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UNDERGROUND WATER FORMATION, IMPORTANT,

UNDERGROUND WATER AND POLLUTION IN TURKEY

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**ABSTRACT**

**Introduction** Underground waters are formed by filling waters within porous waters or rocks that leak from the ground. Such rocks that accumulate in the water are called "aquifer". Aquifer; (Conductive) permeable geological units capable of storing and transporting water in significant quantities (1). Today, the use of groundwater has increased considerably. As a result of global pollution of underground waters used in industry, agriculture, thermal sources or drinking water, human and environmental health have been endangered (2). One of the most important problems of our time is the need for clean water resources. Research shows that water use has increased by two to three times in the last 40 years worldwide (3).

**Aim of the Study**

The purpose of this study is to indicate the importance of groundwater in terms of human and environmental health and to show what polluted ground waters might lead to.

**Material-Method**

A compilation method was used in this study. It is based on literature and studies on various public and private institutions related to pollution of groundwater in Turkey and in the World were examined, internet sources, related regulations and communiqués published in and out of Turkey were used. The study method was carried out in 2 stages. In the first step, studies on the subject have been screened. In the second stage, the interpretation of the studies studied, the evaluation and synthesis of the sources from various angles, and the work done on the basis of them are presented.

## Results

Although we can not reach the water easily in our country, unfortunately the water is among the poor countries. Therefore, underground and surface water resources that can be used are not primarily "polluted". Because water resources in the earth and underground must be treated in order to make them suitable for use in various areas. It is an expensive method to treat the water from underground and polluted water at the treatment plant.

**Key Words:** Underground water, pollution, World, Turkey,

## INTRODUCTION

Underground waters are formed by filling waters within porous waters or rocks that leak from the ground. Such rocks that accumulate in the water are called "aquifer". Aquifer; (Conductive) permeable geological units capable of storing and transporting water in significant quantities (1)

### Factors Affecting the Leaking of Ground Water Leaked From the Ground:

- Rainfall Severity: If the precipitation is in the form of a drizzle, the water leaks to the ground immediately when the water falls to the ground. In torrential rains, the water flows along the topography slope.
- Topography The Slope Of The Surface: The less the slope, the less water flows into the stream and the opportunity to infiltrate
- Ground Moisture: If the amount of moisture prior to the precipitation is too high, the leakage will be minimal.
- Urbanization : Where the urban settlements are intense, the value of the leaking event is minimized. Because water can not find a place to infiltrate underground.
- Plant Cover: The fact that the plant cover is lush will also reduce the leakage.

### Movement in underground waters:

The waters running underground are generally slow and smooth (laminar-lamina). However, in long and wide spaces, water flows turbulently or swirl

### Chemical composition of groundwater:

Ground waters are not purely pure and contain dissolved or dissolved substances such as carbonates, chlorides, oxides, sulfates. Other elements are Mg, Ca, K, Na, Cl, Fe, F (4).

### Underground Water Movement:

Groundwater has been used since ancient times. However, the importance they bear for health is not fully understood until the middle of the 19th century. Underground water is also one of the most important sources of water for irrigation. However, industrial products such as gasoline, oil and chemicals, pesticides and fertilizers infiltrate into groundwater, creating pollution of groundwater and making it unsafe for use (5).

On the other hand, water pollution is not seen in the danger dimensions in the regions where the population is low and the industrialization is not or low (6)

Underground waters are used at places shown in the following materials:

The waters we use as spring water, household water and drinking water are more spring water.

Artesian water, mainly used for agricultural irrigation, underground is the water extracted with tools.

Geothermal spring water, the water from deep underground is hot. This water is used to thermal springs, to heat homes and for geothermal energy (7).

**Underground Water Resources:**

Groundwater is once again the source of groundwater. According to the Warmth of Waters Source:

**A-Cold Water Resources:** They take their water from the earth with precipitation. The temperature and currents of the waters change throughout the year. They are characterized as follows;

- 1) Layer Source (slope): The place where water comes out from the tip of permeable plates.
- 2) Valley Source: Source from the valley bases
- 3) Karstic Welding (Vocluz): Welds on the ground in limestone land. It is most common in the Mediterranean region. Ex: Düden Water. The most important feature of these sources is the abundance of lime in their water.
- 4) Artesian Source: Pressurized groundwater accumulates between two impermeable layers in the shape of a boat. Pressurized water is discharged into the surface by a sounding drilling water pressure pressurized. Such sources are called artesian sources. What separates from other sources is the emergence of the earth by the influence of human factors.

