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ASSESSMENT OF PHYSICOCHEMICAL PARAMETERS AND SOME OF HEAVY METALS IN BAHR AL-NAJAF-IRAQ

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Abstract

The present study was conducted to evaluate some physical and chemical parameters such as (water temperature, pH, turbidity, total dissolved solids, electrical conductivity, salinity, dissolved oxygen, biological oxygen demand, total hardness, calcium and magnesium hardness, and sulfate ions) and the concentrations of some heavy metals such as (Zinc, Lead, Cadmium, Manganese and Iron) in water of Bahr Al- Najaf. Five sites were chosen in Bahr Al- Najaf; the samples were monthly collected from April 2017 to March 2018. The results showed that water temperature ranged between (12.3-37.8) C^0, pH values (7.16 -8.88), electrical conductivity (EC)(3.8-77.8) ms/cm, salinity (2.43- 49.79) ppt turbidity (Tur) (7.16 -45.5) NTU, total dissolved solids(TDS)(2476-32366) mg/l, total hardness (TH) (553.18 - 2073)mg/l, calcium(Ca^{+2}) and magnesium (Mg^{+2})ions (122.91-689.37) and (80.29-609.21) mg/L respectively, sulfate ions $(SO_4)^{-2}$(360.9 -1263.1)mg/l, dissolved oxygen (DO) (6.6 - 17.8) mg/l, biochemical oxygen demand (BOD_5) (0.73- 12.77) mg/l. The study results of heavy metals concentrations in water showed that Zinc (Zn) ranged between (0.001-13.86) ppm, lead (Pb) (0.02- 1.87) ppm, cadmium (Cd) (0.001-3.33) ppm, manganese (Mn) (0.006-0.23) ppm, iron (Fe) (0.03-0.91) ppm. The water quality of Bahr Al- Najaf depression under this study was considered of salinity, slightly alkaline, very hard and concentrations of BOD_5 were recorded in some months exceeding the permissible limit. It seems clearly that Bahr Al-Najaf depression was contaminated by domestic sewage. Increasing levels of heavy metals in Bahr Al-Najaf depression exceeded the permissible limit, giving a hint of water pollution by heavy metals.

Key words : Physicochemical, parameters, heavy metals, Bahr, Al-Najaf.

Introduction

Bahr Al-Najaf is one of the most interesting environments, where all scientific studies and researchers referred that it plays an active role in the growth of Al-Najaf city, since it was an easy water route to become the most agricultural territory (Al-Moussawi, 2012). The term "heavy metals" refers to any metallic element that has a relatively high density and is toxic or poisonous even at low concentration (Duruibe *et al*., 2007). However, the rapid growth of urbanization, increasing population and establishment of industries in the urban areas result in the discharge of heavy metals, sewage effluents and organic pollutants into the water bodies (Benson *et al*., 2007; Omran *et al*., 2014). Toxic heavy metals show harmful effects even at very low concentration on the aquatic organisms including plankton, aquatic plants, invertebrates and vertebrates (Atici *et al*., 2008). The problem of water pollution is more acute in some countries than in others (Javed and Mahmood, 2000). In aquatic environments, when evaporation exceeds the contribution of rivers, the concentration of pollutants and salts is subjected to increasing, causing effects on organisms, biodiversity and human health (Morales *et al*., 2001). Toxic heavy metals have the ability to accumulate in the organisms through the transition to different levels of the food chain reaching to human or other organisms at the top of food chains and cause ecological damage. It also poses a threat to human health due to bio magnifications over time (Benson *et al.,* 2007). The current study aimed to assess the pollution level of the aquatic ecosystem of Bahr Al-Najaf by some physical and chemical parameters and concentration of some heavy metals such as Pb, Cd, Fe, Zn and Mn.

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General description of the study sites

Bahr Al-Najaf is a wetl and depression area, composed of a lake or marsh-like area with limited cultivated orchards beyond, surrounded by vast desert or semi desert areas, located to the west and south-west of

Holy Al-Najaf city. Five sites were chosen for the present study as mentioned in fig. 1. The geographical coordinates of studied sites were taken (table 1).

