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Analysis of Water Quality in Seawater Samples Collected from Beaches of Istanbul

İstanbul Sahillerinden Toplanan Deniz Suyu Örneklerinin Su Kalitesinin Analizi

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ANALYSIS OF WATER QUALITY IN SEAWATER SAMPLES COLLECTED FROM BEACHES OF ISTANBUL

ABSTRACT

Oceans all throughout the world are becoming more acidic. Due to significant anthropogenic and natural consequences, the acidification of the marginal seas is a more serious threat than it is to the open ocean. Changes in the pH, temperature, level of dissolved oxygen, and salinity of seawater may also be signs of ocean acidification. The current study's objective is to evaluate the water quality in three coastal areas of Istanbul by taking measurements of the physicochemical characteristics over a period of around 3 months. The Marmara coast is a well-liked site for outdoor activities like swimming and fishing in Istanbul, a heavily industrialized and congested metropolis. Bostanci, Kartal, and Maltepe are the most visited swimming beaches on the Anatolian side of the Marmara coast, and the Sea of Marmara is significant for the variety of coastal species. This study looked at certain water quality measures to see if the saltwater quality near the shore was adequate for marine life and human health. The research was conducted from November 2022 to January 2023. The results showed that there is no major risk to human or aquatic life health from the levels of pH, temperature, salinity, and dissolved oxygen in the Sea of Marmara.

Keywords: Water, Parameters, Ecosystem, Marine.

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İSTANBUL SAHİLLERİNDEN TOPLANAN DENİZ SUYU ÖRNEKLERİNİN SU KALİTESİNİN ANALİZİ

ÖZ

Deniz suyunun pH'ındaki, sıcaklığındaki, çözünmüş oksijen seviyesindeki ve tuzluluğundaki değişiklikler su kalitesi için önemli parametrelerdir. Bu çalışmanın amacı, yaklaşık 3 aylık bir süre boyunca fizikokimyasal özelliklerin ölçümlerini alarak İstanbul'un üç kıyı bölgesindeki su kalitesini değerlendirmektir. Marmara kıyısı, yoğun sanayileşmiş ve kalabalık bir metropol olan İstanbul'da yüzme ve balık tutma gibi açık hava etkinlikleri için çok sevilen bir alandır. Bostancı, Kartal ve Maltepe, İstanbul'un Anadolu yakasının en çok ziyaret edilen rekreasyonel kıyılarıdır ve Marmara Denizi, kıyı türlerinin çeşitliliği açısından önem taşımaktadır. Bu çalışma, kıyıya yakın tuzlu su kalitesinin deniz yaşamı ve insan sağlığı için yeterli olup olmadığını görmek amacıyla belirli su kalitesi ölçümlerini inceledi. Araştırma

Kasım 2022'den Ocak 2023'e kadar gerçekleştirildi. Sonuçlar, Marmara Denizi'ndeki pH, sıcaklık, tuzluluk ve çözünmüş oksijen düzeylerinden insan veya su canlıları sağlığına yönelik büyük bir risk bulunmadığını gösterdi.

Anahtar Kelimeler: Su, Parametreler, Ekosistem, Deniz.

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1. INTRODUCTION

Approximately 71% of the Earth's surface is made up of marine habitats, which also hold 97% of the water on the planet. One key factor in the primary production of the ocean, dissolve oxygen, has a sensitive integrating property that can detect changes in the physical and biogeochemical composition of the ocean. While temperature, despite being conservative, has a substantial impact on biological production, salinity is essential to understanding the dynamics of the water column. By analyzing the fluctuation of dissolve oxygen, temperature, and salinity, one can assess the environmental status of the area under study (Mandal ve Das, 2021).

