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Research Article

Bathymetric, Physicochemical and Microbiological Analyses of Sarikum Lake (Sinop-Turkey)

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Abstract: Sarikum Lake located in the protected area of Sarikum Village boundaries of Sinop Province Central District was investigated in terms of bathymetric, physicochemical and microbiological aspects. This study was carried out between October 2017 and March 2018. For bathymetric analysis, a Garmin echo 551 c brand dual frequency depth gauge (echo sounder) and 2 GPS receivers were used. For pollution parameters, water samples were taken from stations determined at 3 different points of the lake. Parameters such as temperature, Total Dissolved Solids (TDS), salinity, electrical conductivity, Oxidation Reduction Potential (ORP) and pH were measured with the multifunctional meter during sampling. In addition, ammonia nitrogen (NH_4^+-N), iron (Fe), phosphate phosphorus (PO_4^{3-}-P), manganese (Mn), nitrite nitrogen (NO_2^--N), nitrate nitrogen (NO_3^--N) and total hardness (Ethylene Diamine Tetra Acetic (EDTA) titrimetric) according to standard methods (Apha, Awwa, Wef, 2005). Total coliform, *E. coli*, fecal streptococcus, fecal coliform, sulfide reducing anaerob and *Clostridium perfringes* analyzes were performed for microbiological analyses. Sulfide reducing anaerobes were not detected in the assay results. Based on the obtained results, it is determined that Sarikum Lake within the sanctuary area of Sarikum Village of Sinop province (Turkey) is close to the dirty/pollution limit according to the inland field regulations.

***Keywords*: Sinop, Sarikum Lake, microbiology, water, bathymetry**

1. Introduction

Almost all the societies around the world have settled around water bodies. For this reason, water is the most influential factor in the development and growth of a society. However, industrial growth, uneven urbanization, increasing fertilizer usage in agriculture cause deterioration of natural water environments. Especially with the increasing urbanization, the water ecosystems of the big cities are getting depleted [1].

Contaminated water sources put the life of the creatures at risk and cause economic losses. However, even if the water is adequate, the water availability rate drops when the water quality standards do not match. In water quality management, it is necessary to improve the quality of water by taking into account the needs of the country and the

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acceptance of resources as an ecosystem and the preservation of existing qualities.

Many lakes and rivers in our country have been researched for water quality and pollution [2-4]. In a study, Çiçek studied the water quality parameters of Köprüköy river (Antalya) and stated that the water is less polluted according to the quality criteria [5]. Another study, the numbers of total mesophilic aerob bacteria (TMAB), enterobactericeae, coliforms, faecal coliforms, *E. coli*, Staphylococcus-Micrococcus, *Staphylococcus aureus*, yeasts and moulds, *Vibrio parahaemolyticus*, *Vibrio cholerae*, *Yersinia enterocolitica* and anaerob bacteria were analyzed in the water samples of Tigris river. The contamination of coliforms and *E. coli* were detected in 100% and 90% in the samples, respectively. As a result, he stated that water is harmful to public [6]. Besides, some lake and dam reservoirs have been examined from the bathymetric point of view [7, 8]. However, no study on the water quality and bathymetry of Sarikum Lake has been detected.

The purpose of this study is to determine the bathymetric analysis of Sarikum Lake within the borders of the Central District of Sinop province and also to examine the pollution of the lake water by microbiological and physicochemical aspects. Especially, anaerobic bacteria which are long term pollution indicators for microbiological pollution were analyzed. A study on the suitability for drinking and use in terms of the provisions of the Water Pollution Control Regulation, the Quality Criteria According to Classes of Inland Water Resources, and the Regulation on Waters for Human Consumption was further aimed.

2. Materials and methods

2.1 *Study area*

Sarikum Lake, under protection (Ramsar), is located in the Central Black Sea Region, 21 km west of Sinop provincial center and on the edge of Sarıkum village. The most striking part of the area in terms of nature is the Sarikum Lake, which is fed with a few small streams and is slightly salty and shallow with an area of 1.84 km^2, which flows into the sea through a small canal when the water level rises. Tectonic movements of the lake and its surroundings are located on the resulting pit areas [9].

