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WATER SYSTEMS AS CULTURAL LANDSCAPES: CONSERVING THE VALENS SYSTEM AND THE STRANDJA FORESTS

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Abstract

Urban dependence on water has historically driven infrastructure development. In water-scarce Istanbul, the Valens Waterline, the longest Roman-period waterline, was constructed, sourcing water from the Strandja Forests. Today, this interconnected system is at risk: while the Strandja Forests are under intense pressure, the water system is only passively and fragmentarily protected by legal recognition. This research aims to contribute to the literature by evaluating the area as a cultural landscape for the first time and offering conservation recommendations. The study finds that the area linked to eight UNESCO World Heritage criteria as an organically evolving cultural landscape. Using a mixed-methods approach, including literature review, archival analysis, spatial analysis, and field surveys, the study assesses the heritage value according to UNESCO guidelines, analyzes conservation issues using the DPSIR framework, and compares site management to the Pont du Gard example. The conclusion identifies conservation priorities and proposes a multi-stakeholder site management model.

Keywords: *Valens Water System; Cultural Landscape; UNESCO World Heritage List; Strandja Forests; Heritage Conservation Management*

Introduction

Just like today, mankind has been dependent on water for drinking and consumption throughout history. Water has become an element of politics and governance, a source of economic activity, infrastructure, and culture, as it represents power for cities [1]. It has been a component that can alone establish and spread civilizations, and today's cities are located either close to water resources or on the coasts as a result of the relations established with water in the past. Today, this historical dependence faces new challenges; increasing water consumption, along with environmental, climatic, and anthropogenic pressures, has redefined water supply and security as critical issues within the context of water scarcity. Notably, only 2.5% of the Earth's 1.4 billion km³ of water is freshwater [2], and approximately 85% of wetlands have disappeared in the last 300 years [3]. Beyond these physical realities that determine the fate of today's cities, water has also served as a universal symbol of birth, production, cleansing, purity, and death for humanity. This symbolism, combined with the immutable nature of water resources and the cyclical character of history, has rendered the solutions developed by previous civilizations as valuable sources of knowledge. These solutions illuminate modern approaches and emphasize the need to view the entire system as cultural heritage, as they are products of humanity and represent a universal responsibility.

The need for water has brought human beings to the effort of owning and managing water, and this was also the case in ancient times. Water systems, which were produced for the need in

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ancient times, include all kinds of infrastructures to provide water from the source to the site. The purpose of their production may include the absence, inadequacy, or poor quality of water as a necessity arising from the usage, as well as the aesthetic or economic orientation of the resource for a purpose. These water-based historical systems are early examples of cultural landscapes.

Water systems are more than just a harbor or a fountain structure. They represent the technological knowledge and social cultures of their era, reflecting integrated management strategies and technical expertise.

Liu Z. H. and Liu F. [4] argue that water does not create a culture on its own and that water culture can be the result of human interaction with water. In other words, water culture is the way people use water and all the meanings they attribute to it. Water systems and forested areas have evolved in the context of human–nature relationships since ancient times. People transformed their knowledge of abundant and high-quality water being found in mountains and forests into technological interventions and cultural practices [5], which were then guided by natural conditions to allow water to reach settlements. Such environments shaped by the mutual interaction between humans and nature were first defined as cultural landscapes in 1925 [6]. UNESCO's inclusion of this concept in World Heritage definitions in 1992, recognizing areas where natural and cultural elements coalesce [7], solidified the concept in practice.

Natural areas present problems and potentials for settlements with their geographical conditions, climate characteristics, and biological environments. Humans have an impact on the areas and their usages in line with their technological and cultural accumulation over time. These areas represent cultural landscapes formed by the interaction between nature and culture, expressing the identity, culture, and universal value of the region [8]-[10]. Since the other implicit components are behind the layers of nature and culture and no single dimension, discipline, or concept is sufficient to make sense of the relationship between people and these areas [11], the cultural landscape approach has found its place in the literature and practice [12].

Considering water systems, which have the characteristics of cultural landscapes, separately from the context of the natural environment and only on the basis of building elements, fragments the protection approach by neglecting the system's purpose and function. Such an assessment causes the water systems to lose their meaning as a living urban infrastructure that once worked in the natural environment that created the need for their production and ensured the continuity of the city. On the other hand, leaving the system to its fate and neglecting it is, according to Vallerani [13], a form of genocide. Therefore, historical water systems should be managed holistically as dynamic structures that represent cultural continuity, extending beyond engineering heritage to understand their multi-dimensional interactions with nature.

Ancient water systems in their natural environment are subject to conservation problems arising from their archaeological nature, as well as the problems of the natural environment. The problems that this research addresses are two-dimensional: (1) resources in the natural environment on the peripheries of today's cities have been used to supply water to historic urban centers in the past, and today's cities include a trend of development towards peripheral areas. (2) Ancient water systems, which are vulnerable in natural environments on the peripheries of cities, face problems such as treasure smuggling and destruction due to their archaeological nature. These problems put ancient water systems at risk of threats and pressures.

In this context, historical water systems should be considered dynamic structures that represent cultural continuity, extending beyond engineering heritage. This perspective can be concretely observed in the water management strategies of Istanbul, which was selected as the research area for this study. The Valens Water System, which transported water to the imperial capital of Istanbul from the Strandja Forests of the Yıldız Mountains in Turkish Thrace, was constructed starting in the fourth century [14]. Estimated to stretch up to 500 kilometers, this system is considered the longest known waterline of the Roman period [15]-[17]. These forests, located on the outskirts of the Istanbul Metropolitan Area, currently provide 31% of the city's water needs [18].

In the recommendations of the Council of Europe (1995), it is emphasized that cultural landscapes are under threat, and the necessity of protecting them, especially in terms of memory and identity, is highlighted [19]. In addition, since ancient water systems are the basis of today's modern hydraulic technologies and water management strategies, they are memory documents that directly reflect the identity characteristics of their periods, which should be preserved for future generations. However, the current conservation approach treats natural areas and structures independently, applying a passive and fragmented protection model based solely on legal registration. This research identifies the lack of an integrated theoretical and managerial conservation approach that addresses the relationship between ecological functionality and cultural meaning production within memory spaces as the main problem.

In order for water systems to be classified as cultural landscapes, they must include at least one of the criteria of the World Heritage List. Examples of cultural landscapes on the World Heritage List, which are on the list as a direct result of their character, are limited in literature and practice. Only 4% of the 1223 sites on the World Heritage List include areas with ancient water systems, underscoring the rarity of this heritage [20]. This is a point of view that isolates the structures from the natural environment in which they are located and the purpose for which they were produced, and from the other components of the system.

The aim of the research is to determine the cultural landscape potential of ancient water systems and to determine the effect of this qualification on the conservation of the sites with a comparative perspective. The research offers a unique contribution to the literature by treating the Valens Water System and Strandja Forests as a unified cultural landscape, developing a managerial framework for the landscape's character, and discussing the relationships between conservation policies in a multi-layered manner. The results of the evaluation are based on a settlement (Çatalca) within the borders of the metropolitan area, which contains the longest waterline of the Roman Period. Unlike other settlements along the route, Çatalca preserves the technical integrity of the Valens System within a forest ecosystem covering sixty percent of its territory [21]; it continues to provide urban water while facing critical spatial, environmental, and legal pressures.

The research was conducted using a mixed-methods approach, combining both qualitative and quantitative analyses. Qualitative methods include literature reviews, legislation analysis, and thematic and comparative analysis, while quantitative methods are used in spatial analysis, employing geographic information systems during fieldwork.

The study found that the Valens Water System and Strandja Forests represent a cultural landscape with the potential to meet eight of the ten World Heritage criteria. The issues hindering the conservation of the area were evaluated in ecological, physical, legal, managerial, and social terms. The recommendations are presented in terms of conservation and planning disciplines, focusing on multi-dimensional, multi-stakeholder management strategies and governance models within the context of site management.

Water Systems as Cultural Landscapes and Their Environmental Context

The first examples of water systems, even though they were built on the waterfront, were produced by Mesopotamian and Mediterranean civilizations in order to use water as a resource for the continuity of their economic activities [22].

The oldest known aqueduct water system was built during the Assyrian period in Jerwan, in present-day northern Iraq [23]. Sennacherib's aqueduct thus predates the oldest Roman aqueduct, the Aqua Appia [24], by about four centuries. This evolutionary process was not merely a matter of engineering; it was a response to the varied constraints of the physical environment, ranging from arid Mediterranean climates to karst landscapes and high-altitude mountainous terrains [25]-[32].

In diverse and challenging natural environments, aqueducts emerged as the most significant and symbolic elements of ancient water systems, serving as architectural solutions

designed to overcome topographical constraints and ensure resource continuity. These structures are crucial, as they influence the use and scale of all other system components; for example, after the construction of the aqueduct in Pompeii, the baths were immediately expanded and turned into complexes [33]. The Romans, who built aqueducts to show the abundance of water in their water systems wherever they reached [34], are associated with aqueducts not only because of the large number of constructions. The aqueducts of the Roman period stand out with water systems based on hydraulic know-how and sometimes monumental-scale applications based on comprehensive, resilient, and systematic efforts. Essentially, aqueducts from Mesopotamia, the Mediterranean, and other civilizations to the east were learned about and renovated as a result of Alexander the Great's eastern campaigns and expansionist policies [35]. At the end of the process with Hellenism, hydraulic technology and much other knowledge were learned by the Greek civilizations and then developed by the Romans [36], [37]. In other words, like many other innovations, while the Greeks were the producers of the idea, the Romans were the upgraders. This Roman upgrade transformed water systems from mere engineering conduits into sophisticated cultural landscapes that harmonized with their natural environments. Along with this, such a high level of integration between human ingenuity and challenging topographies remains a rare example of such mastery in the world.

Fig. 1. World Heritage Sites Containing Ancient Water Systems [20].

