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CRITERIA FOR DETERMINING WATER BASIN BOUNDARY AND THE IMPORTANCE PLANNING DECISIONS IN SUSTAINING WATER RESOURCES

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ABSTRACT

Together with earth and air, water is one of the most vital sources. The need for drinking, potable and irrigation water is increasing day by day, with the increase in population and expansion of the settlement areas. Only 0.03 of the total water resources on earth is fresh water and 0.75 of the fresh water resources are in the glaciers and in the form of permanent snow. Turkey is not in the region receiving direct precipitation due to its geographical location and it is among the countries which will possibly have water shortage in the future. Therefore, it is vital to store and protect the precipitation that forms the fresh water source. Expanding settlement areas and increasing human activities reduce water yield in water basins, from which water is provided. Water basin preservation plans are prepared to protect supplies from pollution. The preservation zones are defined by standard distances in the prepared plans. However, water is collected in the same reservoir with surface or underground movements in the water basin. Elements that may pollute the water supply, defined by the plan and legislation, may also be present in these areas. Defining polluting sources depending on the distance in a water basin is not considered scientific. The nature, density and continuity of the polluting sources are among the criteria for determining water yield. In current practices, a drainage divide generally constitutes the water basin preservation zone. Determining the side boundaries of the water basin solely by drainage divide is not sufficient to understand the actual feeding zone of the reservoir. Slope, age and presence of faults and cracks in the underground beds have an essential impact in determining the side boundaries of the water basin. The purpose of the study is to emphasize the importance of fresh water resources, to draw attention to the pollution sources in the water basins, and to reveal the importance of geological structures in the water basin. The subject is discussed based on the analysis of a natural water basin system and an inductive method. The findings reveal that plans and laws are effective tools for preserving water basins. Current legislation and the planned decisions of Istanbul Elmalı water basin are examined, in order to clarify the issue. It is observed that the criteria for preservation and sustainability of water basins need to be shown in detail for legislation. The geological structure analysis in water basins is expected to be a guide for future plans.

KEYWORDS:
Water basin, Elmalı water basin, water basin boundaries, geological structures in the water basin

INTRODUCTION

The survival of the earth population depends on the sustainable use of air, water and earth resources. Factors, such as settlement area demands, due to increasing population, industrial activities, uncontrolled and excessive use of natural resources have a negative impact on the ecosystem. Environmental issues, arising from human activities, are main issues, which need to be resolved with the help of scientific approaches. In addition, water is vital for agricultural production and any industrial activity [1].

The sustainability of natural resources and ensuring optimum benefit by maintaining resources, require multi-disciplinary studies in the fields of natural and social sciences. Natural systems have a delicate balance interacting mutually. At the same time, the relationship between industry and natural resources should be taken into consideration and the carrying capacity should be measured, in order to maintain the required socio-economic development and to achieve the optimum balance [2]. Changes in any of the system elements affect each other and also the entire system. “Water” is among the main sources of life for the creation and survival of all creatures. The water resources on earth are 97% composed of salt water. Three-fourths of the fresh water supplies that constitute 3% of the total water resources, are on the other hand, in the form of permanent snow at the ice bergs, and are not usable [3]. The distribution of the usable fresh water (0.0075 of the available water resources) is as follows [4]:

- Underground waters 95 %
- Lakes and rivers 3.5 %
- Soil moisture 1.5 %

Turkey is not in the region receiving direct precipitation due to its geographical location and it is among the countries that will likely have water shortage in the future. Therefore, it is vital to store and protect the rainfall that forms the fresh water source. Pollution arising from expanding settlement areas and increasing human activities reduces water yield in water basins, from which water is provided. Whereas planning of water resources in 1970s was mainly aimed at preventing floods and regulating river regime, increasing environmental pollution in the following years increased the need for a planned development of the water basins, where drinking and potable water has been obtained. Water basin preservation plans are prepared in order to protect water supplies from pollution. The plans should be prepared with scientific analyzes which ensure the sustainability of natural resources and the applicability of the plan decisions. The preservation zones are defined by standard distances in the prepared plans. However, water product in the short, medium and long distance is collected in the same reservoir with surface or underground movements in the water basin. Elements that may pollute the water supply should be defined by the plan and legislation may also be present in these areas. Defining polluting sources depending on the distance in a water basin is not considered scientific (SAME sentences was already used above). The quality, density and continuity of the pollutant sources are among the criteria for determining the effects on water yield. In current practices, drainage divide, which is determined by combining the highest ridges of the topography, generally constitutes the boundaries of the water basin preservation zone. Determining the side boundaries of the water basin solely by drainage divide is not sufficient to understand the actual feeding zone of the reservoir. The slope, age and presence of faults and cracks in the underground beds have an important impact in determining the side boundaries of the water basin. The purpose of the study is to emphasize the importance of fresh water resources, to draw attention to the pollution sources in the water basins, and to reveal the importance of geological structures in the water basin. The plan decisions of Elmalı water basin in the Anatolian Side of Istanbul Province are examined in line with this purpose as a sample.

MATERIALS AND METHODS

Water basins contain system elements of natural, terrestrial and aquatic nature. They can also be described as subsystems of the ecosystem, which can provide and maintain their natural cycle without any human intervention. However, legal and administrative practices incompatible with urban systems and water basin ecosystem create disruptive (anthropogenic) effects. Anthropogenic effects have been discussed with cause and effect relationship (induction), and the structure and function of the water basin ecosystem have been examined. Along with the elements of natural system, laws, plans and administrative practices within the scope of urban systems were used as input materials of the study. The mutual relationships of natural water basin system and urban systems have been analyzed with systematic approach. Accordingly, the effects on the existing section, parameters of the system and the interaction between the parameters have been analyzed and alternative approaches for a sustainable water basin management have been proposed.

System and ecosystem. Churchman defines system as "the whole formed by the dependent parts (elements) interacting with each other". Understanding the system is possible with a holistic approach to the system, its surrounding, resources, components, function, purpose, performance criteria and management [5]. In other words, according to the definition by Arslan, system is "the name of a whole comprising of units having stable and meaningful relationships" [6]. The general structure of the system can be summarized as follows:

- System is the functional whole in which the units covered are in a mutual relationship,
- It can be a sub-system or unit of the surrounding systems,
- All or parts of the system may intersect with other systems,
- Systems are usually open systems, and
- There is a functional, continuous, stable relationship between units and systems.