Here, hydrographic measurement studies were first carried out to obtain consultation work, installation of fixed points and data on the water base. The obtained data were merged into the Netcad 7.6 program in the office. Later, Geographical Information System was integrated with ArcGIS 10.3 software and bathymetric maps of the Lake were created with this program.

Figure 1. Sarıkum Lake

2.2 *Water quality analysis*

The Sarikum Lake is located 21 km west of the city center of Sinop 42°01'21"-42°00'33" North latitude and

34°54'34"-34°55'54" East longitude (Figure 1). In this study, temprature, pH, TDS, ORP, salinity, electrical conductivity, ammonium nitrogen (NH_4^+-N), iron (Fe), phosphate phosphorus (PO_4^{3-}-P), manganese (Mn), nitrite nitrogen (NO_2^--N), nitrate nitrogen (NO_3^--N) values were evaluated. The water samples were collected from designated stations on the same day of each month during the 6-month period from October 2017 to March 2018. Two liters of water samples 659097.63 E 4653657.94 N, 658019.31 E 4654021.59 N and 659656.46 E 4653092.79 N, respectively (Figure 2). Ammonium nitrogen (NH_4^+-N), iron (Fe), phosphate phosphorus (PO_4^{3-}-P), manganese (Mn), nitrite nitrogen (NO_2^--N), nitrate nitrogen (NO_3^--N)-(Merck), total hardness (EDTA titrimetric) were performed according to standard methods [10]. Parameters such as temperature, TDS, salinity, electrical conductivity, ORP and pH were measured with the multifunctional meter (salinometers-ISOLAB mark) during sampling.

Figure 2. Stations at Sarıkum Lake (Yellow points)

2.3 *Microbiological analysis*

In microbiological analysis, coliform, *E. Coli*, *Clostridium perfringens*, Fecal enterococci and for sulfite-reducing anaerobic bacteria were evaluated. Coliform chromogenic agar broth with membrane filter method was used in *E. coli* and total coliform assay. M-CP Agar was used for *C. perfingens* analysis and *C. perfingens* was confirmed in ammonium vapor. Fecal enterococci were studied in the Slanetz-Bartley broth and esculin azide agar was confirmed. Iron sulfate agar was used for sulfite-reducing anaerobic bacteria.

To prepare ten dilutions, 1 mL of sample is transferred to tubes containing 9 mL of dilution fluid and 1/10 dilutions are prepared and microorganisms were counted. After the 250 mL sample was thoroughly shaken, it was passed through sterile membrane filters with 0.45 µm and 0.20 µm pore diameter using membrane filtration system. In order to detect microorganisms (*E. coli* and coliform bacteria-intestinal enterococci-sulfite-reducing anaerobic bacteria-*C. perfingens*) as a result of the filtration process, a membrane filter clamp was placed on top of the appropriate medium so that there would be no air bubbles at the bottom. After being incubated at the appropriate temperature, the colonies that reproduce in the media under membrane filter are counted according to coloni types and the number of suspected colonies is more than 10 if 10, if the number of suspected colonies is below 10, all suspected colonies are calculated by calculating the amount of fluids filtered through the membrane filter and the results are written as kob/mL or kob/g.

E. coli and total coliform determination by placing in coliform chromogenic agar medium by membrane filtration method. It is incubated at 36 degrees for 21 hours. Results; dark blue-purple colored colonies, *E. coli* colonies. The total number of coliform bacteria was collected by counting all pink-red and blue-purple colonies seen in petride. It was then incubated for 21 ± 3 hours and 44 ± 4 hours at a temperature of 36 ± 2°C and 44 ± 0.5°C. The process was repeated for each sample to be incubated at 44 ± 0.5°C for the purpose of preventing unwanted reproduction in polluted waters or detecting fecal coliform.

Slanetz-Bartley media was used for the detection of intestinal enterococci. All prepared Petries were incubated at a temperature of 36 ± 2°C for 44 ± 4 hours. All bombed colonies with red, purple and pink color around and center were evaluated as possible enterococci. In addition, colors that varied from skin color to black in the section surrounding the colony were considered to be the intestinal enterococci of all typical colonies. The membrane filter bile Esculin was placed on Azide Agar and incubated for 2 hours at (44 ± 0.5°C) temperature, resulting in the Black color surrounding the colony was determined as enterechoc.