It is considered as a severe problem that environmental pollution has been entering the seas for some time, especially in relatively contained sea systems like the Mediterranean and Marmara seas. Agricultural activities, atmospheric precipitation, commercial shipping, direct discharges and conveyance via rivers, leaky discharges, and agricultural operations are some of the sources of pollution in the Marmara Sea and its surrounding areas (Yuce ve Altundag, 2020). In addition to that, environmental factors can affect marine ecosystems. As a result, marine habitats can get degraded by excessive quantities of heavy metals. Mining, industry, agriculture, and urban wastes are the main causes of heavy metal pollution, which harms coastal areas through heavy metal contamination. When seawater is used for industrial and recreational purposes or when marine resources are employed as a source of nourishment, this sort of pollution can impact both the marine ecosystem and human health. Millions of people, both locals and visitors, visit the beach in Turkey to swim and sunbathe, especially during the warmest times of the year (Kopuz vd.,2020).

Furthermore, the increased amount of tourism in Istanbul can be deemed as an important factor in terms of danger to the water quality in the coastal areas. Different forms of waste generated by humans' i.e. plastic waste and food waste etc. can lead to harmful effects for the marine life. Moreover, a lot of beach activities such as swimming and surfing etc. are carried out in the analyzed stations on everyday basis, further damaging the marine ecosystem. (Özdemir vd., 2022). Hence, the local government has a crucial duty to maintain environmental quality, which can be used to judge the success of environmental management programs, in addition

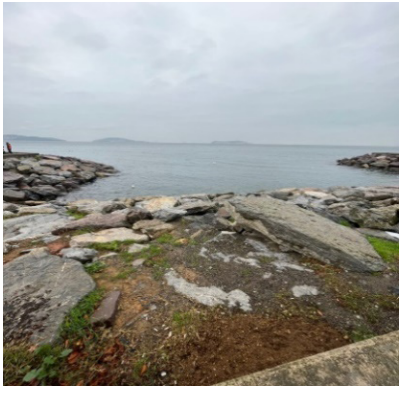
to having a say in how to develop policies and materials for public communication (Salman, 2021).

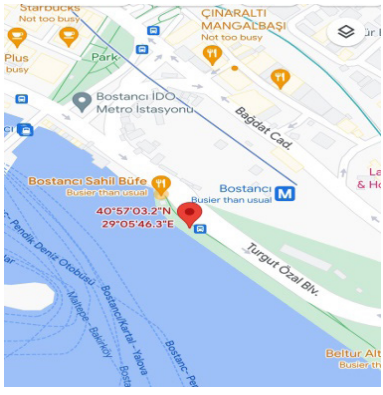
In this investigation, three different Marmara Sea coastal locations were taken into account. Bostanci, Maltepe, and Kartal were the stations under consideration. The investigation lasted from November 2022 to January 2023. The study also had two phases: the first involved gathering samples from those stations, and the second involved lab examination. In terms of analysis, the samples were collected from different points at the stations and later examined. The major values to be determined in order to examine the water quality was the pH, temperature, salinity, and the dissolved oxygen. This helped to distinguish the water quality index in a useful way. The water quality index (WQI), which reflects the combined impact of multiple water quality indicators, can be used to categorize waters and provide information about their health (Abdel-Halim ve Aly-Eldeen, 2016).

The report provides some examples from some other coastal areas around the world in order to provide a better understanding that how certain factors can affect the marine ecosystem and where does the Marmara Sea stand in terms of the water quality with regards to being safe for both human and marine life.

