman-Byzantine periods in Western and Southern Anatolia, from the Seljuk and Ottoman periods in different parts of Anatolia, make Turkey one of the leading open air museums of the world. One remarkable part of ancient remains are waterworks, such as pipes, canals, tunnels, inverted siphons, aqueducts, reservoirs, cisterns and dams.

**Key-Words:** Cultural heritage, Ancient water works, Aqueducts, Historical ruins, Ancient water supply systems

## 1 Introduction

Anatolia peninsula has been at the crossroads of many civilizations, which have left thousand by thousand remains during the last 4000 years. A great variety of hydraulic structures were implemented over the times on Anatolian soil. Today, Turkey is one of the foremost open-air museums of the world with respect to ancient waterworks.

The map (see Fig 1) shows only remarkable remains of waterworks, such as pipes, canals, tunnels, inverted siphons, aqueducts, reservoirs, cisterns and dams. There are remains of several waterworks from the second millennium BC Hittite period in Central Anatolia; from the first half of the first millennium BC Urartu period in Eastern Anatolia; from the second half of the first millennium BC to the first half of the first millennium AD. Hellenistic, Roman, Byzantine periods in Western and Southern Anatolia; from the second millennium AD Seljuk and Ottoman periods especially in Istanbul and its vicinity.

The Samram irrigation canal in the Van region from the 8th century BC, the water conveyance systems and aqueducts of Taslimusellim-Edirne and Kirkcesme-Istanbul constructed by the great Architect Sinan in the 16<sup>th</sup> century ad, the Istanbul water supply dams of the 17<sup>th</sup> to 19<sup>th</sup> centuries, as well as some other hydraulic systems, are still partly or completely in use.

Although archeologists, historians and occasionally civil engineers prepared a limited number of publications until the second half of the 20th century on ancient waterworks, they attracted growing interest after the 1950s, especially with increasing contribution from civil engineers. Major publications are given in the bibliography at the end of the paper.

All these works reflect the several thousand years old water engineering tradition of Turkey, constructing universally important modern waterworks, which will also be appraised in the future. It is anticipated that both national and international interest in the ancient waterworks of Turkey, from the Hittite, Urartu, Hellenistic, Roman, Byzantine, Seljuk and Ottoman periods, some still in use, will continue to increase.

## 2 Historical Waterworks in Anatolia

### 2.1 Hittite and Urartu Periods

It is believed that the most ancient dam in Anatolia is the Karakuyu dam, constructed by Hittites towards the end of the second millennium BC for the irrigation of Uzunayla. The U-shaped crest of the dam has a total length of 400 m, the central part being 200 m long (Figure 2); the upstream slope of the dam appears to be covered with a stone pavement. The embankment of the 8 m high Karakuyu dam probably collapsed in its first year, due to seepage along the bottom outlet in the form of a

