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# Estimation of Some Physical and Chemical Properties and Some Heavy Elements in Lake Habbaniyah in Anbar Governorate

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**Abstract**

*The current study focused on impact of heavy elements in Lake Habbaniyah, which is within Anbar Governorate. Samples were collected from six stations. Samples were collected during the period from November 2022 to October 2023 to measure some physical and chemical properties including salinity and pH.. And studying some heavy elements, namely (lead, cadmium, chromium, zinc, copper). The results showed that the air temperature reached a maximum of (36) degrees Celsius, while the water temperature reached a maximum of (32) degrees Celsius, and the Electrical Conductivity values as maximum (2176) microcemns/cm, exceeding the permissible limits, while the salinity was also higher than permissible by (1.392) g/L, and the pH values ranged (8.5). As for the heavy Matels, the values of lead, cadmium and chromium were outside the permissible limits, which are (0.1054), (0.1280), and (0.1844) mg/L, respectively. As for the rest of the elements such as Zn and pb, recording (0.0227-0.2125), (0.0710-0.1096) mg/L, respectively.*

**Keywords:** *Heavy Elements, Environment, Lake Habbaniyah.*

## Introduction

Water is one of the main sources of life, covering an area of about 71% of the Earth's surface, and the share of fresh water from lakes and rivers does not exceed 0.26%, while the area of lakes is less than 0.7% of the world's fresh water [1]. The physical and chemical characteristics of water determine the quality of water in terms of the diverse use of the population, and the livelihood of aquatic organisms is sensitive to it, and these factors affect the nature of life for the organisms living in it [2]. Although heavy elements are found in small quantities in water, their impact in the case of accumulation is very large on the water environment and its quality and is measured in parts per million (ppm) [3]. A heavy metal is defined as a metal whose density is more than five times the density of water [4]. The level of concentration of heavy elements depends on the type of rocks and biological activity greatly affects water [5]. The sources of these elements are human activities such as industrial activities, the discharge of excess water from daily uses, and the presence of a defect in agricultural activity that causes pollution [6].

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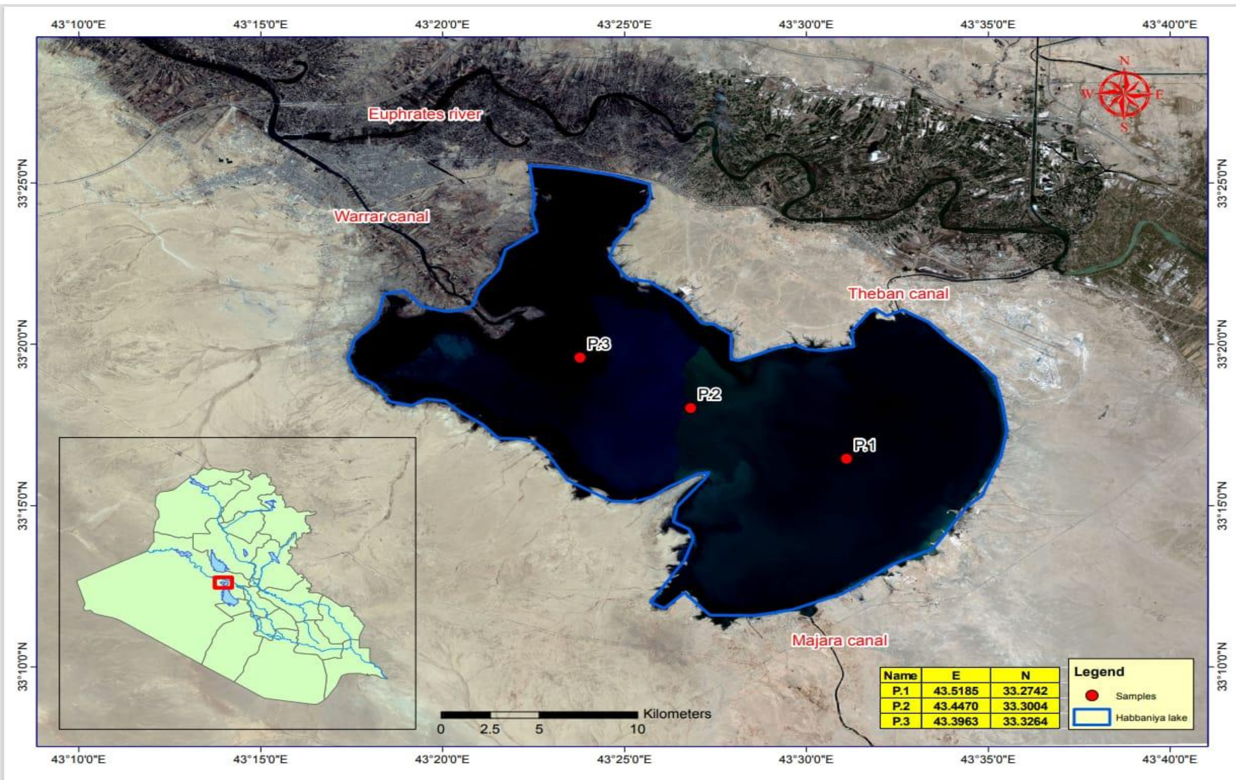
*Materials and Methods*

