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Assessment heavy metal ions and toxic metal ions in ground water

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ABSTRACT

The present study was carried out to determine various physi-co-chemical parameters and water quality index of the Patancheru in Medak District of Telangana state to examine the quality of water for public consumption, recreation and other purposes. This study deals with the influence of environmental factors as well as domestic activities in the water quality in the related area.

Keywords:
heavy metal ions, toxic metal ions, ground water

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Introduction

Patancheru, in Medak District of Telangana State, is facing unprecedented problems due to pollution caused by unregulated release of untreated waste effluents and sludge into the environment from some of the biggest manufacturers of bulk drugs and pharmaceutical formulations, assorted chemicals, pesticides, paper, pulp, paint and dye products. The extent of contamination has been well documented by several scientific committees, including those appointed by the Telangana High Court and Supreme Court. The Central Pollution Control Board (CPCB) has identified Patancheru as one of 24 'critically polluted areas' and considers it in need of 'urgent attention for control of pollution'. The heavy metal concentrations in the water have increased between five to 25 times over permissible limits, rendering many wells and tanks unusable. Investigations by National Geological Research Institute (NGRI) reported abnormally high quantities of arsenic, close to 700 times above permissible levels! The deadly bio-accumulative chemicals in the environment are damaging the health of all living things in the locality. The decolourisation and peeling of the skin of buffaloes is a common sight. Elevated levels of arsenic have been found in the blood, urine, hair and nail samples of Patancheru residents. An epidemiological study conducted by Greenpeace in 2004 reveals abnormally high rates of pollution-related illnesses like cancer, heart diseases, asthma and bronchitis. A status health report on health problems at Patancheru by Osmania Medical College submitted to the additional advocate general, TS High Court in 1998 to 1999 states that morbidity rates in the area have increased from 10.18% to 30.49% over a period of 19 years. The same report also stated that inadequate and irregular supply of drinking water to the 14 villages predisposed them to the hazards of water pollution

Keywords

Water quality index; Physico-chemical; Fresh water

Methods

Five different sites were selected for the collection of water samples (Figures 1 and 2). The samples were collected in sterilized polythene bottles of one litter capacity. Monitoring was performed during September 2012 to August 2016 (seasonal monsoon, winter and summer). For unstable parameters such as temperature, electrical conductivity (EC), pH, and dissolved oxygen (DO) were measured at the sampling site. Samples were brought to the laboratory for analysis of other physico-chemical parameters like sodium, total alkalinity, total hardness, calcium, magnesium, chlorides, sulphate, nitrate, phosphate and Biochemical oxygen demand (BOD). The parameters were compared according to the standard methods described in the literature. The weighted arithmetic index method was used for the calculation of water quality index (WQI) of the water body. Further, quality rating or sub index (qn)was calculated by the following expression.

$$qn=[(Vn-Vid)/(Sn-Vid)]*100$$

Where: qn=Quality rating for the nth water quality parameter,

Vn=Estimated value of the nth water quality parameters of collected sample,

Sn=Standard permissible value of the nth water quality parameter,

Vid=Ideal value of the nth water quality parameter in pure water.

(i.e. 0 for all other parameters except the parameter pH and Dissolved oxygen (7 and 14.6 mg/L respectively.) (Let there be n water quality parameters and quality rating or sub index (qn) corresponding to nth parameter is a number reflecting the relative of this parameter in polluted water with respect to its standard permissible value.)

Unit weight was calculated by a value inversely proportional to the recommended standard value Sn of the corresponding parameter.

