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RESEARCH ARTICLE

A Comparative Study of Physico-Chemical Parameters of Keenjhar Lake, Thatta, Sindh, Pakistan

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Abstract

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The present study was conducted to examine different physico-chemical properties of Keenjhar Lake, located in Thatta district, Sindh, Pakistan, during three consecutive years i.e. February 2009, March 2010 and March 2011. Physicochemical parameters including Temperature, pH, Colour, Odour, Conductivity, Dissolved oxygen (DO), Biological oxygen demand (BOD), Chemical oxygen demand (COD), Chloride, Calcium, Magnesium, Phenols, Chromium, Lead, Cadmium and Nickel. The minimum and maximum ranges of physico-chemical properties were as, temperature 18–29°C in February 2009 and March 2011 respectively, pH 7.12–8.29 in February 2009 and March 2011 respectively, Colour (brown to deep brown) and Odour (Fishy, Phenolic, smell of diesel) in February 2009 and March 2011 respectively, Conductivity 238–490 μScm^{-1} in February 2009 and March 2011 respectively, Dissolved oxygen 7.2–3.02 mg/L in February 2009 and March 2011 respectively, Biological oxygen demand 4.23–5.76 mg/L in February 2009 and March 2011 respectively, Chemical oxygen demand 6.78–10.46 mg/L in February 2009 and March 2011 respectively, Chloride (60–186 mg L⁻¹), Calcium (56–82 mg L⁻¹), Magnesium (27–75 mg L⁻¹) in February 2009 and March 2011 respectively. Toxic metals like Chromium (18–26 ppb), Lead (12–20 ppb), Cadmium (3.4–6.8 ppb) and Nickel (5.3–8.1 ppb) in February 2009 and March 2011 respectively, Phenols (1.7–3.57 ppb) in February 2009 and March 2011 respectively.

This study was specially designed to assess physical and chemical properties of water quality of Keenjhar Lake, Thatta, Sindh, Pakistan. This field study can be helpful to the state how the fresh water reservoir is being polluted now days become bed water resource and drinking water supply for 20 million people in Karachi metropolitan city, Pakistan. The contaminated lake water is also dangerous for the health of thousand people.

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Introduction

The Lakes and reservoirs are most important natural resources of water supply for domestic and industrial uses, fisheries and irrigation throughout the world. In addition, lakes found important habitats for wildlife and support a very diverse fauna and flora, consisting

important plant, bird and animal species. (Anon., 2006).

In Pakistan Lakes and freshwater reservoirs have been severely threatened by a number of anthropogenic disturbances such as eutrophication, acidification and contamination from heavy metals and other contaminants which have directed to

serious damaging effects on the structure and function of aquatic and terrestrial ecosystems. (Mahar et al., 2000, Shafiq et al., 2011. M Zaheer Khan, et al., 2012).

Keenjhar Lake is the biggest and most important artificial freshwater lake in Asia, Pakistan (Figure: 1). It is situated in Thatta, Sindh adjacent to the national highway on the right bank of river Indus.



Figure-1: Study Area map of Keenjhar Lake, Thatta, Sindh, Pakistan

The River Indus is the main source of feeding the lake through Kalribaghar (KB) feeder canal (Maharet al., 2007). Keenjhar Lake is one of the potential water supplies for drinking water to 1.8 million people of Karachi city and parts of Thatta district (Nasiret al., 2002). The River Indus is the main source of feeding the lake through Kalribaghar feeder (Maharet al., 2007). Many valuable high qualities fish specially Rao and Pallas were the main edible fish from this reservoir which now a days face a very serious threat from pollutant burden that will make the whole lake poisonous, if not attended in time. The increasing pollution in the lake has directly affecting the lives of thousands of people at risk who live along the lake's banks and also use it for growing vegetables. Furthermore the incidence of malaria, diarrhea, skin disease, typhoid, jaundice and incidence of skin diseases was very high in all villages at Keenjhar Lake. The turbidity, biological oxygen demand and chemical oxygen demand were high along with the toxic pollutants such as cadmium and lead in Keenjhar Lake water. This may be the cause of fish decline in recent past. The increasing growth of weeds is also adversely affecting the lake's ecology as they release poisonous gases and contaminate water where there is no organization to look after the water quality of the lake and maintaining its ecology (Ilyas, 2011).

