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Research article

STUDIES ON PHYSICO-CHEMICAL PARAMETERS AND OCCURANCE OF HEAVY METALS IN AN URBAN LAKE OF WARANGAL DISTRICT DURING DIFFERENT SEASONS

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ABSTRACT: Increasing heavy metals in freshwater sources can pose severe threats to human being and environment. The heavy metal pollution occurs in rivers, lakes and ponds in various ways such as disposal of industrial effluents, sewage sludge from municipal wastage and modern agriculture practices. Various heavy metals and physico- chemical parameters were analysed during pre monsoon, monsoon and post monsoon seasons in the water of Chinna Waddepally Lake. The results reveal that physico-chemical parameters like Temperature, EC, COD, Total solids were significantly ($p<0.05$) increased during the monsoon. A drastic increase in chemical parameters like Nitrates and phosphates in post monsoon and Calcium, Magnesium in pre monsoon season was recorded. Results also shows that the content of heavy metals like Lead, Chromium, Copper, Zinc, Cadmium and Iron were significantly increased during post monsoon, whereas the content of Nickel and Mercury did not vary during the three seasons, it is observed.
Key Words: Heavy metals, Physico-chemical parameters, Pre-monsoon, Monsoon, Post- monsoon, Eutrophication.

INTRODUCTION

Water is the most vital resource of all kinds of life as it forms a medium in which physical, chemical transformations especially those of biological significance takes place. Water is an elixir of the body and it is a primary need of all living organisms. It is a valuable commodity available in very limited quantities to man and other living beings. The major source of fresh water include the lotic (rivers and streams) and lentic (ponds and lakes) water bodies and with the human practices they are adversely affected [1]. Living organisms are facing the problem of ever widening threat of water pollution due to modern technology, industrialization and civilization [2]. Water pollution has become a global problem due to industrial effluents, city sewage, chemical fertilisers of agriculture and various religious activities [3,4,5]. The increasing pace of developmental activities and extensive use of water resources are subject to the quality and hydrobiology of freshwater resources [6].

Water is one of the prime necessities of life without which we can hardly live for a few days. Trace amounts of metals like Iron, cadmium, Manganese, Silica, Fluorides, Nitrates, Phosphates, Sulphates, and Chlorides are common in water and these limited levels are not harmful to human. In fact some metals like Cu, Fe, Zn etc., are needed at low levels as catalysts for enzyme activities but excess have severe consequences on health [7]. When the quantity of these metals raise it affects the body systems and cause distractions of health [8]. Thus heavy metal pollutants is a major problem to aquatic environment like ponds, lakes and rivers because of toxicity, persistency and tendency to accumulate and cause stress in organisms and finally undergo food chain amplification [9].Water which is a delicate part of the environment, when polluted can be totally deoxygenated and life in it becomes impossible. Concentrations of heavy metals will increase in the cross river systems because of human activities and this in turn increases heavy metals in fish and shellfish which finally effect living systems [10]. The problem of water pollution by trace metals has become crucial all over the world and especially in a developing country like India. Occurrence of heavy metals in the aquatic ecosystem and its impact on flora and fauna has been reported [11]. The present work has taken up to study the physicochemical properties and heavy metals and their concentration at different stations with in the lake during different seasons.

MATERIAL AND METHODS

Collection of water samples for determination of physico-chemical parameters

The water samples for the analysis of physico-chemical parameters were collected in clean, pre-rinsed containers of one litre volume. The water samples were collected every month regularly for one year from June, 2012 to May, 2013 at four different sites covering total area of the lake. Dark coloured reagent bottles measuring 125ml were used for collecting water samples for the analysis of biological oxygen demand (BOD) and dissolved oxygen (DO). The samples for the determination of DO were fixed at the spot with 1ml of $MnSO_4$ and alkaline Iodide azide solutions.

Collection of water samples for the detection of heavy metals

Water samples were collected with one litter plastic containers and treated with 2 ml concentrated nitric acid in order to stabilize the oxidation state of the metals. The heavy metal contents were determined by Atomic Absorption Spectrophotometer (AAS650IF) model.

Analysis of samples

Dissolved oxygen (DO) was measured by the use of the Winkler's Iodometric method.