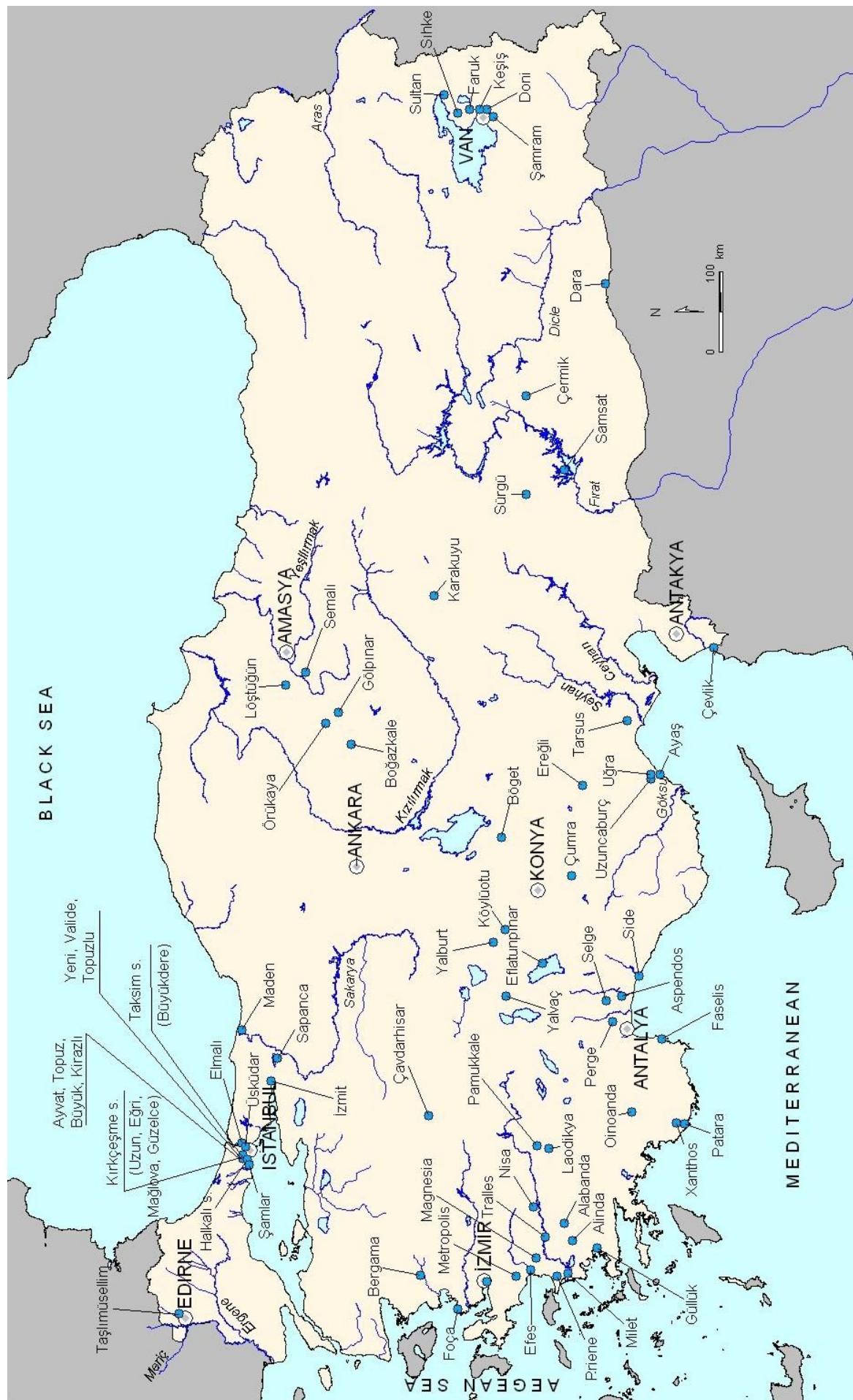


Figure 1 Location of the Ancient Water Works in Anatolia

masonry gallery, located at the deepest point of the cross-section, or the dam was torn down by an overflow since they did not know the simple spillway concept.

The most interesting water work in Bogazkoy is a spring collection chamber, in the form of a 2.6 m high by 1.4 m wide masonry gallery. This underground collection work, ending with a pond 1.8 m long and 1.1 m in depth, can be reached by descending stairs.

The Urartians developed very important water systems during the first half of the first millennium BC in Eastern Anatolia, especially in the Van area (Figure 3). The most important water work of the Urartu period is the 56 km long Samram (Semiramis, Menua) irrigation canal, dating from 800 BC and conveying 2-3 m<sup>3</sup>/s of water collected from the Engil creek springs south of Van to the then capital city Tuspa (Vankale); this canal is still in use as part of a system irrigating about 2000 ha. There were two dams to increase the volume of the Rusa (Kesis) lake for water supply to the later capital Rusahinili (Toprakkale) and her environment. Two of the three dams, still in use, at Doni Lake and the downstream dam on Engizer creek for additional irrigation water to Tuspa (Vankale) and its surroundings, probably date from the Urartu period. Furthermore, the second dam downstream of the Sultan Lake appears to date from the same period.



Figure 2 Karakuyu dam (2<sup>nd</sup> Millennium BC)

The long-distance underground conveyance and distribution of water by means of masonry-lined tunnels with an egg-shaped cross-section, like that of the spring collection chamber in Bogazkoy, and which were later well known as the qanats of the Iran, were first used by

Urartians. Some of such galleries, still used around Van, are believed to date from the Urartians.



Figure 3 The 56 km long Samram canal, conveying water to the Urartian capital Tuspa (Vankale), from 800 BC.