This study was specially designed to assess physical and chemical properties of water quality of Keenjhar Lake, Thatta, Sindh, Pakistan.

Material and Methods

Surface water samples were collected during the period of February 2009, March 2010 and March 2011 from Keenjhar Lake, Thatta, Sindh (Figure: 2).



Figure-2: Keenjhar lake: The largest freshwater lake in Pakistan

Water sample were collected in a colored, sterilized bottle and sampling was usually done in the morning. All samples were properly sealed under specific codes / labels and dispatched to the laboratory and stored at 4°C in refrigerator for physical and chemical analysis. Water sample for heavy metal estimation were collected in separate plastic bottles and preserved with 5ml HNO₃ (55%) / L to prevent metal absorption on the inner surface of the container. The determination of physico - chemical parameters were done by Standard methods of analysis (APHA, 2005) All the chemicals and reagents used were analytical grade (Merck, BDH) Temperature was measured with a mercury thermometer during study period on sampling site. pH was measured with an Orion model 420 pH meter on sampling sites. Dissolved oxygen samples were analyzed by a modified Winkler method (Whitney, 2011), Conductivity was determined with conductivity meter (portable; 3010, Jenco, USA; Hi 8633, Hanna). Biological Oxygen Demand (BOD) by 5-day BOD technique. Chemical Oxygen Demand (COD) by the open reflux method. Chloride (salinity) by Mohr's argentometric method (Yoder, 1919), Calcium and Magnesium by standard titration method with EDTA. Phenols by reversed phase liquid chromatography. Chromium, Nickel and Cadmium levels were estimated by Atomic

Absorption Spectrophotometer (A Analyst 700, Perkin Elmer USA).

Statistics

Data analysis was carried out using SPSS statistical package Version 20.0 (IBM Corp. Released, 2011)

SPSS Statistics) to arrive at mean, standard deviation and test of significance (P value).

Table-1: Analysis of Physico-Chemical Parameters of Keenjhar Lake, Thatta, Sindh, Pakistan during years 2009-2011.

Parameters	Year 2009	Year 2010	Year 2011
Temperature (°C)	18±1.23	25±1.12	29±0.98
pH	7.12±0.78	8.21±1.42	8.29±1.22
Color	brown	brown	Deep brown
Odor	Fishy	Fishy, Phenolic, smell of diesel	Fishy, Phenolic, smell of diesel
Conductivity ($\mu\text{S cm}^{-1}$)	238±2.12	320±1.87	490±1.54
Dissolved Oxygen (mg/L)	7.2±1.76	5.1±0.87	3.02±0.95
Biological Oxygen Demand (BOD) (mg/L)	4.23±1.43	4.89±2.21	5.76±2.12
Chemical Oxygen Demand (COD) (mg/L)	6.78±0.79	8.65±1.13	10.46±1.57
Chloride (mg L^{-1})	60±1.84	114±1.12	186±1.53
Calcium (mg L^{-1})	56±1.23	72±1.42	82±1.91
Magnesium (mg L^{-1})	27±1.65	45±1.32	75±1.34
Phenols (ppb)	1.7±1.41	2.3±1.14	3.57±1.47
Chromium (ppb)	18±1.59	21±1.64	26±1.14
Lead (ppb)	12±0.56	15±1.94	20±1.46
Cadmium (ppb)	3.4±1.41	4.1±0.48	6.8±0.63
Nickel (ppb)	5.3±1.91	6.4±1.38	8.1±1.23

Results expressed in Mean±SD values

Result and Discussion

The observed results of three years research work as shown in Table-1 are based on environmental monitoring of fresh water reservoir Keenjhar Lake which is the potential water supply for drinking water to the largest metropolitan city and capital of Sindh province Karachi, Pakistan.

