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The Historical Water Systems of Istanbul and Their Preservation Problems: The Case of The Kırkçeşme Water System

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Abstract

This study covers water ways in the city İstanbul, having the characteristics of a museum. The article gives information on the historical water systems and emphasizes the changes in and deterioration of the Kırkçeşme Water System from the time it was constructed. These values- which have not been preserved as a result of inadequate planning, wrong policies, rapid development, and changes and distortions caused by lack of awarenesshave been identified through a literature review and an on-site review. The problem identified in the article is a neglect to preserve the waterways as cultural assets. The aim of this study is to propose a method to detect and protect water structures in the sampling area. Physical analysises were not possible due to the large number of structures and the inability to reach laboratory facilities. This article suggests that there be an implementation of a management model necessary for protection.

1. INTRODUCTION

Since ancient times, water, an indispensable part of life, has played an active role in fulfilling all kinds of biological, psychological, and physical needs of human beings. For thousands of years, people have built water structures in different shapes to protect themselves from the damage caused by water and/or to benefit from water.

Existing dams, long-distance water transport systems, and aqueducts from the Seljuk and Ottoman eras have made Turkey one of the world's leading open air museum in terms of water structures [1]. Şahin (2014) says that Istanbul is one of the rare places of the world with its water resources and historical water facilities. He also states that Istanbul was given life by the water structures built during Byzantine, Roman and Ottoman times, and these structures have met the water needs of İstanbul over the ages [2].

The aim of this article is to draw attention to the historical water systems in Istanbul and to give general information about one of them, the Kırkçeşme Water System, and to present the type of deterioration and change in water structures in that system. The proposals to be used in the solution of the problems are addressed in the final part of the article.

Despite all of its problems, this system continues to supply water to the city of Istanbul, and it is important to preserve these cultural assets for the future both because they are important for human health and because they are the work of architect Mimar Sinan. Therefore, the findings of the study are very

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important. However, a physical analysis was not possible due to the large number of buildings in the area, the difficulties in transportation, and the lack of financing necessary for a detailed analysis.

2. HISTORICAL WATER SYSTEMS OF ISTANBUL

Throughout history, when a settlement center was established or when an existing settlement was expanded, it was necessary to find new resources to meet the water need of the increasing population and bring the water to the center of the city from very long distances. In order to meet these needs, significant planning and construction of a number of facilities were needed to answer such questions as where to get the water, how to collect it, how to bring it from rugged places, how to complete the distribution and usage stages, etc. Dams, reservoirs, wells, cisterns, and pools were built to collect water; waterways, channels, aqueducts, and water scales were built to transport the water; pipelines and water reservoirs on the waterways were built to distribute the water; and fountains, waterfalls, floodplains, and baths were made as facilities where the water could be used. There are many kinds of water structures in Anatolia that have been in place for thousands of years and from almost every period. Of these, the city of Istanbul, formerly the capital of the Ottoman Empire for 470 years, undoubtedly has the most valuable water systems.

Although Istanbul had a regular water system during the period of the Roman Empire, water supply lines outside of the city were destroyed by wars and earthquakes over time. Then, in the late period of the Byzantine Empire, the inner city network became unusable [3].

In the Ottoman period, the water problem in Istanbul continued, and with the increase in population, the need for water also increased because of which old water systems were repaired and used, and new water systems were built. With the establishment of new lines, hundreds of kilometers of waterways were built along with new water facilities were built in Istanbul, and thereby new water systems were created [4].
After the conquest of Istanbul in 1453, Sultan Mehmet the Conqueror was not in favor of the old cisterns. He ordered the repair of the old water supply lines and the introduction of new items so that clean watercould be brought in, and, in a short period of time, the city had abundant water [3, 5].

Some water systems were also built during the reign of Sultan Yavuz Selim. However, when the Sultan Süleyman the Magnificent ascended to the throne, the borders were enlarged, and Istanbul became more crowded and the city started to have water problems. The fountains of the Fatih, Turunçlu, Bayezid, Mahmutpaşa, Şadırvan and Kocamustafapaşa water systems that were built after conquest by Sultan Mehmet the Conqueror were also inadequate [3, 4].