## 2.2 Hellenistic, Roman and Byzantine Periods

Remains of Hellenistic and especially Roman and early Byzantine waterworks in Western and Southern Turkey, from the second half of the I. Millennium BC to the first half of the I. Millennium AD, are very numerous and new discoveries add to the rich variety of them. Noteworthy are the 240 km long water conveyance system to Istanbul, the almost 100 km long system to Phocaea, up to 65 km long systems to Pergamon, up to 43 km long systems to Ephesus, others to Smyrna, Priene, Miletus, Alabanda, Laodicea, Xanthos, Patara, Perge, Aspendos, Side, Diocaesarea, Olba, Elaiussa, Samosata, Amaseia.

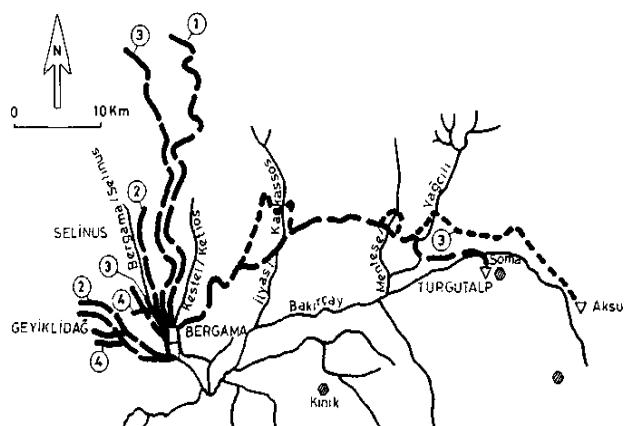


Figure 4 Locations of ancient water conveyance system to Pergamon: (1) Hellenistic; (2) Hellenistic-Roman; (3) Roman; (4) Roman-Byzantine-Turkish.

Source: Garbrecht, et al, 1973-87.

They encompass aqueducts up to 40 m height, tunnels of over 2 m height, inverted siphons up to 190 m pressure, lead, stone, clay-pipes of various sizes, rock-cut (Figure 5) and masonry canals (Figure 6), spring water collection chambers, city reservoirs, water distribution and sewerage networks. From the same period date also diversion tunnels like that in Seleuceia Pieria (Figure 7), tunnel-like superstructures on creeks like those in Pergamon and Nysa, with diameters up to 9 m; dams like the 10m high Cavdarhisar, 16 m high Orukaya and some others.

Covered and open cisterns in Istanbul, with side lengths in the order of 150 to 250 m, are extraordinary examples of antique cisterns.



Figure 5 Elaiussa Sebaste (probably between 1<sup>st</sup> and 2<sup>nd</sup> Century AD)

### 2.3 Seljuk and Ottoman Periods

There are certain remains from the Seljuk period in Central and Eastern Anatolia, from 10 to 13<sup>th</sup> Centuries, like the water conveyance canal to a mill in Cermik, the Sahip Ata irrigation canals in Konya, irrigation systems in Eregli and elsewhere.

