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Water Quality Monitoring of Sur Sarovar (Keetham) Lake, Agra (Uttar Pradesh)

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Abstract: *Water quality information in aquatic ecosystem is crucial in setting up guideline for resource management. The biota in the surface water is governed entirely by various environmental conditions that determine the selection of species as the physiological performance of the individual organisms. This study explores the water quality status and pollution sources in Sur Sarovar (Keetham) Lake, Agra (Uttar Pradesh), water quality parameters analyze of five sampling zone was done from water samples collected monthly from September 2014 to July 2015. The primary production of organic matter, in the form of phytoplankton and macrophytes is more intense in Sur Sarovar (Keetham) Lake. In contrast to the chemical quality of water bodies, which can be measured by suitable analytical methods, biological quality is a combination of both qualitative and quantitative characterization. The present piece of research work is initiated on pollution status at Sur Sarovar (Keetham) Lake by interference and increase in the population of phytoplankton and microbe. We were selected keys physico chemical parameters for analysis like, temperature 19.50 to 38.00 ^{0}C, pH 7.39±0.04 to 8.21±0.06, dissolve oxygen 5.90 ± 0.55 mg/L to 6.48 ± 0.87 mg/L, alkalinity 93.73 ± 5.09 mg/L to 124.27 ± 5.05 mg/L, hardness 119.33 ± 9.06 mg/L to 138.93 ± 8.07 mg/L, ammonia 0.52± 0.03 mg/L to 0.64 ± 0.032 mg/L, nitrate 0.71 ± 0.02 mg/L to 1.79 ± 0.02 mg/L, nitrite 0.21 ± 0.01 to 0.47 ± 0.02 mg/L, phosphate 0.22 ± 0.03 mg/L to 0.36 ± 0.05 mg/L and heavy metal concentration like Zn 0.023 ± 0.00 mg/L to 0.27 ± 0.00 mg/ L, Cr 0.022 ± 0.00 to 0.036 ± 0.00 mg/L , Cd 0.002 ± 0.00 mg/L to 0.010 ± 0.00 mg/L, Pb 0.013 ± 0.00 mg/L to 0.033 ± 0.00 mg/L, Hg 0.015 ± 0.00 to 0.02 ± 0.00 mg/L in the water were undertaken.*

Keywords: *Sur Sarovar (Keetham) Lake, Water Quality, Desirable Limit, Heavy Metals*

Introduction

Sur Sarovar (Keetham) lake is a water body which is located at 27° 15’ 95” N, 77° 51’ 875” E Lat/Long on the Agra Delhi highway (NH–2). Lake is a source of water for Agra in the months of summer and survey showed that it is polluted and the water is not fit for human consumption. The entire lake is formed in a catchment area of 7.13 km². Sur Sarovar (Keetham) lake is pentagonal in shape. There are artificially created islands for shelter and breeding grounds to the migratory birds. Sur Sarovar (Keetham) lake is a scenic lake. It was under the control of forest department. Today surface water is most vulnerable to pollution due to its easy accessibility for disposal of pollutants and waste waters. Worldwide surface water quality is governed by complex anthropogenic activities and natural processes Jarvie *et al.,* (1998), Ravichandran, (2003) including weathering, erosion, hydrological features, climate change, precipitation, industrial activities, agricultural land use, sewage discharge, and the human exploitation of water resources Beaugrand *et al*., (2004) Koster *et al*., (2005), Ravichandran (2003), Mahvi *et al.,* (2005), Liao *et al.,* (2008), Gantidis, *et al.,* (2007), Arain, *et al.,* (2008). The evaluation of water quality in most countries has become a critical issue in recent years; especially due to concerns that freshwater will be a scarce resource in the future Alberto *et al.,* (2001), Simeonov *et al.,* (2003), Singh *et al.,* (2004), Qadir *et al.,* (2008). The protections of integrity of world water resources have been given topmost priority in the 21st century due to limited supply. Chinhanga (2010), Wei *et al.,* (2008) reported that of anthropogenic activities played very important role to water quality deterioration. Numerous

