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Research Article

Investigation of Pollution Loads of Marmara Sea Discharge Points between Suleymanpaşa (Tekirdag) and Kuçukçekmece Lake (İstanbul)

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Abstract

In this study, the pollution that may be caused by wastewater discharges into the Marmara Sea between Tekirdağ provincial campus and Küçükçekmece Lake (Istanbul) was investigated. The samples were taken and evaluated from the locations after the discharge points, before and after mixing with the sea. The pH, salinity, conductivity, dissolved oxygen, and inorganic pollutants (Cu, Cd, Co, Cr, Mo, Ni, Pb, P, Hg, Fe, As, Mn, Zn, Al, Na, Mg, K, Ca, B, Bi, Sb) were examined. The parameters measured as a result of these investigations were evaluated according to the regulations of the Republic of Türkiye, Water Pollution Control Regulation, Properties of Domestic/Urban Wastewaters Allowable for Deep Sea Discharge and Characteristics of Industrial Wastewaters for Allowable Deep Sea Discharge. It was observed that most of the parameters did not exceed the limit values specified in the regulation, but the boron element was above the limit values in the samples taken from Büyükçekmece and Küçükçekmece lakes. The reason for this may be laundry bleach, soap, detergent wastes, reactants used in industry, and fertilizers and pesticides used in agricultural areas. In addition, it is thought that the high solubility of boron minerals in water causes the boron concentration to be high at the discharge points of water sources passing through domestic and industrial areas. As can be seen, the first reason for the pollution of the Sea of Marmara is the discharge of industrial and domestic wastewater into the sea without it being sufficiently treated. In addition, it is necessary to constantly monitor the Sea of Marmara, which is dense in terms of maritime traffic, and to prevent negative behaviors that may cause pollution. Furthermore, depending on the intensity of agricultural activities in neighboring land areas, it is seen that agricultural fertilization and agricultural spraying are impacting sea pollution.

Keywords: Heavy metal, ICP-OES, Pollution Load, Ship Traffic, Treatment, Streams, Sea of Marmara.

Süleymanpaşa (Tekirdağ) - Küçükçekmece Gölü (İstanbul) Arası Marmara Denizi Deşarj Noktalarının Kirlilik Yüklerinin Araştırılması

Öz

Bu çalışmada, Tekirdağ ili ile Küçükçekmece Gölü (İstanbul) arası Marmara Denizi'ne yapılan atıksu deşarjlarının denizde oluşturabileceği kirlenmeler araştırılmıştır. Numuneler, deşarj noktalarının denize karışmadan ve denize karıştıktan sonraki lokasyonlardan alınmıştır ve değerlendirilmiştir. Su numunelerinin pH, tuzluluk, iletkenlik, çözünmüş oksijen ve inorganik kirleticiler (Al, B, Cu, Fe, Mn, Zn) yönünden incelenmesi yapılmıştır. Bu incelemeler sonucunda ölçülen parametreler Su Kirliliği Kontrolü Yönetmeliği, Derin Deniz Deşarjına İzin Verilebilecek Evsel/Kentsel Atıksuların Özellikleri ve Derin Deniz Deşarjına İzin Verilebilecek Endüstriyel Atıksuların Özellikleri mevzuatlarına göre değerlendirilmiştir. Parametrelerin çoğunun yönetmelikte geçen sınır değerleri aşmadığı ancak Büyükçekmece ve Küçükçekmece göllerinden alınan numunelerde bor elementinin sınır değerlerin üzerinde olduğu gözlenmiştir. Bunun nedeni evsel atıksulardan gelen çamaşır beyazlatıcı, sabun, deterjan atıkları, sanayide kullanılan reaktanlar ve tarım alanlarında kullanılan gübre ve tarım ilaçları olabilir. Ayrıca bor minerallerinin suda çözünürlüklerinin yüksek olması evsel ve sanayi alanlarından geçen su kaynaklarının deşarj noktalarında bor konsantrasyonunun yüksek çıkmasına neden olduğu düşünülmektedir. Görüldüğü üzere Marmara Denizi'nin kirlenmesinin birinci nedeni sanayi ve evsel atık suların yeterince arıtılmadan denize deşarj edilmesidir. Bunun yanı sıra deniz trafiği açısından yoğun olan Marmara Denizi'nin sürekli izlenmesi ve kirlilik

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oluşturabilecek olumsuz davranışların önüne geçilmesi gerekmektedir. Ayrıca komşu kara alanlarda tarımsal faaliyetlerin yoğunluğuna bağlı olarak tarımsal gübreleme ve tarımsal ilaç kullanımının da etkili olduğunu görülmektedir.