Table 1

Water Quality Index	Water Quality Status
0-25	Excellent Water Quality
26-50	Good Water Quality
51-75	Poor Water Quality
76-100	Very Poor Water Quality
>100	Unable To Drink

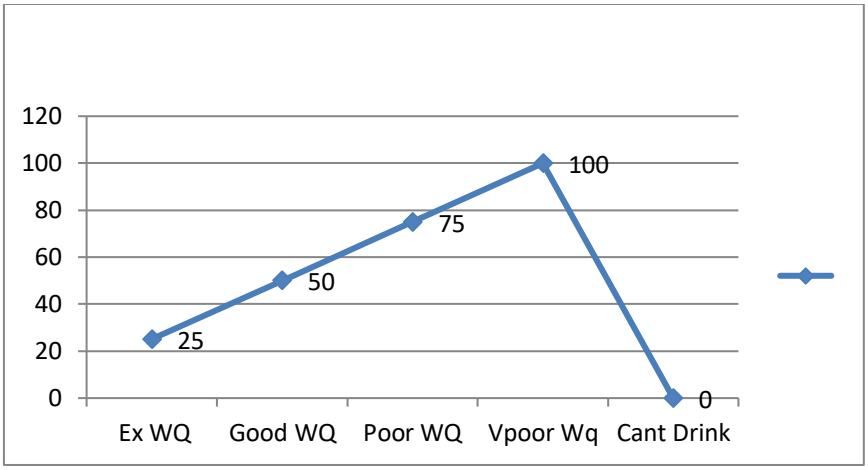

Figure 1 Water quality Index (WQI) and its status according to chaterjee, and Raziuddin and Thakur

Table 2

Average with Standard Error Values of physico-chemical parameters of sample water collected at nakkavagu river lake				
Sno	Parameters	Year 2012-2016		
		Manson	Winter	Summer
1	Electrical Conductivity (Ω/cm	3.47±0.8	3.14±0.77	2.15±0.02
2	Total Dissolve Solid(mg/L)	1224±42.79	1008±14.88	1142±12.66
3	Ph	8.6±0.17	8.9±0.50	8.2±0.22
4	Alkalinity(mg/L)	224±3.36	214±3.36	204±8.44
5	Total Hardness(mg/L)	348±19.82	310±11.2	335±14.22
6	Calcium(mg/L)	94±0.47	72±0.12	80±0.62
7	Magnesium(mg/L)	41±0.39	37±0.43	36±0.87
8	Dissolved Oxygen	5.89±0.39	3.29±0.67	3.13±0.44
9	Chloride(mg/L)	104±3.4	108±4.9	135±4.9
10	Nitrate(mg/L)	7.2±0.79	2.14±0.27	1.78±0.24
11	Biochemical Oxygen Demand(mg/L)	3.22±0.79	2.14±0.27	1.78±0.24

Average with Standard Error Values of physico-chemical parameters of sample water collected at Nakkavagu lake