The solution to the water problems of Istanbul was found in the time of Sultan Süleyman the Magnificent [3, 4]. The water systems built by Mimar Sinan in Istanbul and in Edirne on the orders of Kanuni Sultan Süleyman (1520 - 1566) created the emergence of the most important water facilities of the Ottoman Period [5]. The water systems used in Istanbul during the Ottoman Period were Kırkçeşme, Halkalı, Taksim, Üsküdar, Terkos, and Hamidiye (Figure 1) [4].

Figure 1. *Map of the waterways and benders of Istanbul drawn by Mirliva Ibrahim Edhem Pasha and his son Lieutenant Nureddin Bey in the period of Sultan II. Abdülhamit [2] (1-Kırkçeşme Water System, 2-Taksim Water System, 3-Terkos Water System, 4-Halkalı Water System, 5a)Topuz Dam, 5b)Ayvad Dam, 5c)Büyük Dam, 5d)Kirazlı Dam, 5e)Topuzlu Dam, 5f)Valide Dam, 5g)II.Mahmut Dam)*

2.1. Kırkçeşme Water System

The Kırkçeşme Water System drainage, the biggest project done by Mimar Sinan, is 55.274 meters long. This system collects surface water around the Belgrade Forest in the north of Istanbul, and the system is composed of two lines [3, 4]. The water coming from these two coves merges in Başhavuz in south-west Kemerburgaz, passes through the Alibey River with the help of the Mağlova Aqueduct, and then continues to the south taking in a branch of the Cebeciköy River. From its origin, the canal line passes through numerous arches and piers and finally reaches the Egrikapı Maksim (Figure 5) [4, 7].

In this system, there are 33 aqueducts, four dams and seven water intake places and sedimentation pools. The most important ones in terms of engineering and architecture in the Kırkçeşme Water System are the Mağlova Aqueduct, 258 m in length, (Figure 2); the Uzunkemer Aqueduct, 710 m in length; the Gözlücekemer (Güzelcekemer) Aqueduct, 165 m in length; and the Kovukkemer Aqueduct (Eğri Kemer), 342 m in length. A part of the latter is thought to have existed in the Roman Empire because of the different arches used. Apart from these arches, there are important one-storey arches that can not be considered monuments including Ayvad Kemeri Aqueduct, 195 m in length; Kurt Kemeri Aqueduct 305 m in length; Karakemer Aqueduct, 62,60 m in length; Balıklı Kemer Aqueduct, 125 m in length; and Valide Kemeri Aqueduct, 38,80 m in length [4, 7].

When the Kırkçeşme Water System was built in 1563, there were none of the current dams, and the water supply decreased in August and September due to the lack of water storage facilities. For this reason, a total of four dams were built to store water in times of abundance in order to use it during the periods when the supply decreased: Topuz Bendi (Karanlıkbent), Büyükbent, Kirazlıbent (Figure 3), and Ayvad Bendi [4].

Figure 2. *Mağlova Aqueduct [8]*

Figure 3. *Kirazlı Dam [8]*

When the Kırkçeşme Water System was being constructed, it was predicted that water would be taken from the bottom, so, after the water level had risen because of water flowing in from a connecting stream, it was drained from the side by water intake poinst with a grid located immediately behind each one; here, there were sedimentation pools for the settling of solid materials such as sand and gravel to the bottom of the water [3, 4]. This system involves the Çiftehavuz Intake (Figure 4), the Kirazlıdere Intake, the Ayvad Intake, the Middle Water Intake, the Bakraçdere Intake, and the Kurt Kemeri Pool.