Anahtar Kelimeler: Ağır Metal, ICP-OES, Kirlilik Yükü, Gemi Trafiği, Arıtma, Akarsular, Marmara Denizi

1. Introduction

Due to the intensity of industrial and agricultural activities in the Marmara Region, its population is increasing enormously. The decrease in natural resources as a result of human consumption also brings environmental problems (Yümün and Kam 2021). Among the most important causes of pollution is the uncontrolled and illegal discharge of industrial or domestic waste into rivers, lakes, and seas. The pollution of surface and underground waters is caused by the transportation of domestic and industrial wastes, agricultural fertilizers and pesticides to the water environment (Önce et. al. 2021; Atlas and Büyükgüngör 2008). Many researchers (Yipel and Tekeli 2016; Yümün and Önce 2017; Dereli et. al. 2017) define water pollution as the presence of some organic, inorganic, radioactive or biological substances, to such an extent that it prevents water use or significantly reduces its quality. Polluted water discharged into the seas or other surface water environments poses a problem in the aquatic ecosystem. In particular when toxic elements reach harmful amounts by accumulating (bioaccumulation and/or bioaccumulation) in the tissues and organs of organisms that make up the food chain for many living things (Aktop and Çağatay 2020; Atabeyoğlu and Atamanalp 2010). As a result, the food chain and all other living things can be harmed. There are also many industrial establishments that can cause atmospheric pollution in the Marmara basin. This pollution density around the Marmara Sea leaves it vulnerable to atmospheric pollution loads. It is known that from time to time, industrial establishments in the region directly or indirectly discharge their waste into the environment without treatment, resulting in an increase in the pollution load in the Marmara Sea. The Marmara Sea, which is a waterway between the Aegean Sea and the Black Sea, carries pollutants to other seas with its currents. In particular pollutants suitable for bioaccumulation pose great dangers to the ecosystem (Taşdemir 2002). In recent years, many scientific studies have been carried out in order to detect the pollution in the seas and rivers and to take precautions (Özgür 2006; Yümün 2017; Yümün et. al. 2019; Tao et al. 2012).

Researchers have conducted many studies on the transport of pollution from terrestrial areas to the seas (Artüz 2002; Balkıs and Çağatay 2001; Çağatay 1996; Çağatay 2006; Dinçer et al. 2019; Kam and Önce 2016; Mülayim et al. 2011; Yümün and Kam 2021; Yümün and Önce 2017; Yümün 2017; Yümün et al. 2022; Yümün et al. 2023). Artüz (2002) conducted a due diligence by examining the ecology and ecological changes of the Marmara Sea and the straits. In the study conducted by Balkıs and Çağatay (2001) the factors controlling the metal distributions in the surface sediments of Erdek Bay of the Marmara Sea were examined and the precautions to be taken were emphasized. On the other hand, Dincer et al. (2019) examined intracontinental pollution by evaluating the total carbon (Tc), total organic carbon (Toc), inorganic carbon (Ic), total nitrogen (Tn) and Toc/Tn ratios. He stated that organic matter discharged into the seas should be reduced to prevent pollution. Cagatay et.al. (1996) investigated the distribution of carbonate and organic carbon contents in the Late Quaternary sediments of the Southern Marmara Shelf and emphasized its role in marine pollution. Çağatay et.al. (2006) prepared the sedimentary geochemistry map of the Marmara Sea and revealed the distribution of pollution in the sea. The accumulation and pollution potential of heavy metals in the current marine sediments between Bandırma (Balıkesir) and Lâpseki (Çanakkale) in the Marmara Sea were investigated by Kam and Önce (2016). Similar to the previous study, Mülayim et.al. (2011) also focused on the total metal distribution of the surface sediments of Bandırma and Erdek Bays. Yümün (2017) investigated a wide area covering the West of the Marmara Sea and examined the effect of heavy metal pollution of the current marine sedimentary on microorganisms (Foraminifers). In addition, heavy metal pollution in the West Marmara Sea was investigated by sediment evaluation methods. These studies were carried out not only for the Sea of Marmara, but also for other seas. One of these studies is "Monitoring Heavy Metal Pollution in Foraminifera from Edremit Bay (Northeast Aegean Sea)" by Yümün and Önce (2016). The detection of marine pollution and the precautions to be taken by scientists continued with different scientific research techniques. The heavy metal concentrations of the marine sediments of the Yalova Section of the Marmara Sea were measured by Yümün et al. (2022) using the libs method and the pollution was evaluated with the principal component analysis. Increasing pollution in the Sea of Marmara in recent years has led to the formation of mucilage in the sea and thus to significant environmental pollution. The reasons for the formation of mucilage and the solution methods were examined by Yümün and Kam (2021). Later, Yümün et.al. (2023) stated the methods of preventing mucilage by working on the Causes of Sea Saliva Composition in the Light of the Findings of Sea Saliva (Mucilage) Composition and Suggestions for Solutions in the Sea of Marmara. This study was carried out to determine the water quality in the western part of the Marmara Sea and the factors that change this water quality. Moreover, this study has created a scientific awareness to take precautions before marine pollution occurs.