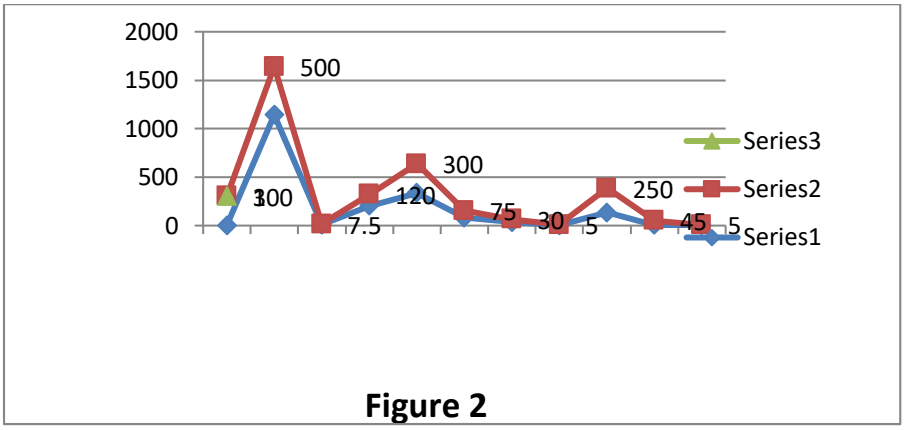

Figure 2

Table 3

alculation of WQI of water samples in monsoon seasons of Nakkavagu Lake

Sno	Parameter	Obeserved Value(Vn)	Standard Values(Sn)	Ideal Value (V10)	Unit Weight(WN)	Quality Rating (qn)	Wnqn
1	Electrical Conductivity(Ω/cm)	3.47	300	0	0.371	1.15	0.42
2	Total Dissolve Solid(mg/L)	1224	500	0	0.0037	244.8	0.90
3	pH	8.6	7.5	7	0.219	320	70.08
4	Alkalinity(mg/L)	224	120	0	0.0155	186.66	2.89
5	Total Hardness(m/L)	348	300	0	0.0062	116	0.71
6	Calcium(mg/L)	94	75	0	0.025	125.33	3.13
7	Magnesium(mg/L)	41	30	0	0.061	136.66	8.33
8	Dissolve Oxygen(mg/L)	5.89	5	14.6	0.3723	90.72	33.77
9	Chloride(mg/L)	104	250	0	0.0074	41.6	0.30
10	Nitrate(mg/L)	7.2	45	0	0.0412	16	0.65
11	Biochemical Oxygen Demand(mg/L)	3.22	5	0	0.3723	64.4	23.97
					∑Wn=1.4946	∑Qn=1343.3525	∑WnQn=145.2190454

WQI=97.16248187

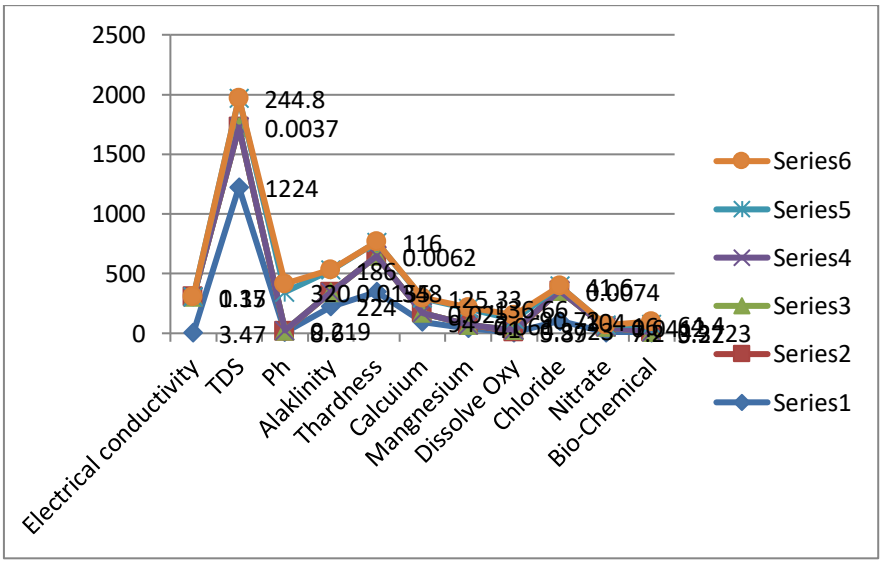

Figure 3

Table 4

Calculation of WQI of water samples in monsoon seasons of Nakkavagu Lake

Sno	Parameter	Obeserved Value(Vn)	Standard Values(Sn)	Ideal Value (V10)	Unit Weight(WN)	Quality Rating (Qn)	WnQn
1	Electrical Conductivity(Ω/cm)	3.14	300	0	0.371	1.15	0.38
2	Total Dissolve Solid(mg/L)	1008	500	0	0.0037	201.6	0.74
3	pH	8.69	7.5	7	0.219	380	83.22
4	Alkalinity(mg/L)	214	120	0	0.0155	178.33	2.76
5	Total Hardness(m/L)	310	300	0	0.0062	103.33	0.64
6	Calcium(mg/L)	72	75	0	0.025	96	2.4
7	Magnesium(mg/L)	37	30	0	0.061	123.33	7.52
8	Dissolve Oxygen (mg/L)	3.29	5	14.6	0.3723	117.81	43.86
9	Chloride(mg/L)	108	250	0	0.0074	43.2	0.31
10	Nitrate(mg/L)	7.9	45	0	0.0412	17.55	0.72
11	Biochemical Oxygen Demand(mg/L)	2.14	5	0	0.3723	42.8	15.93
					∑Wn=1.4946	∑Qn=1305.0.1422	∑WnQn=158.5214026
WQI=109.627526							