Temperature:

Temperature is one of the major important factors that can affect the speed of chemical reactions in aquatic life (Kumar, 1992). In addition, temperature can also affect the solubility of chemical compounds and effect the interaction of pollutants with their environment. During study period, temperature varied between 18-29°C in year 2009 -2011 (Figure: 1). An increase in temperature leads to faster chemical and

biochemical reactions. The growth and death of microorganisms and the kinetics of the biochemical oxygen demand are also regulated to some extent by water temperature (Khuhawar and Mastoi, 1980).

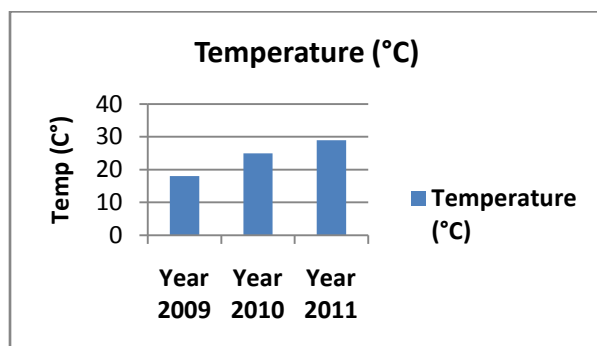


Figure: 1 Temperature of Keenjhar Lake during year 2009-2011.

pH:

The pH of water is a measure of its acidity and basicity that can be determined by the production of hydrogen and hydroxyl ions. The pH of an aquatic ecosystem is closely associated to biological productivity and hence, fluctuation of water pH can be caused by excessive primary production (Carr and Neary, 2008). The pH of lake water was 7.12-8.29 during three years as shown in Figure: 2. The high range of pH may be due to the increase biological activity and temperature changes. In addition a significant change in pH also occurs due to dumping of drainages and seasonal variation.

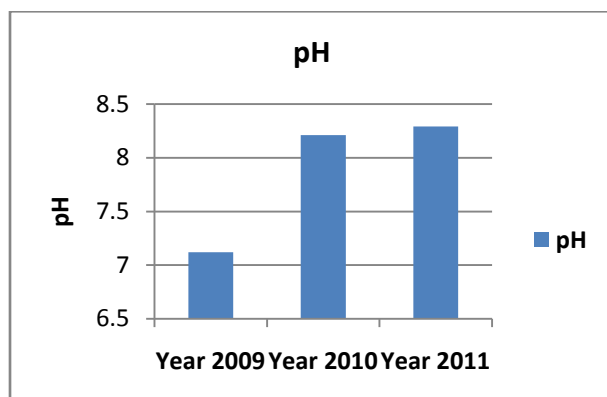


Figure: 2 pH of Keenjhar Lake during year 2009-2011.

Color and Odor:

Drinking-water should preferably have no visible color. During the study period the observed color of lake water was varied from brown to dark brown with

fishy, phenolic and stinging smell of diesel due to the presence of a number of hydrocarbons particularly alkyl benzenes such as trimethylbenzene, may give rise to a very unpleasant “diesel-like” odor. It should not be considered acceptable for drinking purposes.

Electrical Conductivity

The electrical conductivity of water depends on the concentration of ions and its nutrient status. The range of electrical conductivity was 238 – 490 $\mu\text{S cm}^{-1}$ in the year 2009-2011 (Figure: 3). The standard level of EC is 400 $\mu\text{S cm}^{-1}$ recognized by world health organization.