2. Material and Method

2.1. Collection of Samples

In this study, water samples were taken and analyzed to determine the pollution status of the Marmara Sea, which is between Süleymanpaşa (Tekirdağ) and Küçükçekmece (Istanbul). 14 water samples were taken from the sea water before and after the discharge into the sea (Figure 1). Coordinates of the 14 sampled points are shown in Table 1. Samples were collected using 0.5-1.5L sterile plastic bottles. The sample cup was first washed 2-3 times by shaking with the water in the environment where the water sample was to be taken, and then the sample was taken. Care was taken to avoid any air between the lid and the water sample in the sample container. TS EN ISO 5667-3 March 2007 Standards have been applied in the collection, preservation, and transportation of water samples. According to this standard, water samples were taken by immersing the sample cups approximately 30-40 cm from the water surface. For chemical analysis, sample volumes specified in the TS EN ISO 5667-3 standard and appropriate sample containers were used and the containers were labeled with the sample names. Water samples taken in 1.5L plastic pet bottles were stored at +4°C until measurement. Analysis of organic and inorganic pollutants (Al, B, Cu, Fe, Mn, Zn) were made by 'Tekirdağ Namık Kemal University Central Research Laboratory NABİLTEM.

Figure 1. Study area location map

Table 1. Coordinates of the work area

SAMPLE LOCATION	GEOGRAPHIC COORDINATES	
	X	Y
S 1.1 : Yenice District	41° 0'44.10"K	27°43'44.60"D
S 2.1 : Kum Stream	40°58'11.50"K	27°55'35.00"D
S 2.2 : Kum Stream	40°58'11.15"K	27°55'33.68"D
S 3.1 : Kınıklı Stream	41° 0'38.20"K	27°59'7.70"D
S 3.2 : Kınıklı Stream	41° 0'40.47"K	27°59'9.82"D
S 4.1 : Çeltik Yolu District	41° 3'37.80"K	28° 6'23.60"D
S 4.2 : Çeltik Yolu District	41° 3'37.15"K	28° 6'23.80"D
S 5.1 : Tuzla Stream	41° 4'39.90"K	28°14'8.20"D
S 5.2 : Tuzla Stream	41° 4'38.73"K	28°14'8.70"D
S 6.1 : Büyükçekmece Lake	41° 1'17.90"K	28°34'24.15"D
S 7.1 : Küçükçekmece Lake	40°58'39.90"K	28°46'28.80"D
S 7.2 : Küçükçekmece Lake	40°58'37.80"K	28°46'29.50"D