Biochemical Oxygen Demand (BOD) was determined using the Winkler's Iodometric method after the samples were incubated in the dark for five days.

Temperature, Electrical Conductivity and Turbidity: These physico-chemical parameters were measured in-situ by the use of a U10 Horiba water checker. This was done by introducing water at each station into the metal container of the equipment. The probe of the U10 Horiba water checker was then put in the container and the water checker then switched to measure each parameter one at a time. The readings of each parameter were displayed electronically on a display screen as bright red lights.

Sulphate determination was done by Turbidimetric method [12].

Phosphate was determined by stannous chloride method [12].

Nitrate was measured according to Brucine method [12].

STATISTICAL ANALYSIS

Data was subjected to statistical analysis using the SPSS software. Means and standard deviations were calculated for sampled variables. Analysis of variance (ANOVA) was employed to compare means at the 95% confidence limit. The study was done during the period from June, 2012 to May, 2013.

RESULTS AND DISCUSSION

Table1and 4 shows the physico-chemical parameters of water samples at four stations in lake water. The results were compared with the Federal Ministry of Environment and International Standards for maximum limits. Temperature varied between 23.48^{o}C and 24.10^{o}C in all stations with lowest recorded in S2 station and highest in S4 (Table1 and Fig 1). The temperature values of the present study recorded in between 24.5 to 32°.2c, similar trends were also reported by and Kaur and Joshi [13] and Mishra and Tripathi [14] in river Ganga. Srikanth [15] and Gowri [16] were also reported similar temperature values in their studies. The temperature of water is an important physical parameter which directly influences some chemical reactions in aquatic ecosystem. There is a significant correlation between seasonal changes and water temperature [17].Results also show that temperature varied significantly between three seasons with highest in monsoon and lowest in post monsoon season (Table 3). The difference in temperature is due to reduced sun-shine during the rainy season as compared to the dry season. Alagoa [18] has observed similar reduction in temperature in Taylor creek during the rainy season and cool rainwater may be the reason for temperature reduction.

The P^{H} of water is an important indicator of water quality. The P^{H} recorded did not show any significant variation during three seasons with minimum (7.36) in S2 station and maximum of 7.48 at S3 station (Table 1,3 and Fig1).The alkalinity of lakes can be attributed to increasing concentration of domestic sewage from nearby area. Recorded P^{H} values were within the BIS limits of 6.5-8.5.

Electrical Conductivity is the ability of an aqueous solution to pass electric current which depends on ions and their total concentration, mobility and temperature. The EC values recorded were in the range of 690.83 to 1130.67 with a minimum in S4 and maximum in S1 station (Table1 and Fig1).The high EC values indicates presence of salts and ions in higher concentration [19]. Table 3 shows that highest EC was recorded in monsoon season and least in post monsoon. The BOD used to assess the quality of water.

It is applicable in measuring organic load on water bodies. Present work show that BOD values in four stations varies between 22.08 mg/lit and 26.58 mg/lit with minimum in S1 and maximum in S3 station (Table1 and Fig1). The BOD increases with increase in the amount of available metabolic organics present in the water [20]. Present results show that BOD values were recorded almost same in pre monsoon and post monsoon seasons with not much variation from monsoon (Table 3)**.**

Table 1: Spatial variation of physico-chemical parameters of lake water in four stations

Stations	**1**		**2**		**3**		**4**	
Parameters	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Temperature(◦C)	24.05	±2.22	23.48	±2.39	24.01	±2.91	24.10	±2.79
P^H	7.40	±0.23	7.36	±0.30	7.48	±0.33	7.38	±0.27
EC (moh/ cm)	1130.67	±582.98	937.00	±107.34	712.25	±123.00	690.83	±83.65
BOD (mg/lit)	22.08	±5.23	25.67	±7.30	26.58	±5.70	24.33	±5.99
DO (mg/lit)	6.06	±0.41	5.99	±0.45	6.09	±0.53	5.97	±0.47
NO3(mg/lit)	1.35	±0.28	0.73	±0.35	0.59	±0.07	0.69	±0.10
PO4(mg/lit)	0.88	±0.27	0.63	±0.10	1.09	±0.33	0.95	±0.25