Therefore, water systems, including canals, pools, and wells, some of which are still in operation and which were produced especially for agricultural purposes, were produced by these civilizations in ancient times, and today they are under conservation for these qualities. The significance of this heritage is further emphasized by the rarity of such examples; of the 1223 properties on the World Heritage List, only 4 percent are related to ancient water systems [20].

The geographies where the ancient water systems conserved within the scope of World Heritage are located are the areas that are hosting the oldest and greatest civilizations (Fig. 1). Although they have economically important qualities like other settlements in similar geographies, the most important feature that distinguishes them from others is their efforts to cope with thirst when water is insufficient or inconvenient, perhaps as a problem or a solution.

Ancient water systems represent a cultural landscape environment in which humans acted on nature in order to benefit from it, and in the absence of today's technology, they had to learn its conditions and adapt to it due to the irreplaceable nature of the source in case of thirst. Moreover, even though it may be possible to see similar building elements and facilities in various geographies, each geography's own conditions necessitated the development of unique water system solutions.

Ancient water systems are included in the World Heritage List due to their cultural qualities, but they may also include natural area criteria due to the nature of the environments in which they are located. In Table 1, the World Heritage criteria that ancient water systems may be associated with are analyzed and evaluated through the areas on the list.

Table 1. Evaluation of World Heritage Criterias in terms of Water Systems
Source: Produced by the authors based on World Heritage Criterias [38]

	World Heritage Criteria (Cultural)	World Heritage Criteria for Water Systems (Cultural)
Criterion (i)	To be an outstanding work of art or architecture.	Exemplifies unique, significant, and rational water management or infrastructure.
Criterion (ii)	To be an important example of interdisciplinary interaction and development.	Water systems shaped by engineering, architecture, and planning skills, which are milestones for each discipline, are aligned with the natural landscape.
Criterion (iii)	To be a unique or extraordinary proof of a civilization or cultural tradition.	Presents examples reflecting the water history, techniques, and management strategies of its period.
Criterion (iv)	To contain a value reflecting important stages of human history.	Represents primitive but functional examples of any kind of infrastructure for water supply or a significant stage of development.
Criterion (v)	To be an important example of traditional human settlement or land use.	Development of water management strategies appropriate to the terrain, which are linked to contemporary urban areas under pressure.
Criterion (vi)	To be directly connected to events, ideas, or beliefs.	The emphasis on water or the system from an artistic, social, or religious perspective, and its association with a specific event or belief.

When examining World Heritage Sites, it is evident that examples containing water systems are most commonly associated with the third, fourth, and fifth criteria. These criteria include (iii) representing a unique or exceptional testimony to a civilization, (iv) being an outstanding example of a type of building or architectural ensemble that illustrates a significant stage in human history, and (v) being an outstanding example of a traditional human settlement or land-use. In this context, ancient water systems reflect both the water culture of their era in terms of management strategies and the accumulated hydraulic knowledge. Moreover, these systems demonstrate the ability to design and effectively use the landscape's features in the absence of modern technology and systematic knowledge. The techniques and knowledge embodied by ancient water systems make them not only engineering products but also a representation of human–nature interaction, enabling them to be considered as part of cultural landscapes and global heritage.

Since considering cultural landscapes only within the scope of the relevant criteria of the World Heritage List does not include the layers of nature and culture and the relationships and interactions behind them and only emphasizes certain features, they are considered within a triple categorization [39]. This cultural landscape categorization, associated with the World Heritage sites in Figure 2, comprises designed, organically evolving, and associative landscapes [38]. This approach underscores the heritage value of systems shaped by environmental and social processes, establishing a theoretical foundation for evaluating complex hydraulic infrastructures.

Some of the water systems were designed due to aesthetic considerations, and others because of their symbolic religious meanings, but water systems were created in response to societal needs and social and economic requirements. These areas, which evolve organically in interaction with the natural environment and are shaped by societal needs, define organically evolving landscapes. Among the 14 ancient water systems evaluated as cultural landscapes on the World Heritage List, 11 are categorized as organically evolved landscapes [20]. These multilayered areas represent not only the technical knowledge and infrastructure of past civilizations but also the harmony and interaction processes between humans and the environment, carrying unique and universal heritage value.

Fig. 2. Examples of Water Systems in the Cultural Landscape Category of the World Heritage List
Source: Produced by the authors based on World Heritage List [20]

Even though they represent universal cultural value, a significant portion of ancient water systems has survived to the present only in a limited form; furthermore, the surviving examples have generally lost their original social, functional, and economic characteristics, with their functions often altered. The aging of these systems, which leads to the loss of their quality, is one of the key factors affecting the physical integrity, original character, and legibility of the structures within the landscape. As these systems reflect the hydraulic knowledge, technology, and environmental adaptation strategies of their time, they serve as primary sources for understanding the interaction between technology, culture, and the environment in human history.

Therefore, the preservation of water systems is not only essential for maintaining their physical continuity but also for ensuring the transmission of historical knowledge and the sustainability of urban memory. Treating water systems as cultural landscapes ensures their consideration within a holistic protection and management approach that integrates structural components and the natural environment.

The multifaceted relationship between humans and nature calls for addressing these areas with an approach that supports multilayered and participatory conservation models [40], while also strengthening awareness, education, and promotion processes. Additionally, World Heritage status transforms the protection of these heritage areas into an international prestige and responsibility by contributing to the social, economic, and symbolic levels of the contracting states [41].

Experimental part

Study Area

Although Istanbul, the capital of three great empires, was surrounded by waters, its lack of fresh water became a problem due to the increasing need for water after the city became the capital in the Roman period in 330 AD due to its strategic location [42].

The inadequacy of the water supplied from the city's inner sources led to the search for water from outside the city. Although water systems were initially produced to supply water from the surroundings closer to the city (Halkalı and Belgrat, Istanbul), the water supply efforts initiated during the reign of Emperor Hadrian marked the first steps toward a more comprehensive, long-distance system [43], [44]. This network was significantly extended by Emperor Valens in 373 AD to tap the resources of the Strandja Forests, thereby becoming known as the Valens Waterline, and was subsequently expanded by the Theodosian dynasty to its monumental, 426-kilometer scale [45], [46].

Çeçen [15] argues that this water system is the longest known water supply line and system of the Roman Period, and Crow *et al.* [14] support this with a length exceeding 450 km, including its branches. The system is located within the administrative borders of three provinces: Kırklareli, Tekirdağ, and Istanbul (Turkey) [47]. The system originates from the springs of the

Strandja (Istranca) Mountains, a region lying in a transitional climate zone with a rugged topography of steep valleys that were strategically utilized for water extraction.

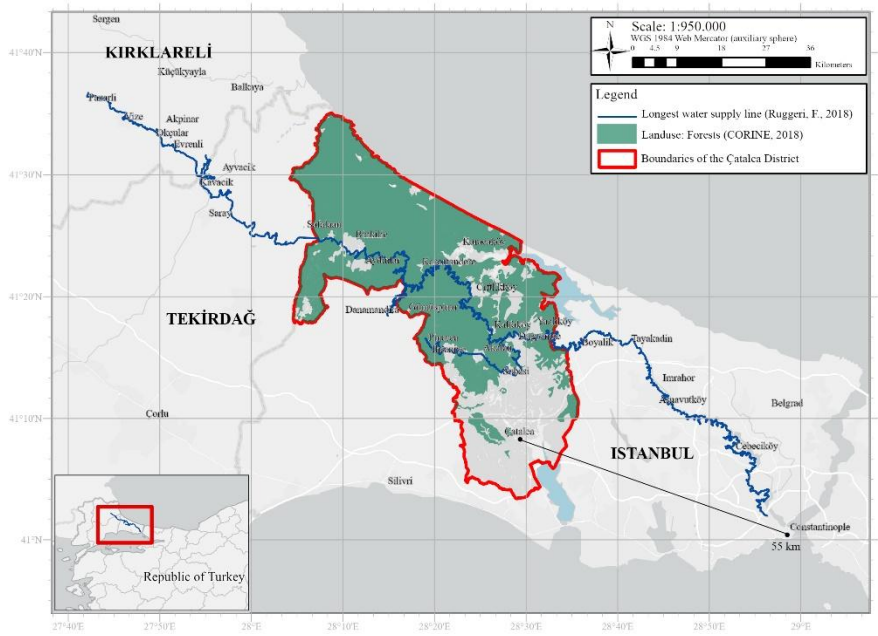

Fig. 3. The Valens Water System route and the study area in Çatalca [47], [48].

Çatalca is located in the Marmara Region of Turkey, within the boundaries of Istanbul Province (Fig. 3). The center of the settlement is located at 41.14° N - 28.45° E [49], approximately 55 km from the historical city center of Istanbul (Fatih). It is a critical settlement within the metropolitan area consisting mainly of forest villages, with the exception of only two central neighborhoods. It is selected as the primary research area because approximately half of the total length of the entire water system passes through this district. Most importantly, Çatalca hosts the complete range of technical infrastructure and structural diversity of the Valens Line, including monumental aqueducts, tunnels, and water catchment basins.

The region represents an 'organically evolving cultural landscape' where the continuity of the Strandja forest ecosystem has historically functioned as a protective shield, preserving archaeological integrity against physical degradation. Characterized by a rural fabric with 60% forest and 30% agricultural land, the area is currently a high-risk peri-urban zone facing urban sprawl [21]. Despite these threats, Çatalca maintains its 1600-year-old functional role, with 91% of its territory designated as a basin protection area, still providing 31% of Istanbul's water [18]. The site's unique biodiversity, hosting globally threatened species (IUCN: VU, EN, CR), further necessitates a holistic conservation approach that bridges cultural heritage with ecological sustainability.

The system is significant because it (i) represents historical and technological achievements, (ii) contributes to the water history of Istanbul and its connection to urban memory, (iii) houses water catchment basins that directly influence the biodiversity of the region and still provide water supply today, and (iv) requires comprehensive conservation, yet is still subject to fragmented and insufficient conservation regimes.