For the detection of sulfite-reducing anaerobic bacteria (Clostridia) spores, after the sample was thoroughly shaken, 2 tubes of 25 mL and a 25 mL tube containing tap water were prepared in parallel. The tubes were kept in a water bath with a temperature of 75 ± 5°C for 15 minutes and the vegetative forms of the bacteria were destroyed. The water sample from which the vegetative forms were destroyed was passed through a 0.2 µm pore diameter membrane filter and placed on the membrane filter iron sulfide agar. The membrane was completely covered with molten iron sulfide agar, which was kept at 50°C. Petries prepared in this way were placed in anaerobic jara and incubated at a temperature of 37 ± 1°C. They were examined after 20 ± 4 hours and 44 ± 4 hours, and the black typical colonies were read and counted. It was assumed that all black colonies surrounded by black hale originated from a sulfite-reducing anaerobic bacterial spore.

C. perfingens was used on M-CP Agar for detection. The opaque yellow colonies identified after the Petries prepared in this way were incubated for 20 ± 4 hours at a temperature of 44 ± 1°C by placing them in the anaerobic jara were considered to be suspected *C. perfingens* and taken for verification. Petri, where suspected colonies were found, was exposed to ammonium hydroxide vapor (25%) for 20-30 seconds, and colonies that turned yellow to pink-red were considered *C. perfingens*.

2.4 *Bathimetric analysis*

According to the Large Scale Map and Map information Production Regulations, 4 points of polygon point were established in Itrf-96 coordinate. Elevation from sea level is calculated as ellipsoidal.

2.5 *Hydrographic measurements*

In the bathymetric survey of the Sarikum Lake, a 3.5 m long boat belonging to the General Directorate of Nature Conservation and National Parks belonging to Sinop Provincial Branch Directorate, Garmin echo 551 c brand double frequence depth gauge (echo sounder = sonar) and 2 GPS receivers were used. The mobile GPS receiver is set to 3^{11} epoch spacing, horizontal and vertical position ± 0.5 cm. Horizontal position information with RTK-GPS and depth information with a distance of about 10m on the line determined on the water surface are measured simultaneously with the sonar device. Hydrographic measurements were completed at 585 points and in about 5 hours. The data obtained from field trials are combined with the Netcad software tool in the office environment (Figure 3).

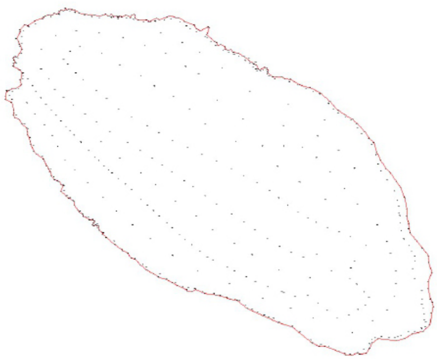

Figure 3. Bathymetric reception points of Sarıkum Lake

The X, Y, and Z values obtained from the numerical models we have obtained in the Netcad environment have been exported to ArcGIS 10.3 software in the ESRI shape format (Figure 4).

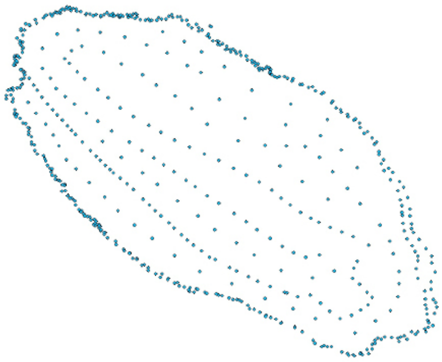

Figure 4. Bathymetric reception points in the GIS environment of Sarıkum Lake

From the exported points, a digital elevation model was obtained using the 3D analyst module (Figure 5).