Figure 4. *Çifte Havuz [8]*

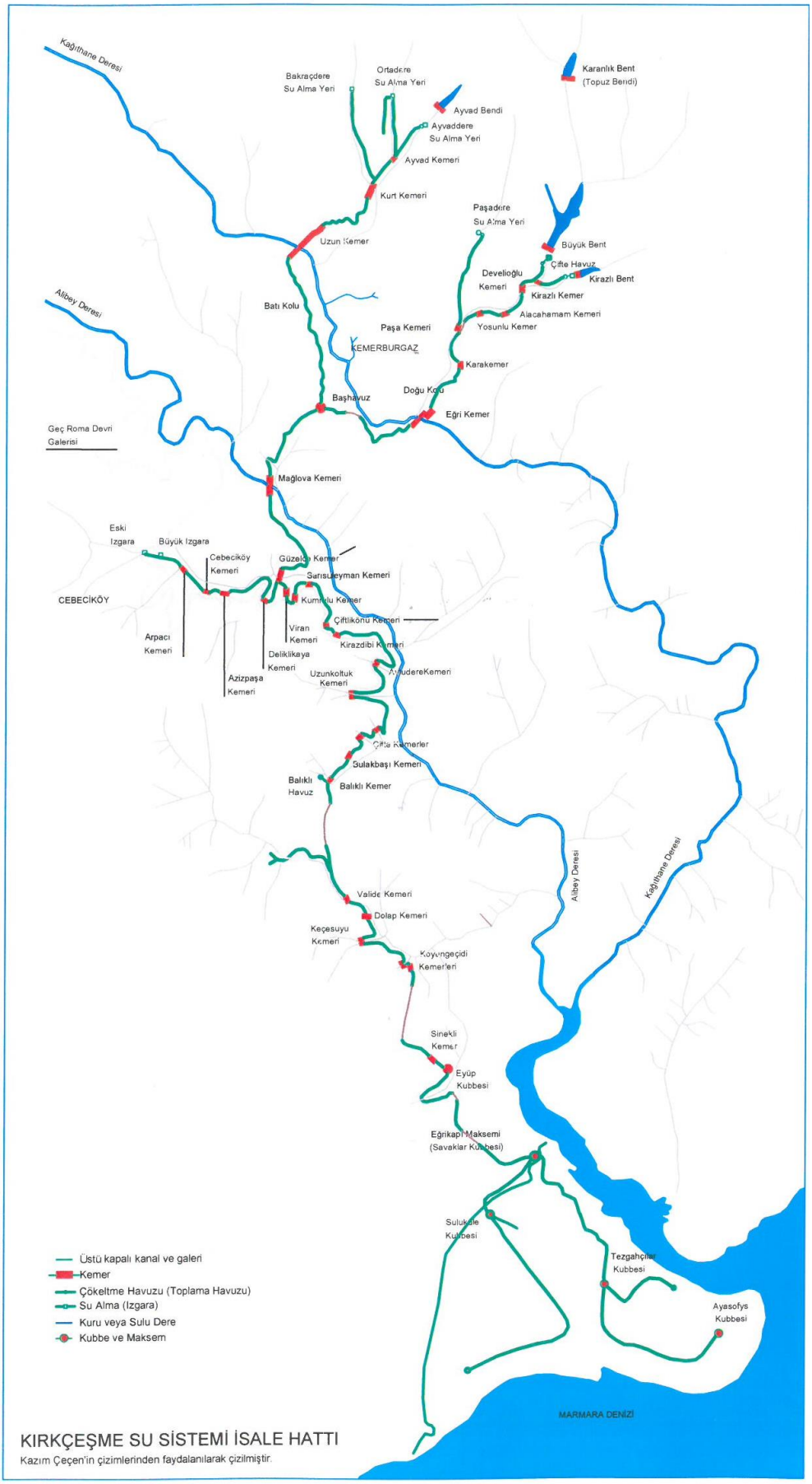

Figure 5. *Kırkçeşme isale planı [4, 8]*

2.2. Types and causes of deterioration (damage) occurring in water structures of the Kırkçeşme Water System

In determining intervention methods, it is extremely important to identify and classify types of deterioration (damage) and the reasons for such deterioration so that the preservation of culturally important structures can be ensured.

