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Seasonal Variation in the Physico - Chemical Parameters of Vattakkayal Lake, Corporation of Kollam, South India

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Abstract: ***The present study was focused on the variation of physico-chemical parameters in water and sediment samples taken from Vattakkayal, Kollam. Water and sediment samples from three sampling sites from the Lake were analysed for various water quality parameters during the period February 2018- January 2019. The measured water parameters were compared with the guidelines proposed by the WHO and WRCfor drinking water and sediment respectively.The results showed that parameters like Temperature, pH BOD, Salinityare within the permissible range except for DO. The concentration of heavy metals such as Cu, Cr, Pb and Cd were found to be lower than the maximum permissible limits both in water and sediment recommendation of international guidelines except for Fe. Nutrient accumulation were found to be high in the lake, especially phosphate and sulphate in water is present above the maximum permissible limit. At present heavy metal load in the Lake is low when compared to previous studies. It may be due to the awareness among people about the ill effects of water pollution. Organic pollution and encroachment are the main reasons for the deterioration of the water body.***

Keywords: Vattakkayal, Heavy metals, Nutrients, Pollution, Water quality

1. Introduction

Pollution is the introduction of contaminants into the environment that causes discomfortor deterioration to ecosystem. The presence of increasedlevels of pollutants in water bodies is of major problem because of their potential threats to the health of both human and ecosystem. Nowadays evaluation of water quality is considered as serious issue, especially when freshwater is becoming a scarce resource in the future [1].Water resources in Kerala have been under increasing threat of pollution in recent years. A wide range of human and natural processes affect the biological, chemical, and physical characteristics of water.Contamination by pathogenic organisms, trace metals, changes in the acidity, temperature and salinity of water, all can affect aquatic ecosystems and make water unsuitable for human use (WHO).

2. Literature Survey

The physico- chemical characteristics of the aquatic system indicate the extent of pollution existing there. The purity of the system can be investigated mostly by analyzing the water and sediments. Determination of harmful and toxic substances in water and sediment gives direct information on the significance of pollution in the aquatic environment [2].Sediments can function as secondary source for water pollution. The heavily adsorbed pollutants in sediments can transfer in to water. The concentration of heavy metals and nutrients indicates the extent of pollution in a water body Alemayuhu [3].

The nature of heavy metal and nutrient contamination in the water and sediment samples of Vattakkayal Lake has been reported by Seethallal et al[4,5] and Neethu G P et al[6]. The dominant factors responsible for deterioration of the vattakkayal is anthropogenic interferences like pollution and encroachment [7]. At present, because of high nutrient load, eutrophication is one of the serious problem of the water body,that led to the growth of many floating weeds.The objective of this study was to assess specific water quality parameters in the water and sediments of the lakethat would help to evolve mitigation and control measures.

3. Methods

3.1 Study area

Vattakkayal Lake (Figure 1) located in the Sakthikulangarapanchayath of Kollam district, South India is selected as the study area. It occupies an area of about 36 acres and is located at 8°55'3" North latitude and 76°32'57" East longitude. Vattakkayal is “the life line” of people of Sakthikulangara, Kavanadu,Maruthady area of Kollam Town[6].The Kattakkathodu on the western sideis located very close to the Vattakkayal. The southern part of Vattakkayal is connected to sea through Ozhukkuthodu.

Figure 1: Location map of study area

3.2 Sample collection and treatment

Water and sediment samples were collected from three study sites. Site 1: Kochumaruthadi Temple, Site 2: Lakeford School, Site 3: Northern part. In order to study the seasonal variation of Vattakayal, the water and sediment samples were collected from the three selected sites from February, 2018 to January 2019. Thesamples for heavy metal and nutrient analysis were collected in clean, 2 litre polyethylene containers and properly labelled. Samples for DO estimations were collected in DO bottles and immediately fixed with chemicals. The temperature and pH of the samples was recorded at the site itself. The samples were brought to the laboratory for the analysis. All the characteristics of water and sediment samples were analysed using standard procedures (APHA[8], 2012). The elements in the samples were determined using an Atomic Absorption Spectrophotometer and ICP- OES.

3.3 Statistical analysis

Statistical calculations, ANOVA was performed by Excel 2013 (Microsoft corporate, USA). The statistical significance of the data was evaluated by one way analysis of variance [ANOVA]. A value of $P<0.05$ was considered to indicate a significant difference between groups.