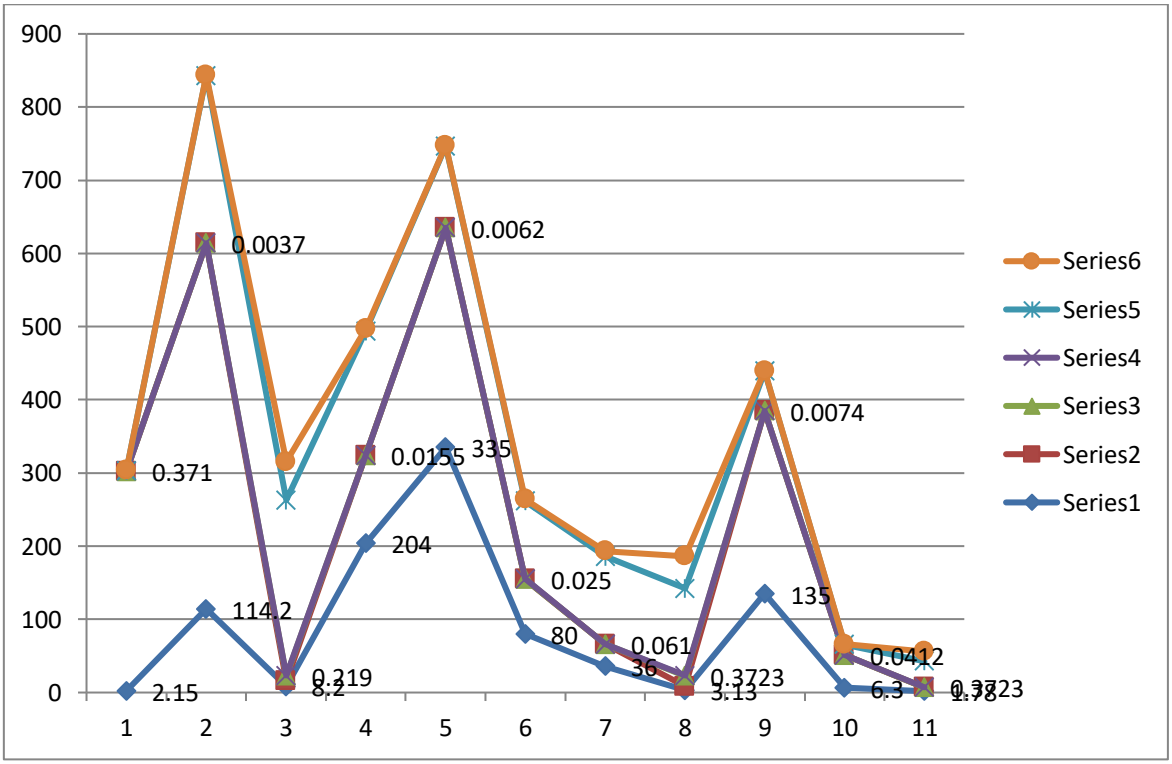

Figure 4

Calculation of WQI of water samples in monsoon seasons of Nakkavagu Lake

Sno	Parameter	Obeserved Value(Vn)	Standard Values(Sn)	Ideal Value (V10)	Unit Weight(WN)	Quality Rating (Qn)	WnQn
1	Electrical Conductivity(Ω/cm)	2.15	300	0	0.371	0.71	0.26
2	Total Dissolve Solid(mg/L)	1142	500	0	0.0037	228.4	0.84
3	pH	8.2	7.5	7	0.219	240	52.56
4	Alkalinity(mg/L)	204	120	0	0.0155	170	2.635
5	Total Hardness(m/L)	335	300	0	0.0062	111.66	0.69
6	Calcium(mg/L)	80	75	0	0.025	106.66	2.66
7	Magnesium(mg/L)	36	30	0	0.061	120	7.32
8	Dissolve Oxygen(mg/L)	3.13	5	14.6	0.3723	119.47	44.18
9	Chloride(mg/L)	135	250	0	0.0074	54	0.39
10	Nitrate(mg/L)	6.3	45	0	0.0412	14	0.57
11	Biochemical Oxygen Demand(mg/L)	1.78	5	0	0.3723	35.6	13.25
					∑Wn=1.4946	∑Qn=1200.53	∑WnQn=1253697