Ecosystem is used to describe the whole or a part of the biosphere (Rocks and soil on the surface of earth (lithosphere), water surfaces (hydrosphere), lower levels of the atmosphere and all living creatures constitute biosphere altogether). Natural cycles run numerous system networks in the Biosphere regularly and stably. Accordingly, the system created by biotic (living) and abiotic (non-living) beings in nature with the mutual connections among them is called Ecological System or Ecosystem [7]. The definition of ecosystem can be described as [8] "a unit of spot comprising of biotic and abiotic creatures that are in mutual relations and feeding and renewing itself through the circulation of substance and energy between these creatures" [9]. In balanced ecosystems, the substance cycle is continuous, energy inputs and outputs are equal, and there is a balance defined as golden balance (Figure 1) between producers, consumers and decomposers.

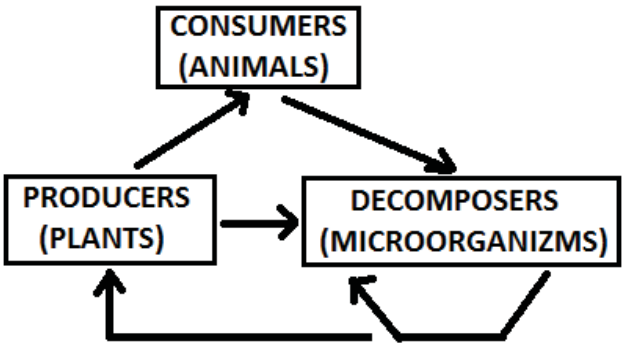


FIGURE 1
The Golden Triangle of the Balanced Ecosystem

The preservation and sustainability of the balance depends on the return of the materials consumed by the food chain to the system for reproduction. The existence of raw material in the ecosystem is definite, and should return to the system after use. If the used raw materials do not return to the system, if there is an excessive increase or decrease in system elements, if the interconnections break [10], and if there are external effects on the system, the golden balance may collapse. Interventions by the human beings to the vegetation in the water basins and the wastes mixed into the soil and water will break the connection between the elements, will affect the substance cycle, energy input-output, and ecosystem elements, and will disrupt the balance of the water basin ecosystem [8].

Water basin and water basin ecosystem. The water basins discussed within the scope of the study can be categorized into four groups. Water Basin Classifications by Region can be done as follows;

a. Catchments/Watersheds (i.e. Small-Scale Water Basins)	A<100ha
b. Medium-Scale Water Basins	100ha<A<1000ha
c. Drainage Basins (i.e. Large-Scale Water Basins)	1000ha<A<10000ha
d. Very Large-Scale Water Basins	A<10000ha

The small-scale water basins are called "catchments" or "watersheds" and large-scale water basins are called "drainage basins". With its 83.4 km2 area [11], Elmalı Water Basin, the plan decisions, which are examined within the scope of this study, is classified within small-scale water basins.

Some of the water basin definitions in the literature are given below:

"It is the water catchment area surrounded by ridges called water lines (drainage divide) where rainfalls or spring water flow into the same course or lake" [12]. "It is a piece of land with a concave topographic structure that is bounded by the drainage divide passing from the ridges and where the surface water collected on it as a result of precipitation can reach a single outlet" [13].

The natural system formed together by the forest, water, river, vegetation, lake, microorganisms, fauna, soil and other factors, such as climate and geomorphology in the water basin zone, can be defined as "Water basin ecosystem". The water basin ecosystem has, both terrestrial and aquatic features. Therefore, the water basin ecosystem is extremely complex in terms of elements, functions and interactions. The boundaries of the water basin ecosystem should be known in order to determine the system elements and to be able to analyze, plan and implement accordingly.

Water movement in water basin ecosystem. The source of water is precipitation, and water is one of the renewable natural resources. It is stored in the atmosphere, oceans, on the surface of and underneath the ground, and is constantly circulating between these resources. Water vaporizing from the earth and oceans reaches the atmosphere and the water vapor in the atmosphere condenses and reaches back to the earth in the form of snow or rain. Some of the water reaching the earth falls to the open water surfaces, such as seas, lakes and rivers and some falls on the soil, vegetation and forest surfaces. Water falling to the soil reaches to the groundwater tables partly by surface flow and partly by flowing towards the underground, and feeds the moving and standing water resources.

The water yield in the streams feeding the reservoir in the water basins is connected to the surface and underground flows. The part of the rainfall that cannot be infiltrated by soil, flows towards the streams with the surface flow. Surface flows may cause the stream beds and reservoirs to fill and become polluted with the materials they carry from the surface. Problems of sudden deluge and water flood may occur as well as a transfer of more pollutants to the resource, especially in the zones turned into open areas and firm ground by human activities.

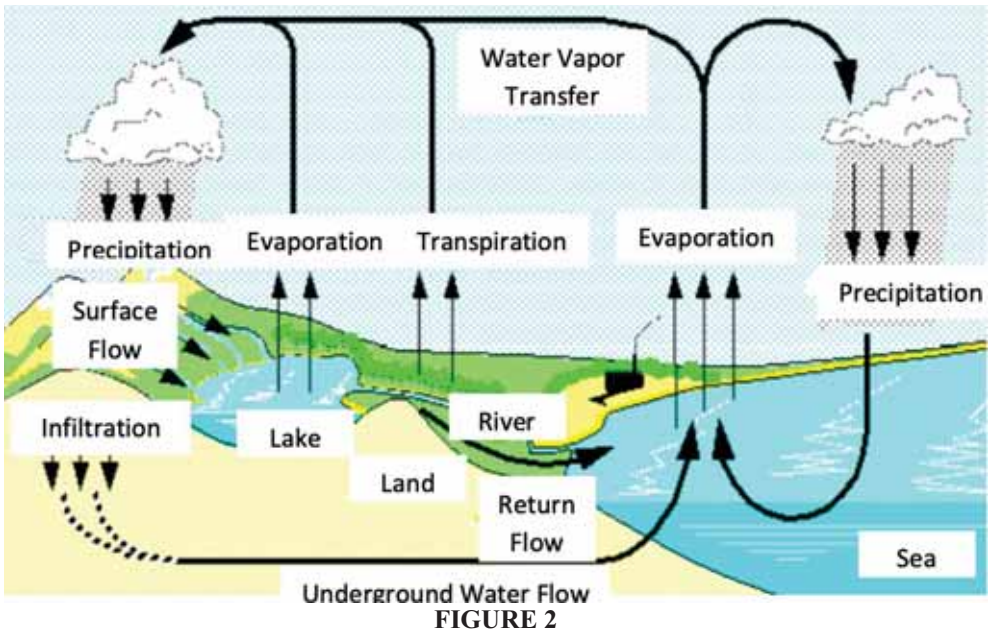


FIGURE 2
Hydrologic cycle [14]

Water leaking underneath the surface is filtrated and cleaned through soil layers and reaches the underground water reserves after a longer period, but still regularly. In case of the event of the water amount penetrating into the soil, becomes higher than the amount of water the soil can retain, some of the excess water infiltrating towards the deeper levels of soil, may reach the surface of the soil again as spring water, whilst some of the water may mix with streams and lakes, and also some of it may mix with underground water. The order of the stream flows depends on the water reaching the stream by infiltrating through the soil or by surface flow. Human factor is effective on vegetation and soil. Decreasing vegetation affects the hydrological status of the water basin and increases erosion and sedimentation. It is preferred that water feeding the reservoir comes from the underground in the water basin system, to obtain water regularly in all seasons and to control its quality and quantity.