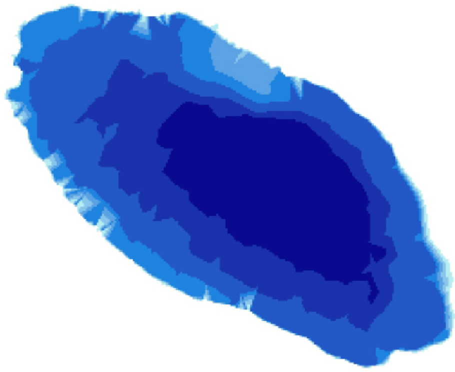

Figure 5. Digital elevation model of Sarıkum Lake

3. Results

The minimum, maximum and average values for the six-month sampling results are given in Table 1 and the monthly data for all stations are given in Table 2. Table 3 shows the measured values of all the stations built during the field trials.

Table 1. Minimum, maximum and mean values of physicochemical parameters in Sarikum Lake

Parameters	Minimum	Maximum	Mean values
Ammonium (NH_4^+-N)/mg/L	0.11	1.97	0.83
Iron (Fe)/mg/L	0.04	0.59	0.22
Phosphate (PO_4^{3-}-P)/mg/L	0.11	2.63	0.87
Manganese (Mn)/mg/L	0.07	0.94	0.35
Nitrite (NO_2^--N /mg/L	0.00	0.06	0.02
Nitrate (NO_3^--N)/mg/L	0.02	4.54	1.16
Total Hardness (TS)/FS°	26.00	144.00	86.62

Table 2. Monthly values of physicochemical parameters in Sarikum Lake

Parameters	Month					
Ammonium(NH_4^+-N)/mg/L	October	November	December	January	February	March
1. st.	0.27	0.71	1.78	1.53	0.38	0.85
2. st.	0.22	0.58	1.34	0.44	1.97	0.69
3. st.	0.27	0.55	1.42	0.11	0.99	0.77
Aluminum/mg/L	October	November	December	January	February	March
1. st.	0.00	0.00	0.00	0.00	0.00	0.00
2. st.	0.00	0.00	0.00	0.00	0.00	0.00
3. st.	0.00	0.00	0.00	0.00	0.00	0.00
Iron (Fe)/mg/L	October	November	December	January	February	March
1. st.	0.13	0.06	0.57	0.04	0.37	0.16
2. st.	0.06	0.06	0.59	0.07	0.44	0.13
3. st.	0.13	0.04	0.38	0.06	0.56	0.18
Phosphate (PO_4^{3-}-P)/mg/L	October	November	December	January	February	March
1. st.	0.56	0.25	1.89	0.11	1.22	0.65
2. st.	0.22	0.27	2.63	0.16	1.35	0.45
3. st.	0.77	0.18	1.84	0.25	2.18	0.76
Manganese (Mn)/mg/L	October	November	December	January	February	March
1. st.	0.21	0.13	0.77	0.08	0.51	0.21
2. st.	0.07	0.14	0.94	0.12	0.54	0.17
3. st.	0.26	0.10	0.90	0.13	0.77	0.23
Nitrite (NO_2^--N)/mg/L	October	November	December	January	February	March
1. st.	0.01	0.01	0.04	0.00	0.03	0.01
2. st.	0.00	0.01	0.06	0.00	0.03	0.01
3. st.	0.01	0.00	0.04	0.00	0.04	0.02
Nitrate (NO_3^--N)/mg/L	October	November	December	January	February	March
1. st.	0.17	0.39	0.32	0.02	2,00	4,54
2. st.	0.11	0.13	0.47	0.26	1,66	4,28
3. st.	0.49	0.32	0.34	0.19	1,93	3,20
Total Hardness (TS)/FS°	October	November	December	January	February	March
1. st.	122.00	118.00	26.00	132.00	84.00	58.00
2. st.	86.00	110.00	28.80	144.00	48.00	62.00
3. st.	132.00	124.00	36.40	136.00	44.00	68.00

Table 3. Monthly values of measurement parameters made in the field of Sarikum Lake