1.1. Area of Study

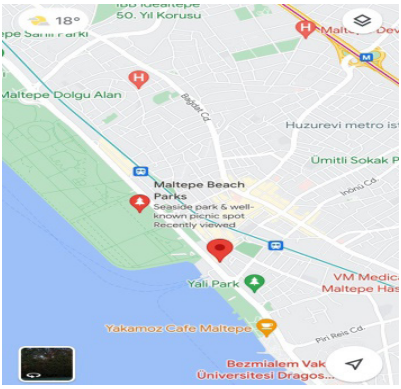
Bostanci





1 a) Bostanci water collection site 1 b) Bostanci Google Map coordinate https://maps.app.goo.gl/1pKQi79VuQKWwTEE6?g_st=iw

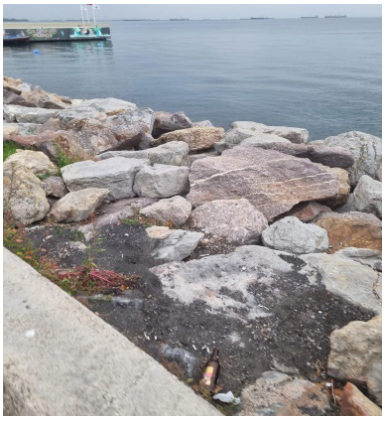
Maltepe

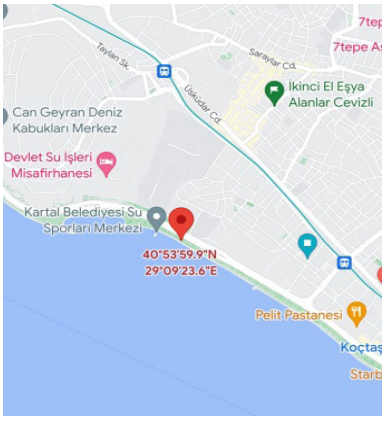


2 a) Maltepe water collection site 2 b) Maltepe Google Map coordinates

https://maps.app.goo.gl/jZLqM5xVbnBHba4WA?g_st=iw

Kartal





3 a) Kartal water collection site 3 b) Kartal Google Map coordinates

https://maps.app.goo.gl/gPzpcgNDnD9tig348?g_st=iw

2. MATERIALS USED

Polyethylene Bottles

A semi-crystalline polymer in the polyester family is called polyethylene terephthalate (PET) as shown in figure 1. For the collection of water, it is the best packaging option. For the past 40 years, PET bottles have been sold, steadily dislodging glass and polyvinyl chloride (PVC) bottles from the market (Bach vd., 2012). There were several reasons to use these bottles i.e. the ability to withstand UV rays and higher temperatures, it can be recycled, and resistivity to various chemical solvents.

Sterile Syringe

A sterile, microorganism-free syringe is known as an aseptic syringe. This is the reason that it was used for the laboratory work as any chance of polluting the sample is eliminated. In general, the syringe is used to remove or inject fluids for various kinds of sampling. Sterile syringes have a needle connected to them and are constructed of glass or plastic as shown in figure 2.

Fig 1 Polythene bottle

Fig 2 Sterile syringe

PES Sterile Syringe Filter

Filters are used to carry out filtration which is done to get rid of bacteria that could potentially interfere with ambient analyze concentrations or to remove suspended contaminants that could interfere with some analytical processes. Sterile syringe filters as shown in Figure 3 are used to sterilize non-sterile solutions or clarify sterile solutions.

Fig 3 Sterile syringe filter

Fig 4 Multi-parameter Device

Multi-Parameter Device

The high water quality needed for aquaculture can be maintained with the use of a portable multi-parameter water monitoring device as shown in figure 4. The data from the sensor node was handled by the system using a CPU. For monitoring water quality, the sensor nodes had sensors for dissolved oxygen, pH, electrical conductivity, and temperature (Defe ve Antonio, 2018). This device proved decisive in regards to being as much accurate as possible.

Water Quality Parameters

Temperature

In the sea, temperature is a fundamental physical element. Changes in temperature can have a profound impact on the characteristics of other seas and marine life. The solubility of gases necessary for photosynthesis, like CO2 and O2, is influenced by temperature. Low temperatures accelerate photosynthetic rates because gases dissolve more readily there than they do at high temperatures. The heat from sunlight that the sea surface absorbs creates variations over time.