WQI=84.10076275

Table 5

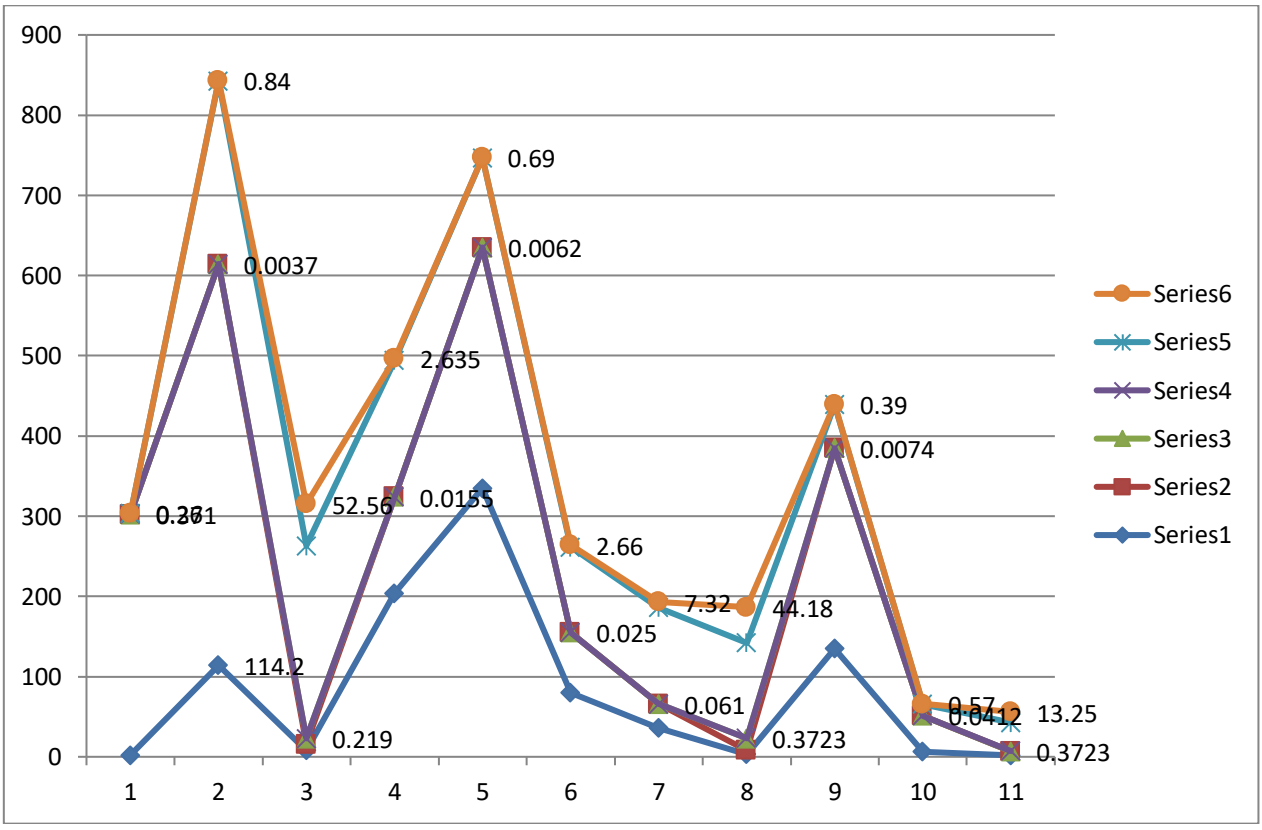

Figure 5

$Wn = K / Sn$

Where: Wn=Unit weight for nth water quality parameter,

Sn=Standard permissible value of the nth water quality parameter,

K=Constant for proportionality.