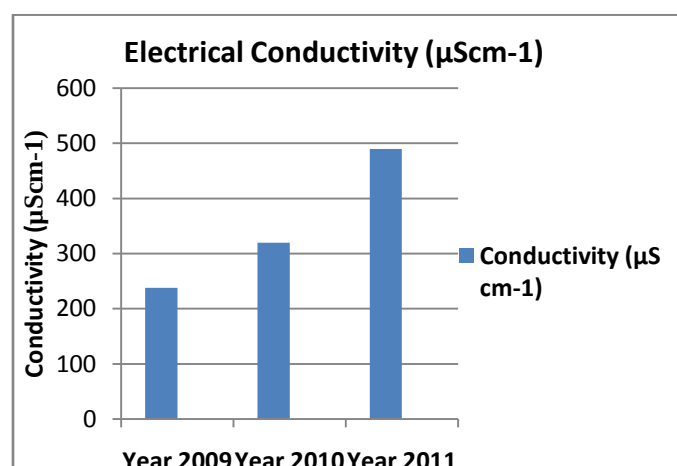


Figure: 3 Electrical conductivity of Keenjhar Lake during year 2009-2011

Dissolved Oxygen (DO):

Dissolved oxygen is one of the most important physical characteristics of water bodies and it is a measure of the amount of oxygen dissolved in water. Dissolved oxygen supports biological life in water, its fluctuations depend upon temperature and algal population (Maharet *al.*, 2004; Lashari *et al.*, 2009). Which was present at adequate levels in Keenjhar Lake during 2003-2008 as shown in Figure: 4. Majority of aquatic organisms need a minimum of dissolved oxygen in the range of 5-6 mg/L (Pennington and Cech, 2010). The Dissolved Oxygen (DO) has been found below or near 3.0 mg/l (ppm) in 2011 which does not support fish life and harmful for fishes and other aquatic life. This may be the cause of fish decline in recent past.

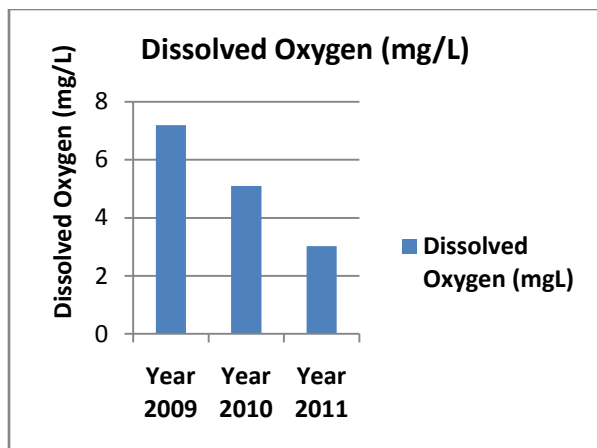


Figure: 4 Dissolved oxygen of Keenjhar Lake during 2009-2011.

Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD)

The biological oxygen demand and chemical oxygen demand were high along with the toxic pollutants such as cadmium and lead in Keenjhar Lake water. During the study period the BOD and COD load was varied between 4.23-5.76 and 6.78-10.46 respectively (Figure: 5). Results showed that BOD and COD is far higher than the WHO's standard (WHO, 1997 and 2004). The higher the BOD and COD is the indication of increased organic loads due to agricultural and domestic discharge in the water as well as increased household wastewater and waste discharges (Mullaret *et al.*, 2012).

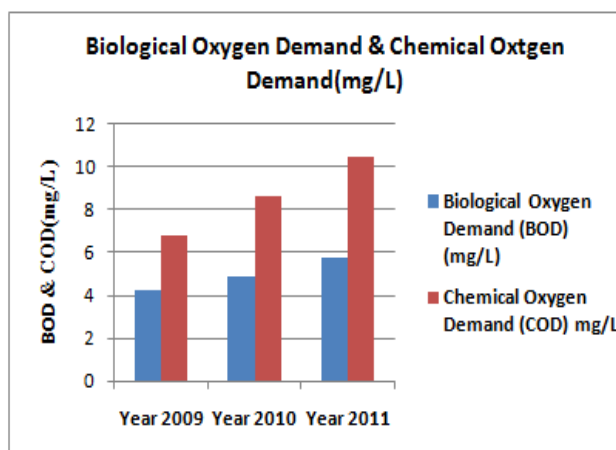


Figure: 5 Biological Oxygen Demand and Chemical Oxygen Demand of Keenjhar Lake during 2009-2011.