All the values are mean of three replications

Table 2: Spatial variation of heavy metals of four different stations of lake water

Stations	1		2		3		4	
Parameters	Mean	SD	Mean	SD	Mean	SD	MEAN	SD
Lead(Pb)(mg/lit)	1.18	±1.43	0.70	0.97	0.72	0.93	0.67	0.77
Nickel(Ni) (mg/lit)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Chromium(Cr) (mg/lit)	0.26	±0.33	0.24	0.29	0.25	0.29	0.24	0.29
Copper(Cu) (mg/lit)	1.14	±0.71	1.46	0.75	0.98	0.60	1.46	0.75
Zinc(Zn) (mg/lit)	0.60	±0.38	0.63	0.41	0.28	0.13	0.63	0.41
Mercury(Hg) (mg/lit)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmiun(Cd) (mg/lit)	0.04	±0.04	0.07	0.09	0.06	0.06	0.08	0.09
Iron(Fe) (mg/lit)	1.17	±1.06	0.96	1.04	0.53	0.52	0.82	0.70

All the values are mean of three replications

Table 3: Physico-chemical parameters of lake water during different seasons

Parameters	**Monsoon**	**Post-monsoon**	**Pre-monsoon**
Temperature(◦C)	25.2	21.58	24.95
pH	7.31	7.45	7.44
EC (moh/ cm)	997.9	697.6	907.6
COD(mg/lit)	111.9	103.2	97.88
BOD(mg/lit)	22.81	25.38	25.81
Chlorides	183.4	178.8	227.1
Sulphates	35.06	34.81	34.38
Nitrates(mg/lit)	0.814	0.852	0.849
Phosphates(mg/lit)	0.844	0.958	0.861
Total solids	799.1	736.1	695.4
TDS	768.6	720.3	672.7
DO(mg/lit)	6.098	6.0	5.978
Total hardness	229.4	230.6	259.8
Ca++	44.5	44.3	47.45
Mg++	56.4	53.75	57.45

All the values are mean of three replications

Table 4: Concentrations (mg/lit) of various Heavy metals in lake water during different seasons

Parameters	Monsoon	Post monsoon	Pre monsoon
Lead (Pb) (mg/lit)	0.35	1.74	0.25
Nicke (Ni) (mg/lit)	#DIV/0!	#DIV/0!	#DIV/0!
Chromium(Cr)(mg/lit)	0.07	0.55	0.14
Copper(Cu) (mg/lit)	1.37	1.73	0.80
Zinc(Zn) (mg/lit)	0.47	0.79	0.39
Mercury(Hg)(mg/lit)	#DIV/0!	#DIV/0!	#DIV/0!
Cadmium(Cd)(mg/lit)	0.04	0.11	0.03
Iron(Fe) (mg/lit)	0.49	1.67	0.47

All the values are mean of three replications

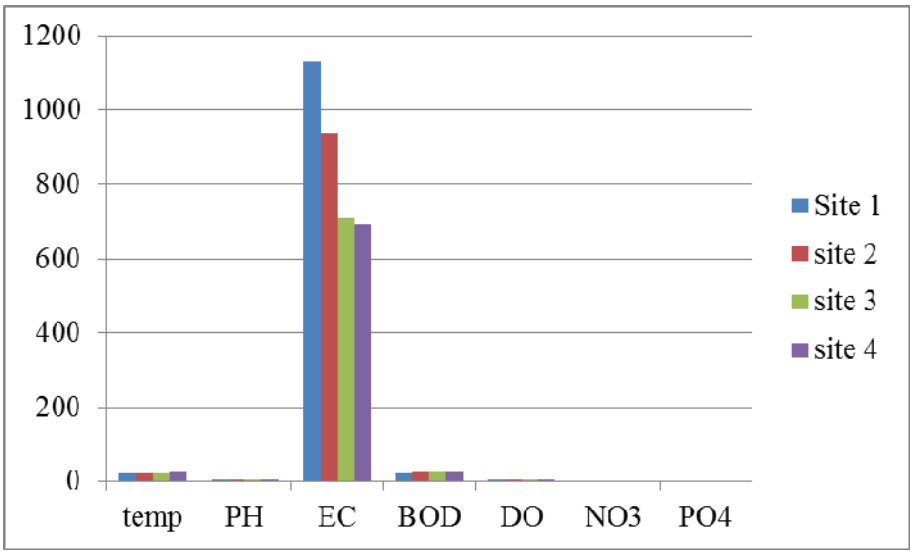

Fig-1: Spatial variation of physico-chemical variables of four stations in lake water