Parameters	Month					
Temperature (°C)	October	November	December	January	February	March
1. st.	16.8	12.1	8.1	8.8	10.2	13.5
2. st.	17.0	10.2	7.5	8.6	9.6	13.3
3. st.	17.3	12.5	8.5	8.6	13.2	13.1
TDS (ppm)	October	November	December	January	February	March
1. st.	202	627	1156	1026	875	479
2. st.	201	775	1172	1086	945	542
3. st.	145	557	1319	1056	1319	546
Salinity (ppm)	October	November	December	January	February	March
1. st.	66.5	480	882	783	609	363
2. st.	88.9	645	906	823	706	415
3. st.	127	435	999	762	753	418
pH	October	November	December	January	February	March
1. st.	8.08	8.19	7.54	8.07	7.82	7.99
2. st.	8.28	8.6	7.53	7.46	7.73	7.76
3. st.	7.94	7.86	7.44	7.99	7.46	8.06
ORP (mV)	October	November	December	January	February	March
1. st.	-63.5	-67.4	-29.5	-61	-45.3	-57
2. st.	-73.5	-59.7	-29.8	-26.6	-41	-43.3
3. İst	-53.2	-49.5	-25.3	-56.4	-27.4	-60.3
COND. (μS)	October	November	December	January	February	March
1. st.	305	318.75	1737	1456	1316	742
2. st.	235	294	193	1658	1432	830
3. st.	295	320	1999	1589	1537	820

Table 4. Minimum, maximum and mean values for microbiological values of Sarikum Lake

	Maximum	Minimum	Mean values
Total coliform	9840	20	2038
Fecal coliform	1700	0	180
Fecal streptococcus	360	0	57
E.coli	3620	0	621
Clostridium perfinges	310	0	63
Sulfide reducing anearob bacteria	0	0	0

Table 5. Monthly distribution of microbiological analyzes at 1st station in Sarikum Lake

1. st.	Total coliform	Fecal coliform	Fecal streptococcus	*E.coli*	*Clostridium perfinges*	Sulfide reducing anearob bacteria
October	2630	0	0	540	0	0
November	320	0	0	0	90	0
December	60	0	20	10	0	0
January	400	5	230	140	50	0
February	9840	10	30	3620	310	0
March	1320	870	70	510	50	0

Table 6. Monthly distribution of microbiological analyzes at 2nd station in Sarikum Lake

2. st.	Total coliform	Fecal coliform	Fecal streptococcus	*E.coli*	*Clostridium perfinges*	Sulfide reducing anearob bacteria
October	2590	0	0	760	0	0
November	1470	0	0	360	80	0
December	20	0	0	0	0	0
January	380	60	360	90	170	0
February	2000	80	50	390	70	0
March	1730	420	20	580	170	0

Table 7. Monthly distribution of microbiological analyzes at 3rd station in Sarıkum Lake

3. st.	Total coliform	Fecal coliform	Fecal streptococcus	*E.coli*	*Clostridium perfinges*	Sulfide reducing anearob bacteria
October	2760	0	0	980	0	0
November	360	0	0	180	10	0
December	30	0	10	11	0	0
January	260	16	110	0	110	0
February	9000	90	140	2550	0	0
March	1520	1700	0	420	30	0

3.1 *Color*

Throughout the research period, the water color changed between brown and green.

3.2 *Ammonium*

The lowest ammonium nitrogen (NH_4^+-N) value in surface water of Sarikum Lake was 0.11 mg/L at the 3rd station in January while the highest ammonium nitrogen level was found to be 1.97 mg/L at the 2nd station in February.

3.3 *Aluminum*

Aluminum (Al) was not detected in the measurements. According to the Ministry of Environment and Forestry's Water Pollution Control Regulation and Classes of Inland Water Resources, Sarikum Lake is in Class I water quality. It has been determined that does comply with the provisions the Ministry of Health Regulation on the Waters for Human Consumption.

3.4 *Iron*

Iron (Fe) values in the lake water ranged from 0.04 to 0.59 mg/L. The lowest value was found at the 3rd station in November and the highest value was found at the 2nd station in December. According to the Ministry of Environment and Forestry's Water Pollution Control Regulation and Classes of Inland Water Resources, Sarikum Lake is in Class IV water quality.

3.5 *Phosphate*

The lowest phosphate (PO_4^{3-}-P-) value in surface water of Sarikum Lake was 0.11 mg/L at the 1st stationin January; the highest phosphate level was found to be 2.63 mg/L at the 2nd station in December. According to the Ministry of Environment and Forestry's Water Pollution Control Regulation and Classes of Inland Water Resources, Sarikum Lake is in Class II water quality.

