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Water quality in the Armutlu Beach

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There is an ongoing relationship in terms of fishing, tourism and transportation both socially and economically on the coasts. It is important to investigate the dynamics of the coasts in terms of people who use them as recreation areas and aquatic creatures that use them as living spaces. For this purpose, the water quality was examined by measuring the sea water temperature, pH, dissolved oxygen, salinity, and concentrations of As, Cd, Cu, Pb, Ni, and Zn daily between 5-14 August 2020 in Armutlu, Yalova. The levels of parameters were close to the previous studies. The order of heavy metal concentrations was: As > Pb > Zn > Cu > Ni > Cd. Armutlu coastline should be saved from pollution, destruction, and crass development.

Keywords: sea water, water quality, heavy metals

Introduction

Coastline has particular needs and stand in particular danger in crowded and fast developing Yalova city. Armutlu Beach is characterized by sandy and stony substrata[1] is located in the east of the Marmara Sea and is famous for water skiing, free diving, scuba diving, swimming and fishing activities. Besides having thermal springs, Armutlu also has rivers as Kaledere, Armutlu, Yamandere, and Uzundere so rivers can pollute the sea water if they are polluted. Due to the started services of Istanbul sea buses, fishing port, marina and fisher shelter in Armutlu, apart from those who earn their income with olive trees, the number of people working in tourism or port works has increased.

292 marine accidents have occurred in the Marmara Sea in the last 50 years[2]. In 1994, the Bosporus of Istanbul was badly affected by the 20.000-ton oil spill from tanker, Nassia colliding with a dry cargo ship, Shipbroker3. Similarly, the oil spilled into the sea from the explosion that occurred while repairing the DWT TPAO tanker in Tuzla Port in 1997[3]. In January 1999, 2,500 tons of fuel leaked from the "Marmara" tanker burning right around the coast of Armutlu provide habitats for cormorants, gray heron, ruddy shelduck, common pochard, duck, calico mallard, reed chicken, snipe, kingfisher, redfish, seagull, turbot, sole fish, oysters, mussels and sea snails[2].

Over 3000 marine species live in the sea of Marmara[4], and in Erdek Bay, Bandirma, 988 individuals from 20 different exotic and rarest species were reported, including 10 actinopterygii, 6 crustaceans, 3 echinodermata, and 1 mollusc species[5]. Similarly, in 2015, sensitive (Cystoseira barbata, Cymodocea nodosa, calcareous red algae) and opportunistic algae (Ulva spp. and Cladophora spp.) were reported[1].

Temperature and dissolved oxygen concentration is a prime factor in the production of ocean, carbon and nutrient cycles, and sea habitat[6].

Pacific geoduck in the North American Pacific Coast is more positively affected by dissolved oxygen and negatively affected by average temperature rather than negatively affected by low pH in terms of protein abundance and shell growth[7].

Just as increasing salinity may increase the peak as concentration, increasing dissolved oxygen also may increase the concentration of Pb, Cu, Cd released from the sediment in Daya Bay, South Chine Sea[8].

Dissolved oxygen, pH decreased significantly between 1991 and 2015 in the Salish Sea and two NE Pacific estuaries, Washington, USA[9].

pH and dissolved oxygen were significantly correlated with trophic-functional groups as non-selectives, algivores, and bacterivores negatively and with predators positively in the Yellow Sea, China[10].

The fishes cannot tolerate sudden changes in pH values[11], similar to the fish deaths in the study, in which there was a temperature value change of 4 degrees in February and 6 in July[12].

A significant dissolved oxygen difference was found between stations ($p < 0.05$) because of difference in photosynthesis, inhalation, water temperature, and salinity in Ildır Bay (Aegean Sea)[13].

Principal component analysis showed that the sea of Marmara Sea is characterized by pH and dissolved oxygen in the 2014-2016 summer seasons[14].

Experimental

In the Marmara University laboratory, the polyethylene bottles were kept in a mixture of 40% nitric acid and 60% deionized water for 24 hours and rinsed 3 times with deionized water (ELGA purelab) and dried in the oven (Binder). The current study was carried out in Armutlu beach, Yalova for 10 days. 10 seawater samples were collected and water temperature (°C), pH, salinity (ppt), dissolved oxygen (mg L^{-1}) measured by using YSI ProQuatro multi parameter (Fig. 1) every day from 5 August to 14 August 2020. When one polyethylene bottle was filled with sea water, the sample were filtered through a 0.45 µm PTFE filter (Sartorius) with a sterile syringe and added 2% nitric acid (Merck) via micropipette and stored in the refrigerator until analysis began. The heavy metals in the seawater samples were identified using inductively coupled plasma optical emission spectrometry (ICP-OES) (Spectro Blue) in seawater samples. The results obtained were analyzed by statistical package SPSS.

Fig. 1. YSI ProQuatro Multi Parameter for Measuring Temperature, Dissolved Oxygen, Salinity, and pH.

Results and discussion

Ayvalık sea quality data is analyzed and descriptive statistics are explored. Four methods are used to investigate the normality assumption. Firstly, data distribution in the histograms is not exactly symmetric because they have not one prominent peak and equal tails to the left and the right. But detrended normal Quantile-Quantile (Q-Q) plot depicts the normal distribution of the sea quality values. Secondly, the coefficient variation (CV) which is the ratio of the standard deviation (σ) to the mean (μ) is greater than 30% for each quality parameter except Ni (Table 1). Thirdly, absolute values of measures of variability include the kurtosis and skewness are less than twice standard errors for each quality parameter and kurtosis and skewness values are between -1 and 1 [15]. Fourthly, significance value of the Shapiro-Wilk Test (P) for temperature, pH, dissolved oxygen, salinity, As, Cu, Pb, and Ni data is greater than 0.05 (Table 1). Therefore, data distributions of all parameters are normal since they satisfy at least three of the 5 conditions.