Site one (S1): Located in the southern part of Bahr Al-Najaf depression adjacent to the main street, where some small tributaries feed it like Al Dasim river. It is also distinguished by fishing activities.

Site two (S2): Located 1 km from the first site, its water is sweet because the source of water is from Al-Dasim river and due to the presence of some aquatic plants such as cane and papyrus plants and some plants submersible.

Site three(S3): Located in the western side of the depression near the oil strategic line. It has discharge of wells and spring waters.

Site four (S4): Located in the northern side of Bahr Al-Najaf depression about 5 km away from the third site at the end of Bahr Al-Najaf depression. Its water is highly saline and does not contain aquatic plants.

Site five (S5): Located in the north-east of Bahr Al-Najaf depression located adjacent to Al-Hawli street in front of the fourth station and is characterized by the presence of some aquatic plants such as cane and papyrus and the tributaries passing by the groves of Najaf City.

Materials and Methods

This study was carried out from April 2017 to March 2018. Samples were taken from five sites from Bahr Al-Najaf in Al-Najaf city. Water samples were handled from the surface waters (about 30 cm from the surface) using pre-cleaned polyethylene containers with a volume of 5 litters (were rinsed with water, filled and labeled) for study of some physiochemical properties. These samples were later stored in cool place at 4°C. Water samples for dissolved oxygen (DO) and biological oxygen demand (BOD) were collected in sterile dark Winkler bottles 250 ml. They were washed and sterilized by placing in the oven for 4hr at 200°C. Oxygen fixation was done on field by adding 2ml of magnesium sulfate and iodide azide (APHA, 1998; Rajiv *et al.*, 2012).

Heavy metals in water are measured by using flame atomic absorption spectrophotometer (APHA, 1998).

Statically analysis

The statistical analysis was performed with CRD design with two factors; first was of 5 sites and second was 12 months, with three replicates. The statistical analysis was performed with GenStat (2007), seventh edition (DE3) software (version 12, Service Pack., Cary, USA). The means of all data were separated by least significant difference (LSD) test at 0.05 level.

Table 1 : GPS values of study sites.

Sites	GPS	
	Longitude (East)	Latitude (North)
1	44.17	31.58
2	44.18	31.57
3	44.12	31.59
4	44.12	32.1
5	44.14	32.1