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studies have also identified the pollution sources and potential influences of natural processes and anthropogenic activities on spatiotemporal variations in water quality Pillsbury and Byrne (2007), Kannel *et al.,* (2008). Abida *et al.,* (2008) reported that *aquatic* organisms often respond to external contamination by different ways, where the degree of accumulation quantity and form of the element in water, sediment, or food will determine. Region of heavy metals accumulation in fish varies at route of uptake, heavy metals, also fish species concerned. Many hazardous chemical elements, if reach into the environment through various channels, ultimately accumulate in the soil and sediments of aquatic environments initially lower aquatic organisms absorb after that transfer by food chain in higher trophic levels, including fish (Vie, J. C. *et al*., 2009). Fish gills directly absorbed the free divalent ions of many heavy metals may be from the water under acidic conditions (Maurya, P. K. *et al*., 2012). Hence, level of pollution or concentrations of heavy in the water and food primarily determined by the fish organs. Chemical elements accumulated in the silt and bottom sediments of aquatic environment can migrate back into the water under certain conditions.

Materials and Methods

Water qualities of Sur Sarovar (Keetham) lake were analyzed from the period of September 2014 to July 2015 using standard methods (APHA 2005) shown in Fig. 2-15 lake has five sampling sites water samples were collected from each sampling sites. Water samples were transferred into precleaned polythene container for analysis of physico-chemical parameters. Sampling were conducted between 9:00 AM and 11:00 AM during the study period monthly intervals basis. Water samples were directly taken in wide mouth polyethylene bottles for analysis of various physico-chemical properties. For the determination of dissolved oxygen concentration used portable ELICO water quality analyzer PE 138 kit or by Winklers method on site. Fig. 1 shows Diagrammatic view of Sur sarovar (Keetham) lake at various coordinates.

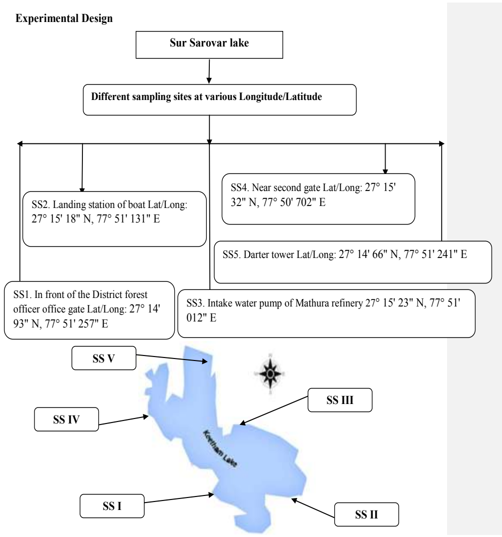

Fig. 1 shows Diagrammatic view of Sur sarovar (Keetham) lake at various coordinates.

Samples were transported to the laboratory for analysis of other parameters, under standard ideal conditions. ELICO water quality analyzer model no.PE 138 was used for analysis of Temperature, pH and dissolved oxygen. ELICO SL27 spectrophotometer used measurement of Ammonia, nitrate, nitrite, phosphate. AAS (Atomic Absorbance Spectrophotometer) using for measurement of heavy metals concentration. Statistical analysis and computations were done with the help of software (Microsoft excel, SPSS 16.0 version). The data presented is the mean values of three replicates with the standard error as shown in Figures.

Results and Discussion

Temperature

Temperature of Sur Sarovar (Keetham) Lake ranges between 19.50 to 38.00 ^{0}C (Fig. 2), Santhosh and Singh (2007). During summer season maximum temperature was recorded and the minimum was recorded during winter season. The maximum temperature during summer was due to greater solar radiation, Nainital Shastri and Pendse (2001). Lower temperature in winter due to shorter photoperiod and cold low ambient temperature Sirage (2006) and Major (2006).

pH

pH is calculated mathematically by, the negative logarithm of hydrogen ions concentration. Carbon dioxide which is an acidic gas those concentration greatly influenced pH of natural water body. Sur Sarovar (Keetham) lake has pH value ranges between 7.39±0.04 to 8.21±0.06 (Fig. 3) and there is significant variation found. Between 6.7 and 9.5 Suitable pH range for fish fauna an ideal pH level is between 7.5 and 8.5 and above and below this is stressful for the fishes according to Santhosh and Singh (2007).