Table 1. Descriptive Statistics Analyze for Ayvalık Sea Quality Data.

Parameter	σ	μ	CV	Skewness	Std. Error	Kurtosis	Std. Error	P
As	0.651	44.372	0.015	-0.493	0.687	-0.044	1.334	0.935
Cd	0.481	1.806	0.267	-0.833	0.687	-1.266	1.334	0.013
Cu	1.772	7.099	0.250	-0.590	0.752	-0.340	1.481	0.468
Pb	0.827	35.449	0.023	0.583	0.687	1.013	1.334	0.369
Ni	0.918	2.262	0.406	0.128	0.687	-1.355	1.334	0.346
Zn	0.813	12.676	0.064	1.076	0.687	-0.093	1.334	0.018
Temperature	0.599	24.140	0.025	0.482	0.687	0.367	1.334	0.833
DO	6.451	86.984	0.074	0.524	0.687	-1.514	1.334	0.085
pH	0.108	7.976	0.013	0.511	0.687	-0.382	1.334	0.593
Salinity (ppt)	0.535	25.830	0.021	-0.579	0.687	-0.484	1.334	0.456

The normal quantile quantile plot for a sample of size 10 from a normally distributed values can be used for regression.

In August 2020, mean values for the sea water temperature, pH, dissolved oxygen, salinity, and concentrations of As, Cd, Cu, Pb, Ni, and Zn are respectively 24.14 °C, 7.98, 86.98 %, 25.83 ppt, 44.37, 1.81, 7.10, 35.45, 2.26, and 12.68 ppb.

The strength of the relationship was classified with the Pearson correlation[16]. When amount of temperature increases, dissolved oxygen also increases because temperature has positive and strong association with dissolved oxygen (0.5 Pearson correlation). pH has a weak negative relationship with dissolved oxygen (-0.2 Pearson correlation), a medium positive relationship with temperature (0.3 Pearson correlation), but a medium negative relationship with salinity (-0.4 Pearson correlation). Salinity has a medium negative relationship with both dissolved oxygen and pH because the correlation values between salinity and dissolved oxygen and between salinity and pH are -0.3 and -0.4 respectively. As a result, salinity decreases when pH, and temperature increase.

The sea water temperatures, pH, and salinity were respectively from 23.2 to 25.3°C and from 7.82 to 8.16 and from 24.97 to 26.58 ppt, the dissolved oxygen was in the range of 80 to 96.46 %. These dissolved oxygen values did not exceed the Turkish threshold values[17] (in the range of 80 to 120 %) as heavy metals did not exceed Turkish limit values[18] (10 ppb for Cd, and Cu, and 100 ppb for As, Pb, Ni, and Zn). The pH values were in the range of the threshold values for Turkey[18] (6–9) and EPA[19] (5–9 for human health, and 6.5–8.5 for aquatic life).

Concentrations of As (50 ppb), Cd (8 ppb), Cu (37 ppb), Pb (120 ppb), Zn (700 ppb) from polluted Dil Deresi stream water adversely affect to Izmit bay, Marmara Sea[20] however our measured values were under threshold limits. Pb (less than 10ppb) and Zn (21.75ppb) in sea water samples from Dil Iskelesi shore of Izmit[21], mean of pH (8.59), temperature (21.8°C), dissolved oxygen (9.5mg/L), and salinity (21.3ppt) in Armutlu[1], and pH (between 7.8 and 8.5), and salinity (between 20.1 and 24.17) in Marmara Sea[14] were close to our obtained values. The temperature, dissolved oxygen, pH, and salinity were formulated by using regression and figure 2 shows that original values were predicted very closely by formulas (1-4).

$$T = 30.535 + 0.037DO - 0.538SAL + 0.535pH \quad (1)$$

$$DO = 10.497 + 0.244SAL - 10.842pH + 6.489T \quad (2)$$

$$pH = 9.329 - 0.069SAL + 0.031T - 0.004DO \quad (3)$$

$$SAL = 47.419 - 0.52T + 0.001DO - 1.149Ph \quad (4)$$

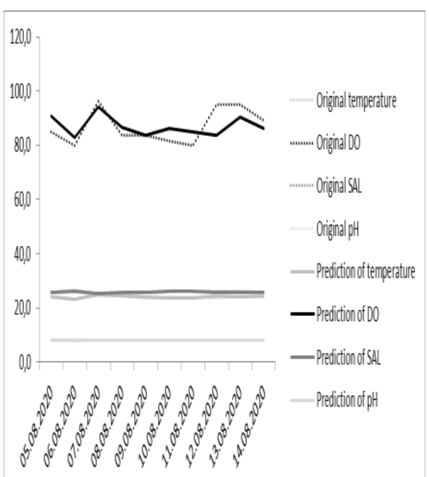

Fig. 2. Temperature, Dissolved Oxygen, Salinity, and pH Predictions by Regression.

Conclusions

An explored descriptive statistic, which aimed to determine normality for Armutlu sea quality data, was carried out during the period of 5-14 August 2020. This data was normally distributed. Moreover, the values of sea quality parameters did not exceed the limits for clean seawater. While salinity showed a negative linear relationship with the temperature, and pH, temperature showed a positive linear relationship with the dissolved oxygen. The formulas for temperature, dissolved oxygen, pH, and salinity depending on each other were obtained via regression. When compared with the real values and the predicted values found by these formulas, it was seen that they were very close. Armutlu beach may be monitored periodically for the prevention, reduction and elimination of marine pollution, adaptation to the circular economy and climate change impacts, sustainable use and management of marine resources, urban, coastal and marine area planning with respect to the public health and marine life.

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