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Comparative study of water quality of Manchhar Lake with drinking water quality standard of world health organization

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Abstract: Manchar Lake is the largest fresh water lake in Pakistan, which is degrading day by day due to effluents of various industrial sectors. This simple study was carried out to assess the possible changes in water of lake due to waste water discharge from industrial sectors, the analysis was carried out at Environmental Analytical Laboratory in the Department of Chemistry, University of Sindh Jamshoro and parameters were compared with water quality standards of world health organization. The analysis include the determination of pH, Electric Conductivity (EC), Salinity, TDS (Total dissolved solids), Alkalinity, Dissolved Oxygen (DO) Nitrate, Chlorides and total hardness were performed.

Keywords: Pollution, Manchar Lake, Eutrophication, Waste Water

1. Introduction

Pakistan is home to many natural and manmade lakes and reservoirs. Manchar Lake is the largest lake in Pakistan (1) as well as largest lake in South Asia. The lake is spread over an area of over 100 square miles. Manchhar lake is a flood plain natural lake, located at a distance of about 18 km from Sehwan town, (district Dadu), at longitude 67º, 34' to 67º, 43' E while its latitude extend as from 26º, 23' to 26º, 28' North on the globe (2). Pollution of Manchhar Lake is serious issue (3). Lake is polluted by various trace and toxic elements (3). Main cause of these pollutants is anthropogenic activities which is degrading entire ecosystems all over the world (4; 5). The lake is main reservoir for lot of bird's fishes as well as it is an earning source of 45000 to 50000 fishermen living there and it is habitat of approximately 50000 water fowls (6). Various studies have been carried out on lakes for assessment of various types of pollutants. (7)It was Found that metals in the surface sediments all exceeded their standard level in Nansi Lake China, (8) Scientists worked to investigate the presence of plastic pollution in the Laurentian Great Lakes ecosystem; Baiyangdian Lake, China was also found highly contaminated (9). These contamination causes eutrophication in lakes due to increase of nutrients (10-15) which results the deficiency of oxygen in lakes. Lake's conserves the fish biodiversity (16-19), hence the fish population of lakes is highly at risk (18-20).

pH, TDS, DO, and alkalinity is directly related with metal ions, so the variation in these parameters indicates the trace and heavy metallic pollution (21). These pollutants degrade mostly whole aquatic system (22). Seasonal variations also affect the concentration of these contaminates (23). Former studies also indicating the serious health problems related with eating contaminated fishes caught from pollutes lakes (24, 25). The Manchar Lake support the livelihood of thousands of families, formers, fish and Aquatic life, flora and fauna and various

species of migratory birds (1-3, 26-28). This study was simply conducted on physical parameters and dissolved oxygen. Aim of this study was to assess possible variation of different pollutants in lake from former studies (1, 3, 26, and 29).

2. Material and Method

2.1. Sampling

From the Manchar lake, five sampling stations were selected which includes zero point (waste entrance point into lake), near to zero point (inside the Manchar lake), mid of the Manchar, Danistar Wah (Manchar Lake) and Aral Wah (Manchar Lake) respectively. Sampling was carried out in February, 2012 and June, 2012. Each sampling was carried out after the interval of three months.

Pre-cleaned plastic bottles of 1000 ml with scraped caps were used for sampling. The sample bottle was plunged neck downwards about 15 cm below the water surface and about 60 cm from the side of local fisher man boats. The samples were stored in the laboratory at the room temperature on the top of cupboard until required for use. All the analyses were conducted according to the standards of American Public Health Association (30). The entire chemicals and study standards solution were obtained from Sigma Fluka.

2.2. Determination of pH

pH was measured with Orion 420 A pH meter. Before using the meter was calibrated with buffer solution. After that, the electrode of the pH meter was inserted into the samples and value was noted.

2.3. Determination of Electric Conductivity (EC), Salinity, and Total Dissolved Solids (TDS)

The parameters were measured with WTW 320 conductivity meter.

2.4. Determination of Dissolved Oxygen (DO)

The sample was collected in 250ml Winkler bottles at the sampling site and fixed by adding 2ml of $MnSO_4$ reagent and then 2 ml of alkali iodide-azide reagent. The bottle was closed tightly, sealed and mixed thoroughly. The sample was transferred to laboratory. In laboratory the bottles were opened and a supernatant liquid was carefully removed (30-40 ml) without disturbing the precipitate. 2.0 ml of orthophosphoric acid was added and the solution was kept in darkness for 5-10 minutes, then 2-3 drops of starch indicator, was added and titrated with standard sodium thiosulphate solution 0.1N, at the end point the blue color disappeared.

2.5. Determination of Alkalinity

Alkalinity is estimated by titrating the sample (50 ml) with the standard solution of strong acid (HCl), first to pH 8.2 using phenolphthalein as an indicator (carbonate alkalinity) and then further to second end point to pH 4.3 using Methyl Red +Bromocosal as mixed indicator (bicarbonate alkalinity) (30).