Coral bleaching is becoming more frequent because of rising ocean temperatures brought on by a rise in carbon dioxide in the atmosphere. Due to corals' extensive (hundreds or thousands of years) adaptation to local environments, their tolerance is quite, specialized. Unfortunately, because of global warming, which has dramatically raised temperatures in the regions with the biggest concentrations of coral, corals are bleaching out much more quickly than they would have in the past. The distribution of marine organisms may be impacted by extreme

temperatures. To find optimal temperature ranges, some species may migrate to other latitudes or move to cooler regions. This may throw off the stability of marine ecosystems (Feller ve Nybakken, 1983).

Dissolved Oxygen

The quantity of oxygen gas (O2) that is dissolved in water is referred to as dissolved oxygen. Because it directly affects aquatic organisms' survival and general health, it is a crucial parameter. Temperature, salinity, atmospheric pressure, and biological activity are just a few of the variables that affect the amount of dissolved oxygen in water. It also helps to indicate pollution. (Salman, 2021) For the survival of many aquatic creatures, such as fish, invertebrates, and microbes, high concentrations of dissolved oxygen are essential. By providing a suitable habitat for a variety of aquatic species, adequate dissolved oxygen levels enhance biodiversity. Higher levels of dissolved oxygen are often found in thriving and diversified ecosystems. When dissolved oxygen levels are low (< 2.0 mg/l) it causes hypoxia, which is a condition where oxygen availability is inadequate to meet the demands of aquatic organisms. Anoxic is a condition when there water does not contain dissolved or is at (0.2 mg/l). The equilibrium of an ecosystem can be upset by low dissolved oxygen levels. It can change the species composition of the aquatic environment, disrupt the process of nitrogen cycling, and reduce production. Although some species may have particular requirements, the permissible range of dissolved oxygen levels for the majority of aquatic organisms is normally between 4 and 7 milligrams per liter (mg/L). However, depending on the species, water temperature, and other variables, the ideal dissolved oxygen levels can change.

Salinity

The concentration of dissolved salts in water, especially seawater, is referred to as salinity. It is often expressed as the quantity of salt that is dissolved in one kilogram of water, typically measured in grams of salt. Salinity is a crucial element in marine habitats because it affects the physical and chemical characteristics of saltwater and has a variety of effects on marine life. Salinity plays a crucial role in determining the distribution of marine organisms. Certain species are adapted to live in specific salinity ranges, such as estuarine species that can tolerate fluctuating salinities in areas where freshwater meets the ocean. Changes in salinity can lead to shifts in species composition and alter ecosystems. At sea, the salinity ranges from 33 to 38, with an average of 35. The salinity of saltwater fluctuates throughout time as a result of evaporation andprecipitation, river runoff, cooling, and glacier melting. Salinity levels can rise above 40 inregions with heavy evaporation (Rugebregt ve Nurhati, 2020).

Total Dissolved Solids

It represents the concentration of various salts, minerals, and other dissolved materials present in the ocean. TDS is frequently expressed in parts per million (ppm) or milligrams per liter (mg/L). It is crucial to keep in mind that TDS levels can be impacted by human activities such as industrial discharges, pollution, and agricultural runoff. These activities can introduce additional substances into seawater, leading to changes in TDS concentrations and potentially affecting the marine environment. TDS concentration in saltwater is about 35 g/L, or around 35,000 ppm. The delicate balance of marine ecosystems can be upset by sudden variations in TDS, which can cause stress, decreased reproductive success, and even mortality in some species. (Yuce ve Altundag, 2020).