Alkalinity

Alkalinity concentration in water due to bicarbonates and salts of weak acids of highly alkaline water Kataria *et al.,* (2006). Alkalinity concentration were recorded between 93.73 ± 5.09 mg/L to 124.27 ± 5.05 mg/L (Fig. 4). During winter season minimum alkalinity values were recorded and during summer season maximum value of alkalinity were recorded Das and Chand (2003). During summer water level decreases resulting the decay and death of plants and living organism. Thus CO_2 is released resulting in the addition of carbonate and bicarbonate due decomposition might also be one of the reason for the increase in alkalinity value. Stone and Thomforde (2004) suggested 50-150 mg/L ($CaCO_3$) as suitable range; an acceptable range of above 20 mg/L and less than 400 mg/L for lake and pond water.

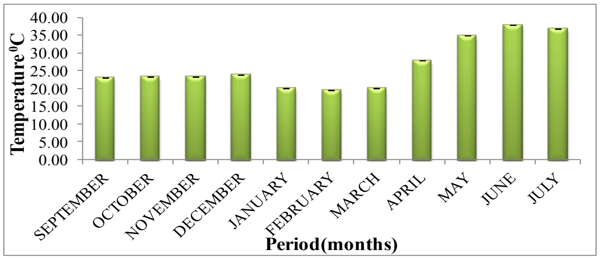

Fig. 2 Monthly variation of temperature mean ± SE values in Sur sarovar (Keetham) lake during study periods.

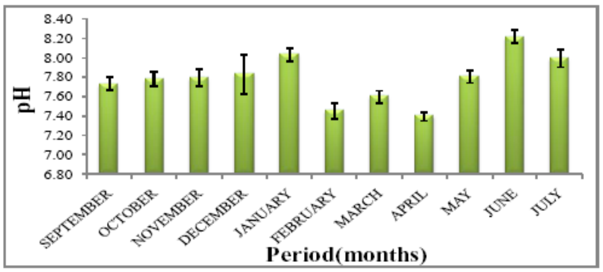

Fig. 3 Graph showing the mean values ± SE (pH level) of water for the Sur sarovar (Keetham) lake during the experimental periods.

Hardness

Alkaline earth elements such as calcium and magnesium in an aquatic body along with other ions such as aluminium, iron, manganese, strontium, zinc, and hydrogen ions are the source of hardness. Calcium and magnesium

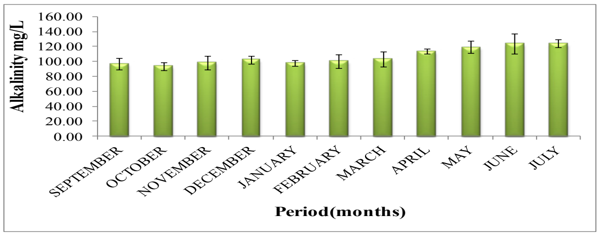

Fig. 4 Graph showing the mean alkalinity values ± SE of water for the Sur sarovar (Keetham) lake during the experimental periods.

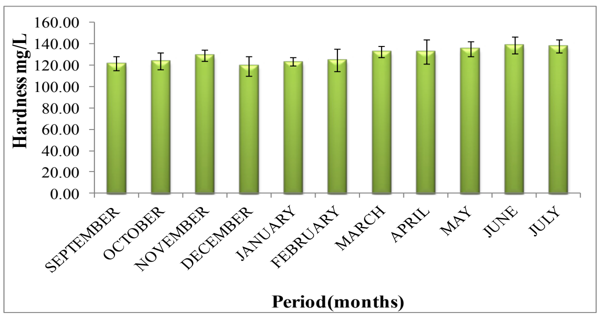

Fig. 5 Monthly variation in concentration of hardness means values ± SE in Sur sarovar (Keetham) lake during study periods.

are important element for fish to formation of scale, bone and metabolic reactions. Hardness concentration in Sur sarovar lake between 119.33 ± 9.06 mg/L to 138.93 ± 8.07 mg/L (Fig. 5) were recorded similar result also observed by Ranjan and Yasmin, (2012), Salve *et al*., (2007). During winter minimum concentration of total hardness were recorded and in the summer season maximum in concentration of Sur Sarovar (Keetham) lake were measured Udhyaya *et al.,* (2006) similar result were observed.