Methods

In the research, it is aimed to determine the cultural landscape character of ancient water systems within the scope of World Heritage criteria and to develop strategies and determine the effects of this on the protection of the sites. This evaluation was analyzed through the study area,

the cultural landscape potential of the area was determined, the conservation problems it faces were evaluated in the context of cause-effect relationships via DPSIR analysis, conservation strategies were developed, and the possible effects in the context of the approach were continued through a comparative perspective on a site on the World Heritage List.

Since ancient water systems are archaeological cultural heritage elements reflecting the qualities of previous eras, the study is grounded in the theoretical framework of urban conservation and planning disciplines, employing a mixed-methods approach that combines quantitative and qualitative techniques in five stages (Table 2) to systematically address three research questions: (a) the analytical determination of the landscape's heritage value in accordance with UNESCO criteria, (b) the identification of the nature and spatial patterns of pressures affecting the landscape's integrity, and (c) the development of conservation strategies within the context of multi-actor governance. The research was carried out in line with the information and documents covering the years 1985-2024. The reason for this is that the examples where water systems are considered as cultural landscapes point to these periods and the current nature of the research in the field.

In order to determine the cultural landscape potential of ancient water systems, reports on the characteristics of World Heritage Sites were accessed through the UNESCO List online database. The 1223 properties on the World Heritage List were evaluated over 45 sites in three ways: sites of cultural or mixed quality, sites of direct or indirect interest, and cultural landscapes with water systems that are the artifacts of ancient times (8th century BC-5th century AD). This evaluation was carried out in order to determine the criteria and characteristics that ancient water systems may be related to and to determine the impacts in this direction by systematically analyzing spatial indicators—such as historical continuity, authenticity, and integrity—based on the conceptual framework of the UNESCO Guide.

To provide the necessary detailed analyses in the study of the cultural landscape character of the area, research has been conducted by focusing on the sub-scale part of the Valens System via Çatalca. However, the conservation strategies have been developed holistically due to the integral nature of the area.

The research for the ancient water system in Çatalca was based on secondary data sources and field research. Secondary data sources were based on literature reviews, legislative research, and information and documents obtained from institutions. Firstly, literature findings and publications accessed from the university library, departmental archive, and online databases were accessed. International legislation was accessed through UNESCO Legal Texts and national legislation through the Republic of Turkey Legislation Information System. The aim was to determine the place of the approach in the legislation and literature and to establish its relevance to the field. Secondly, data were obtained from the Ministry of Culture and Tourism, the Ministry of Agriculture and Forestry, and local administrations regarding the natural and cultural qualities of the area and its conservation status.

Quantitative spatial data were evaluated within a Geographic Information System (GIS) environment, and the DPSIR (Drivers-Pressures-State-Impact-Response) framework was used to classify conservation pressures and prioritize management recommendations. The data collection process was divided into short-term (September–October 2023), medium-term (May–August 2024), and long-term (November–April 2024) periods, taking into account the length and scope of the research area, as well as the data publication schedules of the institutions. These data were used for the evaluations related to the natural and cultural qualities of the area, where the cultural landscape quality of the area was determined.

Conservation issues are based on observations and unstructured interviews conducted by the researchers during field research with the experts and local stakeholders who work in the municipality and ministry. This data was analyzed using the thematic analysis method. It was provided to reveal the current situation of the area and to determine the possible effects of the approach to its problems and a comparative policy analysis of the Pont du Gard (France) to

develop inter-scale conservation recommendations and a model for strategies. Table 3 presents the criteria and rationales for selecting the Pont du Gard as a comparative case study.

Table 2. Research Methodology

STAGES		WHAT	HOW	WHY	WHEN	WHERE	WHO
Stage 1	Preliminary Research and Formulation of Problems	Intro	Observations Oral and casual interviews Overview of the Literature	Research Gap Problem Statement	Short-term	GIS in the field Library, Archive and UNESCO the List	Authors
Stage 2	State of Art and Research Design	Methodology	Bibliograph Search	Method setting	Short-term	Library and Archive	Authors
Stage 3	Data Collection and Analysis	Research	Literature Review	Determination of cultural landscape character	Long-term	Library and Archive	Authors
			Legislative Research	Impacts as a cultural landscape		Library, Archive and UNESCO Legal Texts	
			Identification of samples in the WH list	Comparison of the field and the sample field		UNESCO the List	
			Field Survey Research			GIS in the field	
			Information and Documents Provided from Authorities	Current problems and potential of the field		Archive in Organisations (Ministry of Cultureand Tourism& Agriculture and Forests; Local Goverments)	Organisations and Authors
Stage 4	Evaluation of Findings	Findings	Classification and Analysis of Findings	Determination of findings for conclusion	Mid-term	MSOffice, and GIS	Authors
Stage 5	Conclusion and Recommendation	Discussion and conclusion	Review of Findings	Conclusion and recommendations	Mid-term	MSOffice, GIS and Reports for WH List Proporties	Authors

Table 3. Justifications for Selecting the Pont du Gard Site
Source: Prepared by the authors for this research based on World Heritage List: Pont du Gard [50]

Justification	**Pont du Gard, Natura 2000 Area and Biosphere Reserve Qualities**	**Connection to the Istranca Forests and Valens Water System**
1. Typological and Technological Similarity	A monumental, multi-tiered Roman aqueduct and water system that contains advanced engineering solutions.	The structural integrity can be examined with respect to the universal qualities of the area.
2. World Heritage Status	Listed as a UNESCO World Heritage site; holds universal value.	Can serve as a reference point for discussing the potential World Heritage value of the Valens Water System.
3. Integration with the Landscape and Monumentality	An aesthetic structure harmoniously positioned with the natural landscape.	Allows for an evaluation of the relationship between the Valens Water System and the forest ecosystem.
4. Conservation and Management Model	Thoroughly documented in archaeological, architectural, and functional terms, and managed through a multi-stakeholder conservation model.	Can serve as an example for sustainable conservation and management strategies for the Valens Water System.

The main limitation of the research is the inability to access the entire Valens Water System due to geographical challenges. Additionally, due to passive protection approaches, human and natural interventions have compromised the system's integrity, complicating the collection of field data. To overcome these limitations, previous comprehensive studies conducted in the area [14], [15] using specialized equipment and tools were leveraged. This allowed for the completion of missing information and provided a more holistic evaluation of the conservation status of the area.

Results and discussion

Qualifications of Valens Water System and Strandja Forests: Çatalca Case Study

Natural Qualities

The geological, hydrological, edaphic, geographical, climatological, and biological environments of the settlement, which are shaped by these factors, have made the supply of water to the metropolitan area possible over time.

Built on a plateau with an elevation of approximately 500 meters, 63% of the land use of the Çatalca settlement [21] consists of Çatalca Forests and the forest groups of the Strandja Mountains extending to Bulgaria. Forest groups are a source of ecosystem services for citizens and a habitat for the species living in this area.

Due to the nature of the water source, 91% of the settlement's boundaries are within the basin preservation area [18]. Even though their scales are changing, the streams that enabled the establishment of the first settlements have not lost their qualities of providing the drinking and using water needed today (Fig. 4). The water resources born within the settlement have supplied two important lakes of Istanbul, called Terkos and Büyükçekmece Lakes, which are ecosystems.

The dominant climate type in the settlement is called the Marmara Transitional Climate. This climate type is a combination of Black Sea and Mediterranean climates. Meteorological conditions create a unique pattern for the diversified flora and fauna species in the settlement and ensure the existence of these species in the area. As a matter of fact, there are rich and diversified species within forests, marshes, and wetlands. Among these species, there are also endemic or globally threatened (IUCN criteria: VU, EN, CR) species that need to be protected due to their ecological importance. Especially Centaurea hermannii and Ophrys sphegodes subsp. Catalcana (Fig. 5) is an endemic species associated with the region [52].

Fig. 4. Istranca Stream located in a basin preservation area, surrounded by the vegetation of the Strandja Forests [51]

Fig. 5. Ophrys sphegodes subsp. catalcana [53]

The fact that a settlement under the development pressure of the metropolitan area contains the limited natural resources of the city, includes ecologically important ecosystems, and tries to maintain its rural character despite all these threats and damages, and especially the critical species that try to survive within this structure and are affected by the conditions, constitutes the natural dynamics of the district and can point to the seventh and tenth criteria of the World Heritage List.

Cultural Qualities

The natural dynamics of the settlement have ensured the supply of water to Constantinople (modern Istanbul) from the past to the present. During the Roman Period, interventions were made by using the resources in the natural environment, and the ancient water system was produced.

While early efforts to address the city's water needs date back to the Hadrianic period, the transformation of Byzantion into the capital "Nova Roma" necessitated a significantly more extensive infrastructure. The rapid population growth following this transformation made the existing local wells and streams insufficient, requiring the tapping of distant resources.

Historical records and archaeological evidence indicate that the construction of this long-distance water supply system was not the work of a single ruler; although the project gained momentum under Emperor Valens, its extension and consolidation—eventually reaching a length of over 426 km—were achieved during the reigns of the Theodosian dynasty [43].

The Strandja water was then discovered after a campaign, and efforts to obtain water from this area continued in the following years [14]. This is quite possible because Çatalca was a bridge and a stopover point for military, religious, economic, and recreational use as a hunting area, including roads and accommodation units (mansio, man-sus) along the way [54].

In the absence of modern technology, the water system is based on the knowledge of hydraulics and fine calculations involving the use of gravity and slope to guide and transport water across the landscape. The process of directing and transporting water involves the production and placement of relevant and functional buildings on the land.

On the other hand, all this needs to be a management process in which the land and its conditions are well known. Considering the characteristics of the period, this implies a rational process that requires effort in terms of construction technique, labor force, raw materials, and transportation of all these [16]. This infrastructure, commonly referred to as the Valens Water System, was a rational and complex management process that integrated hydraulic expertise with the topographic and environmental conditions of the Strandja Forests. In such a situation, the Strandja Water System, as the longest waterline of its period, was produced in a way to include monumental elements, and despite the physical integrity of the system being damaged, it is still standing centuries later.