2.2. Sample Analysis

As soon as the samples were taken, their physical properties such as salinity, conductivity, dissolved oxygen, and pH were measured instantly. Other samples taken for organic matter and chemical analysis were preserved in accordance with the standards and brought to Tekirdağ Namık Kemal University Central Research Laboratory. Detection of inorganic contaminants in water samples was carried out using an Inductively Coupled Plasma Optical Emission Spectrometer (ICP-OES) device (Cu, Cd, Co, Cr, Mo, Ni, Pb, P, Hg, Fe, As, Mn, Zn, Al, Na, Mg, K, Ca, B, Bi, Sb) (Yümün and Önce Nişancıoğlu 2023). The measurement method with the ICP-OES device is based on the measurement of the emission of atoms excited by passing into the gas phase by spraying the sample into the high-temperature plasma (Yümün, 2017, Yümün and Önce, 2017, Yümün et. al. 2021). The sample in the solution state is sprayed into the plasma at a temperature of about 6,000-10,000 °C, and in this process the sample passes into the gas phase. Atoms that pass into the gas phase enter the excited state in the plasma. The measurement method is based on the principle of determining the amount of elements in the solution by measuring the radiation emitted by the excited atoms in the plasma with a suitable detector (Akdemir 2014).

2.3. Legal Framework and Discharge Standards

According to Article 56 of the Constitution of the Republic of Türkiye: "all people have the right to live in a healthy and balanced environment. It is the responsibility of the state and citizens to ensure the development of the natural structure of the environment and to take measures against the pollution of the environment." The general quality criteria of sea water from the seas have been determined in the Regulation on Water Pollution Control (table 2), and the chemical and physical properties of sea water have been determined and correlated. It has been interpreted by making use of the element concentrations obtained from the samples, General Quality Criteria of Sea Water (Regulation 1, Table-4), Discharge Standards of Mixed Industrial Wastewaters to the Receiving Environment (Regulation 1, Table 19), Wastewater Standards for Discharge of Wastewater to Wastewater Infrastructure Facilities (Regulation 1, Table 22) and " List of Harmful Substances that are Forbidden to be Dumped into Inland Waters and Seas, and Acceptable Values of the Receiving Environment" (Regulation 2, ANNEX-5) given in ANNEX-5 of the Fisheries Regulation (Official Gazette dated 10.03.1995 and numbered 22223).

Table 2. *General Quality Criteria of Sea Water (Regulation 1, Table-4)*

PARAMETER	CRITERIA	DESCRIPTIONS
PH	6.0-9.0	-
COLOR AND TURBENCE	Natural	It should be such that the photosynthetic activity necessary for natural aquatic life does not affect the normal value at measurement depth by more than 90%.
FLOATING MATERIAL	-	Liquids such as oil, tar-like liquids and solids such as garbage cannot be found floating.
SUSPENDED SOLID (MG/L)	30	-
DISSOLVED OXYGEN (MG/L)	More than 90% of saturation	Dissolved oxygen values should be monitored throughout the depth.
DEGRADABLE ORGANIC CONTAMINANTS	-	After dilution, it should not be in an amount that would endanger the presence of dissolved oxygen more than the value predicted above.
CRUDE OIL AND OIL DERIVATIVES (MG/L)	0.003	Water should be evaluated separately in biota and sediment and preferably not found at all.
TOTAL PHENOLS (MG/L)	0.001	It should not be more than the given limit values
VARIOUS HEAVY METALS		It should not be more than the given limit values
COPPER, (MG/L)	0.01	It should not be more than the given limit values
CADMIUM, (MG/L)	0.01	It should not be more than the given limit values
CHROMIUM, (MG/L)	0.1	It should not be more than the given limit values
LEAD, (MG/L)	0.1	It should not be more than the given limit values
NICKEL, (MG/L)	0.1	It should not be more than the given limit values
ZINC, (MG/L)	0.1	It should not be more than the given limit values
MERCURY, (MG/L)	0.004	It should not be more than the given limit values
ARSENIC, (MG/L)	0.1	It should not be more than the given limit values
AMMONIA, (MG/L)	0.02	It should not be more than the given limit values

