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STUDIES ON THE PHYSICO-CHEMICAL PARAMETERS AND THEIR SEASONAL VARIATIONS IN WATER AT SELECTED SITES OF NEYYAR RIVER, KERALA- INDIA

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Abstract: The 'Neyyar' river is the southernmost river in Kerala. The river water is polluted mainly due to anthropogenic sources, domestic effluents, Hospital Sewage, hotel waste discharges and sand mining. This polluted water is used for drinking purpose in some areas especially coastal areas and for irrigational purpose. A proper monitoring is required and this work will help to get an idea about the present status and in the future evaluation studies. The work underlines the water quality through the assessment of sub parameters like pH, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Nitrate Nitrogen Content (NO_2-N), Phosphate Phosphorus Content (PO_4-P), Total Dissolved Solids (TDS), Turbidity and MPN Coliform Count. Based on these parameters, Water Quality Indexing (WQI) of the selected water bodies had been undertaken to facilitate a convenient single value mathematical means for assessment as well as comparison as per the criteria prescribed by National Sanitation Foundation. Present study covers the seasonal deflection (Pre-monsoon and Post-monsoon) in pollution load and site/position variation to the respective. In selected four zones starting from origin to the end, significant variations in parameters were observed.

Key words: Neyyar river, Water quality, Coliform count

INTRODUCTION

Water is the most common substance on earth and it is omnipresent. It is the most abundant constituent of any organism and life is considered to have evolved from water. Water as rain continuously erodes the land, washing the soil into rivers. Rivers cut through rocks, carve canyons, and buildup land at the barmouths. A river is a natural water resource flows towards an ocean, a lake, a sea or another river. In a few cases a river simply flows into the ground or dries up completely before reaching another body of water. Small rivers may be also called by several other names including stream, creek, brook, tributary and rill, there is no general rule that defines what can be called a river, although in some countries or communities a stream may be defined by size.

In India, the state of Kerala has 44 rivers, 29 fresh water lakes and perennial springs and the highest well density in the world (250 open wells/Km^2). In Kerala, at present, there are about one hundred and twenty schemes in operation for providing drinking water to the rural and urban areas of Thiruvananthapuram District. Seventy one rural water supply schemes and twelve urban water supply schemes are under implementation. Disruption of water supply happens on a regular basis due to reasons such as bursting of main pipelines, mechanical problems, contamination from garbage treatment plants etc. (The Hindu – May 19, 2005; Monday, Jun 06, 2005).

Neyyar River is the southern-most river of the Kerala state. The river water is polluted mainly due to anthropogenic sources, domestic effluents, Hospital Sewage, hotel waste discharges and sand mining. This polluted water is used for drinking purpose in some areas especially coastal areas and for irrigational purpose. So a proper monitoring is required and

this work will help to get an idea about the current status and in the future evaluation studies.. The study also helps to evaluate the seasonal changes of physico-chemical parameters of river water.

MATERIALS AND METHODS

Study area

Neyyar originates from the Agasthyarkudam hills, flows through Neyyatinkara taluk and joins Lakshadweep Sea near Poovar. It has a total length of 56.Km. The main tributaries are Kallar and Karavaliyar. Streams like Vandichitrathode, Kulathoor Valiyathode, Maruthoorthode, Athiyannoorthide, Thaliyalthode, Kottukalathode and Venganoorthode joins the main stream. There is an irrigation project constructed in 1973 at Kallikkadu near Kattakkada, which is about 29Km from Trivandrum city. Neyyar wildlife sanctuary in this basin is a famous tourist place. Four areas were randomly identified for present investigation.

Site No. 1: (S_1)

Site No. 1 selected for present study belongs to Kallikkadu near Kattakkada. Neyyar dam is situated in this panchayath. The dam has only 32Km east of Thiruvananthapuram. The peak Agasthyarkudam is a lovely spot, very close to Neyyar dam. The area around this river is free from any kind of pollution. This area is rich with fish, fauna and planktons.

Site No.2: (S_2)

Site No. 2 selected for present study belongs to Aruvippuram near Aruvippuram Siva Temple. Aruvippuram is a village in the Southern district of Thiruvananthapuram in Kerala. It is a famous temple established by Sree Narayana Guru in 1888. Activities like bathing, washing and sand mining are the major environmental problems.

Site No. 3: (S_3)

Site No. 3 selected for present study belongs to Neyyattinkara near the banks of Neyyar River. Neyyattinkara and neighboring areas has many cottage industries and handloom. The Balaramapuram handloom industry is worldwide for its fine hosiery. The name Neyyattinkara in Malayalam literary means the Shore of Neyyar River. Neyyatinkara Taluk Hospital is located a few distances away from the river. The waste water from the hospital is directly discharged into the river. This creates a major course of water pollution in this area.