Obtaining the quality of plentiful water regularly in all seasons and optimizing the water yield is directly proportional to the collection of rainfalls in underground water reservoirs (maximum vegetation, minimum firm ground). Protection of the soil and preventing loss of soil layers by erosion, are the primary factors for the retaining of and transmission to the underground of the precipitation. Vegetation cover, especially forest surface covered with litter has an important function in the protection of the soil. Providing there has no intervention to the water resource, other than the natural system and the water is not used in a way that will have a negative effect on the water yield. Its sustainability can be ensured by the hydrological cycle.

Uncontrolled development of human activities, draining wetlands and swamps, erosion, uncontrolled discharge of contaminated liquids and solid materials, reduction of forestlands due to unconscious use and similar negative inputs, disrupt the balance of the ecosystem. With the abovementioned anthropogenic effect, the ecological balance of the terrestrial and aquatic systems, which are the subsystems of the ecosystem, is affected from each other and enters into the process of disruption. The problems in the hydrological cycle lead to disruption of the regime, pollution and decrease in the amount of the surface and underground water.

Water basin boundaries. As it can be seen from the definitions of water basin and water basin ecosystem, the water basin boundary is defined as the boundary of the area (water basin) that collects surface water and transmits it to the reservoir, the boundary passing through the highest ridges of the surface topography (drainage divide, ridgeline). However, a part of the rainwater coming from the surface reaches the reservoir from the underground with a vertical movement. Accordingly, the geological structure underneath the ground is one of the most important factors needing to be analyzed in detail, due to its effect on the correct determination of the water basin feeding zone and on the quality of the water product. The underground water moving to the lower layers of the soil, with vertical movement, fills the cavities and cracks. It can reach all the way to the streams, through the cracks and faults or extract to the surface as spring water at a certain point. When the water reaches the impermeable bed, it collects there and reaches to streams and lakes in the form of underground flow. The underground water surface is generally similar to the surface of the topography and high at the hills and low at the rivers [15]. It is probable for the precipitation coming to the water basin to go out of the water basin by underground flow in the lands

with karstic nature. This situation which is related to the geomorphologic structure of the land, affects the amount of the water in the water basin. The phases of water, from atmosphere to the reservoir in the water basin ecosystem, are given in Figure 3.

It can be said that the "drainage divide" forms the side boundaries of the water basin in the natural water basin ecosystem. The definition can be considered to be sufficient when analyzed only in respect to the surface flow. However, the same may not true for underground water. The existence of faulted and cracked structures is possible at old formations, belonging to the Paleozoic Era. Particularly, the karstic nature of the region may increase the likelihood of emerging differences in the reservoir feeding zones, between the surface water and underground water. Although there are no pollutants in the zones, where the water basin boundary is determined by the surface topography, there may be elements outside the drainage divide polluting the reservoir through underground water [16]. Since the underground water surface is generally similar to the topography [15], it can be presumed that the side boundaries of the water basin are the same in terms of surface water and underground water. On the other hand, when the slopes of surface and underground beds are not the same, the water basin feeding zone may include sections outside the drainage divide. Therefore, geological and geomorphologic studies are important for determining the side boundaries of water basins. During the basin plan analytical study stage, knowing the actual basin feeding zone shall be accurate for calculating the water balance sheet, providing optimal benefit from water [17] and determining water basin plan decisions. Side boundaries of the water basin, proposed to be determined according to the slope of the impermeable bed, are schematized in Figure 4. On the left, the drainage divide formed by surface topography determines the boundary outside the slope of the impermeable bed, and on the right the slope of the impermeable bed underneath the ground determines the boundary outside the drainage divide.

Slopes of the underground beds are, on the other hand, another issue to be considered in determining the side boundaries of the water basin (Figure 5).

In Figure 5, it can be seen on the left that the underground beds direct water to the reservoir outside the drainage divide and it is suggested that the boundaries of the water basin should be passed out of the drainage divide, considering the slope of the bed and the slope of the impermeable bed in this section. On the right side, however, the slope of the bed and the slope of the impermeable bed coincided with the boundary of the drainage divide.

To sum up, determination of the side boundaries of the water basin requires a broad analysis of several factors, such as the surface topography, the geomorphology of the impermeable bed, the slope direction of the underground beds, the age and permeability of the geological formations and, whether they are faulted and cracked.

The part of the atmosphere up to 11-12 km can be considered as the upper boundary of the water basin ecosystem [9] and the surface of the impermeable bed can be regarded as the lower boundary [18].

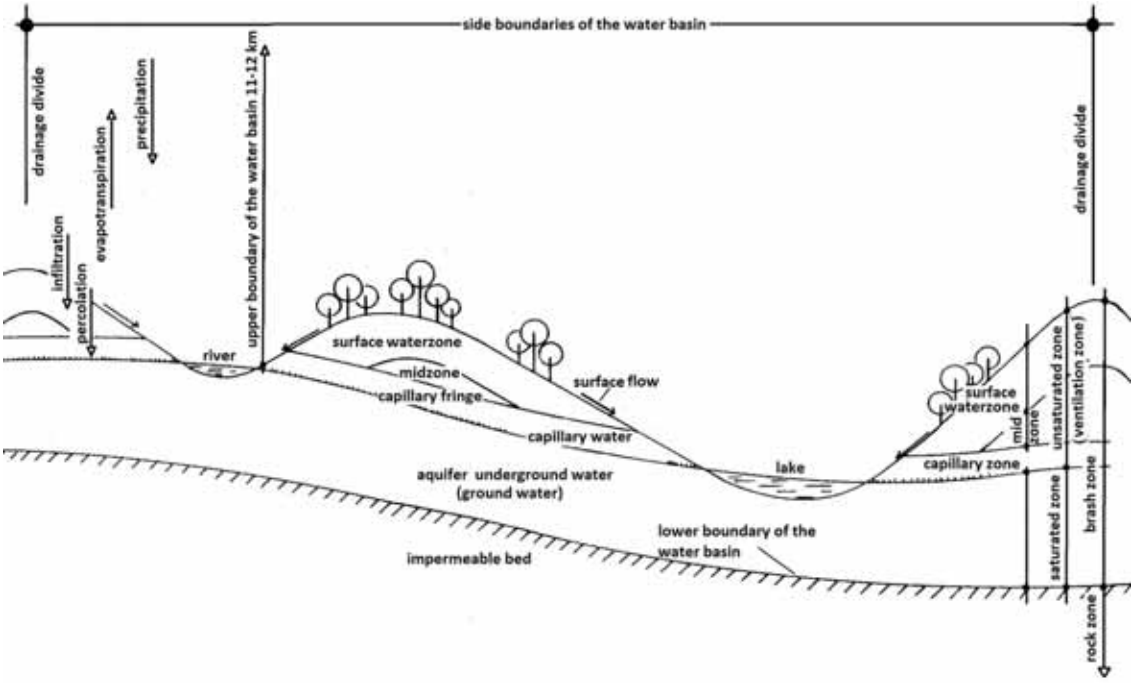


FIGURE 3
Water movement in water basin ecosystem [8]