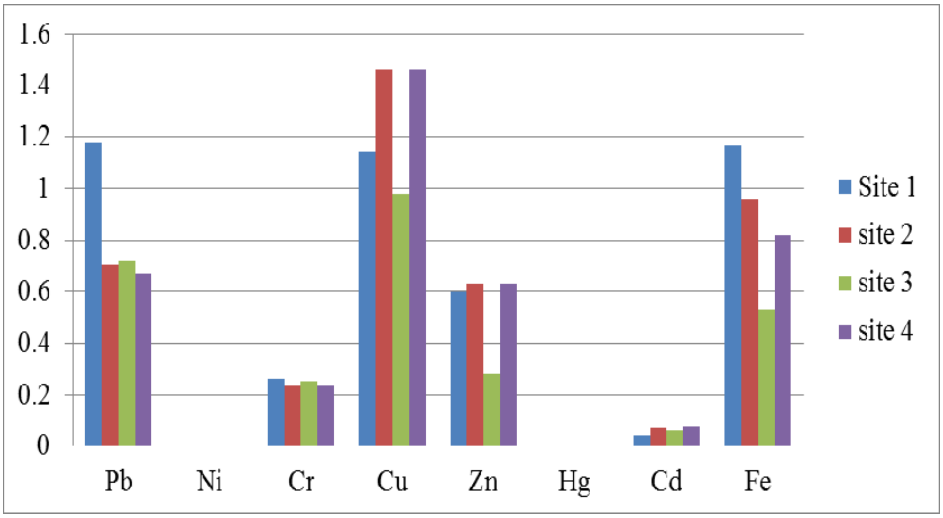

Fig-2: Spatial variation of heavy metals in different stations of water

The DO is an important indicator of ability of a water body to support aquatic life. The low DO content (<3mg/lit) in fresh water aquatic system indicates high pollution causing negative effects on aquatic ecosystem. Recorded DO values in all the four stations did not show any significant variation (Table1 and Fig1). Results also show that seasons also did not have effect on DO of lake (Table 3).

The nitrates and phosphates are the sources of raw sewage in water [21]. Significant variation in nitrates was recorded in four stations with minimum of 0.59 mg/lit in S3 station whereas nitrates got increased to a maximum of 1.35mg/lit in S1 station (Table1 and Fig1). The deterioration of lake water quality could be linked to nutrient loading from domestic sewage. The excessive loading of nitrogen and phosphorous into the system may accelerate the rate of Eutrophication resulting in high algal biomass, cyanobacteria abundance, and loss of macrophytes [22]. Results also show that Phosphates range from 0.63mg/lit to 1.09mg/lit with least recorded values in S2 and highest in S3 station (Table1 and Fig1). Detergents consist of phosphates and washing of clothes add these nutrients to lake water. Seasons also have maximum impact on phosphates and nitrates with high concentrations recorded in post monsoon season.

The seasonal variation has shown its impact on some more parameters like COD, Total solids, TDS with highest recorded values in monsoon. Calcium levels, magnesium levels and total hardness also found increased in the present work during pre-monsoon followed by monsoon and post monsoon seasons. The concentration of various heavy metals in lake water was presented in Table 2 and Fig 2.

Lead (Pb)

Present study reports that lead concentration varies from 0.67 to 1.18 mg/lit with least in S4 station and highest in S1(Table 2 and Fig 2).The recorded lead concentration was much more than 1991 BIS standards (0.05mg/lit). High levels of Pb often occur in water bodies near highways and large cities due to high gasoline combustion [23]. The high levels of Pb in water can be attributed to industrial and agricultural discharges as well as leaded petrol from fishing boats [24]. Results also show significantly highest concentration of lead in post monsoon season in comparison with pre monsoon and monsoon seasons (Table 4).