**B- Hot Water Resources;**

They take their water from the areas close to the shrine. The water is hot or warm according to the depth at which it comes. The temperature of the waters is the same throughout the year. There is no current change. It contains plenty of molten material. They are characterized as follows;

- 1) Fault Source: The earth source along fault line. Among these people, these resources are called hot spring, hot spring, çermik, drinking and mineral waters. For example: Manisa (Kurşunlu, Urganlı, Alaşehir, Demirci), Denizli (Pamukkale, Karahayit, Saraykoy, Buldan), Kütahya (Simav), Balıkesir (Edremit, Gönen) and Sivas (Balıklı Çermik) are located. The common feature of these places is the property of the place structures.
- 2) Geyser Source: It is a source of eruption from active volcanoes at different intervals. There are no examples in Turkey (8).

The ratio of groundwater use to total water use has increased significantly in recent years, because on one hand quality is generally more appropriate than surface water, and on the other hand available surface water resources are decreasing due to contamination. One of the most important problems of today is the need for clean and sustainable water resources. The amount of surface water resources that can be used depends on factors such as climate change, increasing irrigation water requirement, and random watering of used water, and the quality is deteriorating (9).

Especially for the purpose of providing drinking water up to the sun, especially underground waters. The fact that a limited and large portion of underground water resources, which are cleaner than surface waters, has been used, necessitates the use of surface water resources increasingly. It is a known fact that the surface water resources are increasingly polluted with domestic, agricultural and especially industrial wastes at an increasing rate, resulting in the threat of public health, ecological equilibrium is lost and economic value of the waters is lost. This increases the treatment costs required for the availability of surface water resources (10).

**Polluted Underground Water Hazards**

Contaminated ground waters can be serious health effects for people to drink. Diseases such as hepatitis and dysentery can cause contamination from septic tank wastes. The wells may cause poisoning of toxins that have been infiltrated into the water by drinking water. For example, arsenic has become a major international concern in underground waters. Therefore, it is important to select underground resources primarily (11).

Knowing the physical, chemical and bacteriological properties of the water for the healthy life of people and for the survival of the water, If these properties do not exceed certain limits in accordance with their intended use, Especially drinking water must be free from microorganisms and minerals and organic substances that can cause disease and harmful effects. Water should be suitable for drinking in terms of physical characteristics such as turbidity, color, smell, taste and temperature (12). Detailed chemical analysis of groundwater can detect more than 50 components. However, these properties need not be known separately in order to understand whether

groundwater in any place is suitable for drinking, handling, industrial and irrigation purposes. By knowing the quantities of anions and cations not exceeding 10 or 15 in number, as well as properties such as hardness, pH, conductivity (electrical conductivity), it is possible to have sufficient knowledge about the chemical quality of the water and the place to be used.

When minerals are dissolved in water, they are separated into particles called ions. Those that are negatively charged from these particles are called "anion", and those that are positive are called "cation". Water analyzes are usually expressed in terms of the density of these ions. Groundwater, Sodium ( $\text{Na}^+$ ), carbonate and bicarbonate ( $\text{CO}_3^{2-}$ ,  $\text{HCO}_3^-$ ), chloride ( $\text{Cl}^-$ ), sulfate ( $\text{SO}_4^{2-}$ ) and nitrate ( $\text{NO}_3^-$ ) ions. Their concentrations may vary widely depending on the chemical composition of the rocks underground, the pH of the water, the pressure of the environment and the temperature (13).

#### NATURAL AND ARTIFICIAL REASONS IN THE POLLUTION OF UNDERGROUND WATERS

##### Natural Causes:

1-Contamination from geological formations: Saline, gypsiferous, anhydrite, boron and turbid formations are the means of intervention in the groundwater from the high quantities of ions they contain. Saline, gypsiferous, anhydrite, boron and turbid formations are the means of intervention in the groundwater from the high quantities of ions they contain.

2-Sea Water Initiative: Excessive pumping or groundwater run-off causes water interferences in the aquifer from the surrounding aquifers and the sea.

3-Bad Quality Stream, Lake, Swamp Effects: With the development of industry, these wastewaters, which are polluted by discharge of various industrial and household wastes into surface waters such as rivers and lakes uncontrollably, are polluted in the case of groundwater supply

4--Geothermal Field Effects: Boron contamination, which is a consequence of geothermal waters underground waters and adversely affecting agricultural use, arises.