Dissolved Oxygen

Availability of dissolved oxygen were recorded in the Sur Sarovar (Keetham) lake water ranges between 5.90 ± 0.55 mg/L to 6.48 ± 0.87 mg/L highly ($p > 0.05$) there is significant variation observed (Fig. 6). For a long period of time fish can die if exposed to less than 0.3 mg/L of DO recommended by Ekubo and Abowei (2011). DO level >5 mg/L is essential for support good fish production according to Bhatnagar and Singh (2010). Udhaya *et al.,* (2006) reported that increased microbial activity and raise temperature depletion of dissolve oxygen in water. During summer season dissolved oxygen concentration were recorded minimum , whereas maximum dissolved oxygen were concentration were recorded during monsoon season.

Ammonia (NH_3)

Extremely toxic ammonia (NH_3) unionized forms while the ionized form (NH_4^+) is not and both are combined forms are grouped together called as "total ammonia". Decomposition of organic matter and protein metabolism after feed digestion ammonia excreted by bacteria and fish (Fig. 7), such as dead planktons and wasted food, *etc*., concentration of ammonia in Sur Sarovar (Keetham) lake 0.52± 0.03 mg/L to 0.64 ± 0.032 mg/L during the experimental periods. Maximum concentrations were reported in June month and in month of February lowest concentration were reported. Santhosh and Singh (2007) for aquatic organisms maximum ammonia concentration limit is 0.1 mg/L. For pond fish toxic levels un-ionized ammonia at short term exposure usually varies between 0.6 and 2.0 mg /L, and sublethal effects may occur at 0.1 to 0.3 mg/L.

Nitrate

Minimum nitrate concentration of in the Sur Sarovar (Keetham) lake water were recorded in summer season, whereas during monsoon season maximum availability of nitrate were observed. The concentration of nitrate were recorded in the water of Sur Sarovar (Keetham) lake between 0.71 ± 0.02 mg/L to 1.79 ± 0.02 mg/L there is significant different reported ($p > 0.05$) (Fig. 8) Similar results were found by Sahu *et al*., (2007).

Nitrite

Nitrite oxidizes hemoglobin in to methemoglobin in the blood turning the blood and gills brown

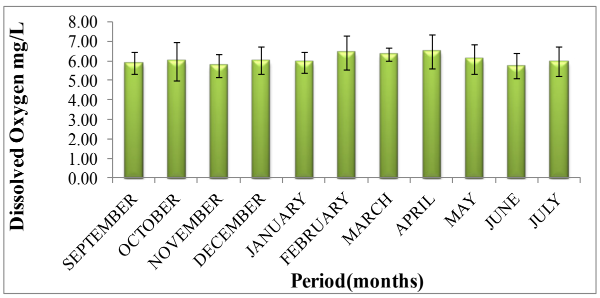

Fig. 6 Graph showing the dissolved oxygen level mean values ± SE of water for the Sur sarovar (Keetham) lake during the experimental periods.

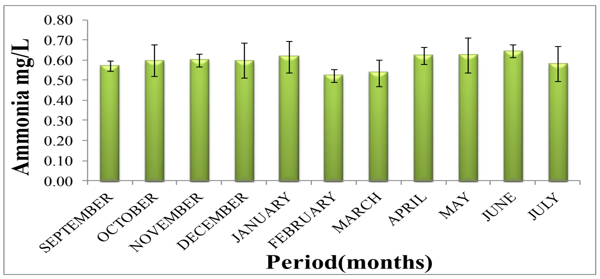

Fig. 7 Graph showing the mean values (ammonia of water) ± SE for the Sur sarovar (Keetham) lake during the experimental period.

and hindering respiration also damage for nervous system, kidneys, liver and spleen of the fish can also called as an invisible killer of fish. Nitrite produced by aerobic and autotrophic nitrifying this is an intermediate product of the nitrification bacterial process, Nitrosomonas bacteria combining oxygen and ammonia (Fig. 9). Nitrite concentration in Sur Sarovar (Keetha) lake between 0.21 ± 0.01 to 0.47 ± 0.02 there is no significant different ($p > 0.05$) have been reported. Highest concentration reported in month on june and lowest concentration reported in February. Nitrite concentration of aquatic water body recommended by Santhosh and Singh (2007) should not exceed 0.5 mg/L.