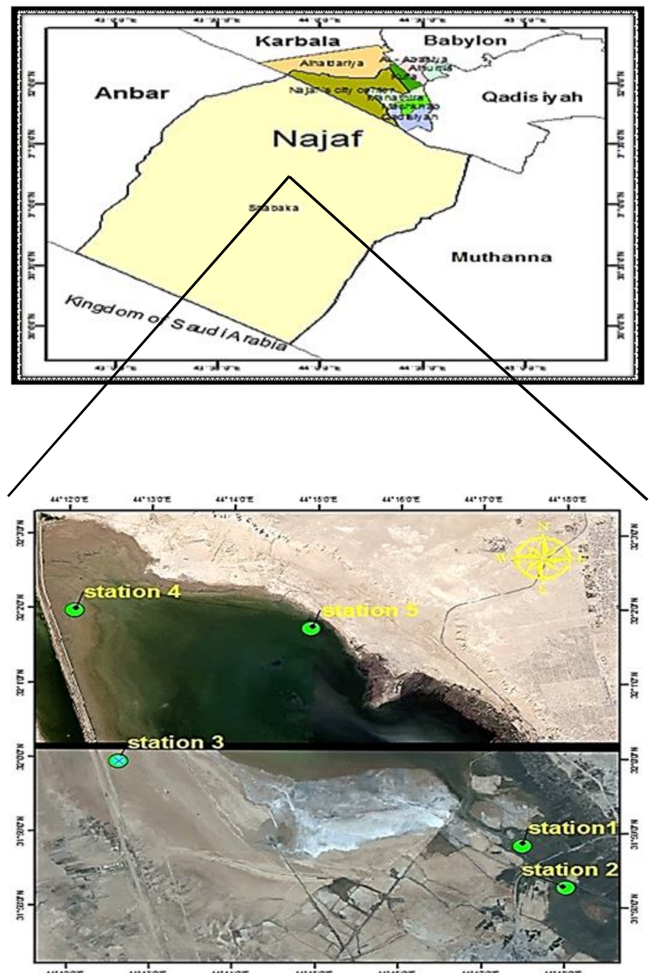

Fig. 1: The study sites in Bahr Al-Najaf

Results and Discussion

The results showed that the lowest value of water temperature recoded in January 2018 which was 12.3C at site 2. Whereas the highest value of water temperature was 37.8^{0}C in August 2017 at site 3 and 4 (table 2). This is due to the change in the time of sample collection.Generally, the results of the present study showed variation of water temperature related with Iraqi climatic nature (Al-Fatlawi, 2005). Varying of pH from 7.16 in September 2017 at second site (S2) to 8.88 was observed in May 2017 at third site (S3) (table 2), which were within the narrow range and tend to be slightly alkaline as it is common in Iraqi inland water. This is due to buffering capacity of Iraqi natural waters which is relatively of high content of calcium bicarbonate (Kumar 2011). The results showed that the lowest value of EC 3.8 ms/cm was recorded in second site during December and highest value 77.8 ms/cm was recorded at first site during October. The obtained results showed that the lowest salinity value was observed in December 2017 which 2.43 ppt. in the second site, while the highest value for salinity was in October 2017; 49.79 ppt. in the first site. The results showed that higher value of EC was recorded in all sites except with site 1. TDS value was shown as the lowest as 2476 mg/l which was observed in December 2017 in the second site, while the highest value was 32366 mg/l in April 2017 at the fourth site (table 2). This is due to the products of decomposition and mineralization of organic materials (UNEP, 2006). Through the results, Bahr Al-Najaf is considered a salty lake, of high salinity which lead to a special halophilic flora and fauna in the lake (Al-Saffar, 2006). The results agreed with other studies such as (Taheer,2015; Al-Taee,2015; and Juda, 2016). In this study the lowest value of turbidity was recorded in March 2018 at site 1 which was 7.16 NTU, whereas the highest value of turbidity was recorded in May 2017 at station 4 which was 45.5 NTU (table 2). The highest value of turbidity, recorded in site 4, was because the site is near the waste collection and sewage disposal which contain large amounts of contaminated materials, soil particle, sand and microorganisms (Mustafa, 2006).

The values of total hardness in Bahr Al-Najaf are presented in Table 2. The lowest value of total hardness was 453mg/l in February 2018 recorded at second site, whereas the highest value was 2300 mg/l in August 2017 recorded at third site. The study findings showed that lowest concentration for Ca^{+2} was 122.91 mg/l in February 2018 at second site and for Mg^{+2} was 80.29mg/l in February 2018 at second site. High concentration of Ca^{+2} was recorded as 689.37mg/l in September 2017 at third site; while for Mg^{+2} it was 609.21 mg/l in August 2017 in the third site. The result of the present study referred to high concentration of total hardness which is common in Iraqi inland water (Al- Lami *et al*., 2002 and Al-Fatlawi, 2005). The high concentration of calcium and

Table 2 : Mean and standard deviation (First Line), minimum and maximum (Second Line), for physical and chemical characteristics at study stations.