4. Results and Discussion

The water pollution status of the Vattakkayal Lake was evaluated according to the standards suggested by WHO[9] and WRC[10] in order to calculate the number of samples that did not comply with the guideline values.
The results of physico- chemical parameters of the sediment and water samples are given in table 1, 2 and 3.

Table 1: Physico- chemical parameters in water samples during pre- monsoon, monsoon and post- monsoon seasons (Data were presented in table as mean ± SD of samples)

Prarameter	Pre- Monsoon	Monsoon	Post- Monsoon
Temperature	27^0C	25.5^0C	26^0C
pH	7.2	7	7.1
DO	1.3 mg/L	3.25 mg/L	2.1 mg/L
BOD	40 mg/L	35mg/L	40.5 mg/L
Salinity	30.5 mg/L	1.5 mg/L	16 mg/L

Table 2: Heavy metal content in water and sediment samples during pre- monsoon, monsoon and post- monsoon seasons (Data were presented in table as mean ± SD of three samples)

Element	WATER (mg/l)			SEDIMENT (mg/Kg)		
	Pre Monsoon	Monsoon	Post Monsoon	Pre Monsoon	Monsoon	Post Monsoon
Copper	BDL	BDL	0.005	BDL	0.2±0	5.15±1.2
Chromium	0.0025±0.000849	0.01±0.007	0.0195±0.0007	0.01 ± 0.001	1.4±0.42	10.7±1.556
Cadmium	0.0013±0.000141	0.055±0.035	0.02	0.0015±0.007	0.02	0.05±0.007
Lead	0.0038±0.001697	0.035±0.03	0.0181±0.008	0.065 ± 0.049	2.5±1.2	2.2±0.28
Iron	0.0252±0.012728	0.066±0.04	1.75 ±2.15	3958.5± 2106.47	6128.5±1199	2346±581.2

Table 3: Nutrient content in water and sediment samples during pre- monsoon, monsoon and post- monsoon seasons (Data were presented in table as mean ± SD of three samples)

Nutrient	WATER (mg/l)			SEDIMENT (mg/Kg)		
	Pre Monsoon	Monsoon	Post Monsoon	Pre Monsoon	Monsoon	Post Monsoon
Nitrite	0.65±0.41	BDL	0.11±0.12	50.7±24	BDL	34.7±1.6
Nitrate	1.2±0.141	0.15±0.07	5.35±0.636	66±26	BDL	257±31.11
Phosphate	5.5±2.12	1.5±0.14	27.5±14.8	494.5±352.8	0.0075±0.0007	0.07±0.02
Sulphate	109±16.1	111.5±24.74	856.5±27.5	2190.5±1492.5	0.085±0.007	15.2±9.19

The water temperatures at the three sites were found to be between 25.5^0C and 27^0C. The highest temperature (28^0C) and the lowest temperature (25°C) were observed at site 2 during pre- monsoon and post- monsoon respectively. Statistical analysis showed that the variations between seasons (P=0.37) was not significant.The values of pH ranged between 7 and 7.2. The highest value recorded at site 2 and lowest at site 3. Highest pH value (7.3) was observed

during pre- monsoon and minimum (7) during monsoon season. Variations between seasons (P=0.14) were not significant.

The values of salinity ranged between 1.5-30.5 mg/L. The lowest salinity value was observed at site 1 (1.5 mg/L) during monsoon whereas the highest value is 30.5 mg/L at site 2 during pre- monsoon.There exist significant variations between seasons (P=0.0001). The dissolved oxygen values ranged from 1.3 to 3.25 mg/ L. Lowest value (1.2 mg/L) was noted at site 3 inpre- monsoon and highest value (3.5 mg/L) was in monsoon season at site 2. As dissolved oxygen levels in water drop below 5.0 mg/l, aquatic life is put under stress. The variations between seasons (P=0.008) were not significant.Biological Oxygen Demand (BOD) values of present study ranged from 35 mg/ L to 40.5 mg/ L. Lowest BOD (33 mg/L)was noticed in monsoon at site 3 and highest in post- monsoon season (41 mg/L) at site 2. There exist significant variations between seasons (P=0.71).