3.6 *Manganese*

The mean value of manganese was measured as 0.35 mg/L and the lowest value was 0.07 mg/L in October. On the other hand, the highest value was 0.94 mg/L in December. According to the Ministry of Environment and Forestry's Water Pollution Control Regulation and Classes of Inland Water Resources, Sarikum Lake is in Class II water quality.

3.7 *Nitrite*

Nitrite nitrogen (NO_2^--N) values in the lake water ranged from 0.000 to 0.06 mg/L. The highest value was measured as 0.06 mg/L at the 2nd station in December. According to the Ministry of Environment and Forestry's Water Pollution Control Regulation and Classes of Inland Water Resources, Sarikum Lake is in Class IV water quality.

3.8 *Nitrate*

The nitrate nitrogen (NO_3^--N) values in the lake water ranged from 0.02 to 4.54 mg/L. The lowest value was measured 2nd station in January, and the highest value was measured 1st station in March. According to the Ministry of Environment and Forestry's Water Pollution Control Regulation and Classes of Inland Water Resources, Sarikum Lake is in Class I water quality.

3.9 *Total hardness*

The highest total hardness value at Sarikum Lake was found to be 144˚F (French Hardness) in January in 2nd station, while the lowest value was 26˚F in December in 1st the station.

3.10 *Temperature*

The highest value in terms of temperature was found to be 17.3°C in the third station in October and the lowest value was 7.5°C in the second station in December. According to the Ministry of Environment and Forestry's Water Pollution Control Regulation and Classes of Inland Water Resources, Sarikum Lake is in Class II water quality.

3.11 *TDS*

In terms of TDS, the highest value was found to be 1319 ppm in December and February, and the lowest value was found to be 145 ppm in October.

3.12 *Salinity*

The highest value in terms of salinity was found to be 999 ppm in the third station in December, and the lowest value was 66.5 ppm in the first station in October.

3.13 *pH*

The highest value in terms of pH was found to be 8.6 in the second station in November and the lowest value was 7.44 in the third station in December.

3.14 *ORP*

In terms of ORP, the highest value was found as -25.3 mV in the third in December, and the lowest value was -73.5 mV in the second in October.

3.15 *Conductivity*

The highest value for electrical conductivity (COND.) was found to be 1999 µS in the third in December and the lowest value was 235 µS in the second in October.

3.16 *Total coliform*

The highest value in terms of total was determined as 9840 CFU/100 mL in the 1st station in February, while the lowest value 20 CFU/100mL in the 2nd station in December. According to the Ministry of Environment and Forestry's Water Pollution Control Regulation and Classes of Inland Water Resources, Sarikum Lake is in Class II water quality. It has been determined that does not comply with the provisions the Ministry of Health Regulation on the Waters for Human Consumption.

3.17 *Fecal coliform*

The highest value in terms of fecal coliform was determined as 1700 CFU/100 mL in the 3rd station in March, the lowest value was 0 CFU/100 mL in October, December and November at all stations. According to the Ministry of Environment and Forestry's Water Pollution Control Regulation and Classes of Inland Water Resources, Sarikum Lake is in Class II water quality. It has been determined that does not comply with the provisions the Ministry of Health Regulation on the Waters for Human Consumption.

3.18 *Fecal streptococci*

The highest value in terms of fecal streptococci was determined as 360 CFU/100 mL in the 2nd station in January. The lowest value was determined at all stations in October and November, and 0 CFU/100 mL at 2nd station in December, additionally. It has been determined that does not comply with the provisions the Ministry of Health Regulation on the Waters for Human Consumption.

3.19 *E. coli*

The highest value in terms of *E. coli* was determined as 3620 CFU/100 mL in the 1st station in February. The lowest value was determined at Station 1 in November and Station 2 was 0 CFU/100 mL in December. It has been determined that does comply with the provisions the Ministry of Health Regulation on the Waters for Human Consumption.

3.20 *Clostridium perfringens*

The highest value in terms of *Clostridium perfringens* was determined as 310 CFU/100 mL in the 1st station in February. The lowest value was determined at all stations in October and December, and 0 CFU/100 mL at 3rd station in February, additionally. It has been determined that does comply with the provisions the Ministry of Health Regulation on the Waters for Human Consumption.