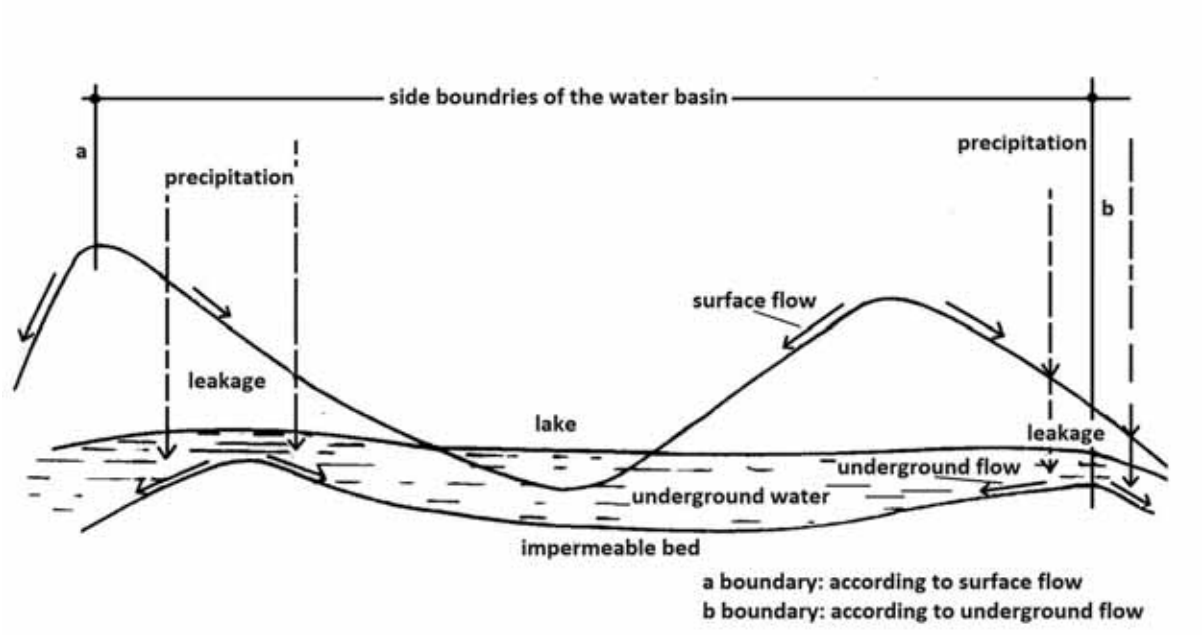


FIGURE 4
Side boundaries according to the slope of the impermeable bed (Adapted from [8])

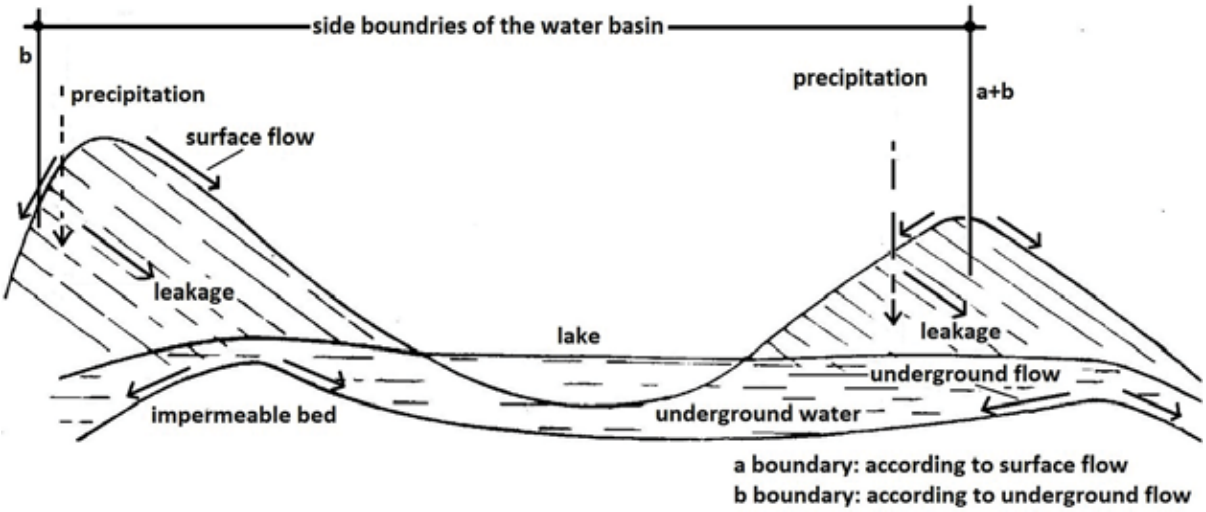


FIGURE 5
Side boundaries according to the slope of the bed (Adapted from [8])

Laws, regulations and plans on water basins are issued with the aim of preserving and sustaining the resources. Determining the elements, targeted to be preserved and sustained in the natural characteristics of the water basin ecosystem and increasing the water yield, are directly proportional to the knowledge of the actual feeding zone of the water basin outside the drainage divide, in other words, the boundaries of the water basin. Except from its role in determining the boundaries of the water basin, the underground geological and geomorphologic structure in the water basin has also the features of directing the underground water, cleaning it by filtration, and changing its minerals and quality consistent with the tectonic movements and permeability of the rocks.