*Study Area and Samples*

Lake Habbaniyah is one of the most important tourist facilities in Anbar Governorate - west of Anbar. It was established in 1969 and opened in 1976. It is characterized by its beautiful scenic views and includes a marina for boats, shops and sports halls. The project was built to store the waters of the Euphrates River and avoid flooding. The lake is an important strategic water reserve. It is 68 km away from Baghdad, 20 km away from Fallujah, and 25 km away from the south of Ramadi. The lake area reaches 426 square kilometers and the highest water storage level reaches 51 meters. The total water level capacity reaches 3.3 billion square meters. The lake is irrigated by the Warar Regulator during the flood season. The lake is located at a longitude of 33 east and a latitude of 34 north and an altitude of 42 to 51 meters above sea level.] 5 [The San Al-Dhaban Regulator and Canal is an important factor in draining the lake's water in the summer. Three positions were selected with six stations, each of which occupies two stations, one on the surface and the other at a depth of 4 to 5 meters. The stations located on the surface were given the numbers

Figure. (1) is a satellite map showing the study area according to the Geographic Information System (GIS) program.




(1, 2, 3) and the stations located in the depths were given the numbers (4, 5, 6). The first site was south of the lake, which includes the first station and the fourth station, and is located at the coordinates (P1=E43.5185, N33.2742). The second site, which is located in the middle of the lake, includes the second and fifth stations, and is located at the coordinates (P2=E43.4470, N33.3004). The third site, which is located north of the previous site, includes the third and sixth stations at the coordinates (P3=E43.3963,N33.3264), noting that all sites and stations are located in the heart of the lake, 4-8 kilometers away from the coast.

*Sample Collection and Analysis*

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After cleaning the glass and plastic tools used by washing them with water and cleaning powders, and sometimes we need to sterilize them, then wash them with distilled water and then dry them in the oven. Samples were collected from the lake at its three locations and six stations at a rate of one sample per month during the study period, which lasted 12 months, starting from November 25, 2022 until October 25, 2023. Samples were collected from the surface layer of the lake, approximately ((30 cm from the surface for the stations located on the surface, and samples were collected at a depth of (4-5) meters for the stations located at the bottom. The sample was taken using a 2.5-liter polyethylene container after washing it twice with sample water at each station. As for the bottom samples, a phantom device was used to extract them. Opaque bottles with a capacity of (250 ml) were used to measure BOD5. The containers and bottles were filled to their full storage capacity without any bubbles so that the transportation process and water movement would not affect the change in a number of properties. After the bottles were tightly closed, the necessary information was recorded on each bottle and then transferred to the laboratory for physical and chemical tests.