##### Artificial Causes;

1. Domestic Wastes: Detergent, sewage etc. from domestic wastes. Waste chemistry,
2. Agricultural Wastes: Pesticide, Nitrogen compounds etc. coming from fertilizers with agricultural chemicals.
3. Bad Quality Stream, Lake, Swamp Effects With the development of industry, these wastewaters, which are polluted by the discharge of various industrial and household wastes into surface waters such as rivers and lakes uncontrollably, are polluted in the case of underground water supply.
4. Industrial Wastes: The use of heavy metals from industrial wastes, factory wastewater, disinfection of waters, reduction of hardness, contamination and contamination of chemicals used to prevent some sedimentation (or sedimentation) into the groundwater without treatment,
5. In the basins where the groundwater is located, a large number of wells that are not suitable for the drilling technique are opened and operated and the protection areas have not been determined (14).

#### **Elements that cause pollution in underground waters**

Depending on the amount of some elements in the water and the duration of the interaction, it can have a toxic effect for exceeding the limit values Arsenic, cadmium, chromium lead, mercury, barium, nitrate, fluoride, radioactive substances, ammonium, chloride

### **Bacteriological Pollution**

Microorganisms (pathogenic bacteria, viruses, protozoa, helminths) that cause disease are easily mixed with anthropogenic origin. Significant bacteria and viruses that have been proven to be effective in water by human body are listed below.

Shigella: Dysentery is the cause,

Vibrio cholerae: causing colic,

E. coli: Intestinal infections are occurring.

Important viruses in terms of public health can be listed as Adenoviruses, Enteroviruses and Hepatitis A. It takes a long time to detect bacilli (typhoid, dysentery, cholera) bacilli or viruses

For this reason, the pollution level of the waters is determined by searching the total coliform bacteria group which has the same characteristics as the disease bacteria. Total coliform bacteria in clean water 0/100 ml (15).

### **CONTROL OF WATER POLLUTION**

The progress of the technology, along with the means of providing maximum benefit from water resources, along with the increase of industrialization and urbanization in parallel with this progress, has brought "environmental pollution" and especially "water pollution" to the agenda. The fact that water pollution has become increasingly important has forced countries to take serious measures in this regard, which has resulted in the formation of many legislation.

The legislation on the protection and management of water resources in the European Union, which was established in 1951 with the European Coal and Steel Community and the 1991 Maastricht Treaty, has a very important place in the EU legislation. This area has over twenty directives. The most important of these directives is the "Water Framework Directive" 2000/60 / EC of 23 October 2000.

Contrary to earlier directives, the Water Framework Directive, which encompasses all water resources, provides an integrated approach to water resource conservation, provides resource reclamation and sustainable use, and is undoubtedly expected to have broad and long-term impacts (16).

### **GROUNDWATER IN TURKEY**

The total amount of water in the world is 1.4 billion km<sup>3</sup>. 97.5% of these waters are in the oceans and in the seas are salt water and 2.5% are fresh water in rivers and lakes. It is understood that only 90% of such freshwater resources are found in poles and undergrounds, and that the amount of available fresh water that humans can easily benefit from. The average annual rainfall in Turkey is approximately 643 mm, corresponding to an average of 501 billion m<sup>3</sup> per year. 274 billion m<sup>3</sup> of this water are returned to the atmosphere through evaporation from soil and water surfaces and plants, 69 billion m<sup>3</sup> of it feeds groundwater and 158 billion m<sup>3</sup> of it flows through streams of various magnitudes into the waters of the sea and the ponds in closed basins. The 69 billion m<sup>3</sup> of water that feeds the underground water rejoins the surface water by 28 billion m<sup>3</sup> of springs. There is also an average of 7 billion m<sup>3</sup> of water per year from neighboring countries. Thus, our country's gross overground water potential is 193 billion m<sup>3</sup>. Our country has an average total of 112 billion m<sup>3</sup> per year, which is consumable surface and groundwater potential. 44 billion m<sup>3</sup> of this is used.