In addition to its scale, the facilities of the water system are also comprehensive. Galleries, waterways made of funnel pipes, numerous bridges, monumental aqueducts, ponds, wells, canals, siphons, and water towers are the water structures through which water was supplied from the system to fountains, cisterns, and baths. On the water structures, there are many cross symbols or motifs symbolizing Christianity, such as Staurograms and Christograms [14], [55], or various figures that can still be identified today, and Figure 6 illustrates these findings. The reason for this is thought to be the knowledge of Istanbul's water problem and the destruction of the water system in case of an attack in order to surrender the city and to protect the water system in case of disasters. The long nature of the water system has caused it to have a disadvantage, as it can be interrupted in various ways [16]. Therefore, these traces and motifs enabled the water system to reflect the experience, technology, and culture of its time.

Fig. 6. Cross symbol located on a bridge in Gümüşpınar, Çatalca

Moreover, the chronicler and biographer Hesychius stated that the name “Byzas” (the founder of Byzantion) came from the Nymphe Byzia/Bizye and that the water of Byzantium came from Bizye (Vize, Kırklareli) [55]. Thus, a legend about the foundation of the city is associated with the water system.

The end of the water system was the Latin Invasion, and it survived only until the thirteenth century [14]. After the invasion, the water system became economically and physically irreparable and, in the end, became completely idle. The length of the water system and its vulnerability to attacks from the Balkans and possible disasters were the main factors that led to its collapse. In later periods, during the Byzantine Period, new waterways were not constructed, and an existing water system was repaired and stored as much as possible [56]. In the early Ottoman period, although the previous waterways were repaired and used, the water needed by the city was provided to the city within the closer environment of the city, the Halkalı and Belgrat line, as in the first searches of the Roman period [15], [57].

Qualifications of Valens Water System and Strandja Forests

The water system, which takes its source from the Strandja, represents a hydraulic knowledge and culture that was beyond its time. As the longest water system of its period and with its monumental-scale facilities, it refers to a masterpiece in water management that is unique in the world. Research findings reveal that the Strandja Forests and the Valens Water System embody a multi-layered cultural landscape, materializing sophisticated Roman hydrological engineering knowledge through the integration of cultural layers with the region's topography and ecosystem.

While access to the peaks of the land is difficult even in today's technologically suitable conditions, the rough and steep land surrounded by forests in antiquity was covered with water structures with the characteristics reflecting Roman architecture. It represents the knowledge of the Romans in terms of using, supplying, and managing water. This knowledge, experience, tradition, and culture is a heritage that has survived to the present day. Additionally, the site serves as a testimony to the historical evolution of socio-cultural continuity, technological innovation, and the nature-human interaction, underlining its outstanding universal value.

The water system relies mainly on hydraulic engineering, the production of related structures combined with architectural skills, and land management capability. The geographical location of the Strandja Forests, situated at the transition between two climatic zones, is key to the region's ecological diversity. All of this involves the multifaceted evaluation of complex knowledge and the management of vast resources. The area's hydrogeological and geomorphological structure, climatic characteristics, and extensive forest cover, alongside available water resources, made the establishment of such a large-scale ancient water system feasible. In addition, the water system is mentioned in myths and ancient texts because of its social significance, reflecting the technological and symbolic entity of the water management strategies and cultural value systems of the era.

The natural environment in which the water system is located is an ecosystem that is a locally specific synthesis of geographical and climatic characteristics. The ecosystem includes threatened, sensitive, and endemic species.

In Table 4, according to the UNESCO World Heritage criteria-based evaluation, the area meets eight out of the ten criteria, indicating that it constitutes an exceptional example both in terms of the originality and integrity of its tangible heritage components and the continuity of its intangible cultural values.

Despite all these qualities it represents, the water system is subject to destruction, threats, and pressures. In a peripheral settlement whose rural identity is at risk, beyond the lack of active conservation, several structural components of the water system remain officially undocumented and unregistered. The fact that the site is a universal document reflecting the hydraulic knowledge of an era requires the continuation of comprehensive management strategies for the site.

When all these factors are evaluated, the Valens Water System within the Strandja Forests refers to an organically evolved cultural landscape environment that has intervened in the natural environment in line with technological and cultural backgrounds in order to benefit from resources as a result of necessity.

Table 4. World Heritage Value of Strandja Forests and Valens Water System
Source: Evaluated by the authors based on World Heritage Criterias [38]

Area Type		World Heritage Criterion		Connection to Water System's World Heritage Criteria	
mixed	cultural	i	**Masterpiece**	x	Monumental structures with the longest water route and associated facilities
		ii	**Discipline**	x	The intersection of disciplines in water management strategies
		iii	**Testimony**	x	Roman hydraulic knowledge, culture, and management
		iv	**Milestone**	x	Foundation of modern water supply systems
		v	**Land Skills**	x	An extraordinary example of land use and knowledge skills
		vi	**Intangible Relationship**	x	The water system intertwined with legends and narratives [14].
		vii	**Outstanding Natural Character**	x	Endangered local environment
	natural	viii	Geological Representation		
		ix	Flora and Fauna Development		
		x	**Critical Species and Diversity**	x	Habitat for endemic and endangered species

Authenticity

The site has largely preserved its structural integrity, construction techniques, and spatial organization from the ancient period. The components of the Valens Water System, including arches, tunnels, galleries, and channels, reflect the original structural and material solutions that embody the engineering knowledge of the time. The protective function of the forest cover has helped preserve the structural elements from modern interventions, thereby reinforcing the site's authenticity (Fig. 7). Furthermore, rituals, narratives, and traditional practices associated with water continue to support cultural continuity within the intangible heritage context, demonstrating that the landscape remains a living system.

Fig. 7. The Kumarlıgerme Aqueduct, illustrating the Roman engineering and its organic evolution within the landscape

Integrity

The natural, cultural, and spatial integrity of the area has largely been maintained to this day. The route of the ancient water system, its hydrological connections, and the ecological network structure are still traceable. In Figure 8, Geographic Information Systems (GIS) analyses show that the spatial overlap between the water system's route and the forest ecosystem supports the landscape's integrity through the ecological and morphological relationships between ancient water structures and forest habitats. Urban pressures, mega-projects, and land fragmentation present risks to this integrity; however, the existing conservation status allows for in-situ preservation and sustainability.

The Valens Water System and the Strandja Forests landscape are regarded as an organically evolved cultural landscape that integrates principles of cultural continuity, spatial integrity, and ecological harmony, spanning from the Roman to the Ottoman period and into modern-day Istanbul. The system is a rare example that, beyond serving as a water-carrying engineering infrastructure, demonstrates the long-term interaction between the natural environment and human production, providing solutions that align with the environmental knowledge of the time. This holistic approach enables the evaluation of the site as a heritage area of outstanding universal value, allowing for the technical and cultural aspects of ancient water management to be understood in concrete terms.

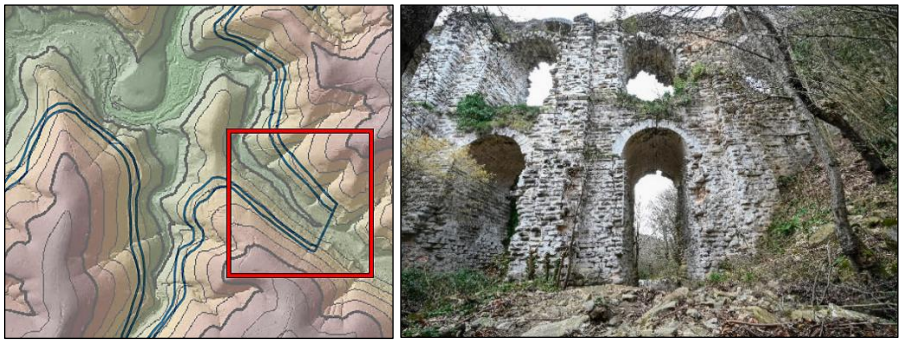

Fig. 8. Relief Map Showing the Valens Water System (left) and Kurşunlugerme Aqueduct (right) [47], [48]

Conservation Status and Issues of the Strandja Forests and Valens Water System

The structures related to the Valens Water System, reflecting Roman water management, technical knowledge, and cultural framework, are classified as archaeological cultural assets, with conservation responsibilities held by the Ministry of Culture and Tourism of the Republic of Turkey. The Strandja Forests, encompassing a significant portion of the Valens Water System and classified as State Forests, are protected and managed under the Ministry of Agriculture and Forestry of the Republic of Turkey. This situation leads to jurisdictional overlap and fragmented decision-making processes in conservation efforts for multi-layered sites, where both natural and cultural values coexist.

Table 5. Distribution of Valens Water System Areas by Province, District, Length, and Conservation Institutions

Province	District	Length (km)	Share in Total (%)	Associated Institution		
Kırklareli				Edirne Regional Board for the Protection of Cultural Heritage	General Directorate of Cultural Assets and Museums	Ministry of Culture and Tourism of the Republic of Turkey
	Vize	35,2	9,1			
Tekirdağ						
	Saray	46,3	10,9			
İstanbul				Istanbul 1st Regional Board for the Protection of Cultural Heritage		
	Silivri	11,9	2,8			
	Çatalca	210,6	49,4			
	Arnavutköy	62,7	14,7			
	Eyüpsultan	20,1	4,7			
	Sultangazi	30,6	7,2			
	Gaziosmanpaşa	8,7	2,0			

The Valens Water System has been constructed based on the reciprocal relationship established with the Strandja Forest ecosystem. Therefore, the conservation and management of such cultural heritage sites must inherently adopt an approach that aligns with the integrity of the ecological system [58]. The research findings reveal that the site is currently being evaluated under a piecemeal and passive conservation approach, based solely on the registration of

individual structures. This conservation framework, combined with institutional issues within legal and administrative frameworks, has created conditions that facilitate irreversible degradation risks, while the ecological and cultural structures are mutually influencing the challenges they face.