*Methods and Materials*

Air temperature was measured using a mercury thermometer and water temperature was also measured. The electrical conductivity of water was measured using a multiparameter analyzer type 830 CONSORTC after calibration of the device and the results were expressed in terms of μs/cm. Salinity was measured based on electrical conductivity values based on the following relationship as stated in [7]. Salinity (mg/L) = EC (μs/cm) X 0.00064. The pH of water was measured using a pH meter after calibration with standard buffer solutions (4, 7, 9). The concentrations of heavy elements in water samples were measured using atomic absorption spectrometer (AAS) type (PYE UNICAM Model SP 191) to measure five heavy element concentrations.

## Results and Discussion

*Temperature* is one of the important physical factors as it an important on biotic and abiotic factors, as it affects activities within the ecosystem such as rates of photosynthesis, respiration, and the solubility of salts and gases in water [8]. Air temperatures showed a clear seasonal variation during the study period, recording the lowest values during the winter and the highest during the three months on a summer. As results indicated that increase value of air temperature (36C°) at the third and sixth stations during the month of August, and the decrease of temperature reach (10C°) at the first and second sites during the month of January, Table (1-4 a). As for the lowest value recorded for water temperature, it was (10℃) at stations (3,4,5) during decrease of temperature season in January, and the highest value was (32℃) at stations (1,2) during the summer season in August, Table (1-4 b). The reason for changes in temperatures according on the stations of this study may be via seasonal climate changes [9].

*Electrical Conductivity and Salinity*; Electrical conductivity expresses the role of water in transmitting electric current and depends on the concentration of ions dissolved in water. It is one of the important factors for assessing water quality as it is affected by the solids dissolved in water and temperature. The level of concentrations of dissolved ions expresses electrical conductivity and its role in water and is considered one of the important parameters for assessing water quality. It is affected by the presence of solids dissolved in water and temperature. [10]. The electrical conductivity values ranged during the study period between (1304) microsemns/cm in the second station during November 2022 to (2176) microsemns/cm in the fourth station during October 2023. From Table (4-4a,b), we note that the values of electrical conductivity and salinity showed clear differences, as the monthly changes in conductivity and salinity values recorded the highest values in October, specifically in the fourth station. The relationship between salinity and electrical conductivity is direct. Salinity rates did not exceed one part per thousand (1PPT) during the first three months of the study and at all stations, but they began to increase month after month until they reached (1.3PPT) during the last two months of the study. The reason for this is the scarcity of water supplies on the one hand and the increase in evaporation processes due to the large surface area of the lake on the other hand, in addition to the large amount of household and agricultural waste dumped in the lake.

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In addition to the salts resulting from sand washing operations from sand factories located on the Warar Canal that feeds the lake from the Euphrates River.

*The pH* the pH values ranged at all stations within the permissible limits (6.3-8.5). The lowest value was observed at station 6 in February, while station 2 recorded the highest value during April. The values and levels were close at all stations throughout the study period, but the stations located in the depths recorded slightly lower values than the stations located on the surface. This may be attributed to the decomposition processes carried out by benthic organisms in the lake sediments, which was confirmed by the results of the statistical analysis. The degree of variation was small due to the storage capacity of the water, which contains bicarbonate and carbonate compounds, in addition to what enters the water body of these compounds from the surrounding soils, considering that Iraqi soils are rich in these compounds that work to neutralize acidity when they enter the water.

*Heavy Elements*

*pb;* the current study showed that the values ranged about (0.0288) mg/L, (0.1054) mg/L in the second and sixth stations during the month of June and in the sixth station during the month of April. It is possible that the waste brought by the Al-Warrar Canal, whether industrial or household waste from the region as the concentration of lead ions increases in the spring and early summer seasons in most stations. This may be due to the rotation or movement of sediments and the formation of the phenomenon of spirling and the accompanying bottom emergence (Uprulling), which causes an increase in the element in the water column. This is known as the spring overturn. We can attribute the variation between months in the values of lead to the processes of its release from the sediments to the water column, especially when the pH of the water tends towards basicity [8]. The results in the current study showed that the values exceeded the permissible limits, and showed a strong negative correlation coefficient with air and water temperatures, as well as electrical conductivity and salinity ($r = -0.383, -0.440, -0.323, -0.326$) respectively at a significant level ($p \leq 0.01$),