Sources polluting water basin ecosystem. While the reservoir is fed by the surface and underground movements of water, the materials and pollutants carried with the water also reach the reservoir. Elements which do not exceed the carrying capacity of the renewable natural systems and are native in the natural system, can be cleaned within the natural cycles of the system. However, pollutants arising from human activities, which the natural system is not familiar with, are out of the cleaning capability of the natural system, and have a high volume and continuity, collect in air-water-soil resources and are transmitted to the reservoir. Departing from the aforementioned golden triangle rules creates irreversible situations in the water basin ecosystem or causes costly measures to be

taken. Accordingly, the amount of water in the basin decreases, quality of the water disrupts and the opportunity to access the water regularly in all seasons (The amount, quality and regime of the basin water can be briefly referred to as "water yield") is restricted. Plans should be handled with a holistic approach [19]. The factors reducing the yield of water in the basin can be summarized as: Decrease in the forest surface and vegetation other than forest, loss of soil by erosion in open areas, unconscious agricultural activities, expansion of settlement and industrial zones (firm ground), presence of unhealthy areas such as garbage patches and wrong site selection for them, discharge of wastes directly to the water resource, soil or air, mine exploration works, large infrastructure projects, such as highways, and so on.

The impact of the pollution of vital water resources, caused directly by human activities, increases due to climate change. Laws, regulations and plan studies should seek ecological and economical solutions that will eliminate the anthropogenic effects in water resources.

The Elmalı Dam Catchment Basin Protection Plan has been examined with the stated purpose.

RESULTS

Elmalı Dam is located 15 km away from Istanbul city center, on the eastern side of the Bosporus and on the west side of Ömerli Dam, in the Anatolian Side of Istanbul and the Kocaeli Peninsula. It is within the borders of Beykoz, Çekmeköy, Sancaktepe, and Maltepe Districts and is one of the smallest dams in Istanbul, with an area of approximately 83 km2 and 15 million m3 water retaining volume.

Two dams constructed over Elmalı Stream (Elmalı 1, 1926-1948) and Çavuşbaşı Stream (Elmalı 2, 1955) operate in an integrated way.

Elmalı Dam is fed by several streams (Figure 7) (Sakıran Stream, Arnavut Stream, Çiftlik Stream, Armutyatağı Stream, Çekmeköy Stream, Değirmen Stream, Karaağaç Stream, Köprü Stream (Kemer Stream)) [21].

The population and settlement areas in the Elmalı Basin began to increase rapidly, especially in 1980s as in the entire metropolis of Istanbul. The construction of the second bridge at the Bosporus (Fatih Sultan Mehmet Bridge) and linking roads (TEM) in 1984, also establishing organized industrial zones, such as Dudullu and IMES in the basin and its hinterland, brought the demand for accommodation areas forward. On the other hand, Zoning Amnesty, the Law on Supporting the Development of Forest Villagers and similar laws, regulations permitting the uses that might cause settlement and pollution in the water basins, presence of the county municipalities, having the authority to make and implement independent plans beyond the responsibility of the Istanbul Metropolitan Municipality, during the specified period, upper scale plan decisions which did not include adequate solutions for subscale plans and implementations towards the sustainability of the natural ecosystem features of the water basins and similar reasons, led to a decrease in the water yield in the basin with high population and settlement pressure [8].

As it can be seen in Table 1, areas that retain and transmit the water to the soil and prevent erosion, such as forest lands and bushes, decreased by 57% between the specified years, but the settlement areas forming firm grounds on the basin increased by 40% (Table 1, Figure 8). Settlement areas cause pollution by industrial activities and domestic waste. At the same time, firm ground increases the surface flow and transmits the pollutants on the surface to the water resources on one hand, and prevents regular water flow towards the underground beds and negatively affects the amount and regime of the water on the other hand.



FIGURE 6
Location of Elmalı drinking water basin [20]

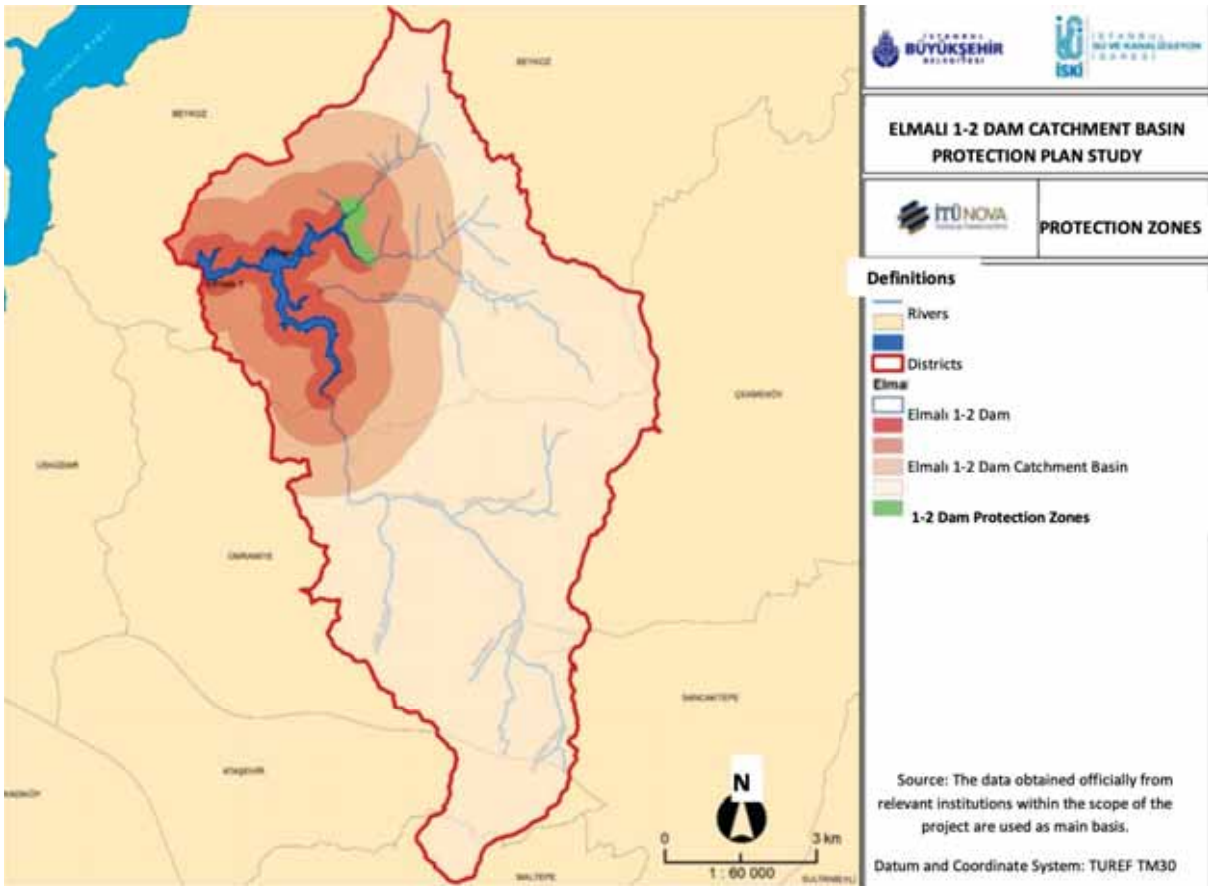


FIGURE 7
Streams and preservation zones in Elmalı drinking water basin [23]

TABLE 1
Changing in the Land Use in Elmalı Drinking Water Basin [20]

Category/ Year	1995		2005		2013	
	Ha	%	Ha	%	Ha	%
Arid Land	92	1	61	1	59	1
Agriculture	423	5	117	1	84	1
Forest	4135	50	3778	45	3757	45
Settlement	2444	29	3233	39	3378	40
Water	97	1	72	1	72	1
Bushes	1150	14	1080	13	991	12
Total	8341	100	8341	100	8341	100

The settlement areas are centered in the southern part of the water basin and are surrounding the Baklacık, Budak, Çekmeköy, Kemer, Karaağaç, Değirmen… streams, feeding the basin. Over the years, the settlement areas have also increased in the north of the water basin.