Sites / Parameters	1	2	3	4	5
Water Temp. Cæ%	25.8±8.17 13.6-37.5	24.4±7.82 12.3 – 37.7	25.4± 7.84 13.7 - 37.8	25.4± 7.8 13.9 – 37.8	3.9±7.17 12.7- 35.1
pH	8.02± 0.41 7.31 – 8.53	7.64±0.35 7.16 – 8.2	8.4±0.2 8.07 – 8.88	8.39±0.27 8 – 8.75	8.07±0.47 7.27 – 8.6
E.C. ms/cm	41.81± 14.21 27.4 - 77.8	8.14 ± 2.73 3.8 - 12.3	26.32± 13.11 6.7 - 45.3	47.24± 18.61 7.4 - 69.7	44.41 ± 8.97 31.8 - 60.1
Salinity Ppt	26.75 ± 9.09 17.51 – 49.7	5.2 ± 1.74 2.43 - 7.85	16.84 ± 8.39 4.31 - 28.97	30.23 ± 11.91 4.75 - 44.6	28.42 ±5.74 20.33 - 38.46
Turbidity NTU	22.04 ± 10.1 7.16 - 43.9	15.97 ± 6.51 7.24 - 29.66	14.6 ± 5.78 8.02 - 26.76	19.97 ± 9.56 9.55 - 45.5	19.56 ±6.92 8.15 - 31.43
TDS mg/L	22709±4224 17780-29200	5483±1916 2476- 8113	21938±5592 11020 - 27080	25402±5537 16106- 32366	24788±3009 20633- 30866
T.H. mg/L	1211.1± 398.9 773.33- 2020	1015 ± 496.44 620 - 1993.3	1320.27 ±485.7 793.33 - 2013.3	1122.77 ±315.8 653.62- 1620	1118.8±513.42 553.18- 2073
Ca^{+2} mg/L	293 ± 61.33 195.05- 363.3	254.89 ± 135.39 122.91- 571.8	382.98± 157.25 243.15 - 689.37	289.66 ± 93.78 154.97- 472.94	307.25 ±141.7 149.63- 577.1
Mg^{+2} mg/L	233.18±88.63 139.48- 366	216.34±154.28 80.29 - 459.58	298.81±203.99 131.74 - 609.21	198.89±59.43 116.55 - 282.36	232.77±153.5 88.35 - 517.37
SO_4 mg/L	1074 ± 86.38 969 - 1263.1	513 ± 94.79 360.9 - 600.6	1160 ± 57.56 1048 -1263	1048 ± 43 1010.8 - 1144.5	1105±50.24 1042.9 - 1163.1
D.O mg/L	10.0 ± 2.31 7.6 - 14.9	12.8 ± 2.76 8.3 - 17.8	9.1 ± 1.70 7.1 - 11.6	8.9 ± 1.17 7.4 - 10.4	8.8 ± 1.30 6.6 - 11.0
BOD mg/L	7.06 ± 2.74 1.5 - 11.27	8.65 ± 2.05 6.4 - 12.77	5.92 ± 2.11 0.73 - 8.93	6.32 ± 1.74 4.00 - 9.87	7.22 ± 1.37 4.53 - 9.30

Table 3 : Mean and standard deviation (First Line), minimum and maximum (Second Line), for: Heavy metals in Water at study stations during 2017-2018.

Heavy Metals ppm / Stations	St.1	St.2	St.3	St.4	St.5
Zinc	3.02±2.12 0.1 - 5.81	1.891± 1.54 0.002 - 4.37	3.174±2.999 0.054 - 8.434	4.796±3.503 0.001 - 12.5	6.388±4.033 1.925- 13.863
Lead	0.575±0.516 0.125 - 1.582	0.166±0.091 0.026 - 0.360	0.468±0.420 0.021 - 1.439	0.633±0.404 0.21- 1.3	1.236±0.405 0.415 - 1.877
Cadmium	1.699± 1.22 0.106 - 3.337	0.882±0.678 0.001 - 2.079	1.475± 1.089 0.1496 - 3.273	1.776± 1.192 0.077 - 3.305	1.634±1.22 20.002 - 3.184
Manganese	0.0748±0.035 0.035 - 0.164	0.044±0.026 0.006 - 0.08	0.0553±0.038 0.006 - 0.111	0.108±0.0396 0.076 - 0.22	0.120± 0.041 0.090 - 0.23
Iron	0.357±0.172 0.136 - 0.62	0.157±0.071 0.055 - 0.265	0.321±0.200 0.038 - 0.663	0.483±0.217 0.141 - 0.91	0.786±0.26 0.333 - 0.90