3. DISCUSSION AND RESULTS

Date	Parameters	Bostanci	Maltepe	Kartal
7-Nov-22	Temp (˚C)	16.9	16.8	16.7
	DO(mg/L)	10.6	11.27	13.77
	SAL ppt	26.82	26.24	25.49
	pH	6.47	6.7	6.84
14-Nov-22	Temp (˚C)	16.2	16.3	16.1
	DO(mg/L)	10.31	19.45	12.23
	SAL ppt	27.38	24.05	27.32
	pH	7.02	7.34	7.44
29-Nov-22	Temp (˚C)	14.7	14.5	14.4
	DO(mg/L)	16.63	17.39	11.48
	SAL ppt	23.49	25.99	13.11
	pH	7.02	7.4	7.51
6-Dec-22	Temp (˚C)	14	14	13.2
	DO(mg/L)	11.43	8.49	5.61
	SAL ppt	28.35	28.4	28.47
	pH	7.28	7.45	7.47
14-Dec-22	Temp (˚C)	12.1	13.3	13.2
	DO(mg/L)	21.71	10.37	13.68
	SAL ppt	25.9	26.42	22.29
	pH	7.45	7.21	7.42

20-Dec-22	Temp (˚C)	13.4	12.8	13.2
	DO(mg/L)	13.99	8.31	13.83
	SAL ppt	29.17	29.3	29.19
	pH	7.3	7.35	7.46
28-Dec-22	Temp (˚C)	12.9	12.4	12.3
	DO(mg/L)	10.49	15.1	20.15
	SAL ppt	27.26	27.48	27.38
	pH	7.16	7.32	7.37
3-Jan-23	Temp (˚C)	12	12	11.8
	DO(mg/L)	8.51	7.72	7.92
	SAL ppt	25.54	25.32	25.37
	pH	7.31	7.43	7.39
11-Jan-23	Temp (˚C)	12.7	11.9	11.7
	DO(mg/L)	14.52	13.14	10.83
	SAL ppt	22.67	23.14	22.96
	pH	7.04	7.21	7.25

The data collection began in November at the three stations. A mean temperature of 15.8 degrees Celsius showed that the Marmara Sea was experiencing cooler conditions in November. This can be due to several factors such as the change in seasons and cooling of surface waters due to lower air temperatures. An adequate supply of oxygen was present in November as indicated by the dissolved oxygen concentration of 13.679 mg/l. With an average pH value of 7.08 in November, the Marmara Sea was on the neutral ph. The salinity value of 26.18ppt, which was measured, suggested a moderately saline condition of the sea. A value of 26571.67 for the dissolved solids showed the presence of dissolved solids like minerals and heavy metals.

In December, the temperature of the sea dropped to about 13 degrees due cooling weather. There was a slight drop of the dissolved oxygen value to 12.76 this was because of the low temperatures. There was a slight increase in salinity with an average of 26.71, which showed that the seas was still saline. The pH of Marmara Sea was found to be a mean value of 7.35. It was indicating the sea was getting more alkaline with an increase in pH.

In January, the temperature continued to drop with an average of 12 degrees Celsius measured. The pH of the sea did not increase much but rather remained alkaline with a pH of 7.37. There was also a drop in the salinity with a mean value of 25.41 ppt calculated. The value of dissolved oxygen was also decreasing compared to November because of the cooling weather conditions. The mean value from the three stations was found to be 8.05 mg/l. The total dissolved solids also decreased to 25924.17 mg/l.

From the data collected, it clearly shows that as the temperature decreased so did the other parameters except for pH. Ph continued to increase slightly over the 3 months. The relationship of temperature and these other factors is not direct as other factors also influence the fluctuation of these parameters. Temperature influences some activities at sea like evaporation, which then affect these parameters. Also during this period, we observed a rise in currents, which means that more cold-water masses were being, transported thereby cooling the sea.

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Compared to the other seas, which have an average salinity of 33-40 ppt, the marmara value is less and in the range of 25-27ppt because it does have 3 rivers (Simav River, Biga river, Nilufer) which help to reduce its salinity. For example, the Ohoililir Sea's salinity (Rugebregt ve Nurhati, 2020) remains constant in the range of 33-33.3 because it directly related to the ocean due to not having tributaries, which will help in lowering its salinity.