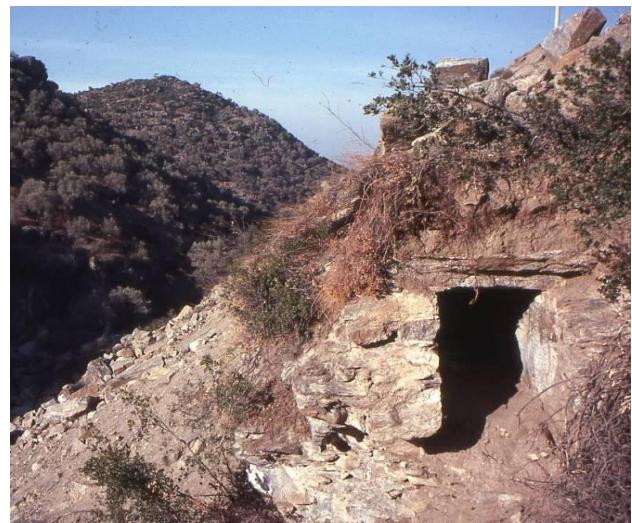


Figure 6 A Masonry canal section from water conveyance to Alabanda

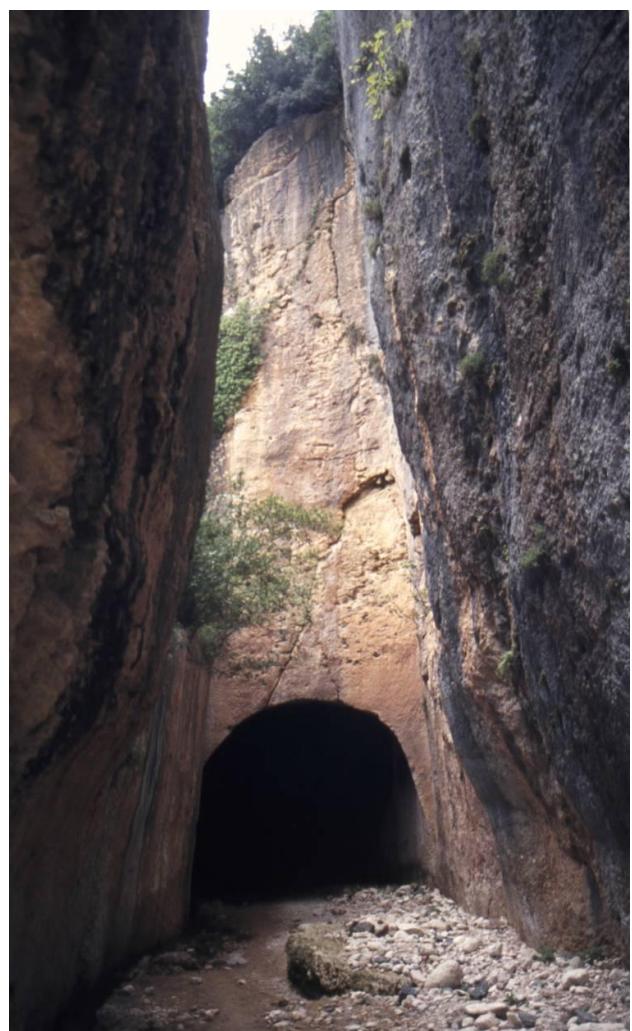


Figure 7 Tunnel System to Seleuceia Pieria

Among the remains of waterworks from the Ottoman period in Turkey, 14<sup>th</sup> to 20<sup>th</sup> centuries, those for Istanbul and Edirne deserve particular interest (Figure 8).



Figure 8 “Yedigoz” aqueduct in Edirne water conveyance system



Figure 9 “Maglova” aqueduct in Kirkcesme water conveyance system

The Halkali conveyance systems to Istanbul, constructed in the period of 1450's to 1750's, consist of 16 systems with a total length of 130 km, including the 50 km long Suleymaniye by Sinan the Architect in 1550's. The 50 km long Taslimusellim system to Edirne, is also considered as a work of Sinan, dating from 1530's. The 55 km long Kirkcesme system to Istanbul from 1560's, is one of the masterworks

of Sinan, with four aqueducts (Uzun, Egri, Maglova, Guzelce) up to 35 m height and 700 m length (Figure 9).

The Taksim water conveyance to Istanbul from 1730's and the Uskudar systems east of Bosphorus from 16<sup>th</sup> to 19<sup>th</sup> centuries are also noteworthy.

In the period of 1620 to 1839, the Kirkcesme system is supported by four, the Taksim system by three dams, with heights up to 17m and crest lengths up to 104 m. All these dams, Kirkcesme and Taksim systems as well as the Taslimusellim-Edirne system are for the large part still in operation.

The diversion of Gediz river to prevent the closure of the Izmir bay in late 19<sup>th</sup> Century; Beysehir-Cumra irrigation south of Konya in early 20<sup>th</sup> century; the generation of the first electricity in Turkey in 1902 at the Tarsus hydroelectric scheme are other interesting achievements at the down of the Ottoman Empire.

### 3 Conclusion

Various waterworks, dating from the Hittite period in Central Anatolia, from the Urartu period in Eastern Anatolia, from the Hellenistic-Roman-Byzantine periods in Western and Southern Anatolia, from the Seljuk and Ottoman periods in different parts of Anatolia, some still in use after several centuries, even millennia, make Turkey one of the most outstanding open-air museums of the world in this respect.

Based on a long tradition of hydraulics technology and engineering, Turkey is actually constructing large-scale waterworks to irrigate 8.5 million ha of land and to generate 130 billion KWh/yr by means of over 600 dams and 500 hydroelectric power plants. The ultimate development of water resources in Turkey during the early decades of the 21<sup>st</sup> century, enjoying a four millennia long tradition as one of the foremost open-air museums of the world in hydraulics technology, will greatly contribute to the welfare of the country as well as of the region.

Therefore, the investigation of historical water works in Anatolia is important both understanding the development of hydraulic engineering and protecting all cultural monuments of the entire universal civilization.

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