Nickel (Ni)

Present study shows that nickel concentration was same in all stations and very low 0.02 mg/lit (Table 2 and Fig 2).Precipitation is very much responsible for metal contamination of surface water [25,26, 27].

Chromium (Cr)

Many chromium compounds are water insoluble. Chromium (III) oxide and chromium (III) hydroxide are the only water soluble compounds [28]. The concentration of chromium recorded during the study period in the lake water was quite low than BIS standards. In the present study the chromium concentration varies from 0.24 to 0.26 mg/lit with not much variation in four stations (Table 2 and Fig 2). Chromium compounds are used as pigments, mordents and dyes in the textiles and as the tanning agent in the leather. The sources of emission of Cr in the surface waters are from municipal wastes, laundry chemicals, paints, leather, road run off etc. The high level of Cr in waste water effluent indicates excessive pollution from textile industries and tanneries [29]. Results also show that highest concentration of chromium was recorded in post monsoon than pre-monsoon followed by monsoon season(Table 4).

Copper (Cu)

The toxicity of copper depends on alkalinity of water. In the present study copper concentration varies from 0.98 to 1.46 mg/lit with least concentration in station S3 and highest in S4 (Table 2 and Fig 2). Results also show that highest concentration of copper was recorded in monsoon and post monsoon seasons in comparison with pre monsoon (Table 4). Over doses of copper will lead to neurological complications, hypertension, liver and kidney dysfunctions [33,31].

Zinc (Zn)

In the present study the zinc concentration varies from 0.28 to 0.63mg/lit with least concentration in S3 station and maximum in S4 (Table 2 and Fig 2).The recorded Zinc concentration was much less than the 1991 BIS standards (5-15mg/lit). Zinc is a very common substance that occurs naturally. High level of these metals in groundwater can harm ecosystems, plants, and animals and cause health problems in humans [2,32]. Results also show that highest concentration of more than 50% was recorded in post monsoon season in comparison with pre monsoon and monsoon seasons (Table 4). The decrease of zinc during monsoon and pre-monsoon was due to its uptake by macrophytes, and its adsorption in to clay particles and then final sedimentation 33].

Mercury (Hg)

Mercury is the most toxic metal and enters the human through fish. Fishes being one of major aquatic organism may often accumulate large amount of metals [34]. In the present study the mercury concentration recorded was less than 0.001 mg/lit (Table 2 and Fig 2).The low level of mercury might be the high ingestion rate of organism, suspension of sediments and absorption onto the particulates. It is also recorded that site and season has no impact on mercury levels in water.

Cadmium (Cd)

In the present study Cadmium concentration varies from 0.04 to 0.08 mg/lit (Table 2 and Fig 2) with least in station 1 and maximum in station 3. Cadmium is a nonessential element has high toxic potential. Present recorded cadmium levels in lake water were nearly 4-8% more than BIS [35] recommended standards which is 0.01mg/lit. More than 3 times of cadmium was recorded in water samples of post monsoon season in comparison to monsoon and pre monsoon seasons (Table 4). High level of cadmium concentration may be due to discharge from industrial waste, agriculture discharge or by leaching from sewage landfills [36,37].

Iron (Fe)

Iron is found in ground water all over the world and its high concentration causes bad taste, discoloration, staining, turbidity, aesthetic and operational problems in water supply system [38]. The results show that concentration of iron in the water samples varies from 0.53 to 1.17 mg/lit in which highest concentration was recorded in station 1 and least in station 3 (Table 2 and Fig 2). Present recorded iron levels in lake water was nearly double than Bureau of Indian standards-BIS [35] (0.3-1.0mg/lit). Results also show that highest concentration of more than 100% was recorded in post monsoon season in comparison with pre monsoon and monsoon seasons (Table 4).

CONCLUSION

Thus, the present study reveals that the Chinna Waddepally Lake will be approaching a complete eutrophication in near future due to various anthropogenic activities like discharge of untreated domestic sewage, washing clothes, animals and immersion of idols during the Ganesh chaturdhi etc. These wastes are highly and adversely influencing the quality of water in the lake. In the light of the present study immediate measures have to be incited to stop all these activities with a view to save this urban lake free from pollution and also eutrophication, which is the need of the hour.

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