*Cd* ; The values was (0.0124) mg/L in the second position on June , While was (0.1280) mg/L in the second position on October. Some of reason for the high percentage of cadmium in all stations during the last three months of the study may be due to the waste that is discharged into the lake without any prior treatment because the sources of pollution in it come from the waste of sand washing plants in addition to detergents and paints coinciding with the significant decrease in water levels due to the scarcity of water supplies from the Euphrates River and the increase in evaporation levels during the summer months, especially since the large surface area of the lake made it more susceptible to evaporation. Natural factors such as chemical weathering it can play role in increasing of cadmium level [8] and increasing trace elements, including cadmium, which accumulate in agricultural soil and are exposed to discharge into the waterway during the rainy season [11]. During on the study months is sometimes due to the difference in the properties of the lake water and what it contains of pollutants and organic and inorganic compounds and the different activities of aquatic organisms that withdraw different amounts of heavy elements to enhancing the metabolic action of external structures. We can attribute the increase to the presence of other elements that work to form complexes with the bonds present in the sediments or the presence of a high percentage of cations that compete with cadmium for the binding sites with organic bonds, which causes it not to precipitate and increases in the water column. [12] Pearson's correlation coefficient recorded a negative relationship between cadmium and pH ($r=-0.515$, respectively. Cadmium values exceeded the permissible limits locally [13] and globally [14] 0.003 mg/L and [15] 0.005 mg/L.

*Cr*; The results showed (0.0163) mg/L in April and (0.1844) mg/L in October. Chromium is considered one of the heavy elements with a significant toxic effect in the environment and is used in industry or is a product of industrial processes. This variation may be due to the difference in the density of the different discharges, the hydrological nature, and the industrial waste discharged [15]. Most of the dissolved chromium found in alkaline waters such as lake water may be of the hexagonal type, which has a dangerous effect on aquatic life. Sediments often contain trivalent chromium, and the high percentage of chromium, especially hexagonal, is due to the presence of something that inhibits its association with sediments, such as the presence of good concentrations of sulfates and phosphates in most seasons, which increases its

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release into the water column. Therefore, the possibility of chromium being present in its dangerous form is likely [16]. The increase in the element within the water column may be due to the effect of pH, which, as long as it is alkaline, works to release the element from the sediments by removing the bonds with the complexes. Studies indicate that the association of elements with sediments can be in multiple geochemical phases, and the basic phases are oxides, hydroxides, organic materials, carbonates, and sulfates [17]. Pearson's correlation coefficient recorded a negative relationship with pH with a value of (0.233 r = -) at a significant level. There is a positive relationship with both EC and salinity (r=0.497, 0.494) respectively. Chromium values in the last month of the study, exceeded the locally permissible limits of 0.05 mg/L [18].

*Zinc*; The values of zinc ranged between the lowest value at the second station of June, and the highest value on April was (0.0227) mg/L and (0.2125) mg/L, respectively. Zinc is found in a complex form and its availability to plants depends on its mineralization in the clays, as it transforms from the organic to the inorganic form to be more available to aquatic plants. Therefore, this process plays a role in determining its concentrations in the water. The high values of zinc during the spring season are perhaps attributed to the type of waste discharged, especially organic waste, which is a source of zinc [19]. Zinc has multiple sources and its increase in water is an indication of the presence of agricultural fertilizers that have washed into the water, especially in the spring [20]. It was shown that Iraqi fertilizers contain 406 ppm of zinc. The increase in spring can be attributed to the spring equinox. Studies indicate that zinc becomes non-exchangeable and soluble in the water column and does not settle at the bottom at pH greater than 5.5. It was also found that its concentration in solutions increases at pH above 7.5, which may explain the increase in zinc concentration in lake water [20]. Pearson's correlation coefficient recorded a negative relationship with air temperature with a value of (r = -0.306,) respectively. And itin limits of 3 mg/L [12].