2.6. Determination of Total Hardness

50 ml of sample was titrated against EDTA (0.01 M) using Erichrome black T as indicator and maintaining pH 10. At the end point the color changed from wine red to blue. This amount of EDTA used corresponds for total amount of Ca and Mg in the sample.

2.7. Determination of Nitrates

Ultraviolet spectrophotometric method was used to estimating nitrates in the surface water. Nitrate and organic matter in water absorb light at 220 nm where nitrate does not absorb light at 270 nm. Nitrate stock solution of 100 mg/L NO_3-N was prepared by dissolving 0.7218- gram anhydrous potassium nitrate in distilled water to which 2 mL of chloroform was added and diluting to one liter. Working solutions of nitrate in the range of 0.5 -10mg/L NO_3- N was prepared by dilution from the stock solution. Concentration of NO_3 –N in the sample along with absorbance was noted with at wave length of 220 nm. Twice absorbance value at 270 nm was subtracted absorbance at 220 nm for NO_3 –N estimation in the samples. Standards solutions of higher concentration were prepared to measure nitrates in the water higher than 10mg/L NO_3 N.

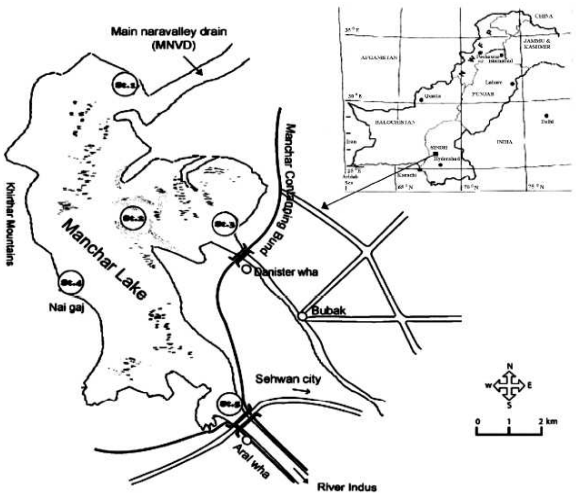

Figure 1. *Location of study area.*

2.8. Determination of Chlorides

Chlorides in the water were determined by argentometric method. Chloride of the silver is sparingly soluble in water and is precipitated as silver chloride by addition of silver nitrate to water. Silver nitrate reacts first with chloride in water and then with chromate to form red colored chromate. Potassium chromate was used as indicator in the silver nitrate titration of chloride.

3. Result and Discussion

3.1. pH

The pH expresses the acidity or alkalinity of water which is determined by means of hydrogen ion (H+) and the hydroxyl ion (OH-) in water. Higher concentration of H+ ions gives lower score on the pH scale and lower concentration of H+ ions gives higher scores on the pH scale. The magnitude of daily fluctuation in pH depends on the buffering capacity (total alkalinity) of water and rates of photosynthesis respiration the water with pH values ranging from abut 6.5-9.0 at daybreak is most suitable for fish production.

They (3) Recorded pH in Manchar was 7.90–8.34. In current study hydrogen ion concentration (pH) values were found from pH 8 to pH 8.48. Sampling station 1 and 2 were found more pH than others. The high values may be due to attributed sewage discharged by surrounding city and agricultural fields. The pH value is very important for plankton growth (31). According to (32) pH is ranged 5 to 8.5 is best for plankton growth. Moreover, pH very often act as an index for reflecting conditions associated with release of nutrients, physical conditions of soil and potency of toxic substances (33, 34).

3.2. Total Dissolved Solids and Electric Conductivity

Total dissolved solids indicate organic and inorganic matter in the sample. It is aggregated amount of the entire floating suspended solids present in water sample. The solids may be organic or inorganic in nature depending upon volatility of the substances. A high concentration of dissolved solids increases the density of water affects osmoregulation of fresh water organisms, reduces solubility of gases and utility of water for drinking, irrigational and industrial purposes. TDS values could be due to the dissolved solid waste originating through the discharge of effluent from the industries which is responsible for water pollution. The TDS of water above 100 mg L−1 starts changing the taste; thus, all samples above 1,500 mg L−1were either brackish or saline in taste.

(26) Report the range of TDS and conductivity in lake 3580–4440 mg/L and 5.01–6.22 µS/cm, respectively. Variation was found in current study which is may be due to high quantity of water received by lake during flood of 2010 and 2011. TDS were found between 1333 to 1725 mg/L and the Electric conductivity value of the water samples varied between 2.1 µS/cm to 2.69 µS/cm. (26) also found that the high level of EC, due to significant amount of dissolved salt. This study records low quantity of dissolved solids which is cause of low EC.