Comparatively speaking, the Marmara Sea has less salinity than other open seas like the Mediterranean Sea. This can be attributed to that it is connected via inflows from the Aegean Sea and the Black Sea, which helps explain why its salt levels are lower. The Mediterranean Sea, on the other hand, has a higher salinity of about 38.49 ppt due to its limited link to the Atlantic Ocean (Abdel-Halim ve Aly-Eldeen, 2016) and the impact of high evaporation rates.

Contrast to previous studies done in the Marmara sea which showed that as the temperature increased, DO would lower, The dissolved oxygen values measured decreased with temperature and this could be a result of other factors like water mixing and circulation. However, in December, the relationship between salinity and DO was different as salinity increased and DO lowered.

The Northern red sea is the closest in comparison of DO levels with the Marmara Sea because it tends to have relatively high DO levels due to warm temperatures and strong currents. Just like the Marmara Sea, it also has coral reefs, which provide oxygen during the day through photosynthesis. In contrast, the Mediterranean sea should have higher DO levels than Marmara because it is more Deeper and saline than Marmara seas but at the recorded time the value was lower due to factors like pollution (Khedr vd., 2019).

Studies done before showered that the Marmara Sea had a pH in the range of 7.45 to 8.45 (Yuce ve Altundag, 2020) and this differed with our results which we found the range to be 7.08-7.35. This could be because of several factors that affect ph. like water circulation and mixing and atmospheric pressure (Flecha vd.,2022). Variations in Ph. are distinctive and will depend on the stations and the season in which the values were taken. This also played a part in why our ranges, differed.

The pH of Marmara sea is relatively lower compared most of the seas for example the Balearic sea which has a pH of 8.14 . This is because compared to the Sea of Marmara, the Balearic Sea is situated in a climate that is more moderate. The Sea of Marmara's rising temperatures may cause the water's carbon dioxide concentration to rise, which could make the water more acidic. The Balearic Sea is also less polluted and since acidification of the water can be caused by pollution it will have a higher pH. It is also more accessible to the Atlantic Ocean hence the

acidity of the Balearic Sea and also Mediterranean sea can be mitigated by the Atlantic Ocean's greater pH (Flecha vd., 2022).

The Marmara Sea is located in a region with milder weather. The Mediterranean climate, with warm to hot summers and mild to chilly winters, affects the sea. The Marmara Sea can have summer temperatures of 22 to 28 degrees and winter temperatures of 8 to 12 degrees. This is further supported by our research which showed that the temperature dropped to 12 degrees.

In comparison, the Mediterranean sea is warmer. This is so because the Atlantic Ocean, a warmer body of water, is connected more directly to the Mediterranean Sea, which is situated further south. Moreover, the Marmara Sea is shallower than the Mediterranean Sea, which causes it to lose heat to the atmosphere more quickly. Other seas located in the tropical region experiences higher temperatures than the Marmara sea as shown by the south China sea (Wu vd., 2015). The TDS value ranged from 26571.67-25924.17 mg/l. This is lower than the average of other seas which is about 35mg/l. The slight differences is due to differences in volume of waste particularly heavy metals and other natural environmental factors within Marmara sea. It was low in winter because of less pollution from fishing and other beach activities. (Yuce ve Altundag, 2020).

Ocean Name	Year	pH	Temperature ˚C	Dissolved Oxygen (mg/l)	Salinity (ppt)
Mediterranean Sea	2012-18	8.34	22.09	6.92	38.49
South China Sea	2015	8.1	25.8	4.65	-
Ohoililir Sea	2019	8.69	29.74	-	33.2
Balearic Sea	2019	8.14	16	-	37.8
Northern Red Sea Egypt	2015	7.97	20.68	7.71	41.35
Izmit Bay, Marmara Sea	2019	7.52	16.47	9.52	-

The pH range that marine species typically favor is between 7.3 and 8.4 (Kopuz ve Kara, 2020). However, the pH threshold values in Turkey range between 6-9, which makes the water acceptable for marine life as our pH was in the range of 7-7.35. For humans the pH acceptable level is in the range of 6.5-8.5 which means in terms of pH the Marmara sea does not pose a threat to human activities.