The Kırkçeşme water system had been used up to the point of the Keçesuyu aqueduct until 2004, and the water was being purified in the Keçesuyu Purification System located at the aqueduct and then disributed to the city. After this year, due to holes in the gates and leaks in the system, the system was working only as far as the Mağlova Aqueduct where the water flowed into the Alibey Dam, and it was distributed to the city from there. It is possible to categorize the causes of changes and deterioration in water structures located in the Kırkçeşme water system as resulting from both natural and human causes:

A. Natural changes and deterioration: These are natural phenomena that occurs with long-term natural cycles that cause sudden deterioration in structures. These will be examined in two groups:

A.1. Changes and deteriorations based on long-term nature cycles; Humidity, frost, rain, vegetation, microorganisms, insects, waves, and under ground water are natural phenomena that cause deterioration over time, and the aqueducts have been exposed to many of these. These natural forces sometimes cause surface impairment only in the material, but sometimes they also affect the entire load bearing structure. Expansion of the materials in hot weather and shrinking in cold weather stresses these materials, causing cracks to grow and breakages to occur (Figure 6).

The wetting and drying cycle on the walls exposed to rain water causes the mortar to lose its binding properties. Rainy weather and moisture lead to the growth of plants which are biological pollutants causing physical and environmental damage in the structures (Figure 7). Flying pollen penetrates the joints in the aqueducts and then plants grow, harming the material with growing plant bodies and roots. These plantings can be are in small size but they can grow in the form of vines or even trees (Figure 8).

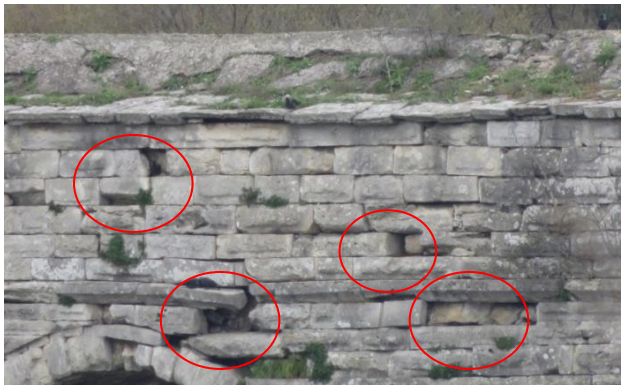

Figure 6. *Damage and fragmentation in stone on façade of the Eğri Aqueduct [8]*

Figure 7. *Vegetation in the Çiftlikönü surfaces [8]*

Organisms such as algae, lichen, and fungus are other causes of deterioration in aqueducts (Figure 8). These factors prevent the building from breathing by wrapping the façade and impacting its visual beauty. Air pollution is another cause of deterioration in aqueducts. This is due to the fuel consumption of the surrounding buildings as well as the exhaust of passing vehicles. The surface of the material is darkened, forming a patina (Figure 9). In addition, the acid formed by the precipitation of the gases in the air causes the stones to crumble.

Figure 8. *Algea and vegetation on the façade of the Karakemer Aqueduct [8]*

Figure 9. *Pollution and blackout on the Karakemer Aqueduct [8]*

A.2. Changes and deterioration based sudden natural causes: The aqueducts have suffered serious physical and environmental destruction partially or totally in cases of unexpected events such as earthquakes, floods, typhoons, volcanic eruptions, and avalanches. Due to these sudden and intense natural effects, many structures have not been able to survive. Uzunkemer, belonging to the Kırkçeşme water system, was damaged by natural disasters. After the catastrophic flood in 1563, some parts cracked, and the building was demolished. In the flood disaster of 1573, it was damaged again but was repaired by Mimar Sinan. Kovukkemer, another aqueduct belonging to the Kırkçeşme water system, was allegidly completely been destroyed in the flood disaster of 1563 [4].

In the earthquake that took place on July 10, 1894, there was not even a drop of water from the fountains in the city due to the destruction of the bays, arches, and waterways in Istanbul. The damaged weirs, arches, and waterways were repaired by Sultan Abdulhamit II, and water in the the city was able to be re-circulated [2].

B. Human based changes and deteriorations: These is the deterioration caused by people intentionally or unintentionally, individually or socially.