In line with the DPSIR (Drivers-Pressures-State-Impact-Responses) analysis framework in Figure 12, the spatial analysis structured in the study addresses the pressures on the interconnected ecological and cultural components of the Valens Water System and the Strandja Forests. It also examines the systemic outcomes of these pressures and the inadequacy of current institutional responses from a holistic perspective. This model allows for the assessment of the site's pressures (drivers), its current state, impacts, and institutional responses in a causal framework. The findings highlight the feedback degradation processes resulting from the mutual interaction of environmental, legal and administrative, physical and economic, and socio-cultural pressures within the area.

Environmental Issues

The Strandja Forests represent an integral natural area housing transitional ecosystems, endemic species, and sensitive biotopes, while the Valens Water System is an ancient hydraulic infrastructure embedded within this ecosystem. The origins of environmental issues lie in the perception of the area as a mere superficial green space rather than an ecological system; this perception leads to the flexible alteration of conservation statuses and the subsequent disruption of ecological balance. The pressures within the area emerge through three main avenues.

The first pressure is the direct destruction caused by mining, industrial, transportation, and energy projects. These interventions fragment the forest cover (Fig. 9), weaken habitat integrity, and disturb water regimes, thereby affecting hydraulic balance. The second pressure stems from pollution and the degradation of soil and water structures; erosion, sedimentation, and the decline in water quality reduce biodiversity and alter the environmental conditions of the Valens Water System, negatively impacting its conservation status. The third pressure arises from indirect effects caused by climate change and human activities, such as increased water consumption, climate change, inappropriate afforestation, wildfires, and invasive species, all of which threaten the long-term integrity of the ecosystem and, consequently, the cultural structures.

Fig. 9. Wind energy plants and highways over fragmented forest land [49]

These pressures trigger each other, weakening ecological integrity and putting the physical preservation of the water system at risk. Therefore, watershed-based management, ecological restoration, and monitoring programs that consider the interactions between structures and the environment should be prioritized.

Legal and Administrative Issues

The primary issue regarding the conservation of the area lies in the ambiguity surrounding the definition of the areas to be protected and the conservation methods to be applied within the legislation. This uncertainty becomes more evident in complex, multidimensional, and large-

scale areas that require interdisciplinary expertise, leading to limitations in management effectiveness, contradictions in decision-making processes, and coordination shortcomings.

The entire Valens Water System has not yet been registered, and challenges related to site access, institutional capacity, and financing have resulted in limited or incidental documentation of the features to be protected, preventing the preservation of the system's integrity. The registration of structures along the same route under different statuses creates inconsistencies in management decisions and double standards in practice (see Appendix A). The passive conservation approach limited to monumental structures, the off-cadastral positioning of structures, and the failure to incorporate registration decisions into spatial planning documents hinder coordination between conservation and spatial planning. Additionally, the absence of a site-specific conservation plan weakens protective measures against physical interventions.

Thus, a governance model that is multi-actor, multi-layered, and requires coordination is needed instead of individual regulatory provisions. The priorities should include completing the registration process, incorporating spatial integrity into planning documents, and strengthening institutional capacities.

Physical and Economic Issues

The Valens Water System, located at the periphery of the metropolitan area and within the Strandja Forests, is directly influenced by the dynamics of urban sprawl and spatial transformation. Over the last twenty-five years, macro-urban projects, neoliberal policies, and increased density and land values in the city have led to the expansion of settlements and infrastructure into the northern forested areas.

Fig. 10. Valens Waterline and mega projects in forest areas [49]

Mega-projects such as highways, airports, and canal developments have led to morphological and hydraulic changes in the area, also disrupting the integrity of the ecosystem. Moreover, the fragmentation of cultural heritage properties without proper registration, land use driven by profit motives, and inappropriate tourism or infrastructure investments will weaken the originality and integrity of the site, potentially jeopardizing its chances for World Heritage status. Therefore, to reduce the conflict between economic development projects and cultural and ecological conservation, the implementation of impact assessment mechanisms (Heritage Impact Assessment and Strategic Environmental Assessment), examination of project alternatives, and the adoption of conservation-compatible land-use models are essential.

Socio-cultural Issues

Field studies and institutional interviews show that local communities possess knowledge and experience regarding the area, but their participation in decision-making processes remains limited. Cultural awareness of archaeological features is somewhat limited, with some segments viewing these assets primarily through an economic lens (treasure hunting), which increases the risk

of looting and destruction. The dense forest cover and remote location of the area make monitoring difficult; damages are often reported by local communities or local authorities, but current oversight is insufficient in ensuring protection. The limited role of local actors in decision-making processes diminishes the alignment of conservation strategies with local knowledge and socio-economic realities, hindering the development of sustainable, locally accepted management models.

Fig. 11. Destruction caused by illicit excavations in the aqueduct [59]

In contrast, field findings show the potential effectiveness of community-based solutions. Local education programs, volunteer monitoring networks, law enforcement-protection collaborations, and economic incentives could enhance conservation effectiveness; however, for these initiatives to succeed, appropriate financing models, capacity building, and integration across planning scales are required.

These findings indicate that the current passive conservation approach, which relies solely on the registration of individual structures, is insufficient for the preservation of the universally significant Valens Water System and the Strandja Forests. The source of the problems lies in conservation practices that do not consider spatial continuity, deficiencies in management processes, and the rapid spatial transformation and degradation dynamics occurring in the area. Therefore, a site-specific, integrated management plan; watershed-based ecological protection measures; registration-planning integration; participatory governance mechanisms; and continuous monitoring and impact assessment programs are essential.

Discussion

These findings have shown that ancient water systems can reveal the potential of organically evolved cultural landscapes due to a necessity in their period. In addition, these areas can be included in the World Heritage list due to their characteristics that reflect the hydraulic knowledge of their period in technological and cultural terms and the relationships they establish with the area they are located in.

These results also highlight that the Valens Water System is a cultural landscape designed with principles of original environmental harmony and continuity, integrating Roman hydraulic knowledge with the topography and ecosystem. Findings indicate that the system has the potential to meet the eight World Heritage criteria. Thus, the cultural landscape character of the Valens Water System and the Strandja Forests has been revealed through its natural and cultural qualities. This illustrates that water management in the ancient period was not merely a technical activity but a spatial strategy integrated with ecological knowledge, which also laid the foundation for modern water supply policies in Istanbul.

The findings align with international literature advocating for the holistic management of water systems as cultural landscapes. However, the current approach to their conservation does

not reflect this holistic understanding, separating their components and failing to present an effective conservation practice in the area. The fundamental issue in the area is the lack of institutional coherence in the governance structure and the inadequacies in the legal framework during the implementation stage, limiting the effectiveness of conservation processes. Currently, conservation is solely carried out through monument-scale designation, with a fragmented approach that neglects the ecological and spatial qualities of the system.

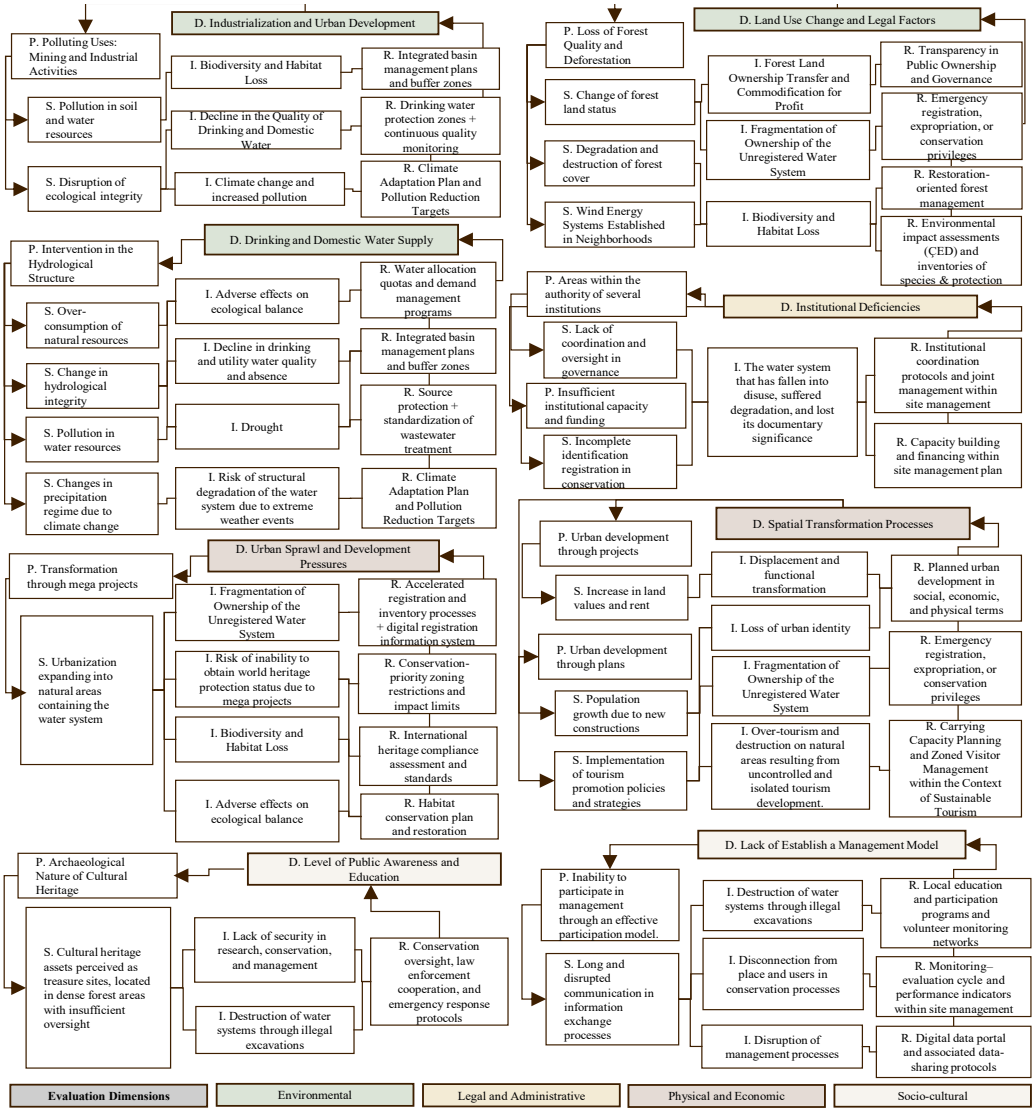

Fig. 12. Analysis of Conservation Issues within the DPSIR Framework

However, the water system and the forest area form an inseparable whole, shaped by the mutual interaction of nature and culture. Researchers such as Fowler [39], Agnoletti [8], Wu [11], Arntzen [10], and Jacques [58] have emphasized that cultural landscapes document the continuity of human interaction with nature and therefore require integrated conservation strategies. The findings of this study prove that the Valens Water System and the Strandja Forests are a cultural landscape that must be managed for both ecological and cultural integrity, beyond the definition of an archaeological site. The neglect of the system and interventions in the forest area have led

to the irreversible loss of historical knowledge documenting the solutions provided by past civilizations to water management crises, as well as the destruction of a critical ecosystem for important species.