3. Results and Discussion

Table 3 shows the ICP-OES measurement results of the water samples at the locations between Süleymanpaşa (Tekirdağ) and Küçükçekmece Lake (Istanbul) that flow into the Marmara Sea and whose coordinates are given in Table 1. All the results obtained were evaluated according to the limit values of the elements in the aquatic environment specified in the relevant articles of the Turkish Republic Water Pollution Control Regulation and the Fisheries Regulation (given in Table 3). Concentration values of (Cu, Cd, Co, Cr, Mo, Ni, Pb, P, Hg, Fe, As, Mn, Zn, Al, Na, Mg, K, Ca, B, Bi, Sb) elements were analyzed with ICP-OES in the water samples taken. Al, Fe, B, Zn, Mn and Cu values were measured in the analysis, but it was determined that other elements were below the measurement values. Laboratory analysis results were interpreted by comparing the regulations applied in the Republic of Türkiye. In the analysis results given in Table 3, the distributions of each element according to the locations were examined. The Aluminum (Al) concentration of the Küçükçekmece Lake (0.025- 0.031 ppm) samples is lower than the regulation values (0.07 mg/L), and the Al concentrations of the other samples are higher than the regulation values. Boron (B) concentration
detected in the Marmara Sea Water sample from Yenice Mevkii (S.1.1.: 0.39 ppm) and Tuzla Stream samples (S.5.1.: 0.53 ppm) are below the regulation values (0.70 ppm). The boron element concentration detected in all samples taken at other locations is higher than the regulation limits. The fact that the boron element is very high in the Marmara Sea samples, and especially in the Büyükçekmece and Küçükçekmece lakes, also indicates the boron accumulation and evaporation in the sea due to industrial waste. Copper (Cu) element was found below the regulation values (3.00 ppm) in all of the Marmara Sea and discharge waters. The Iron (Fe) concentration values of all locations are much higher than the regulation values (0.003 ppm). This shows that it is caused by the waste arising from the

industrial activities and ship traffic around the Marmara Sea. Manganese (Mn) concentration is lower than the regulation values (1.00 mg/L) in all locations. Zinc (Zn) concentrations of Marmara Sea Water (0.009 ppm), Kum Stream (0.001 ppm) and Kum Stream Discharge Point (0.001 ppm) samples from Yenice Mevkii are below the regulation value (0.10-10.00 mg/L). Zinc concentrations from other locations are higher than regulatory values. The high Zn values of the rivers in locations with high Zn concentrations cause us to draw attention to the wastewater discharged into these waters. It also shows that agricultural fertilization and pesticides are effective depending on the intensity of agricultural activities in neighboring land areas. Elements enriched in the soil as a result of agricultural fertilizers and pesticides are transported to rivers and seas through surface runoff.. The analysis results of the study were also visualized and interpreted in the graph given in Figure 2. Here too, although the boron element is high in almost all locations, the fact that the values in sea water are higher than in the discharge waters is a remarkable finding. This situation, which points to the excess of evaporation in Büyükçekmece and Küçükçekmece lakes, indicates that these locations may be boron deposits in the future. This situation shows that the sea is also polluted by other sources than the discharge water.