<b>WATER RESOURCES POTENTIAL</b>		
Annual Average Precipitation	643	mm/yl
Area Of Turkey	783.577	km <sup>2</sup>
Annual Precipitation	501	billion m <sup>3</sup>
Evaporation	274	billion m <sup>3</sup>
Underground İnfiltration	41	billion m <sup>3</sup>
<b>Surface Water</b>		
Annual Surface Flow	186	billion m <sup>3</sup>
Available Surface Water	98	billion m <sup>3</sup>
<b>Ground-Water</b>		
Annual Amount Of Towable Water	14	billion m <sup>3</sup>
Total Available Water	112	billion m <sup>3</sup>
<b>Development Status</b>		
Used in DSI Irrigation	32	billion m <sup>3</sup>
Used İn Drinking Water	7	billion m <sup>3</sup>
Used İn Industry	5	billion m <sup>3</sup>
Total Used Water	44	billion m <sup>3</sup>

**Countries By Water Status Are Classified As Follows;**

**Water Poverty** : The amount of usable water per capita per year is less than 1,000 m<sup>3</sup>.

**Water Depletion** : Less than 2,000 m<sup>3</sup> of usable water per capita per year.

**Water Richness** : The amount of usable water per capita per year is more than 8,000-10,000 m<sup>3</sup>

**Turkey is not a country rich in water.** According to the annual amount of water per capita, our country is a country with water shortage. The annual amount of usable water per capita is around 1,519 m<sup>3</sup>.

<b>Sequencing by water</b>	<b>Amount of usable water per capita per year</b>
Water richness	> 8.000-10.000 m <sup>3</sup>
Water shortage	< 2.000 m <sup>3</sup>
Water poverty	< 1.000 m <sup>3</sup>
<b>Turkey</b>	<b>1.519 m<sup>3</sup></b>

The Turkish Statistical Institute (TUIK) predicts that for 2030, our population will be 100 million. In this case, it can be said that the amount of usable water per capita in 2030 will be around 1,120 m<sup>3</sup> / year. It is possible to predict the impacts of factors such as current growth rate, changes in water consumption habits, and pressure on water resources (17).

Our country is very rich in terms of underground waters. Geological structure and shape of the ground determine the characteristics of underground waters. Especially the coastal areas of the ovals and deltas have a very rich underground water. Also in our karstic areas, groundwater is quite abundant. In some regions of our country, especially in semi-arid areas, underground water is used for irrigation in agriculture. It is important to use underground water in agricultural areas such as Karapınar (Konya), Ceylanpınar (Şanlı Urfa), Polatlı (Ankara) Sivrihisar (Eskişehir) Drinking water of some of our cities is also supplied from underground waters. (Bursa, İzmir, Eskişehir, Konya, Niğde, etc.)

The definition of artesian sources has been made above and spread in Kayseri, Bursa, İnegöl, Erzurum, Malatya, Eskişehir, Mus plains, on the edges of Aegean coastal plains and in Çukurova in Turkey.

We recall that the fault sources are the earth sources from the fault lines. The fault sources in our country are mostly seen through the grabens (graben: depressive blocks surrounded by parallel faults source: wikipedia) in the Aegean and Southern Marmara regions. In addition, such resources have been formed on the North Anatolian fault line. Ex: There are centers like Manisa (Kurşunlu, Urganlı, Alaşehir, Demirci), Denizli (Pamukkale, Karahayıt, Sarayköy, Buldan), Kütahya (Simav), Balıkesir (Edremit, Gönen), Sivas. The common feature of these places is the property of the place structures.

### **Spa and Mineral Waters of Turkey:**

The waters leaking into the depths of the earth warm up to the earth by the effect of the internal heat of the place. Hot water springs formed in this way are called thermal springs or hot springs. If the water of these sources is very hot and they come out to the earth as a pressure, it is called as a geyser, if their water is hot, they are also called hotcakes. Hot water sources also contain dissolved chemical substances in their composition. These waters containing minerals are called mineral water. South Marmara thermal springs, Western and Southwestern Anatolian baths, Inner West Anatolian hot springs and mineral waters, South Anatolian hot springs and mineral waters, we have spa and mineral water resources (18).

### **Geothermal Resources in Our Country;**

In our country, there are sources of hot water (geothermal energy) up to 102 degrees and some 600 sources. Turkey is the most important country among the countries in Europe in terms of geothermal resources after Italy. These sources are higher in Western Anatolia (Aegean Region) due to geological structure of the country than both the temperature and the number of other regions. This is followed by Marmara, Central Anatolia, Eastern Anatolia, Black Sea, Southeastern Anatolia and Mediterranean regions.

In our country which is one of the countries rich in geothermal energy, systematic and programmed researches carried out by the General Directorate of Mineral Research and Exploration (MTA) since 1962 have started with inventory studies of hot water resources. Later, in the detailed studies carried out in suitable areas, the existence of 170 sites containing geothermal fluid at 35 temperature was revealed (19).