3.21 *Sulfide reducing anaerobs*

Sulfite reducing anaerobs weren't detected in the analyzes made. It has been determined that does comply with the provisions the Ministry of Health Regulation on the Waters for Human Consumption.

4. Discussion

In the water analyzes of Lake Sarıkum, the average values of ammonium nitrogen azotu (NH_4^+-N), iron (Fe), Phosphate (PO_4^{3-}-P), manganese (Mn), nitrite nitrogen (NO_2^--N), nitrate nitrogen (NO_3^--N) and total hardness were found to be 0.83, 0.22, 0.87, 0.35, 0.02, 1.16mg/mL and 86.62 FS^o, respectively.

While the average values of these parameters are taken into consideration, Sarikum Lake's water according to the classifications and quality criteria of the continental water resources, in terms of ammonium nitrate (NH_4^+-N) and manganese (Mn) are II. class, in term of iron (Fe) and nitrate nitrogen (NO_3^--N) are the first class and in terms of nitrite nitrogen (NO_2^--N) is III. class. The fact that some parameter values are too high raises the austenitic values, which increases the quality class of the water ie pollution. The reason for this is considered to be excessive mixing of sediment into the water. According to the average hardness value, it is in very hard water [11].

In a study, bacteriological quality parameters of natural spring water fountains in different regions of Istanbul and Anatolian side have been examined. Specimens were detected Coliform bacteria in 47.4%, Enterococci in 27.4%, *E. coli* in 17.9% and Fecal coliform in 14.7% of the water samples. 48.4% of the samples were found to be in accordance with the values stated in the standards [12]. In another study, it was examined whether the water samples of Van province and some districts meet the standards for *E. coli*, coliform bacteria. Some water samples have been found to be harmful to the public health [13].

Arili Stream was defined to be used for drinking water supply with only disinfection, recreational and aquaculture [14]. In present study, Sarikum Lake can be used for recreational purposes. It is stated that when it is compared with the water quality values given in Caro Creek (Elazığ-Turkey) Superstructure Water Quality Management Regulation, it has Class-II water quality in terms of water quality [15]. In the Lake Sarıkum, TDS was calculated on average 779 ppm and it was in the class II group according to urSurface Water Quality Management Regulations.

In microbiological analyses of this study, the total coliform was the highest total of all stations in March. The smallest total value was found in January > 111 and < 20841 CFU/100 mL, fecal coliform 1 and < 2991 CFU/100 mL, fecal streptococci 1 and < 701 CFU/100 mL, *E. coli* > 22 and < 6561 CFU/100 mL, *Clostridium perfringes* > 1 and < 381 CFU/100 mL, sulfide reducing anaerobic bacteria > 0 and < 0 CFU/100 mL were detected. According to the Ministry of Environment and Forestry's Water Pollution Control Regulation and Classes of Inland Water Resources, Sarikum Lake is in Class II water quality, ie less polluted water, in terms of total coliform, fecal coliform III. class water quality and polluted water. It has been determined that this lake does not comply with the provisions of the Regulation on the Ministry of Health Waters for Human Consumption. *C. perfringens* is a long-term contamination indicator. For this reason, it is understood that domestic wastes such as sewage sludge and disinfectants are mixed in the first station. Especially in the 3rd station, results which are not so polluted yet but close to the pollution limit have been obtained.

In the bathymetric analysis of the lake, the surface area of the lake varies according to years and seasons. While the water surface was 28.60 m in November, the water surface was 29.17 m in December. As evident from this, there was an increase of 0.57 m in the water level. Later, depth maps of the lake were produced by applying different methods. First, a depth map was produced on the Digital Elevation Model (Figure 6).

Secondly, the depth map has been produced in the kernel method. This method draws a circular field around each sample point, not each cell, and applies a mathematical function from 1 to 0 toward the boundary of the circular field from where the point is located. It is actually a function of the density function. The map was produced by considering the density of the details of the point and line type (Figure 7).

Third, a depth map is generated using the interpolation method. We performed depth map generation using Inverse Distance Weighted (IDW) and Natural Neighbor methods from Interpolation methods (Figure 8 and 9).