Phosphate

Because of geochemical shortage of phosphate in drainage basin one of the limiting factors for phytoplankton productivity. The concentration of phosphate were recorded in the water of Sur Sarovar (Keetham) lake between 0.22±0.03 mg/L to 0.36 ± 0.05 mg/L there is significant different have been reported (Fig.10). Concentration of phosphate decrease automatically during the multiplication of plankton, Moss and Ball (1989). The maximum amount of phosphate were recorded during summer season and minimum concentration recorded in the lake during winter season. Desirable phosphate for aquatic fauna level of 0.06 mg/L according to Stone and Thomforde (2004).

Zinc (Zn)

During the study period Zinc ions concentration of mean value were 0.023 ± 0.00 mg/L to 0.27 ± 0.00 mg/ L (Fig. 11) there is no significant difference ($p < 0.05$). Month of July maximum

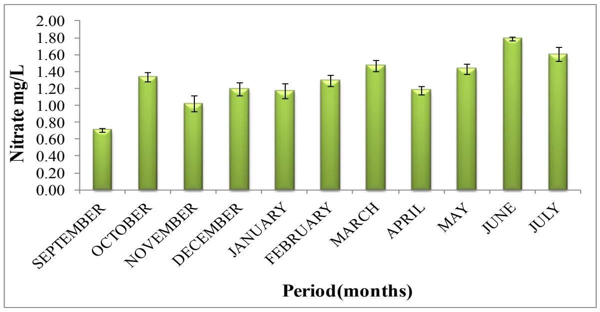

Fig. 8 Monthly variations of nitrate mean values ± SE levels in Sur sarovar (Keetham) lake during study periods.

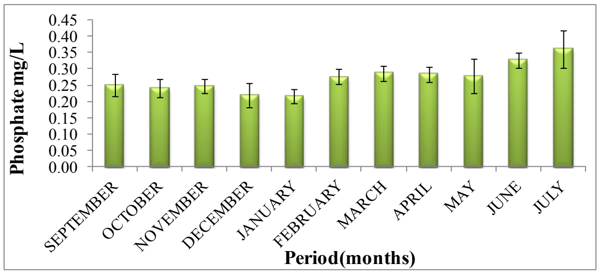

Fig. 10 Monthly variations of phasphate mean values ± SE levels in Sur sarovar (Keetham) lake during study periods.

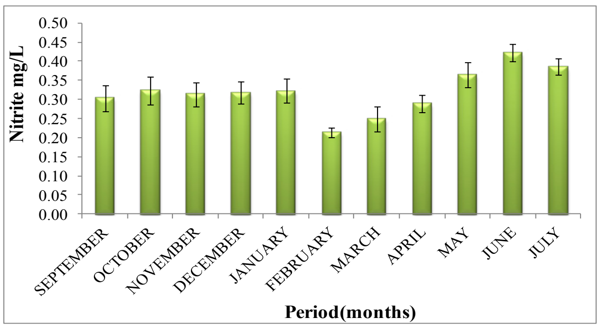

Fig. 9 Monthly variations of nitrite mean values ± SE levels in Sur sarovar (Keetham) lake during study periods.