Site No. 4: (S_4)

Site No. 4 selected for present study belongs to Poovar Pozhikkara near Poovar. Poovar is a small coastal village in the Trivandrum district. The village is almost at the southern tip of Trivandrum and there is only one last village Pozhiyoor which mark the end of Kerala. Poovar lies close to Vizhinjam, a natural harbor. Poovar has an estuary which connects the sea during high tides. This area is a waste dumping site from tourist places and fecal contamination from thickly populated coastal place is another problem in this area.

Sample collection

Water samples were collected from the study areas selected during summer season (pre-monsoon), April and the rainy season (monsoon), June of 2011, in acid-cleaned, non-reactive plastic containers. Temperature and pH value were measured in the field using sensitive thermometer and portable pH meter. Water quality parameters were analyzed following the standard procedures prescribed by APHA (1993), Grasshoff (1983) and Trivedy and Goel (1986). Water quality indexing was performed following the protocol devised by the NSF (National Sanitation Foundation), USA (NSF, 2004).

Biochemical Analysis

Dissolved Oxygen (DO)

DO was determined using the Winkler's method (Michael, 1984) and using the formula.

$$\text{DO in (mg/litre)} = \frac{k \times 200 \times \text{Vol. of } Na_2S_2O_3 \times 0.689}{\text{Vol. of Sample}}$$

Where, k = vol. of bottle

Vol. of bottle - volume of reagent added

Biological Oxygen Demand (BOD)

The standard procedure about BOD prescribed by APHA was followed to find out the BOD. The BOD levels 1-2 mg/l is considered as very good, levels 3-5 mg/l fair 3-9 mg/l poor and 100 mg/l or greater very poor. (APHA, 1992).

Calculate BOD's as follows.

$$\text{BOD, mg/l} = \frac{D1 - D2}{P}$$

Where D_1 = DO of diluted sample immediately after precipitation.

D_2 = DO of sample after 5 d incubation at 20°C mg/l

P = Decimal volumetric fraction of sample used

Nitrogen NO_2 (Nitrite)

Nitrite (NO_2^-) is determined through formation of a reddish purple azodye produced at pH 2.0 to 2.5 by coupling diazotized sulfanilamide with N-(1-napthyl)-ethylendiamine dihydrochloride (NED-dihydrochloride) (US Environmental Protection Agency 1979)

Phosphate phosphorous

(By Ascorbic acid method): Ammonium molybdate and Potassium antimonyl tartate react in acid medium with orthophosphate to form phosphomolybdic acid that is reduced to intensely colored molybdenum blue by ascorbic acid (Murphy, 1962).

$$\text{Mg P/L} = \frac{\text{mg P x1000}}{\text{ml of sample}}$$

Total Dissolved Solids (TDS)

"Total Solids" is the term applied to the material residue left in the vessel after evaporation of a sample and its subsequent drying in an oven at a defined temperature. Total solids include "total suspended solids" the portion of total solids retained by a filter and total dissolved solids the portion that passes through the filter.

A well mixed sample is evaporated in a weighed dish and dried to a constant weight in an oven at 103 – 105°C. the increase in weight over that of empty dish represents the total solids. (US Environmental protection Agency, 1979)

$$\text{Mg total solids/L} = \frac{(A - B)\,x1000}{\text{Sample volume/ml}}$$

Where; A = Weight of dried residue + dish mg and

B = Weight of dish

Turbidity

Turbidity in water is caused by suspended ad colloidal matter such as clay, slit, finely divided organic and inorganic matter, planktons and other microscopic organisms. Turbidity is the expression of the optical property that causes light to be scattered and absorbed rather than transmitted with no change in direction or flux level through the sample.

This method is based on a comparison of the intensity of the light scattered by the sample under defined conditions with the intensity of the light scattered by a standard reference suspension under the same conditions. The higher the intensity of scattered light, the higher turbidity. Formazin polymer is used as the primary standard reference suspension.

Nephelo Metric Method. (US Environmental Protection Agency, 1993)

MPN coliform content

The Coliform group consists of several genera of bacteria belonging to the family Enterobacteriacca. The standard test for the coliform group may be carried out by multiple tube fermentation technique and procedure through the presumptive and confirmed phases. (U.S Environmental Protection Agency, 1989)

DISCUSSION

Scarcity of portable water is increasingly assuming alarming dimensions in Kerala, especially in Thiruvananthapuram district. The water supply schemes implemented here are totally inadequate to cater for the burgeoning demands for the over expanding township and housing schemes. Major rivers in

Thiruvananthapuram district are Neyyar river (56 Km), southern-most river in Kerala state and Karamana River (67 Km). the river water is beneficent for industrial, agricultural, irrigation and drinking water purposes. These water bodies are polluted mainly due to pollutants from anthropogenic origin. Investigations of present kind would provide valuable base-line data about the status of pollution from the origin to the end of Neyyar River.