In terms of salinity, the water is not fit for human consumption because the acceptable range is below 0.5ppt. However, human life and activities can still be sustained in these conditions as the measured was below 30ppt. For aquatic life it is acceptable because according to their native habitat, invertebrates like corals, prawns, and mollusks often require specific salinity ranges. It can range from 20 ppt for corals to above 40 ppt for other fish.

The values of the calculated DO were neither hypoxic(<2-3mg/l) nor anoxic (0mg/l) which means that there was no threat yet to the aquatic life but have to be monitored at the measured values were decreasing.

Table 1. The Turkish recreational (Turkey Recreational Standards, 2006), general sea quality standards (General Quality Criteria of Sea Water in Turkey, 2004), and EPA human health and aquatic life standards (U.S. EPA, 1986).

Parameter	Turkey Recreational Standards	General Quality Criteria Of Sea Water in Turkey	U.S. EPA Human Health standard for the consumption of Water + Organism	U.S. EPA Human Health standard for the consumption of Organism Only	U.S. EPA Aquatic Life Criteria for saltwater (acute)	U.S. EPA Aquatic Life Criteria for saltwater (chronic)
pH	6.0-9.0	6.0-9.0	5.0-9.0	-	-	6.5-8.5
Dissolved oxygen (%)	80-120	90<	-		-	-
Salinity (µg L^{-1})	-	-	250 000	-	-	-

4. CONCLUSION

The information acquired and examined for this study suggests that from November 2022 to January 2023, the water quality along Istanbul's Marmara Sea shoreline, notably at the beaches of Bostanci, Maltepe, and Kartal, appears to be adequate for both marine life and human health. There were no obvious health dangers to people or aquatic life due to the Sea of Marmara's pH, temperature, salinity, dissolved oxygen, and heavy metal concentrations.

During the study period, the sea's temperature varied from 12 to 15.8 degrees Celsius, with November exhibiting improved weather and December and January showing decreasing temperatures. The dissolved oxygen ranged from 12.76 to 13.679 mg/l, which is higher than the minimum required for aquatic life to exist. The pH of the seawater, which ranged from 7.08 to 7.37, remained neutral to barely alkaline. The range of salinity levels, from 25.41 to 26.71 ppt, indicates a moderately salinity environment. Seawater included dissolved solids in the range of 25,924.17 to 26,571.67 mg/l.

Over the course of the three months, these factors varied, but overall values remained within ranges that were secure for both people and marine life. The temperature and dissolved oxygen levels have decreased due to seasonal fluctuations and accelerated ocean currents. The Sea of Marmara has a lower salinity than other seas, which can be attributed to the existence of streams that lower salinity through freshwater imports.

It is crucial to keep in mind that these findings are specific to the research period and particular regions of the Marmara Sea. The water quality may vary depending on the time of year and the location along the coast. Water quality indicators must be continuously monitored and assessed in order to ensure the long-term sustainability of the marine ecosystem and to protect human health.

Overall, the study's findings provide reassurance that the Marmara Sea coast of Istanbul currently has water quality that is appropriate for both marine life and human activities like swimming and fishing. Long-term water quality improvement and preservation, however, also depend on ongoing efforts to lessen pollution from human waste, agricultural practices, and industrial, activities.

Author Contribution Rates

Design of Study: EBK(%50), AR(%17), NC(%17), MK(%16)

Data Acquisition: EBK(%50), AR(%17), NC(%17), MK(%16)

Data Analysis: EBK(%50), AR(%17), NC(%17), MK(%16)

Writing Up: EBK(%50), AR(%17), NC(%17), MK(%16)

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