Chloride

The increase in chloride resulted as decomposition of macrophytes (Kumar, 1992). The maximum value of

chloride 186 was found in the year 2011, while minimum value 60 was observed in 2009 (Figure: 6). The chloride was found within permissible safe limits of WHO and other national and international guidelines.

Calcium

The maximum value of calcium was 82 in the year 2011, while minimum value was 56 observed in 2009 (Figure: 6). The calcium level was detected within approved safe limits of WHO.

Magnesium

The maximum value of calcium was 82 in the year 2011, while minimum value was 56 observed in 2009 (Figure: 6). The magnesium was determined in the acceptable range of WHO and other national and international guidelines.

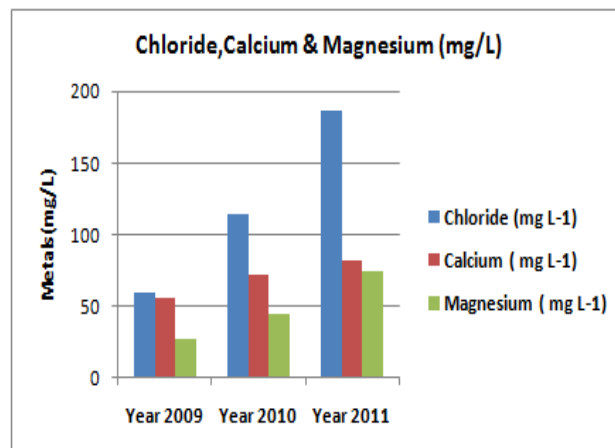


Figure: 6 Chloride, Calcium and Magnesium contents of Keenjhar Lake during 2009-2011

Phenol

Phenols have adverse effects on water and fish taste (David N. Armentrout *et al.*, 1979). Phenols found in water was (1.7-3.57 ppb) in February 2009 and March 2011 respectively (Figure: 7). The Phenol levels were very high due to misuse of water by washing of cloths, utensils, vehicles etc., by the people.

Toxic metals

Toxic metals were detected in the water consisted of Chromium (18-26 ppb), Lead (12-20 ppb), Cadmium (3.4-6.8 ppb) and Nickel (5.3-8.1 ppb) in February 2009 and March 2011 respectively (Figure: 7). These were found within the WHO guidelines, but increasing day by day. These high concentrations indicate the alarming condition of toxicity at Lake Site.

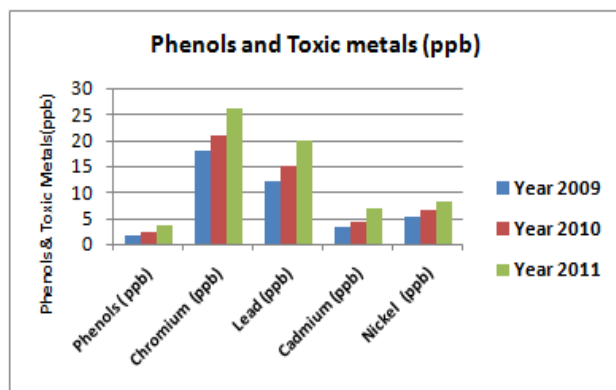


Figure: 7 Phenols and Toxic metals contents of Keenjhar Lake during year 2009-2011.

Conclusion

This research study was the real monitoring of the increasing pollution into the fresh water Keenjhar Lake and their impact on aquatic life. Physico-chemical properties of Keenjhar Lake were within tolerance limit for the growth of aquatic life, plants either animal. No excessive concentration of any parameters was recorded during study period except phenols levels were very high. Such polluted water requires effective and appropriate treatment before its supply to urban and rural areas.

Different organizations including Pakistan Council of Research in Water Resources (PCRWR), Water and Power Development Authority (WAPDA), Environmental Protection Authority (EPA) and some other private authorities have conducted short-term studies on water quality and results indicate that water pollution has increased day by day. The lake, therefore, is facing serious environmental degradation.

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