The cultural landscape approach encompasses not only the physical form of a place but also the processes of memory-making and identity construction. In this context, Halbwachs [60] emphasized that collective memory is reproduced spatially, with communities remembering the past through place. Nora [61] substantiated this relationship with the concept of memory sites, explaining the role of physical traces of the past in the construction of social identity. Lowenthal [62] defined cultural heritage as the selected past, noting that modern societies make certain historical layers visible while excluding others. In this context, places subject to cultural landscape designation should be regarded not only as environmental or aesthetic entities but also as spatial representations of urban identity and collective memory. Based on these theoretical perspectives, the Valens Water System should be considered and conserved not only as an engineering historical asset but also as a heritage site representing the cultural meaning of water in the collective memory of Istanbul.

In this context, the Valens Water System was evaluated and compared with the Pont du Gard site, which is on the World Heritage List, in order to determine this qualification for the conservation of sites.

Pont du Gard was evaluated because it is a close example of the Valens Water System in terms of function, period, and quality of the areas to be preserved. It is also the only example from the Roman period to be included in the heritage list by UNESCO directly within the scope of the character of the water system.

The Pont du Gard was built to supply the colonial city with water from the Eure spring [63], approximately two hundred years before the Valens Water System. In terms of length, the Pont du Gard Aqueduct is about fifteen meters higher than the Kurşunlugerme Aqueduct, which is the best-conserved example in terms of physical integrity and one of the longest of the aqueducts of the Valens Water System, but almost twice as wide due to the characteristics of the land. It should be added, however, that the measurements of the aqueducts of the Valens Water System are those of the surviving part of the aqueduct, which was idle and destroyed in a desolate forest; some measurements might be estimated to be higher. Also, there is another aqueduct connected to the water system called Valens (Bozdoğan), which is 970 meters wide and about 30 meters high [64].

The Pont du Gard is considered a masterpiece of Roman hydraulic ingenuity, a technical and artistic work that characteristically represents the culture and reflects the construction techniques of its time, and was included in the UNESCO World Heritage List in 1985, fulfilling criteria i, iii, and iv [50]. Approximately ten years after the inclusion of the Pont du Gard in the World Heritage List, only the Kurşunlugerme Aqueduct was nationally registered. Despite earlier documentation of its components, the system remained vulnerable to threats for many years due to the lack of a holistic protection status (Fig. 13). This situation demonstrates that the Valens Water System has undergone a continuous fragmentation at the institutional and managerial level.

Fig. 13. Ballıgerme Aqueduct destroyed by illegal excavations (left) and the Kurşunlugerme Aqueduct and its surrounding plants (right). [65]-[66].

Pont du Gard is protected not only as a building unit but also with all other system elements that make it meaningful in the natural environment. The natural environment in which the water systems are located is managed as a Natura 2000 and UNESCO Biosphere Reserve [50]. Like Pont du Gard, Strandja Forests is ecologically important, with critical, vulnerable, and endemic species inhabiting two important wetlands and forest ecosystems, but these species are hardly documented, and their ecosystems are not protected, exposing them to all kinds of risks.

The site is managed by the cultural cooperation public organization in a multi-stakeholder way through conservation and management plans and attracts around one million visitors each year, generating €135 million in revenue [67]. Unlike Pont du Gard, the Valens Water System and the Strandja Forests have a passive, building-scale approach to conservation. There are no management plans, and sites are only marked as "registered." Researchers such as Fowler, Agnoletti, and Wu emphasize that cultural landscapes document the continuity of human interaction with nature and therefore require integrated conservation strategies beyond simple monument-scale designation.

The Pont du Gard site is managed by the Cultural Cooperation Public Institution (EPCC), a semi-autonomous structure that ensures financial sustainability and fosters a governance system based on local ownership and accountability. In contrast, the management structure of the Valens Water System and the Strandja Forests is fragmented due to authority dispersion, lack of institutional coordination, and dependence on central administration, resulting in a lack of holistic governance and the system's abandonment. The management boundaries of the area are similar in that they require a multi-actor management process, but there is only a certain group of actors working in the Valens Water System, and the Strandja Forests in the ministry and local governments are not effective in this system.

In addition to conservation activities in Pont du Gard, the area has been opened to visitors with various outdoor sports and activities, and its meaning has been kept alive with socio-cultural activities that reflect the history and culture of the area. Although there is a demand for related activities within their natural environment in the Valens Water System and the Strandja Forests, these activities in the area are uncontrolled, unconscious, and on an individual scale. In addition, there is no facility in the area to promote such activities in this context.

Fig. 14. Light show held at the Pont du Gard Aqueduct [50]

The Valens Water System, in terms of its engineering typology, location at the urban-rural interface, and spatial scale diversity, is comparable to the Pont du Gard (Table 6). However, its current institutional structure requires significant development in integrated site management, multi-stakeholder governance, visitor planning, and ecological integration. In this context, while direct model transfer is not recommended, the Pont du Gard serves as a guiding reference for processes of institutionalization, conservation planning, landscape management, and site use control that can be gradually adapted to the Valens Water System.

Table 6. Comparison of the Conservation Status, Management Structure, and Heritage Values of Pont du Gard and Kurşunlugerme Water Structures [50]

	Pont du Gard	Kurşunlugerme
Importance	Considered the best-conserved example of Roman hydraulic engineering.	It is the best-conserved example in terms of physical integrity within the Valens Waterline and was the first to be registered.
Scale	Nîmes Aqueduct: approx. 50 km	Valens Waterline: approximately 450 km
National Registration Year	1840	1996
International Registration Year	1985 (UNESCO)	-
Construction Period	Roman Period (1st century)	Roman Period (5th century)
Administration of Site	EPCC (Etablissement Public de Coopération Culturelle) – Cultural Cooperation Public Institution	Ministries (Ministry of Culture and Tourism, Ministry of Agriculture and Forestry) & Local Authorities
Conservation of Site	Managed through a Site Management Plan and Periodic Conservation Reports.	Conservation is limited to the registration process.
Conserved Area Size	165 + 691 hectares (including archaeological cultural assets and natural environment)	The area includes itself, six other aqueducts, and some structural components (not all of which have been registered yet).
Conservation Status	Historic Monument Regional Protection Area and Nature Park UNESCO World Heritage Natura 2000 Network and UNESCO Biosphere Reserve	Registered Cultural Heritage Asset State Forest

Consequently, for the sustainable preservation of the Valens Water System, the following actions are recommended: (i) urgent registration and expropriation, (ii) establishment of a multi-stakeholder governance mechanism with defined institutional authorities, (iii) preparation of a site management plan, (iv) completion of missing inventories, identification, and digital geographical data infrastructure, (v) adoption of an ecosystem-based landscape approach in interaction with cultural heritage, (vi) phased implementation of controlled access, action strategies, and management programs, and (vii) structuring preparation steps for the UNESCO nomination process. This will facilitate the transition to a holistic conservation regime that preserves the cultural and ecological qualities of the Valens Water System, in alignment with international standards and public benefit.

One of the major limitations of this study has been the incomplete registration process of the water structures. Since registration is a fundamental step in determining the conservation method and management approach for a cultural heritage site, this gap has limited the development of comprehensive conservation strategies. Many structures have been damaged before being included in scientific records [14]-[15].

Additionally, limited access to archival documents, gaps in data sharing among institutional structures, and physical accessibility issues for some structures have led to incomplete documentation of the spatial integrity in certain sections of the line. Consequently, the conservation proposals developed in this study are somewhat constrained due to these data limitations. However, the qualitative analyses supported by previous archaeological studies and field observations in this research provide strong evidence of the cultural landscape value of the Valens Water System and Strandja Forests.

Ultimately, the current state of the site demonstrates a critical trend of ecological and cultural dissolution. This research highlights that, to preserve the heritage value, a shift from passive monument conservation to active, integrated cultural landscape management is necessary. This transition requires not only physical restoration but also the simultaneous restoration of legal, administrative, and ecological integrity. In this way, transparent, deliberative, fair, and rational practices can be implemented to address the current problems and potentials of the area. As one of the biggest challenges in the protection and management of archaeological cultural assets, financing can be provided for the sites, and promotional and awareness-raising activities

can be carried out for the sites. This could increase the tourism potential of the sites and the possibility of cooperation for new research and management activities.

Therefore, in light of all the findings and specific to the research area, recommendations have been developed to address the site's challenges and potentials. The conservation of the Valens Water System and Strandja Forests requires the documentation and registration of all components of the site, ensuring that they are preserved without further damage, and the management of the site should be carried out under a public planning framework as shown in Table 7.