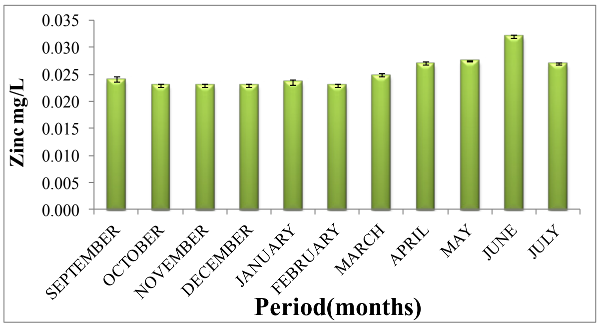

Fig. 11 Graph showing the mean zinc levels ± SE of water for the Sur sarovar (Keetham) lake during the experimental periods.

concentrations of Zinc were recorded and lowest concentration measured in the month of October. Due to agricultural influx, allochthonous origin, wastes of farms or sewage via surrounding cultivated lands Rathod *et al.,* (2011), Nkansah *et al*., (2009), Bhuvan (2012), Mehta (2011), is the major source of trace metals presence in Sur Sarovar (Keetham) Lake . Discharged from the various drains in the lake as well as the wind direction and velocity is major souce of heavy metals. Due to runoff from the surrounding chemicals from fertilizers and pesticides heavy metals increase in the rainy season.

Chromium (Cr)

In the month of June chromium concentration highest in the Sur sarovar (Keetham) lake 0.036 ± 0.00 mg/L due to higher evaporation ultimately higher temperature (Fig. 12). In the month February lowest concentration reported 0.022 ± 0.00 mg/L there is no significant difference (p> 0.05) similar result also reported by Kumar and Pal, (2011), Sarma, (2011), Singh *et al*., (2012). Runoff and drainage by surrounding area source of chromium in Sur sarovar (Keetham) lake including anthropogenic activities, electroplating factories, leather tanneries and textile manufacturing, wood treatment , oil and burning coal. Other factors, such as presence of organic chelators, cations, nutrients, and other heavy metals in solution likely influence toxicity to plants.

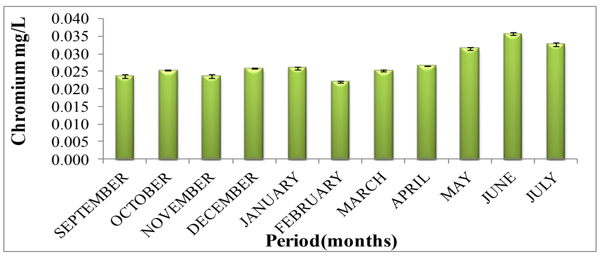

Fig. 12 Graph showing the mean chromium levels ± SE of water for the Sur sarovar (Keetham) lake during the experimental periods.

Lead (Pb)

Lead in the Sur sarovar (Keetham) lake highest 0.013 ± 0.00 mg/L to 0.033 ± 0.00 mg/L ($p < 0.05$) in the month of July were measured (Fig. 13) similar result also observed by Mohammed (2000). Due to atmospheric pollution caused by burning of fossil fuels, smelting, traffic, use of paints, waste incineration, pesticides, and agricultural application of sewage. Human activities have also spread lead and substances that contain lead to all parts of the environment. Lead from leaded gasoline used to be a major source of atmospheric and terrestrial lead, much of which eventually entered natural water systems. Estuarine and coastal marine species generally contain lower residues than those reported for freshwater plants. The relatively low lead content of marine species is primarily related to the extent of ambient lead pollution in coastal waters. Because there is often a good correlation between lead levels in water and plant tissues, several major species have been used as biomonitors of environmental contamination. These include freshwater representatives of *Elodea, Cladophora* and *Myriophyllum*, and estuarine *Fucus, Laminaria* and *Ascophyllum* Abidal and Harikrishna (2010) Sarma, (2011).

Mercury (Hg)

Lowest Mercury concentration 0.015 ± 0.00 mg /L in Sur sarovar (Keetham) lake in the month of June and in month of July 0.02 ± 0.00 mg/L highest concentration were measured (Fig. 14)

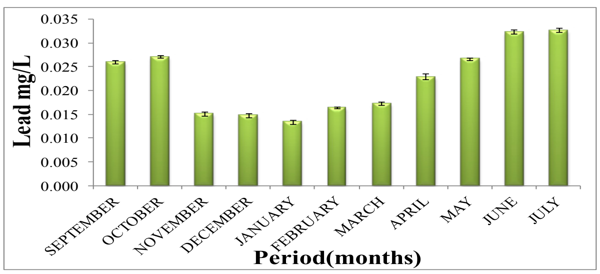

Fig. 13 Graph showing the mean lead levels ± SE of water for the Sur sarovar (Keetham) lake during the experimental periods.