- Individual sources: Incorrectly done repair or restoration work together with improper of construction and vandalism are evaluated in this context. Vandalism is defined as "consciously harming works of art " (Figure 10) [9].

Improper repair work is the work done by people in good faith, but without permission, without a project and in an inappropriate manner legally and technically (Figure 11). Such repairs must be carried out only by expert teams in accordance with the project in the framework of the relevant protection council to prevent damage to the appearance or even the original material. Unless laboratory analysis is done, the mortar, stone, etc. used without determining compatibility with the original material can also cause serious irreversible damage to the structure.

Figure 10. *Destruction by people in Develioğlu Aqueduct [8]*
Figure 11. *Incorrect interventions using cement plaster on top of Karakemer waterway [8]*

- Social factors: Factors that are caused by the community or management mentality such as wars, public works, air pollution, traffic, road-tunnel works, infrastructure works, technological activities, industrialization, and disasters caused by human beings such as fires can be evaluated in this context.

The water structures remain in an environment exposed to intensive construction with an increasing population. Due to the growth of the city, many of these structures are stuck between roads and buildings in the city although they were outside of town originally (Figure 12-13). Since there has been no consciousness developed in this direction and correspondingly, construction plans for conservation have not been prepared, the construction has continued in this way for years.

Villas have been built within the 100 meter protection band of Uzun Aqueduct, and there are buildings belonging to Hamidiye Incorporated Company (I.C.) within the protection band of Eğri Aqueduct. Bulakbaşı Aqueduct, Valide Aqueduct, Çifte Aqueduct 1, and Çifte Aqueduct 2 located between the houses. Along the Kırkçeşme Water supply line, the construction has reached the border of the conservation band near the whole area except the Belgrad Forest. Some of the water supply lines that go to the Koyungeçidi Aqueduct from Keçesuyu Aqueduct are now under the slums and and are damaged. In addition, some parts of the control pods belonging to the water supply line were left on the road, and some buildings are constructed on some of them.

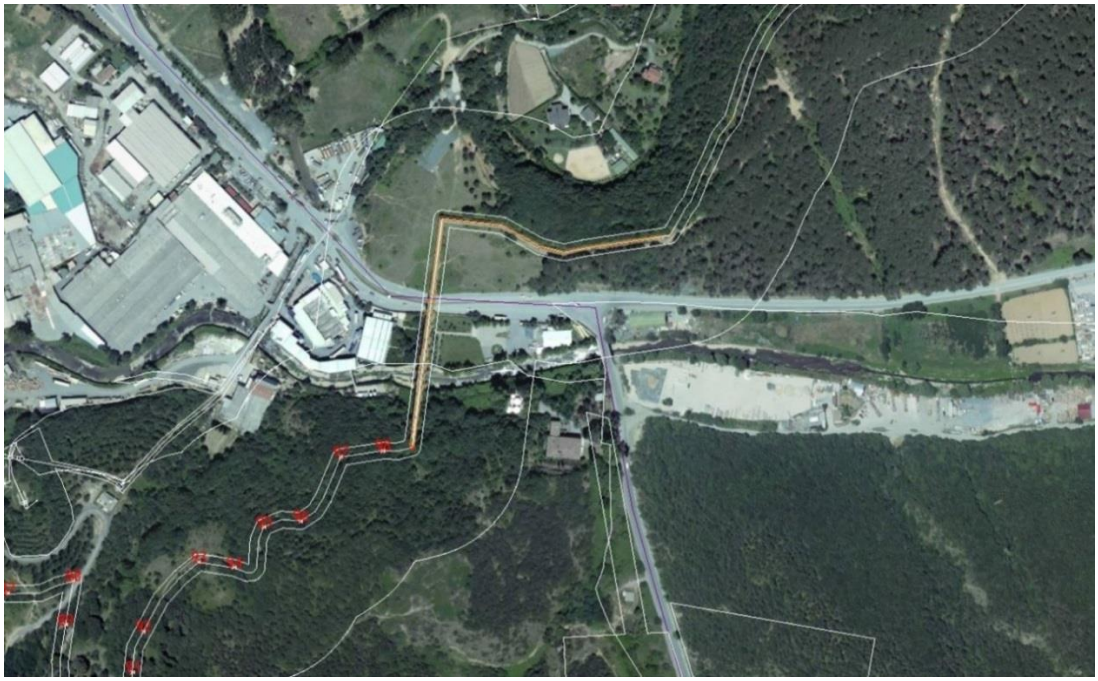

Figure 12. *Buildings belonging to Hamidiye Incorporated Company (I.C.) within the protection band of Eğri Aquaduct [8]*