3.3. Dissolved Oxygen

Dissolved oxygen in water is of great importance to all aquatic organisms and is considered to be the factor which reflects physical and biological process taking place in a water body (35). It is important in support and production of life. It determines nature of an entire aquatic ecosystem to a great extent. Importance of dissolved oxygen (DO) in an aquatic ecosystem brining out various biochemical changes and many ecologists discussed its effect on metabolic activities organisms (36). The low oxygen level was recorded during summer mainly due to the removal of free oxygen through respiration by bacteria and other animals "Studies of Some physicochemical characteristics of old Aswan Dam reservoir and River Nile water at Aswan" as well as the oxygen demand for decomposition of organic matter. Free oxygen (DO) is the single most important gas for most aquatic organisms. When the aquatic organisms exposure to less than 2.0 mgl -1free oxygen for few days may kill most of biota in the aquatic system (37), while values of 5.0 to 6.0 mgl-1 are usually for most of fish population (38). Dissolved oxygen is positively correlated with sulfate (0.527), indicating that these anions increase with increasing dissolved oxygen content where sulfide and sulfite are oxidized to sulfate in presence oxidized sulphur bacteria at high oxygen content.

Water body receives the supplies of oxygen mainly from two sources directly from atmosphere and during the process of photosynthetic activity of chlorophyll bearing plants. Concentration of dissolved oxygen also depends on surface agitation due to temperature, respiration rate of the living organisms and decomposition rate of dead organic matters. Excess dissolved oxygen might not be harmful for health. However, O_2 over saturation is usually linked in surface water to algae (39) and that may be a health problem. Very low concentration of dissolved oxygen supports the growth of anaerobic microorganisms and limits the purification capacity of water as result obtained from the analysis of the water samples of the Manchar Lake was ranged as 3.17-4.17. Low DO values, in the range of 2.5–7.4 mg/L, were found by (26).

3.4. Alkalinity (Alk) and Salinity

The amount of acid required titration the bases in a measure of alkalinity of water or it is the ability of water to neutralize or acids. The minerals, which dissolve in water from soil, atmosphere and waste discharge, provide the source of alkalinity. Carbonates and bicarbonates are the major constituent of pond water and their concentrations are expressed as total alkalinity. Calcareous water with alkalinity more than 50 ppm is most productive. Water with alkalinity less than 10 ppm rarely produces large crops. Water intermediate between 10-50 ppm may give useful results. In highly productive water, the alkalinity is thought to be over 1000 ppm. However, the range of alkalinity as 0.0-20 ppm for the low production, 20-40 ppm for medium production and 40-90 ppm for high production are considered. Influence of alkalinity is probably masked by other more important factor such as dissolved nitrogen and phosphorus.

Maximum alkalinity was found in sampling station 1 as 80 mg/l and minimum value was recorded as 55.3 mg/l at sampling station-2.

The salinity value of all water samples ranged from 2.05 mg/L to 2.71 mg/L.

3.5. Chlorides

It was noticed that the concentration of Cl was high in the surface water than bottom layer. This could be attributed to evaporation from surface water leaving the relative high content of chloride. Chloride contaminates of Lake Water considerable harmful for humans to drink and irrigation at high levels, where it is made of chlorine chemically combined with a heavy metals. Chlorides were found from 672 mg/l to 936 mg/l. high concentration of chlorides was in sampling station 1 whereas the sampling station 4 was contain minimum concentration of chlorides.

3.6. Total Hardness

Total hardness was found in the range of 163 mg/l to 187 mg/l. it was found that hardness was more in sampling station 3 than others, but according to standards of World Health Organization all the sampling stations were under limit.

Table 1. *Results comparison with WHO.*

Parameters	MNVD-1	Near Zero Point-2	Mid of Manchar-3	Danistar Wah-4	Aral Wah-5	WHO Standards
pH	8.09	8.48	8.48	8.02	8.2	6.5-8.5
TDS mg/L	1725	1435	1596	1332	1461	1000 mg/L
DO mg/L	3.92	4.17	3.72	3.17	3.53	N/A
EC µS/cm	2.9	2.1	2.63	2.34	2.69	N/A
Salinity mg/L	2.72	2.7	2.1	2.3	2.05	500 mg/L
CL mg/L	936	712	672	714	687	250mg/L
T.H mg/L	213	118	187	178	163	500 mg/L
Alk mg/L	80	55.3	70.5	60.32	68.3	N/A

4. Conclusion

From the above study it was confirmed that lake has been polluting on its earlier way, no action has been taken yet to protect the South Asians largest Lake. Former studies were taken on this hop that authorities will take the action but from this study it was confirmed that no action has been taken yet. In this study Dissolve solids, Dissolve oxygen and Chlorides were not found according the satisfactory level of WHO. It is highly recommended that an urgent strategy should be mad to protect this valuable fresh water reservoir. Reason of pollution of lake is untreated liquid waste which can be managed by treatment so it also recommended that waste water should be treated before discharging to the lake.

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