The amount, quality and regime of water is directly proportional to the presence of vegetation in the water basin. Studies show that in the forest lands which consume less water and are covered with litter, the amount of precipitation is 15%-50% higher compared to the surrounding areas [24]. More water is retained in the soil, nearly half of the precipitation becomes usable water product (this ratio is 14% in open areas) [13], rain splash and wind erosion is not seen, and the amount of water transmitted to the lower layers increases as the hollow structure of the soil increases [7].

If the population sizes are listed in proportion with basin areas, Elmalı, Alibey, Sazlıdere and Ömerli Water Basins come first [21]. The increasing water demand, and the decreasing and polluted water supply, create an economic burden by promoting the construction of new water transport pipes and treatment plants, at high costs. As the available resources fail to meet the water demand in Istanbul, water is provided from longer distances (Melen, Yeşilçay, Istıranca, Sakarya) (Figure 9).

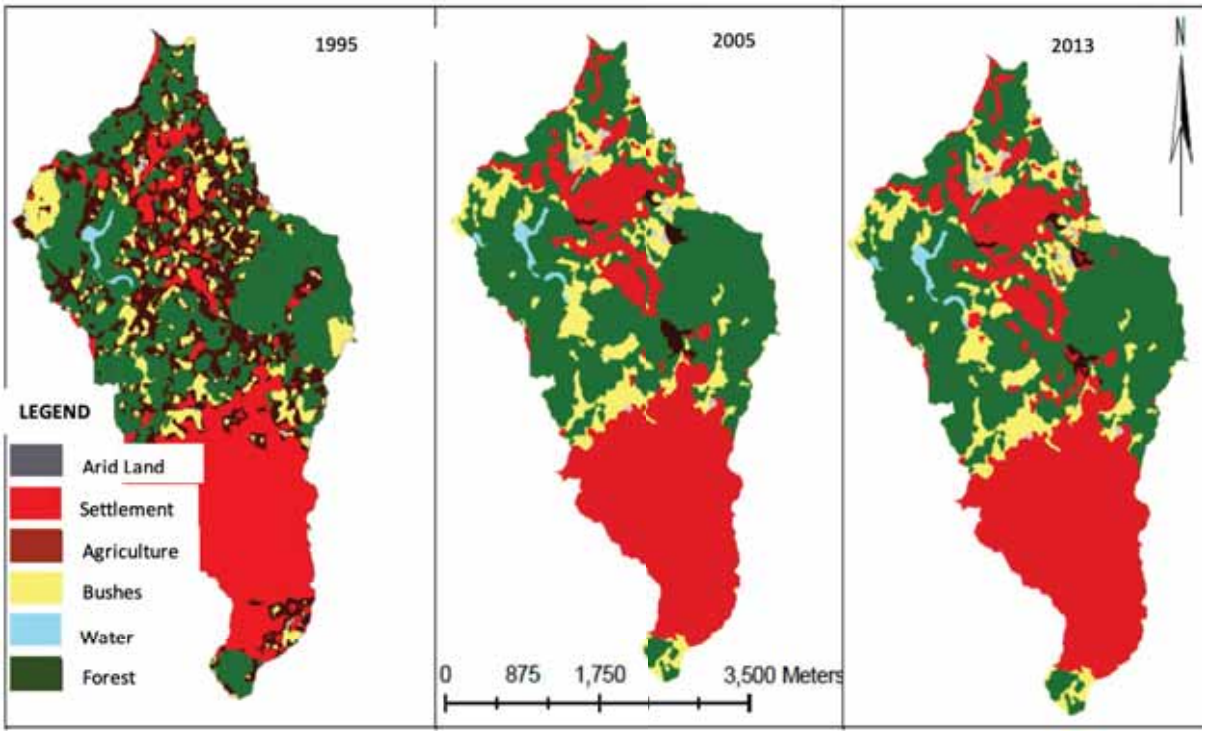


FIGURE 8
Changing land use in Elmalı drinking water basin by years [20]

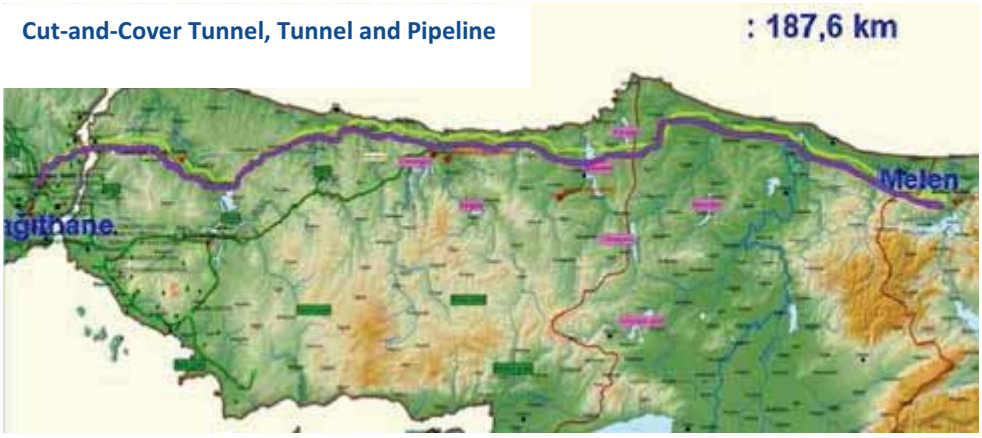


FIGURE 9
Water Supply System from Melen River to Istanbul [25]

Fresh water basin ecosystems formed according to the river resources, provide sustainability in the nearby hinterland, in proportion to the capacity, as long as there is no pressure from other systems. However, directing the resource according to the relatively higher water demands at longer distances, negatively affects the features of the ecosystem in the immediate surroundings of the resource.