The present investigation involved the evaluation of nine water quality parameters in selected regions of Neyyar River.

It was observed that in Neyyar River the water temperature at Site No.1 in April and June were the same. In Site No.2 and Site No.3, slight increase in temperature as compared to first site was observed. In Site No.4, higher water temperature was observed due to increased oxidation of organic pollutants discharged to water from coastal areas (Table 1).

In the case of pH, during April, it is slight acidic in nature at four different locations except Site No.1. In June, the acidity was found to increase slightly. This may be due to the addition of surface run off with lower pH during the monsoon pH of water at Site No.1 in April and June were the same. In Site No.3 and Site No.4 showed higher acidity in the two seasons as compared to Site No.1 due to increased acidic pollutants in these areas (Table 1).

Dissolved Oxygen is a good indicator of general health of an aquatic system. It is also related to the productivity of aquatic systems. It is also related to the productivity of aquatic systems. During the period of study, dissolved oxygen increased in monsoon season due to more dissolution of atmospheric O_2 in water and due to increased movement of river water in rainy season. DO content in water was higher in Site No.1 in the two seasons. At Site No.2 and Site No.3, the DO value slightly decreased. Site No.4 showed very low DO as compared to the other three sites. This low DO was due to the increased accumulation of organic matter from coastal areas and effluents from hotels (Table 1).

BOD is a test used to measure the influence of bio-degradable organic matter present in samples of water. (Agarwal *et al.*, 1976; Badge and Verma, 1991). BOD serves as an indication of amount of organic load as well as occurrence of inorganic materials such as Sulphides and Ferrous ions (APHA, 1992). The BOD value of present study were higher in April as compared to June except Site No.1. At Site No.1, water pollution is low and the present result is BDL (Below Detectable Limit). At Site No.2, the values were in safe range below 3 mg/L recommended by ICMR (1975) and ISI (1991) and the International Standards of 5 and 6 mg/L by USPH and WHO respectively (De, 1999). At Site No.3 and Site No.4, the values were higher than 3mg/L. The higher BOD may be attributed to the accumulation of dead organic matter into the river, higher degree of water pollution (Table 1).

Values of NO_2-N detected in present study remain lower than accepted drinking water standards (20mg/L – ICMR, 1975, 45mg/L – ISI, 1991). Nitrite level in water increased during rainy season. In pre-monsoon, the nitrite values were lower as compared to monsoon because absence of rain-fall, increase in temperature, reduced drainage. The result of present study agrees with the report of Paul and Verma (1999) (Table 1).

Phosphorous in natural water is present in the form of $H_2PO_4^{-1}$, HPO_4^{-2} and PO_4^{-3} and also in association with organic materials (Liss, 1976, Trivedy and Goel, 1986). The major sources of PO_4-P in aquatic systems are domestic sewage, agricultural effluents containing fertilizers and industrial effluents. Higher concentration of phosphates can be linked to higher degree of pollution (Desai, 1995). The values of PO_4-P found in present study remained considerably lower as compared to the prescribed level of USPH standard 0.1 mg/L. In April, the values at four different locations were BDL(Below Detectable Limit). In June, the slight increases in the level due to the presence of rain-fall, increased drainage and decrease in temperature (Table 1).

TDS originates from natural sources such as rain and bottom deposits as well as in flowing water. The TDS value of present investigation at first three sites less than 100 mg/L. At Site No.4, the value more than 500 mg/L. The EPA secondary regulations advice a maximum contamination 500 mg/L for TDS (http://www.epa.gov/safewater/mcl.html). When TDS level go beyond

TABLE 1. Variations in Physico- chemical parameters and their seasonal variations in water at selected sites of Neyyar River during April to June 2011. Observations and SD are given. (Ob: observed; SD: Standard Deviation; BDL: Below detectable level)