The results of heavy metal analysis of water and sediment samples is shown in Table 2.The concentration of heavy metals in water sample ranged from 0.0038 to 0.035mg/ Llead, 0.0013 to 0.05 mg/Lcadmium, 0.0025 to 0.019 mg/L chromium, and 0.025 to 1.75 mg/Liron. The concentration of copper was found 0.005 mg/L in the post- monsoon season and it was found below detection limit in pre- monsoon and monsoon seasons. No significant variations can be observed between seasons for Cd (P=0.42), Cu (P=0.046), Cr (P=0.0024), Pb (P=0.6) and Fe (P=0.16).

The concentration of heavy metals in sediment sample during the seasons studied ranged from 0.065 to 2.5mg/ Kg lead, 0.0015 to 0.05 mg/Kg cadmium, 0.01 to 10.7 mg/Kg chromium, 2346 to 6128mg/Kg iron and copper was found below detection limit in the pre- monsoon and a value of 5.15 mg/L was found in the post- monsoon season.

The variations in concentration between seasons for Pb (P=0.60) and Fe (P=0.39) were not significant. Where asthere exist a significant variation between seasons for Cr (P=0.002), Cu (P=0.008) and Cd (P=0.0013).The concentration of all the heavy metals in both water and sediment were found to be less than the permissible limit recommended by WHO and USEPA. But the concentration of Fe (1.75 mg/L) was present above the Maximum Permissible limit (0.03).

The results of nutrient analysis in water and sediment samples is depicted in Table 3.The nutrient content in water sample during all the seasons studied ranged from 109to 856.5 mg/L for sulphate, 1.5 to 27.5 mg/L for phosphate and 0.15 to 5.35mg/L for nitrate. Whereas the nitrite content was absent during monsoonand a concentration of 0.65 mg/Kg was present in the pre- monsoon season.ANOVA showed that variations between seasons for all the nutrients nitrite (P=0.20), phosphate (P= 0.10), nitrate (P = 0.001) and sulphate (P=0.0001) were not significant.

The nutrient content in sediment sample during the three seasons ranged from 0.085 to 2190.5 mg/Kgfor sulphate, 0.0075 to 494.5 mg/Kgfor phosphate. The concentration of nitrate and nitrite were found below detection limit in the monsoon season.The highest value observed for nitrate was 257 mg/Kg and nitrite was 50.7 mg/Kg during the post-monsoon and pre-monsoon respectively.Statistical analysis showed that no significant variation can be observed between seasons for nitrite (P=0.018) nitrate (P=0.0035), sulphate (P=0.13) and phosphate (P=0.14).

According to the results, the mean value for heavy metal concentrations in water is in the order: Fe>Cd>Pb>Cr>Cu and Fe>Cr>Pb>Cu>Cd in sediment. The mean value for nutrient content in water and sediment is in the same order: SO_4^{2-}>PO_4^{3-}>NO_3>NO_2.

The concentration of all the nutrients and heavy metals were found to be maximum at site 2. Among all the nutrients the accumulation of sulphate was found to be very high in both water and sediment samples.In the present study all the heavy metals are found to be accumulated more in the sediment samples than in water.

5. Conclusion

Water in Vattakkayal was observed to contain higher concentrations of nutrients which indicates organic pollution. Whereas the concentration of heavy metals are within the permissible limit proposed by international standards. Based on the results analysed, it may be concluded thatthe extent of pollution is remarkably low in Vattakkayal when compared to the previous studies conducted by SeethalLal et al[4,5] and Neethu G P et al[6].
To protect this precious water body from further deteriorations, the discharge of sewage into the lake, further encroachment of the lake must be prevented through awareness andimplemention of legislative measures.Future initiatives should be implemented for improving livelihood of people around the area through the conservation of fish biodiversity of the system. For better environmental monitoring and management, routine monitoring of water quality parameters creation of awareness among the public about the importance of Vattakkayalshould be taken into consideration.

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7. Future Scope

Water in Vattakkayal was observed to contain moderate concentration of pollutants therefore not being suitable for human consumption without treatment. This study is believed to assist decision makers in identifying priorities to improve water quality that has deteriorated due to various land uses. Ecological restoration method could be considered to counteract the residual effects from previous pollution; however, more research is needed in this area.

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