### **UNDERGROUND WATER POLLUTION IN TURKEY**

Excessive pollution has been found in some of the existing surface and underground waters due to the rapid increase of the population in our country, the growth of industrialization, the spread of fertilizer and drug use in agriculture, and the lack of environmental awareness. So, some of the surface waters of some basins have polluted water from the 4th degree. Extreme pollution was detected in rivers and lakes in the basins of Meriç-Ergene, Marmara, Sakarya, Gediz, Küçük Menderes, Büyük Menderes, Burdur and Akarçay (Afyon). Contaminations are caused by pollutants such as nitrogen, phosphorus, calcium, organic substances, lead, zinc, chromium. In some water basins, even extremely heavy metal contamination is encountered. Today, pollution in the surface and underground waters of Turkey, which is a country that is in a water-deprived country, creates big problems for health and makes life impossible in the living spaces that water creates. If the pollution of the waters in our country continues in this way, it is calculated that the problems that are created after 25-30 years will turn into an impossible situation (20).

### **CONCLUSION**

Unfortunately, our country is among the poorest countries, although we are not very comfortable with our water use in our country and can not be reached easily. Therefore, underground and surface water resources that can be used are not primarily "polluted". Because of the water resources in the ground and underground, treatment must be done in order to make it suitable for use in various fields. Heavy metal pollution in surface waters also occurs in groundwater. It is an expensive method to treat the water that has been taken out of the ground and the pollution has been detected in the

treatment plant. Therefore, industrial enterprises should not leave their solid and liquid wastes directly to the environment, but they must be brought to the standards specified in the regulations and receive the buyer service. These are well followed by our authorized agencies, but criminal sanctions must be applied when necessary. Besides, the agricultural pesticides and fertilizers used in agriculture are mixed with soil and groundwater according to the geographical feature of the land. Damages of agricultural drugs should be explained to our farmers, and supervision and follow-up of the use of these drugs should be brought. Regulation on Control of Soil Pollution and Polluted Chamber with Point Source (R.G. 08.06.2010-27605) Derogation of Responsibility and Environmental Hazard Article 38 states that "the owners of activities that cause pollution of soil or ground water are responsible for Article 6 and paragraph 28 of Article 13 of the Environment Law" (21).

According to the Water Pollution Control Regulation (Official Gazette 31.12.2004 - 25687); Purpose of regulation; In order to ensure the protection and optimal use of the country's potential for underground and surface water resources, it is necessary to specify the legal and technical grounds necessary to achieve the prevention of water pollution in line with sustainable development objectives" (22).

Therefore, all the formations in the production of wastewater on the earth should protect nature and human by establishing treatment plants. Various public spots should be prepared to raise public awareness about the subject. Trainings should be educated in primary school, even pre-school education institutions and educate conscious generations. Conscious citizens can make the notification of the areas where soil or underground water pollution has taken place for any reason according to Article 11 of the Regulation on Soil Pollution Control and Point Contaminated Polluted Shelf (R.G. 08.06.2010-27605) "List of Suspected Fields of Untrustworthy Areas".

## RECOMMENDATIONS

Our increasing population, urbanization and changing water usage habits cause our water resources to decrease gradually. We see that human and environmental health are beginning to affect the water and soil pollution. Organic farming should be given more importance in order to protect human, soil, and water in our country. Access to these products should be facilitated and pricing should be adjusted according to the purchasing power of the people. With our various distance education systems, our farmers can be trained. In addition, more time can be given to the damages of the chemicals used in agriculture and industry in the relevant parts of our universities to overhead and underground water sources. It depends on the education of our country and our world which will cause the behavior change of our future. However, we can protect our natural resources with the consciousness of the people.

To prevent pollution of groundwater;

1. To protect our public health, our valuable underground water, our lakes, rivers and waterways, and avoid costly repairs that may arise from negligence, education by channels such as social media, webpage etc. should be provided by the Environmental Protection Institutions as necessary (23)
2. Industrial waste should be controlled.
3. The agricultural pesticides and fertilizers used in agriculture mix with soil and groundwater according to the geographical feature of the land. Damages of agricultural drugs should be explained to our farmers, this should be done with supervision and follow-up.
4. Workshops should be organized by local authorities to inform industrial, construction and real estate agencies
5. Regional «river sub-committees» can be established to prevent industrial pollution (24)



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