Table 3. *Analysis results of the elements measured with the ICP-OES device*

SAMPLE	TYPE	AL	B	CU	FE	MN	ZN
		ppm	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**
S.1.1. MARMARA SEA	**1**	0.427	0.387	0.114	0.359	0.346	0.009
WATER IN YENICE	**2**	0.419	0.400	0.326	0.387	0.372	0.085
LOCATION	**<Average>**	0.423	0.394	0.220	0.373	0.359	0.086
S.2.1. Kum Stream	**1**	0.219	0.761	0.000	0.179	0.019	0.000
	2	0.222	0.754	0.000	0.182	0.021	0.000
	<Average>	0.221	0.758	0.000	0.180	0.020	0.000
S.2.2. Kum Stream D.P.	**1**	0.268	1.299	0.000	0.250	0.032	0.000
	2	0.244	1.312	0.000	0.226	0.032	0.000
	<Average>	0.256	1.305	0.000	0.238	0.032	0.000
S.3.1. Kınıklı Stream	**1**	0.322	1.837	1.421	0.351	0.063	0.148
	2	0.322	1.964	1.728	0.369	0.071	0.140
	<Average>	0.322	1.901	1.575	0.360	0.067	0.144
S.3.2. Kınıklı Stream	**1**	0.281	0.725	0.755	0.311	0.141	0.156
D.P.	**2**	0.281	0.731	0.189	0.318	0.141	0.154
	<Average>	0.281	0.728	0.472	0.314	0.141	0.155
S.4.1. Çeltik Water	**1**	0.238	1.470	0.000	0.233	0.144	0.147
	2	0.258	1.466	0.000	0.252	0.145	0.145
	<Average>	0.248	1.468	0.000	0.243	0.145	0.146
S.4.2. Çeltik Water D.P.	**1**	0.213	1.700	0.000	0.214	0.136	0.156
	2	0.233	1.715	0.000	0.233	0.137	0.155
	<Average>	0.223	1.707	0.000	0.223	0.136	0.156
S.5.1. Tuzla Stream	**1**	0.127	0.533	0.000	1.037	0.252	0.045
	2	0.089	0.524	0.000	0.711	0.236	0.088
	<Average>	0.108	0.528	0.000	0.874	0.244	0.061
S.5.2. Tuzla Stream D.P.	**1**	0.119	1.235	0.000	1.047	0.202	0.087
	2	0.085	1.236	0.000	0.710	0.195	0.101
	<Average>	0.102	1.236	0.000	0.878	0.199	0.094
S.6.1. Büyükçekmece	**1**	0.182	2.786	0.636	0.071	0.023	0.058
Lake	**2**	0.081	2.726	0.780	0.069	0.023	0.071
	<Average>	0.131	2.756	0.708	0.070	0.023	0.065
S.7.1. Küçükçekmece	**1**	0.026	2.941	0.000	0.023	0.008	0.025
Lake	**2**	0.024	2.977	0.000	0.020	0.008	0.026
	<Average>	0.025	2.959	0.000	0.021	0.008	0.025
S.7.2. Küçükçekmece	**1**	0.035	2.901	0.000	0.025	0.008	0.105
Lake	**2**	0.028	2.910	0.000	0.021	0.008	0.086
	<x>	0.031	2.906	0.000	0.024	0.008	0.096
LOD		**0.00048**	**0.00161**	**0.00201**	**0.00106**	**0.00052**	**0.00157**
LOQ		**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**
*		**-**	**-**	**-**	**0.10**	**-**	**0.01**
**		**0.07**	**0.70**	**3.00**	**0.003**	**1.00**	**0.01**
***		**-**	**10.00**	**-**	**5.00**	**-**	**3.00**
****		**-**	**-**	**-**	**10.00**	**-**	**2.00**

Limit Of Observation (Lod) = 3 X Standard Deviation Value Limit Of Detection (Loq) = 10 X Standard Deviation Value. (Sda: Below Detectable Values), D.P.: Discharge Point

* *General Quality Criteria of Sea Water (Regulation 1, Table-4)*

**. *Harmful Substances That Are Forbidden To Be Poured Into Inland Waters And Seas And The Acceptable Values Of The Receiving Environment (Regulation 2, Annex-5)*

***. *Discharge Standards of Mixed Industrial Wastewaters to the Receiving Environment (Small and Large Organized Industrial Zones and Other Industries whose Sector Cannot Be Determined) (Regulation 1, Table 19)*

******.** *Wastewater Standards For Discharge Of Wastewater To Wastewater Infrastructure Facilities (Regulation 1, Table 22)*

The instantaneous pH, dissolved oxygen, salinity, and conductivity values of the water samples belonging to the study area are shown in Table 4. Locations with low dissolved oxygen have low pH values, and locations with high oxygen values have high pH values. It is known that the specific electrical conductivity (standardized electrical conductivity at 25°C), which is an indicator of the total ion content of seawater, varies between 51,750 and 55,500 µS/cm (Özyurt et al., 2001). In locations where salinity is high, electrical conductivity is high. The low pH value in locations with high electrical conductivity is striking. Since the electrical conductivity depends on the ion concentration, it also changes the acidity of the environment. Electrical conductivity can be considered as one of the preliminary evaluation parameters for the determination of pollution in aquatic environments.