			Site No.1	Site No.2	Site No.3	Site No.4
Tem.(°C)	Apri	Ob	25.1, 24.7, 25.2	26.7, 27.2, 27.1	27.2, 26.7, 27.1	28.5
		SD	25 ± 0.26	27 ± 0.26	27 ± 0.26	29 ± 0.55
	Jun	Ob	5.2, 24.9, 25.1	26.4, 25.8, 25.8	26.2, 27.3, 27.5	27.3, 26.2, 27.5
		SD	25 ± 0.15	26 ± 0.34	27 ± 0.7	27 ± 0.7
pH	Apri	Ob	6.8, 6.9, 7.3	6.8, 6.7, 6.9	6.7, 6.9, 7.1	6.6, 6.8, 6.7
		SD	7 ± 0.26	6.8 ± 0.1	6.9 ± 0.2	6.7 ± 0.1
	Jun	Ob	6.9, 6.8, 7.3	6.8, 6.6, 6.7	6.4, 6.6, 6.8	6.3, 6.5, 6.7
		SD	7 ± 0.26	6.7 ± 0.1	6.6 ± 0.2	6.5 ± 0.2
DO	Apri	Ob	6.5, 6.52, 6.51	4.79, 4.82, 4.81	4.20, 4.26, 2.26	3.38, 3.39, 3.4
		SD	6.51 ± 0.01	4.81 ± 0.01	4.24 ± 0.03	3.39 ± 0.01
	Jun	Ob	7.33, 7.37, 7.38	5.36, 5.38, 5.37	5.06, 5.08, 5.13	3.53, 3.56, 3.53
		SD	7.36 ± 0.02	5.37 ± 0.01	5.9 ± 0.03	3.54 ± 0.01
NO_2-N(mg/L)	Apri	Ob	0.09, 0.09, 0.12	0.18, 0.21, 0.21	0.6, 0.7, 0.8	0.21, 0.19, 0.2
		SD	0.1 ± 0.017	0.2 ± 0.017	0.7 ± 0.1	0.2 ± 0.01
	Jun	Ob	0.06, 0.08, 0.07	2, 2.4, 2.2	1.9, 1.8, 2.3	0.33, 0.3, 0.3
		SD	0.07 ± 0.01	2.2 ± 0.2	2 ± 0.26	0.31 ± 0.01
PO_4-P (mg/L)	Apri	Ob	BDL	BDL	BDL	BDL
		SD	BDL	BDL	BDL	BDL
	Jun	Ob	0.01, 0.01, 0.01	0.06, 0.05, 0.04	0.05, 0.06, 0.07	0.03, 0.02, 0.01
		SD	0.01 ± 0	0.05 ± 0.01	0.06 ± 0.01	0.02 ± 0.01
TDS (mg/L)	Apri	Ob	58, 89, 62	48, 46, 44	83, 82, 84	513.1, 513.3, 513.2
		SD	60 ± 2.08	46 ± 2	83 ± 1	513.3 ± 0.1
	Jun	Ob	58, 58, 64	57, 56, 58	98, 95, 95	561.6, 561.4, 561.8
		SD	60 ± 3.46	57 ± 1	96 ± 1.73	561.6 ± 0.2
TURBIDITY (NTU)	Apri	Ob	1.4, 1.3, 1.6	2.9, 3.2, 2.9	17.8, 18.1, 17.8	5.8, 6, 6.2
		SD	1.5 ± 0.15	3 ± 0.17	17.9 ± 0.17	6 ± 0.2
	Jun	Ob	2.1, 1.9, 2	106, 106, 103	112, 111, 113	5, 18, 15
		SD	2 ± 0.1	05 ± 1.73	112 ± 1	16 ± 1.73

500 mg/L, it is generally regarded unfit for human consumption. In present study, slight increase of TDS value in June at the four sites as compared to May due to the precipitation in the form of rain-water. Precipitation in the form of rain-water contains as much as 30 mg/L to 40mg/L of solids. The values of present investigation were very low as per accepted standards except the Site No. 4 (Table 1).

Turbidity is considered as good indicator of water quality. The WHO establishes the turbidity of drinking water should not be more than 5 NTU and should ideally below 1 NTU. The turbidity of water increases in monsoon as compared to pre-monsoon due to seasonal fluctuation, increased drainage from surrounding areas. At Site No. 1, the TDS values in April and June are less than 5 NTU. At Site

No.2, the value is less than 5 NTU in April and more than 5 NTU in June. At Site No.3, Site No.4, the values were more than 5 NTU in pre-monsoon and monsoon. This excessive turbidity may due to the presence of heavy metal ions, pesticides or water-borne disease causing organisms may attach to the suspended particles.

The MPN coliform test is used to detect and calculate coliformpopulation in water samples. CPCB has prescribed an MPN count of 50 or less than 50 as accepted standard for potatbility without conventional treatment. The values recorded during the present investigation show a significant decrease in monsoon as compared to pre-monsoon. At Site No.1, the values were <50 in April and June. At Site No.2, Site No.3 and Site No.4, the values were >50 recorded in April and June. The higher values may be due to increased incidence of seepage of domestic effluents from septic tanks and drainage from other anthropogenic sources.

The state of Kerala, best owed with a large number of river-water resources that can serve as principal components of an excellent water-harvesting mechanism. Scarcity of drinking water is a matter of serious concern in Thiruvananthapuram district. The water supply schemes are increasingly becoming very inadequate to cater for the ever-increasing demands for water. In this context, it is highly essential to have sufficient data on the status of existing resources. Hence, the present investigation evaluate water quality status of Neyyar River at four different areas and in two different seasons, investigation of present kind are bound to provide water quality of the river

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