The overall WQI was calculated by aggregating the quality rating with the unit weight linearly.

$WQI = \Sigma qn\ Wn\ .\ \Sigma Wn$

Where:

qn= Quality rating for the nth water quality parameter,

Wn=Unit weight for nth water quality parameter.

Results and Discussion

The physico-chemical parameters such as pH, electric conductivity, alkalinity, dissolved oxygen, total dissolve solid, calcium, magnesium, chloride, biological oxygen demand, nitrate and total hardness of water were analyzed for the water samples collected from the Nakkavagu Lake. These parameters were taken at the five points of the lake season wise (monsoon, winter and summer). All parameters with the mean value of the data with standard error were calculated as

Electrical conductivity

Water capability to transmit electric current is known as electrical conductivity and serves as tool to assess the purity of water. This ability depends on the presence of ions, their total concentration, mobility, valence, relative concentrations and temperature of measurement. The electrical conductivity ranged from 2.15 to 3.47 Ω/cm. The highest electrical conductivity was reported during winter 3.47 Ω/cm due to the addition of domestic wastage into the lake and lowest in monsoon 2.15 Ω/cm because of water dilution by rainy water.

Total dissolved solids

Solids refer to the suspended and dissolved matter in water. They are very useful parameters describing the chemical constituents of the water and can be considered as edaphically relation that contributes to productivity within the water body. The total dissolved solids in the sampled water ranged from the 1008 to 1224 mg/L. The highest TDS reported during winter season was 1224 mg/L and lowest TDS reported during summer season was 1008 mg/L due to the addition of organic matter and solid waste into the lake.

pH

PH is defined as the intensity of the acidic or basic character of a solution at a given temperature. pH is the negative logarithm of hydrogen ion concentration (pH=-log [H+]). The pH in water samples range of 7.0 to 7.85 and water and stated that the pH of water is important for the biotic communities as most of the plant and animal species can survive in narrow range of pH from slightly acidic to slightly alkaline condition. In study period i.e. September 2016 to August 2017 pH value ranged from 8.2 to 8.9. The maximum pH reported during summer was very low due to the water levels and concentration of nutrients in water and minimum was during monsoon due to the dilution of water by addition of rain water.

Alkalinity

The alkalinity of surface water is primarily a function of carbonate, hydroxide content and also includes the contributions from borates, phosphates, silicates and other bases. Alkalinity is a measure of capacity of water to neutralize a strong acid. The alkalinity in the water samples ranged from 204 to 224 mg/L. The highest alkalinity recorded during winter was 224 mg/L due to high nutrients in water and lowest recorded during monsoon was 204 mg/L due to dilution of water by addition into lake water.

Total hardness

The total hardness of water is not a specific constituent but is a variable and complex mixture of cations and anions. Principally the

water hardness are changed by ions such as calcium and magnesium. The total hardness from the water samples at Nakkavagu Lake ranged between 310 to 348 mg/L. The highest amount of total hardness in the water was recorded during monsoon was 348 mg/L due to presence of high content of calcium and magnesium in addition to sulphate and nitrate in the sewage waste added during monsoon. The lowest amount of total hardness was recorded during winter season due to low concentration of calcium and magnesium.

Calcium

Calcium is most abundant ions in fresh water and is important in shell construction, bone building and plant precipitation of lime. The analysis of calcium revealed a ranged between 72 to 94 mg/L. The highest amount of calcium recorded in water samples during monsoon season was 94 mg/L by the addition of sewage waste along with rain water and responsible for the increase in amount of calcium. The lowest amount of calcium in water was recorded during winter season due to calcium absorbed by the large number of organisms for shell construction, bone building and plant precipitation of lime.