Table 7. Key Areas Requiring a Management Plan for the Valens Water System and Strandja Forests

Main Areas Requiring a Management Plan	Current Situation	Proposal
Boundaries of the Area	The water system spans kilometers, and the forest range extends beyond administrative borders. The current approach remains two-dimensional and limited.	A multi-faceted delimitation of the area is necessary, including interactions and relationships within buffer zones that encompass the site and its affecting environment
Management of the Area	The process involves numerous institutions, but coordination is lacking. Collaboration and participation are ineffective within this mechanism.	A transparent, fair, participatory, and effective administrative organization should be established, complete with area-specific advisory, coordination, and monitoring structures.
Scope of the Area	There is a lack of a holistic perspective regarding the scope of the area. Complex ecosystem and cultural structures are handled by singular expertise.	Continuous monitoring and updated research of the area should be ensured through a scientific committee comprising experts from diverse disciplines.
Sustainability of the Area	A management plan that includes a vision and objectives is absent. The area is exposed to threats. One-dimensional restrictions are inadequate for the effective conservation of the area.	A sustainable management plan that is participatory, includes resource allocation, engages users in the process, and promotes cultural identity must be prepared and monitored.

Considering the scale, multi-layered structure, and ecological sensitivity of the site, the conservation process must be conducted by an interdisciplinary team in a participatory, transparent, and data-driven manner. The existing legislation (Turkish Law No. 2863 on the Conservation of Cultural and Natural Assets and Regulation No. 31435 on Site Management) mandates the preparation of management plans for World Heritage sites and the establishment of site management units [68]. In this context, a site management plan aligned with UNESCO nomination criteria and a site management unit with a multi-stakeholder governance mechanism should be established for the Valens Water System and Strandja Forests (Table 8). This approach will ensure the coordination of short-term interventions and the establishment of long-term, site-scale conservation and monitoring capacities.

At the policy level, Law No. 2863 on the Conservation of Cultural and Natural Assets should be updated to incorporate the cultural landscape approach, restructuring conservation plans to establish coherence between natural and cultural components and providing guidelines for management. The current legal framework's ambiguity has led to subjective assessments of protected values and challenges in implementing interventions [69]. In this context, the Valens Water System and Strandja Forests should be treated as a site with potential for UNESCO World Heritage nomination. The management plan should integrate strategies for both conservation and sustainable development. The action strategies within the proposed management plan in Figure 15 are structured according to the scale of the plan, relevant stakeholders, and levels of participation in Table 9. Figure 16 shows the core buffer and zones proposed according to strategies.

Table 8. Proposed Site Management Units and Stakeholder Contribution Types for the Valens Water System and Strandja Forests

Stakeholders	Site Management Unit	Capacity Contribution Type	Rank	Level of Participation	Stakeholder Type
Site Manager	Site Management Team, Coordination and Supervisory Board	Research and Analysis, Planning, Conservation, and Management	3	Partnership	Internal Stakeholder
Relevant Universities and Institutes	Advisory Board	Research, Analysis, and Management	2	Consultation	Internal Stakeholder

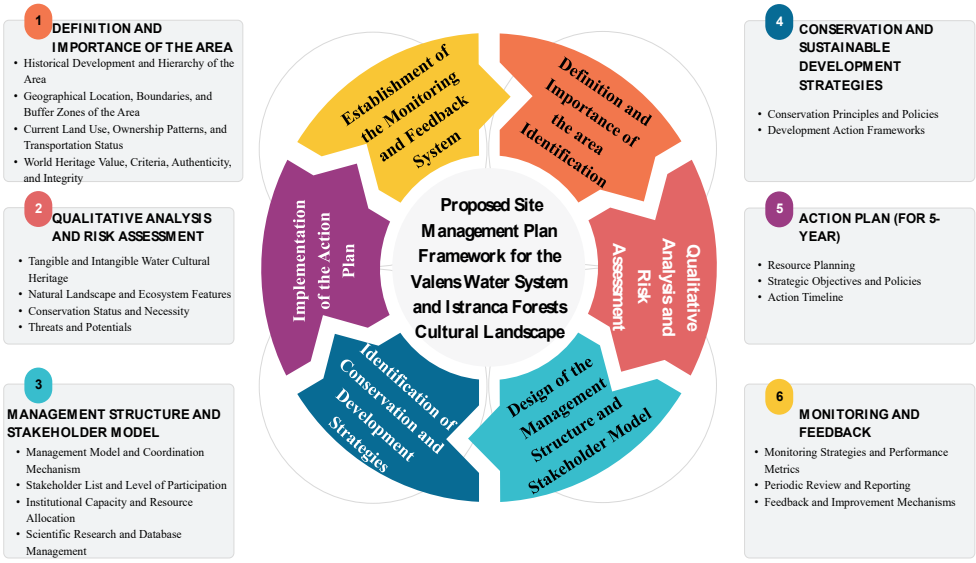

Fig. 15. Proposed Site Management Action Strategies for the Valens Water System and Strandja Forests

Table 9. Proposed Site Management Plan Framework for the Valens Water System and Strandja Forests

Action Framework	Action Strategy	Planning Scale	Phase	Level of Participation (IAP2)	Stakeholders
Visitor Management and Sustainable Tourism	A sustainable tourism plan should be developed, including visitor carrying capacity, area-based visitor restrictions through zoning, flow management, and memory routes.	Site Management Plan and Spatial Strategy Plan - Strategic Tourism Master Plan	Planning, Implementation& Review	Collaborate	Local Authorities, Development Agencies
Education, Awareness, Promotion, and Participation Programs	Cultural landscape-themed education programs, school projects, volunteer guiding and supervision networks, memory routes, and participatory awareness activities should be organized for local communities and visitors.	Site Management Plan and Action Plan	Implementation	Inform, Consult& Involve	International Organizations, Ministries, Relevant Historical, Cultural and Environmental Associations, Local Communities
Scientific Collaborations and Field Research	Field management protocols, institutional capacity, data sharing, and performance indicators. Research programs and conservation decisions should be developed through cooperation with universities and research institutions.		Understanding, Planning& Review	Collaborate& Empower	Relevant Universities and Institutes, Ministries, Relevant Historical, Cultural and Environmental Associations, Professional Chambers, Local Communities
Preventive Maintenance and Intervention System	A digital registration system aligned with international heritage standards. Periodic maintenance, minor repairs, sensors, and digital monitoring systems are recommended for continuous monitoring.		Implementation, Monitoring& Review	Inform& Consult	Relevant Universities and Institutes, International Organizations, Ministries
Climate Change and Adaptation Strategies	Microclimate data should be monitored, and ecosystem-based climate adaptation and integrated watershed management plans should be developed.	Site Management Plan and Complementary/Special Purpose Plan: Climate Adaptation	Planning, Monitoring& Review	Collaborate	Relevant Universities and Institutes, Local Authorities, Professional Chambers
Risk Management and Disaster Planning	Disaster risk maps, species protection measures, forest management, and emergency response protocols. Early warning and resilience-focused planning should be carried out.	Site Management Plan and Complementary/Special Purpose Plan: Disaster Response Plan	Planning & Implementation	Consult& Involve	Relevant Universities and Institutes, Local Authorities, Professional Chambers
Emergency and Crisis Management	Emergency response protocols, monitoring and evaluation cycles. A business continuity plan for crisis situations, an emergency communication network, and evacuation routes should be defined.		Planning, Monitoring& Review	Involve	Local Authorities, Professional Chambers
Ecosystem-Based Spatial Planning	Buffer zones should be created that protect the relationship between forests, water, habitats, and cultural heritage, and construction should be restricted in these areas. Natural drainage and ecological corridors should be integrated into spatial plans.	Site Management Plan, Environmental Plan, and Watershed Protection Plan	Planning	Collaborate	International Organizations, Local Authorities, Professional Chambers
Habitat Monitoring and Ecological Resilience	Inventory, data sharing, and performance monitoring. A continuous monitoring system for ecological and cultural indicators should be established, with citizen tracking and public participation.		Understanding, Monitoring& Review	Collaborate& Empower	Relevant Universities and Institutes, Local Authorities, Relevant Historical, Cultural and Environmental Associations, Local Communities
Local Economic Development Policies	Carrying capacity, planned development, protection privileges, and participation. Models that strengthen local economies and heritage together (eco-tourism, cultural tourism, organic farming, handicrafts, cooperatives) should be developed.	Site Management Plan, Regional and Action Plans	Planning, Implementation& Review	Collaborate	Local Authorities, Development Agencies, Relevant Historical, Cultural and Environmental Associations, Local Communities

Fig. 16. Proposed Core and Buffer Zones for the Valens Water System and Strandja Forests

Conclusions

The integrated evaluation of the Valens Water System and the Strandja Forests demonstrates that this vast infrastructure constitutes an "organically evolving cultural landscape" of outstanding universal value. By addressing the primary research inquiry, this study confirms that the system fulfills eight of the ten UNESCO World Heritage criteria, positioning it as a globally significant legacy that transcends national borders. The findings prove that the system's continued functional relevance demands a transition from fragmented, monument-oriented protection to a holistic landscape management paradigm. Analysis through the DPSIR framework reveals that the most critical threat to this continuity is the "protection vacuum" arising from jurisdictional overlaps, leaving the system vulnerable to the rapid urban growth trends observed in the western districts of Istanbul.

This research provides original contributions to the literature at conceptual, methodological, and practical levels. Conceptually, it identifies the criteria for water systems to qualify as cultural landscapes and integrates this with urban identity and collective memory, bridging the environmental and social approaches that are typically treated separately in heritage studies. Drawing on Lowenthal's conceptualization of the "selected past," the study highlights that the current invisibility of the Valens line within conservation frameworks indicates a rupture in the spatial continuity of memory. Methodologically, by combining archival documentation, field observations, and GIS-based spatial analysis, it offers a replicable template for evaluating multi-layered cultural landscapes. At the practical level, the comparison with the Pont du Gard illustrates that the Valens system's conservation failure stems from institutional fragmentation and the lack of a transparent governance model, necessitating a shift toward a multi-stakeholder site management unit.

A significant limitation of this research remains the incomplete registration process for the system's water structures, which restricts the development of long-term conservation strategies and holistic documentation. This limitation provides a clear roadmap for future scholarship. Subsequent studies should utilize Geographic Information Systems (GIS), digital documentation, and Heritage Impact Assessment (HIA) to map the subterranean layers and ensure the transparency of monitoring processes. Furthermore, systematic field inventories within the unique ecosystem of the Strandja Forests are essential to protect endangered species alongside architectural remains, ensuring that ecological integrity and spatial continuity are maintained.