*Cu*; The results of the current study showed that the concentration of copper ranged between the lowest value (0.0710) mg/L in the second and first stations during the months of November and December respectively, while the third station recorded the highest value (0.1096) mg/L during the month of October. The values of copper ions increased during the last months of the study, which may be due to the discharge of household waste water directly into the lake or its tributary (Al-Warar Canal) without treatment, as well as pesticide and phosphate fertilizer waste [21]. In addition, the stations are located within the Habbaniyah military area, and perhaps military waste increases the concentration of copper ions in the water. The presence of copper in the water column and its release from the bottom depends on the presence or absence of non-calcareous sediments, as these sediments have special mechanisms to retain this element and control its presence in the water column because this element has a high affinity for organic bonds in the sediments and forms complexes with it, which restrict its movement in the sediments, causing its concentration to vary in the water column. The source of copper may be geological, i.e. it depends on the type of rocks, and thus its percentage is high in the sediments, and the water temperature is a reason for increasing its solubility, which may work to release it from the sediments or increase the activity of organisms, especially decomposers, to release different elements into the aquatic medium [22]. This is supported by the presence of a high positive correlation between water temperature and copper (r=0.625). Pearson correlation coefficient recorded a positive relationship with both air and water temperature, conductivity and salinity (r=0.572, 0.625, 0.738, 0.737) respectively at a significant level ($p \leq 0.01$). Copper ions values were within the permissible limits as they did not reach the maximum permissible limit (1.0 mg/L) within [13].

**Table (1) Some physical and chemical properties of Habbaniyah Lake water**

| Compound | P. 1 | P. 2 | P. 3 | P. 4 | P. 5 | P. 6 |
|---|---|---|---|---|---|---|
| | Range | Range | Range | Range | Range | Range |
| **A.Temp.** | 35-10 | 35-10 | 36-11 | 35-10 | 35-10 | 36-11 |
| **W. Temp.** | 32-11 | 32-11 | 31-11 | 31-10 | 30-10 | 31-10 |
| **E.Cond.** | 2064-1316 | 2132-1304 | 2064-1415 | 2176-1364 | 2154-1378 | 2073-1378 |
| **Salinity** | 1.320-0.842 | 1.364-0.834 | 1.320-0.905 | 1.392-0.890 | 1.378-0890 | 1.326-0.881 |
| **pH** | 8.44-7.05 | 8.5-6.5 | 8.33-6.56 | 8.26-6.46 | 8.2-6.4 | 8.11-6.3 |

**Table (2) Concentration rates of some heavy elements (mg/L) in the waters of Lake Habbaniyah**

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| Compound | P. 1 | P. 2 | P. 3 | P. 4 | P. 5 | P. 6 |
|---|---|---|---|---|---|---|
| | Range | Range | Range | Range | Range | Range |
| Pb | 0.105-0.071 | 0.091-0.028 | 0.095-0.038 | 0.105-0.038 | 0.103-0.031 | 0.105-0.028 |
| Cd | 0.127-0.028 | 0.128-0.012 | 0.123-0.018 | 0.123-0.013 | 0.120-0.018 | 0.123-0.013 |
| Cr | 0.139-0.025 | 0.145-0.022 | 0.154-0.017 | 0.166-0.018 | 0.184-0.016 | 0.171-0.02 |
| Zn | 0.125-0.091 | 0.212-0.022 | 0.124-0.077 | 0.212-0.057 | 0.151-0.093 | 0.138-0.095 |
| Cu | 0.105-0.071 | 0.103-0.071 | 0.109-0.071 | 0.109-0.079 | 0.099-0.078 | 0.105-0.073 |

## Conclusions

A lake water is somewhat warm, with almost neutral water tending to be slightly basic, with good conductivity due to the chemical elements it contains, and with a salinity that exceeded PPT1 during the last months due to the low water level in the lake and increased evaporation. As for the Heavy Matale, the values were outside limits, while some of such Zn and pb was within the permissible limits.

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