Magnesium

Magnesium is often associated with calcium in all kinds of waters, but its concentration remains generally lower than the calcium. Magnesium is essential for chlorophyll growth and acts as a limiting factor for the growth of phytoplankton. The amount of magnesium recorded in the water ranged between 36 to 41 mg/L. The highest amount of magnesium in the water samples was recorded during monsoon season 41 mg/L as it is associated with calcium in all water types and during monsoon, calcium was higher in monsoon season. The lowest value was recorded during summer season due to the magnesium essentiality for chlorophyll bearing plant for photosynthesis.

Dissolved oxygen

The higher value of dissolved oxygen indicates good aquatic life. The amount of dissolved oxygen of Nakkavagu Lake water samples ranged between 3.13 to 5.89 mg/L. The highest amount recorded during monsoon season was 5.41 mg/L due to the turbulence of water facilitating the diffusion of atmospheric oxygen and the increased solubility of oxygen at lower temperature. The lowest dissolved recorded during summer season was 3.13 mg/L due to the high temperature and addition of sewage and other waste which can be responsible for low value of dissolved oxygen.

Chloride

The chloride in drinking water originates from natural sources, sewage and industrial effluents, urban runoff containing de-icing salt and saline intrusion. A chloride concentration in Nakkavagu Lake was noticed between 98 to 103 mg/L. The highest chloride reported in winter was 79 mg/L due to frequent run-off loaded with contaminated water from the surrounding slum area and evaporation of water. The lowest value of chloride recorded during monsoon season was 98 mg/L due to the dilution of lake water by rain.

Nitrate

Nitrates are contributes to freshwater through discharge of sewage and industrial wastes and run off from agricultural fields. The highest amount of nitrate concentration was known to support the formation of blooms. The amount of nitrate recorded in the water of Nakkavagu Lake ranged from 6.3 to 7.9 mg/L. The highest amount of nitrate was recorded during winter season was 7.9 mg/L because of high vegetation during winter which supported the growth of plankton. The lowest amount of nitrate in water was recorded during summer season was 7.5 mg/L by the utilization by plankton and aquatic plants.

Biochemical oxygen demand

The biochemical oxygen demand may be defined as the oxygen required for the microorganism to performed biological

decomposition of dissolved solids or organic matter in the wastewater under aerobic conditions. The biochemical oxygen demand reported from water samples at Nakkavagu was ranged between 1.78 to 3.22 mg/L. The highest demand of oxygen in the water was recorded during monsoon season was 3.22 mg/L due to the possible addition of high amount of waste along with rain water from the surrounding and addition of organic waste in lake by certain human activities which also be responsible for the increase in BOD . The lowest demand was recorded during monsoon season was 1.78 mg/L due to less vegetation. WQI of Nakkavagu Lake was established from various physicochemical parameters in three seasons (monsoon, winter and summer) from September 2013 to August 2014. The values of various physicochemical parameters for calculation of water quality index are presented in Table 2. Season wise WQI calculations are presented in the Tables 3-5. The WQI obtained for the water body in different seasons of study period i.e., monsoon season, winter season and summer season are 97.1624, 109.6275 and 84.1007 respectively, which indicate that water is not suitable for drinking due to high pollution level during winter season when compared to the monsoon and summer seasons.

The water is not used for public consumption due to high WQI and high pollution level. Water purification system must be installed to purify the water body as other alternatives, for domestic usage is not recommended by the civic body. The purification requires civic body initiative to clean up. This reason on a view that concerned agency had already installed three water purification systems in the city.

Conclusion

Some of the samples have total dissolved solids, pH, alkalinity, total hardness, magnesium, calci-um and dissolved oxygen values exceeding the permissible limits as prescribed by Indian stand-ards. We noticed parameters such as electrical conductivity, chloride; nitrate and biological oxy-gen demand values are within permissible limits. The competed WQI indicates that the water quality is poor and not totally safe for human consumption due to presence of high level of pollu-tants. The water is not used for public consumption and recreation due to lack of water purifica-tion. This study showed that the water quality of Nakkavagu Lake remain as it is than it will de-stroyed the ecosystem of the lake. The government such as, AMC and other civic organization should take the action against releasing of domestic waste directly into the lake or installed a wa-ter purification system.

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