magnesium in September and August is attributed to the degradation of dead algae cells at high temperature and thus the return of magnesium and calcium to the water (Kamal *et al.*, 2004). Bahr Al-Najaf sites showed variation in sulfate value; the minimum value was 360.9 mg/l in the second site during April 2017, and the maximum value was 1263.1 mg/l in the first site during August 2017 (table 2). This increase in sulfate value is associated to evaporation. The results are consistent with findings of Juda (2016), who found the sulfate value between 616 mg/l-1431 mg/l in Bahr A l-Najaf. Data of DO at the present study area are shown in Table 2. The lowest value was 6.6 mg/l in October 2017 recorded at site 5, whereas the highest value was 17.8 mg/l in November 2017 recorded at site 2. The obtained BOD data showed that the minimum value was recorded in December at site 4 which was 0.7 mg/l while the maximum value was found in September at site 1 which was 6.9 mg/l. Results showed highest value of DO noted in the second site due to the presence of aquatic plants and absence of discharge of waste in site 2. The concentration of BOD_5 in sites 1, 3 and 5 in some months exceeded the limits of Iraqi standards for water quality 1998, which was less than 5 mg/l, and exceed the WHO standards (2004), which was less than 3 mg/L. High BOD_5 levels indicate decline in DO, because the oxygen that is available in water is being consumed by the bacteria leading to the inability of fish and other aquatic organisms to survive (Vaishali and Punita 2013).

Table 3 shows the concentration of heavy metals in water**.** The lowest concentration of Zn was recorded in August 2017 at fourth site which was 0.001 ppm, while the highest value of Zn was recorded in April 2017 at fifth site which was 13.86 ppm. The high concentration values of Zn were especially at fifth site because of nearness for this site from collection and burning of waste. Awad (2014) on Sawa Lake recorded Zn value ranging between (0.02-0.13) ppm. Water samples of all sites showed variation in Pb value; the lowest value was 0.021 ppm in site 3 during November 2017, and the highest value was 1.877 ppm in site 5 during February 2018 (table 3). The lowest concentrations is because the second site is far from of the sewerage and waste collection site. The concentration of Pb for most of the stations of study exceeded the permissible limit for Iraqi standards river water 1967 No. (25), which was 0.005 ppm, WHO standards drinking water (1993), which was 0.01 ppm, and EQS standards water pollution (2001), which was 0.01 ppm.

The higher values in site 5 is due to the proximity of the site to gathering and burning waste of Najaf city.

The obtained results showed that the minimum value of Cd recorded in January 2018 at site 2 was 0.001 ppm, while the higher value of Cd was recorded in April 2017 at site 1 which was 3.337 ppm (Table 3). The statistical analysis of the data showed significant differences among months at (Pd<0.05). The levels of Cd are different; the first and fourth sites showed a very high increase in the proportion of cadmium, which may be caused by the presence of a large coefficient number of bricks surrounding this area. The main sources of cadmium are the burning of fossil fuels such as coal or oil and the incineration of municipal waste (Friberg, 1983). The current study results were lower than Taheer's (2015) in Bahr Al-Najaf; he found that the values of dissolved Cd varied between 0.0034mg/l to 0.2159mg/l. The results of this study showed that the lowest value of dissolved manganese concentration was 0.006 ppm recorded at site 2 and 3 during November 2017, whereas the highest value was 0.23 ppm recorded at site 5 in April 2017.

There were some variations among the different localities in the values which may be due to the different input of the agricultural and discharge along the Bahr Al-Najaf as well as the different population densities. The recorded results are lower than Awad's (2014) who registered Mn value ranging between 0.04 to 0.87 ppm in Sawa Lake. The obtained results showed that the minimum value of Fe recorded during November 2017 at site 3 which was 0.038 ppm, while the higher value of Fe was recorded in October 2017 at site 4 which was 0.916 ppm (table 3). The proportions of the Fe vary depending on the surrounding ecological conditions. The results showed that the increase in the concentration of the Fe is the highest in site 5 and decreases toward site 2. This probably indicates the presence of a source of human activities that recorded clear excesses for most of the heavy metals such as iron, lead, cadmium and zinc, (Tulonen *et al*., 2006).

Conclusion

The current study concluded that the water quality of Bahr Al-Najaf depression under this study is considered saline water, to be slightly alkaline, and very hard. The concentrations of BOD_5 were recorded in some months exceeding the permissible limit. It seems clearly that Bahr Al-Najaf depression was contaminated by domestic sewage. The study indicated to spatial and temporal variations in all characteristics of water studied. Increasing levels of heavy metals in Bahr Al-Najaf depression where the permissible limit exceed, may give a hint of water pollution by heavy metals.

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