Elmalı 1-2 Dam Catchment Basin Protection Plan. The given information on the water basin ecosystem and Elmalı Basin in a summary, has been tried to be examined within the scope of Elmalı Dam Catchment Basin Protection Plan. The impact of the plan on the basin, and the headings considered important, are mentioned in the paragraph below.

It was stated that Elmalı 1-2 Dam Catchment Basin Protection Plan has been approved by the consent of the Ministry of Agriculture and Forestry, dated 20.03.2019 and entered into force [23], was prepared for the purpose of establishing all legal and technical principles, regarding the preservation and sustainability of the water yield of the dam for providing drinking water, and regulating of all kinds of activities within the dam catchment basin.

Determination of the water basin boundaries, as a result of geological studies, including the details explained in the previous sections, and knowing the actual feeding zone of the water basin, gains importance in the realization of the purposes of the plan. There is no small-scale geological map which shows the current situation of the region. Detailed

geological studies need to be conducted in the basins [26].

The strict short-, medium-, long-distance preservation zones in the regulations and plans are defined under the title of 'water basin preservation zones' in Elmalı water basin plan as: reservoir green diversion zone ((dam reservoir boundary) areas between 0-300 m), reservoir preservation zone (300-700 m), short distance preservation zone (700-1000 m) and long distance preservation zone (1000-basin border). Apart from these, "Controlled Use Zone" which covers "the region which was established before the preparation of the Preservation Plan, is compulsory for settlement and urban development, and where human activities are intense and necessary measures are taken to minimize the negative effects of these activities on the dam catchment basin ecosystem" are identified (Figure 10).

The mentioned area is the settlement area with dwellings and facilities adjacent to the northeastern border of the reservoir. In the settlement next to the reservoir, and which is stated to be densely populated, but preserved in the plan, minimizing the pollution caused by human activities will result in high costs. Settlements cause problems, resulting from the formation of firm ground. The number of organisms carrying diseases easily increases in the areas where domestic waste is collected, the pollution reaches to the water resources with the water infiltrating through the surface and this carries high risks of illnesses [27] . A detailed analysis of the geological structure of the region is required and the region has to be converted into soft ground with vegetation, instead of firm ground, by clearing the region of the settlement, which may be aimed in time.

The concept of "preservation zones", implemented with standard values, was brought to the agenda in accordance with the protocol signed between the General Directorate of State Hydraulic Works and the Ministry in 1976, and was used with the purpose of providing preservation around the drinking water resources, until zoning plans were made. It was written in the relevant protocol that: "...Regulations shall be prepared for the protocol areas following the detailed local researches in the regions priorities of which to be determined. The strict, short and medium distance preservation zones may be expanded in the regulations to be prepared for these regions considering the boundaries determined by the protocol to be minimum..." The preservation zone distances have been used as standard values in the plans, and regulations approved later, instead of performing the basin-specific studies, proposed in the protocol. The same applies to the Elmalı Water Basin Plan. As it can be understood from the definition of water basin, water feeding the dam reservoir from the surface and underground reaches the lake by covering the entire basin.

The plan [23] states that the number of building stocks in the controlled use zone, adjacent to the dam reservoir, has to be reduced in time. The solution of the property problem and the term 'in time' may not be covered in practice. While the gross density is 30 people/ha in this region, maxTAKS (TAKS: Base density rate):30 value is regarded as firm ground in urban scale. The statement under the same heading that 'the existing industrial plants and commercial enterprises that do not generate waste water can continue their activities without generating industrial waste water' does not comply with the water basin ecosystem.

The values of density depending on the distances are increased in the same plan. The table adapted from the plan by the author is below. (Table 2).

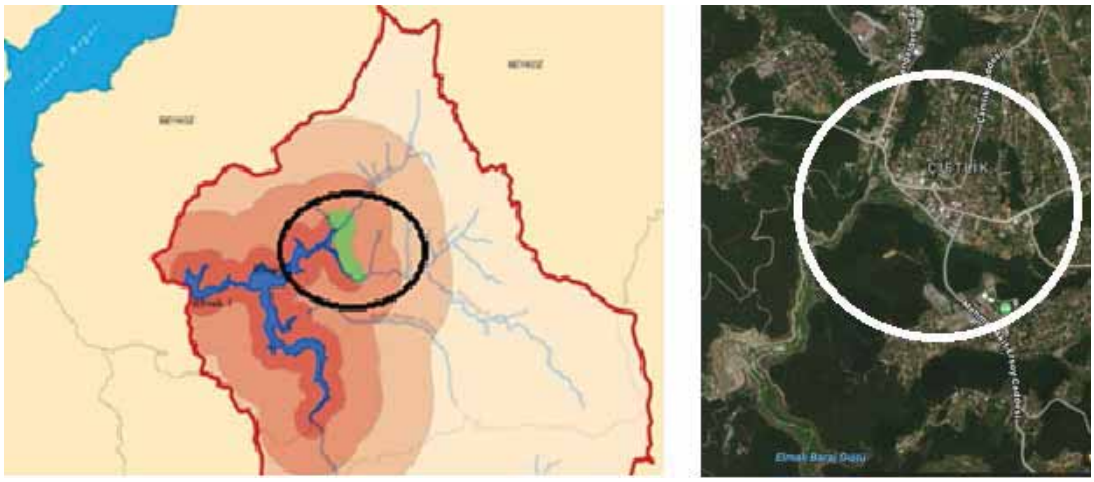


FIGURE 10
Elmalı Water Basin Plan Controlled Use Zone
(Prepared by referring to [23] and Google Map source)

TABLE 2
Elmalı 1-2 Dam Catchment Basin Protection Plan [23]

Elmalı 1-2 Dam Catchment Basin Protection Plan	Gross Density person/hectare		BCR	Function
CONTROLLED USE ZONE	30		30	Dwellings, commercial buildings, new highways, railways can be constructed.
RESERVOIR PRESERVATION ZONE	50		30 (dwelling) 50 (social infrastructure)	Dwellings, universities, student dormitories, guesthouses, boarding primary schools, boarding secondary schools, boarding high schools, accommodation facilities, tourism facilities except for those qualified as boardinghouses, congress and conference centers, socio-cultural facilities, primary care clinics, new highways and railways can be constructed. The existing industrial plants and commercial facilities can continue to operate, existing cemetery can be used.
SHORT DISTANCE PRESERVATION ZONE	Beykoz Ümraniye Çekmeköy Sancaktepe Ataşehir Maltepe	60 80 60 40 60 20	-	In addition to the above, the existing Organized Industrial Zone is preserved. The existing fuel stations are allowed to continue their fuel and LPG/CNG supply activities under the condition that they meet TSI standards and perform preliminary treatment on their waste water and connect to the collector line. New tourism facilities are not allowed, except for environmentally friendly ecotourism facilities, the existing cemetery can be used, mining activities are conditionally allowed, solid waste transfer stations are conditionally allowed, new highways and railways can be constructed. Pet shops, shelters and training camps for pets, salesrooms, accommodation facilities, such as guesthouses, boardinghouses, and hotels or training areas can be constructed.
LONG DISTANCE PRESERVATION ZONE	Beykoz Ümraniye Çekmeköy Sancaktepe Ataşehir Maltepe	75 140 100 120 140 25	-	In addition to the above, recreation facilities, fuel stations and similar other facilities and roads can be constructed. The existing organized industrial zone is protected, regular storage mine tailings disposal plants are allowed in the Long-Distance Preservation Zone after 3 (three) km horizontally from the border of Short-Distance Preservation Zone. The existing fuel stations, gas filling stations and chemical substance depots are allowed to carry out filling activities, fuel and LPG supply activities, under the condition that they meet TSİ standards, except for service activities in the stations, solid waste transfer stations are conditionally allowed. The mining activities and tailings generated as a result of these activities are conditionally allowed. Pet shops, shelters and training camps for pets, salesrooms, accommodation facilities, such as guesthouses, boarding houses, and hotels or training areas can be constructed.