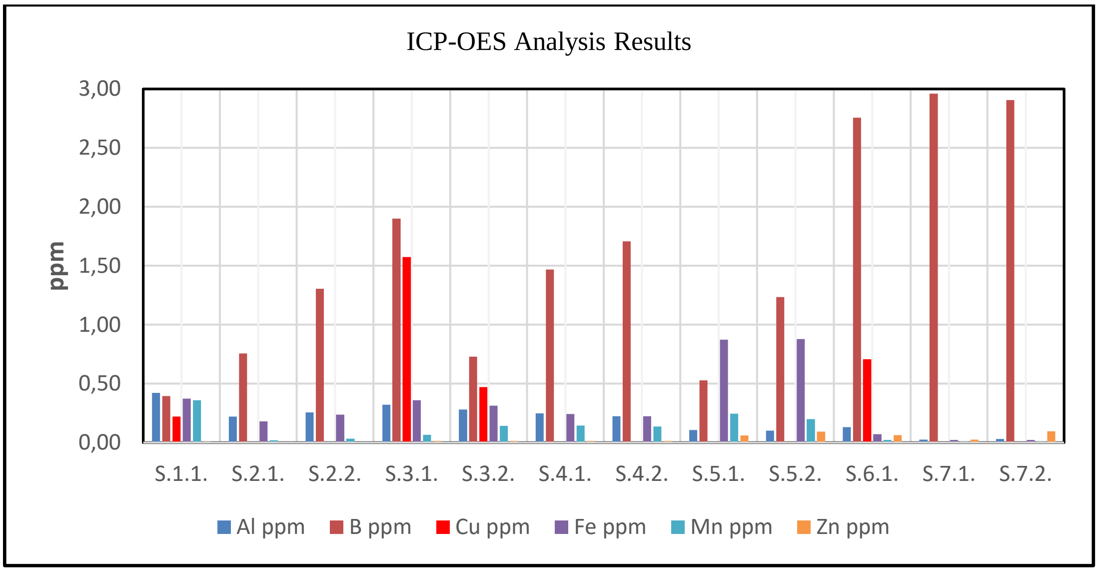

Figure 2. *Elemental Analysis Results of Water Samples (ICP-OES Analysis Results)*

Table 4. *pH, dissolved oxygen, salinity, conductivity values of water samples*

SAMPLE LOCATIONS	PH	DISSOLVED OXYGEN (MG/L)	SALINITY (%)	CONDUCTIVITY MS/CM
S 1.1	8.01	5.9	3.01	52350
S 2.1	8.21	8.7	2.75	49850
S 2.2	7.95	5.7	2.96	48550
S 3.1	7.99	7.8	2.81	51500
S 3.2	7.95	5.1	2.80	50960
S 4.1	8.16	8.6	2.75	53500
S 4.2	7.89	6.1	2.98	54120
S 5.1	8.16	7.5	3.13	52300
S 5.2	8.01	6.6	2.86	50850
S 6.1	7.59	6.9	3.07	52050
S 7.1	8.05	6.2	2.89	51200
S 7.2	8.13	6.9	2.88	51850
AVERAGE	8.01	5.94	2.91	51590

Although most of the sea waters have salinity values of 3.0% to 3.7%, the salinity rate of the seas varies around the world. In this study, salinity values in the Northeast of the Sea of Marmara are between 2.75% and 3.13%. The reason for the low salinity here can be shown to a large extent by the surface water flows from the Black Sea to the Marmara Sea. It is known that the pH value of ocean and sea waters varies between 7.5 and 8.4. In this study, pH values are between 7.95 and 8.7. Here, again, the effect of diluted sea water coming from the Black Sea can be seen. Although the saturated dissolved oxygen (DO) values in the Black Sea between 2014-2019 are 6.5-7.5 mg/L, the average value is 6.2 mg/L (Yümün and Önce-Nişancıoğlu 2023). In the Mediterranean, surface water dissolved oxygen concentration values in the summer period are in the range of 4.20-8.33 mg/L, with an average of 7.0 mg/L (Salt and Tanaş 2017). Although the dissolved oxygen (DO) values measured in the coastal and open surface waters of the Aegean Sea vary between 4.1 and 8.0 mg/L during the summer period, the average value is determined as 6.9 mg/L (Salt and Tanaş 2017). In the measurements made in the Marmara Sea during the summer period, the Dissolved Oxygen Ratio is 6.5-8.0 mg/L and the average value is 6.8 mg/L (Salt and Tanaş 2017). Within the scope of this study, while the oxygen values measured in the Northeast of the Marmara Sea ranged between

5.94 and 6.9 mg/L, this value was measured between 7.5-8.7 mg/L in the stream samples pouring into the same locations. Although the water discharged into the sea here is polluted, the high oxygen values are a remarkable result.