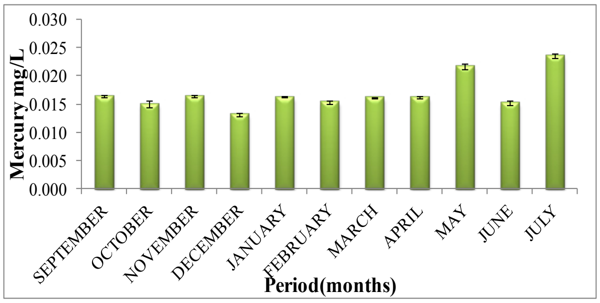

Fig. 14 Graph showing the mean mercury levels ± SE of water for the Sur sarovar (Keetham) lake during the experimental periods.

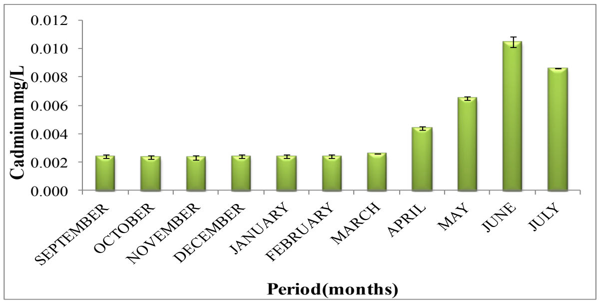

Fig. 15 Graph showing the mean cadmium levels ± SE of water for the Sur sarovar (Keetham) lake during the experimental periods.

there is no significant ($p < 0.05$) Similar observation was found by Hoo (2004) in Labu river of Malayasia; Yadav and Kumar (2011) in Kosi river; Zaidi *et al*., (2011) in Betwa and Pahuj rivers of India. Anthropogenic and human activities (Pesticides, Fertilizer, Fungicides, Bleached flour, Wood preservatives, Batteries, Paint pigments Floor waxes and polishes *etc*) source of mercury in sarovar (Keetham) lake. Mercury is a naturally occurring metal found throughout the environment as a result of normal breakdown of earth's crust (minerals) (Olajire *et al*., 2001) The total amount of mercury in the environment caused by natural processes throughout the world is far greater than the total amount caused by human activities (Shumbulo E. 2004). However, the amount of mercury that exists in any one place through natural processes is usually very low. In contrast, the amount of mercury that may be at a particular waste site because of human activity can be very high.

Cadmium (Cd)

Cadmium is natural constituent of surface waters and groundwater, found in the Cd^{+2} oxidation state. Cadmium in Sur sarovar (Keetham) lake water may arise through industrial discharges (metal processing operations, direct discharge from industrial operations) and waters mining, erosion of soils, weathering and bedrock, leakage from landfalls and atmospheric deposition, contaminated zone (phosphate fertilizers), fertilizers in agriculture and burning of fossil fuels Maurya *et al*., 2012. In the month of June Highest concentration of cadmium and lowest in September there is no significant difference 0.002 ± 0.00 mg/L to 0.010 ± 0.00 mg/L (Fig. 15).

Conclusion

This study expose that physicochemical variables such as pH, temperature, DO, Hardness, Alkalinity, Nitrate, Ammonia, Phosphate and Nitrite of Sur Sarovar (Keetham) lake has higher sometime than the recommended levels and this affect the growth and reproductive performance of fauna and flora. Heavy metals concentrations were analyzed and reported that dynamic fluctuation during study periods higher in rainy season and lower in winter. This could probably be explained by the fact that the pollution originates in effect driving the heavy metals to storm water to "wash" adjacent area before reaching the lake. In the summer months is normal that the effect is more pronounced than in the cold winter months, when the ground is frozen, and thus less exposed to erosion. The results showed that fundamental information for developing better pollution control strategies in the Sur Sarovar (Keetham) lake water.

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