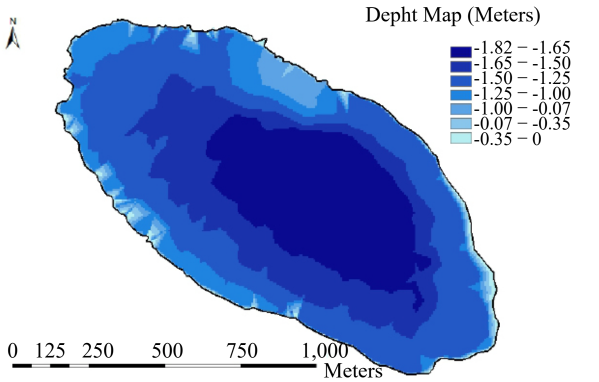

Figure 6. Depth map from digital elevation model of Sarıkum Lake

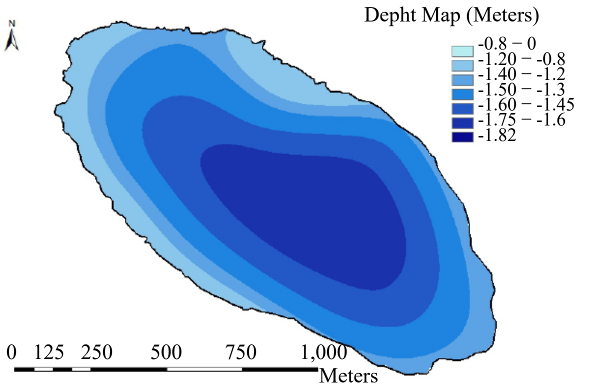

Figure 7. Depth Map with Kernel Method of Sarıkum Lake

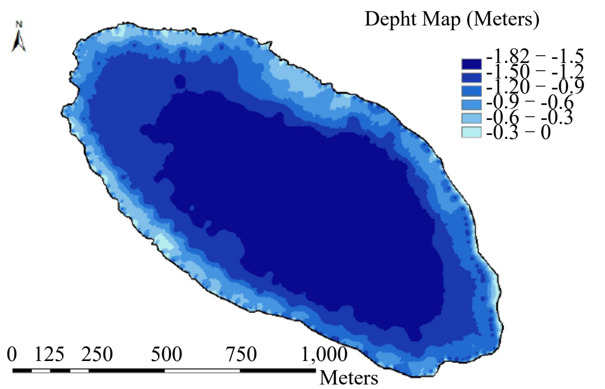

Figure 8. Depth map with IDW method of Sarıkum Lake

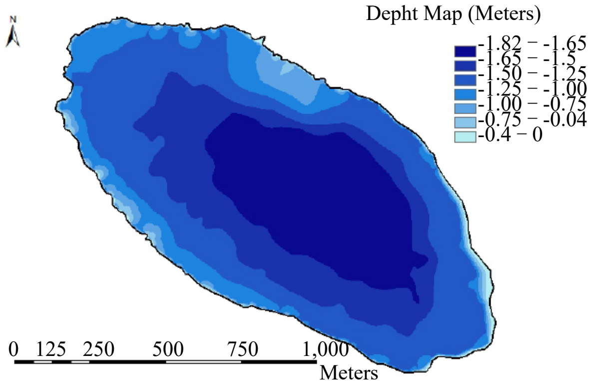

Figure 9. Depth map with natural neighbor method of Sarıkum Lake

In the literature review, depth remote sensing, ie satellite photographs and echosounder were used [16-18]. While the sensitivities are examined, they can be said to be more suitable for double-frequency echo-sounder depth measurements.

GPS methods are usually used for horizontal positioning methods. These methods are based on hand GPS and RTK-GPS were used [7, 8]. The method which is sensitive to these methods is RTK-GPS with ± 1 cm [19].

5. Conclusion

A more accurate measurement of the lake can be achieved by cleaning the Reed (*Phragmites australis*) area in and around the lake. It is very difficult to approach the shore because of the low depth of the Lake. For this reason, water level measurements can be performed between December and April while the water level is high. In terms of water quality and microbiological parameters of the lake, the negative effects of human activities around the lake should be eliminated. In addition, the drainage water that feeds the Sarikum Lake has to be removed from the intervention.

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