4. Conclusions and Recommendations

Pollution can harm all living creatures in or around the aquatic environment in which it lives, and it also prepares the environment for the extinction of some species and living communities. One of the most important causes of pollution of aquatic environments is the direct or indirect discharge of waste that may have toxic effects on the aquatic environment. Apart from this, the mixing of calcium, sodium, magnesium, iron, and other main and trace elements, which exist in nature and mix with water naturally, into water in higher amounts than the standards are among the causes of pollution. Consumption of dissolved oxygen in water by animal and plant species can also create a situation for pollution in the environment. Depending on the prevalence of the discharge points of the waste waters that may pollute the aquatic environment, the pollutions are considered as point pollution and diffuse pollution. In this study, samples were taken from seven locations in the north of the Marmara Sea in order to investigate whether the pollution is widespread or punctual. For the measurement of pollution, chemical and physical analysis were made and the results were evaluated.

Pollutants cause physical and chemical changes in water. While there are physical changes in color, turbidity, suspended matter, odor and taste, chemical pH, oxygen content, conductivity and chemical substance concentrations change. For this reason, pH, Dissolved Oxygen, Salinity, Conductivity and chemical contents of the water samples were measured and the results were evaluated according to "T.R. Ministry of Agriculture and Rural Affairs, fisheries license permit for real persons, harmful substances that are forbidden to be poured into inland waters and production areas in the seas, and the list of acceptable values pertaining to the receiving environment".

The analysis of the samples taken shows that pollution in the Sea of Marmara is more common than pointwise. Except for Küçükçekmece Lake (0.025- 0.031 ppm) Aluminum (Al) concentration, the Al concentrations of the other samples are higher than the regulation values. Boron (B) concentrations in the waters of the Marmara Sea and Tuzla Stream in Yenice District are below the regulation values (0.70 ppm) and higher than the regulation limits in other locations. The fact that the boron element is very high in the Marmara Sea and in Büyükçekmece and Küçükçekmece lakes indicates evaporation and boron accumulation in the sea. The reason for this increase in boron value is that our country is rich in boron mines and boron mines reach the seas by mixing with water in various ways (Kalafatoğlu et al. 1997). Copper element was found below the standards in all of the Marmara Sea and discharge waters. Iron (Fe) concentration values are higher than the regulation values. The high level of iron is thought to be due to industrial activities in the land areas adjacent to the Marmara Sea, as well as ship traffic and waste. On the other hand, the manganese concentration is below the regulation values in all locations. At the discharge point of Marmara Sea Water, Kum Stream, and Kum Stream in the Yenice Region, Zinc concentration is lower than the regulation value and very high in other locations.

In this study, the salinity values vary between 2.75-3.13%, and the locations with low salinity values are mostly the discharge points of rivers to the sea. It has been observed that the electrical conductivity is also low in locations where salinity values are low. The quality levels of the surface waters pouring into the sea between Tekirdağ-Küçükçekmece lake are moderate. Further increase in these values will increase the pollution level of the Sea of Marmara, so it would be beneficial to keep it under control. As can be seen, the first reason for the pollution of the Sea of Marmara is the discharge of industrial and domestic wastewater into the sea without it being sufficiently treated. In addition, it is necessary to constantly monitor the Sea of Marmara, which is dense in terms of maritime traffic, and to prevent negative behaviors that may cause pollution.

In addition, the analysis shows that agricultural fertilization and pesticides have an impact depending on the intensity of agricultural activities in neighboring land areas. Elements enriched in the soil as a result of agricultural fertilizers and pesticides are carried to rivers and seas by surface transport. Although the boron element is high in almost all locations, it is a remarkable finding that the values in sea water are higher than in the discharge waters. This situation, which points to the excess of evaporation in Büyükçekmece and Küçükçekmece lakes, indicates that these locations may be boron deposits in the future. This situation shows that the sea is also polluted by other sources than discharge water.

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T.R. Regulation -2: Fisheries Regulation # (3) (10.03.1995-22223 Official Gazette): APPENDIX-5: List of Harmful Substances Prohibited to be Poured into Inland Waters and Production Places in the Seas and Acceptable Values of the Receiving Environment, 2- Acceptable Values of the Receiving Environment, A- Chemical Substances, (In Turkish)