In final synthesis, the Valens Water System and Strandja Forests represent a holistic cultural landscape that reflects Istanbul's historical resilience and cultural identity. The conservation of this system is not merely an act of preserving the past but a vital contribution to the construction of a sustainable urban memory. By learning from these historical water management strategies, modern metropolises facing similar resource challenges can develop more resilient urban development models. Ultimately, safeguarding this 1,600-year-old engineering marvel is an international responsibility, requiring an institutional commitment that recognizes the forest and the water as an inseparable, living heritage entity, ensuring that this "place of memory" remains a functional part of Istanbul's future.

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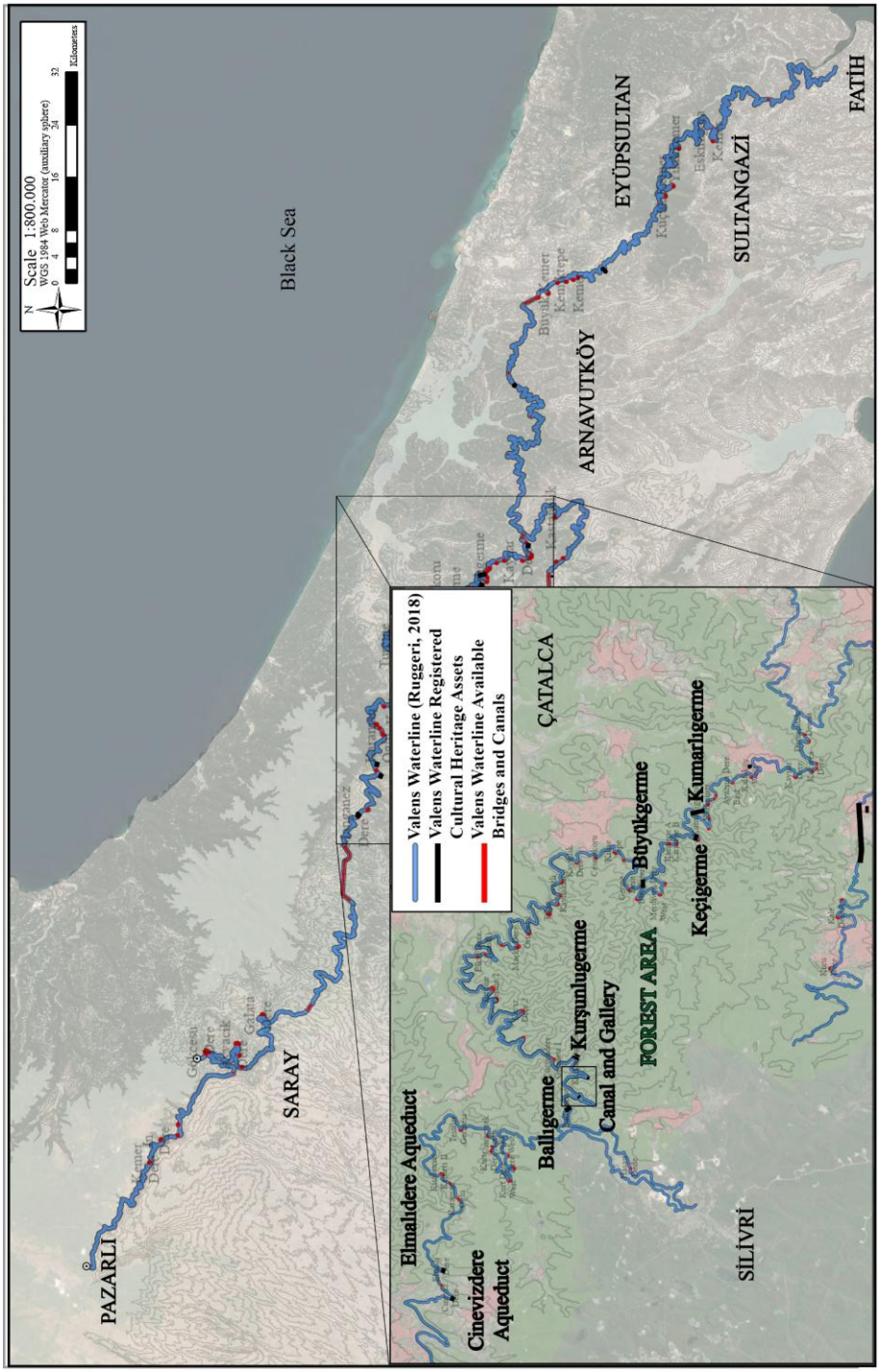
Appendix A.

Characteristics of Registered Cultural Heritage within the Scope of the Valens Water System



A.1 Registered Cultural Heritage within the Scope of the Valens Water System
Source: Prepared by the authors for this research [14], [15], [21], [47], [70].

Appendix B

Conservation Status of Structures within the Scope of the Valens Water System
Source: Prepared by the authors for this research [14], [15], [21], [47], [70].

Building Type	Building Name	Location	Conservation Status	Conservation Character	Conservation Authority
Water Canal and Tunnel	-	Kırklareli (Vize), Tekirdağ (Saray) ve İstanbul (Arnavutköy, Çatalca, Eyüpsultan, Gaziosmanpaşa, Silivri and Sultangazi)	Partial conservation (individual structures, not all are officially registered)	Archaeological Site and Registered Cultural Property – Conserved Area (Group: 1)	Ministry of Culture and Tourism – Edirne and Istanbul (Board No. 1) Regional Council for the Conservation of Cultural Heritage
Gallery	-				
Pond	-				
Aqueduct	Yıkıkkemer	İstanbul- Sultangazi	No / Not Registered	-	Ministry of Culture and Tourism –Istanbul (Board No. 1) Regional Council for the Conservation of Cultural Heritage
	Eskiızgara Aqueduct		No / Not Registered	-	
	Büyük Aqueduct	İstanbul- Eyüpsultan	No / Not Registered	-	
	Boğazköy Aqueduct	İstanbul- Arnavutköy	Yes	Registered Cultural Property and Conservation Zone	
	Büyük Aqueduct		No / Not Registered	-	
	Küçük Aqueduct		No / Not Registered	-	
	Ortanca Aqueduct		No / Not Registered	-	
	Kemiktepe Aqueduct		No / Not Registered	-	
	Balıkgerme	İstanbul- Çatalca	No / Not Registered	-	
	Kumarlıgerme		Yes	Registered Cultural Property and Conservation Zone	
	Keçigerme		Yes	Registered Cultural Property and Conservation Zone	
	Büyükgerme		Yes	Registered Cultural Property and Conservation Zone	
	Talas		No / Not Registered	-	
	Turçine Aqueduct		No / Not Registered	-	
	Kayınlık Aqueduct		No / Not Registered	-	
	Çüçürüdere Aqueduct		No / Not Registered	-	
	Kurşunlugerme		Yes	Registered Cultural Property and Conservation Zone	
	Ballıgerme		Yes	Registered Cultural Property and Conservation Zone	
	Kısaburun Aqueduct		No / Not Registered	-	
	Cinevizdere Aqueduct		Yes	Registered Cultural Property and Conservation Zone	
	Elmalıdere Aqueduct		Yes	Registered Cultural Property and Conservation Zone	
	Bridge of Hasandede	İstanbul- Silivri	Yes	Registered Cultural Property and Conservation Zone	
Bridge	Unnamed Bridge (on Sazlıdere)	İstanbul- Arnavutköy	No / Not Registered	-	
	Unnamed Bridge (on Kurudere Stream)	İstanbul- Çatalca	No / Not Registered	-	
	Unnamed Bridge (on Kaledere Stream)		No / Not Registered	-	
	Unnamed Bridge (on Büyükkamara Stream)		No / Not Registered	-	
	Unnamed Bridge (on Küçükkamara Stream)		No / Not Registered	-	
	Unnamed Bridge (near Kestanelik)		No / Not Registered	-	
	Unnamed Bridge (on Derinçatak Stream)		No / Not Registered	-	
	Unnamed Bridge (on Kokarca Stream)		No / Not Registered	-	
	Unnamed Bridge (on Kaynar Stream)		No / Not Registered	-	
	Unnamed Bridge (near Kalfaköy)		No / Not Registered	-	
	Unnamed Bridge (on Ayazma Stream)		No / Not Registered	-	
	Unnamed Bridge (on Kaşıkçı Stream)		No / Not Registered	-	
	Unnamed Bridge (near Karlıpınar)		No / Not Registered	-	
	Unnamed Bridge (on Şarap Stream)		No / Not Registered	-	
	Unnamed Bridge (on Merdiven Stream)		No / Not Registered	-	
	Unnamed Bridge (near Karatepe)		No / Not Registered	-	
	Unnamed Bridge (near Kilisetepe)		No / Not Registered	-	
	Unnamed Bridge (on Kayınlık Stream)		No / Not Registered	-	
	Unnamed Bridge (on Maçka Stream)		No / Not Registered	-	
	Unnamed Bridge (on Evkaf Stream)		No / Not Registered	-	
	Unnamed Bridge (on Dervişkapı Stream)		No / Not Registered	-	
	Kurtdede Bridge		No / Not Registered	-	
	Karamanoğlu Bridge		No / Not Registered	-	
	Unnamed Bridge (on Manganez Stream)		No / Not Registered	-	
	Unnamed Bridge (on Babadar Stream)		No / Not Registered	-	
	Unnamed Bridge (on Galata Stream)	Tekirdağ- Saray	No / Not Registered	-	Ministry of Culture and Tourism – Edirne Regional Council for the Conservation of Cultural Heritage
	Unnamed Bridge (on Ayvacık Stream)		No / Not Registered	-	
	Unnamed Bridge (on Gökçesu Stream)	Kırklareli- Vize	No / Not Registered	-	
	Unnamed Bridge (on Akpınar Stream)		No / Not Registered	-	
	Unnamed Bridge (on Kemer Stream)		No / Not Registered	-	