DISCUSSION AND CONCLUSIONS

As it can be seen in Table 2, Elmalı Dam Catchment Basin Preservation Plan could allow the construction of all uses within the water basin, including unhealthy facilities that may be located in urban fabric, such as dwellings, industrial plants, fueling facilities, social-cultural facilities, cemeteries and an organized industrial zone. CO2 emissions from the energy consumption in the settlements and fossil fuels, used by cars [28] also directly reach the air, water and soil resources in the basin. Provisions for the conditional allowance of some facilities involve several difficulties, as it can be seen in similar implementations today. SCHEDULE 2 annexed to the plan under the heading 'Working program for the implementation of the measures' includes the program for the management of domestic, industrial, hazardous and special wastes, medical wastes and mineral tailings. Taking land use decisions which the natural system is not familiar with and is not able to clean, and which will cause a development beyond its carrying capacity, cannot be regarded as one of the scientific methods. Pollution of the water basin, with the plan decision, regulations and implementations supporting the plan decisions, cause the irreversible depletion of the polluted resources, and Figure 8 reflects how this happens in practice. Treatment of the polluted resource and transportation of water from other regions are implementations with high costs.

Pollution within the water basin boundaries shall be carried to the dam reservoir by the water (Figure 11).

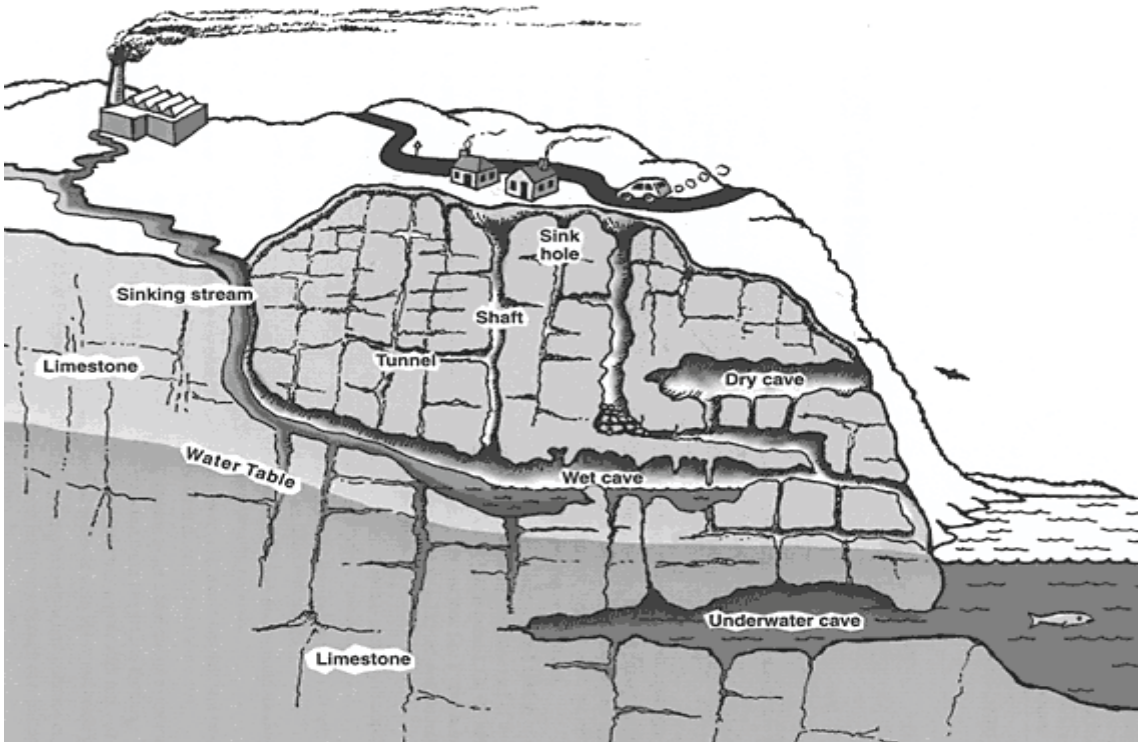


FIGURE 11
Water in the basin reaching to the dam reservoir regardless of distance [4]

The preservation mentality, depending solely on the surroundings of the dam reservoir, without analyzing the water basin ecosystem elements, definition of standard distance, and increasing settlement conditions in proportion to the distance of the preservation zones to the reservoir, do not comply with scientific data and are far from a planning mentality. It is considered beneficial to prepare water basin plans and boundaries in the context of detailed geological maps. It may be suggested, that water permeability of the formations, the chemical reaction of the rocks, according to the content of the water coming, the capacity and capability to filtrate-store different organisms within the water, contribution of the rocks to the quality of the water, the hollow-faulted-cracked structure or impermeability of the formation and similar analysis of the geological maps, should be handled with vertical sections in sensitive areas if necessary, with the participation of relevant disciplines.

Solutions sought as emergency action plans, in order to meet the current needs cannot produce solutions to the water shortage fundamentally and in the long run. It should be aimed to sustain water resources by benefiting from their natural features. Accordingly:

- Calculation of the population of the plan, in line with the carrying capacity [29] of the resource,
- Determination of the land use decisions in the plans, in reference to the calculated population and the natural structural features of the water basin,
- Including measurements to prevent regional accumulations in the plan decisions,
- Including provisions which support the planned decisions in the laws can be counted among the principles of sustainable fundamental solutions.

Urban systems which put pressure on the water basin ecosystem, should be planned in an integrated way in the upper stage, within the sociocultural structure of the societies, and should have content that provides a sustainable solution, applicable to the plans at lower stages.

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