Figure 13. *Villas near Uzun Aqueduct [8]*

Water structures are damaged during infrastructure work. Reinforced concrete implementations damaged the original material of the water structures, causing structural and environmental damage. Traffic passing through the arched openings is another cause of damage to the aqueducts (Figure 14). The vibrations created by heavy-duty vehicles, especially when passing along these roads, have been damaging to the aqueducts.

Figure 14. *Passing through the arched openings of Uzun Aqueduct [8]*

The aqueducts under the water of the Alibey Dam are the Mağlova Aqueduct and the Güzelce Aqueduct (Figure 15). The water, which runs to the interior parts of the original building stones, caused moisture to build up inside the building. The deterioration of building materials occurred due to freezing and dissolution effect, particularly in winter. Surface and material losses occurred due to the water expanding while freezing in joints inside the aqueducts.

Figure 15. *Mağlova Aqueduct under the water of Alibey Dam [8]*

As a result of the increase of the ground levels because of construction activities, we see some aqueducts being partially under the ground (Figure 16). Attention should be paid to the aqueducts and the surrounding parcels when road work is being carried out. Alternative proposals and construction plans should be made so that construction activities are undertaken as far away as possible from cultural assets, and the existence of cultural assets should be made known to the community.

Figure 16. *Due to the elevation of the road level Keçesuyu Aqueduct below the road level [8]*

Another problem encountered with the aqueducts is that their ownership status is not clarified. Although it is thought that the property should be in the General Directorate of Foundations because of their being foundation work, such an expression does not exist in the land registry records. In The Law on the Establishment and Duties of the General Directorate of Istanbul Water and Sewerage Administration, dated 20/11/1981 and numbered 2560 in the 26th article that regulates the transfer works, it is stated, "The existing water, sewarage facilities, and movable and immovable properties of the municipalities and villages will be transferred to İSKİ[1] with a protocol when the municipalities and villages are connected to İSKİ." Similarly, in Temporary Article One of the same law, it reads, " Foundation Water and all kinds of rights and obligations and facilities were transferred to this administration with the law in the Water Administration of Istanbul Municipality numbered 2226 and dated 27.5.1933. Despite the interpretation that these works are owned by İSKİ in accordance with these provisions of the İSKİ Law, this issue must be resolved and the property transferred to land registry records [10].

3. CONCLUSION

Today, the Istanbul Water and Sewerage Administration (İSKİ) works under the Department of Istanbul Water and Sewerage Administration overseeing the administrative and operational rights of the historical waterways and water structures, in Istanbul. The Restoration Technical Group established in 1998 focuses on the protection of these works and renovating them in order to pass them on to future generations. However, historic waterways in Istanbul, a world city containing World Cultural Heritage sites, face the danger of extinction due to improper reconstruction, public works, and non-expert repairs. In order to develop an integrated and comprehensive protection policy for the protection of these very valuable assets which are at such risk, a management model for sustainable protection should be prepared. According to this management model, the management plan should be prepared in three main stages. These steps are:

- Definition of the area and determination of the cultural value and importance,
- Determination of evaluation and preservation policies,
- Application, monitoring, and review [11].

It is crucial in terms of transferring these water systems to future generations for the public institutions and organizations related to Istanbul's historical water systems to show the necessary self-sacrifice so that this management plan can be implemented quickly. For this purpose, it is necessary to establish a management field presidency and similar practices in other water systems. The research conducted in this context should be considered a guide for further studies.

[1] İSKİ: İstanbul Water and Sawage Administration

CONFLICTS OF INTEREST

No conflict of interest was declared by the authors.

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