Assessment of seasonal variation in water and sediment quality parameters in an urban pond in TamilNadu

D. V. Sharmila Kumari[1], H.Mary Helen[2]

[1]Department of Chemistry, School of Basic Engineering and Sciences, PSN College of Engineering and Technology (Autonomous), Tirunelveli,627152, Tamil Nadu, India.
[2]Department of Chemistry, S.T. Hindu College, Nagercoil,629 002, Tamil Nadu, India.
(Affiliated to Mononmaniam Sundaranar University, Abihekapatti, Tirunelveli)

Abstract:
Surface water resources have played an important role in the development of human civilization. Surface water and sediment samples were collected during pre-monsoon and monsoon seasons for the determination of physicochemical parameters. Parameters were determined using standard methods. The study report discusses about the analysis of various physico-chemical parameters of TDS, DO, turbidity, pH, Temperature, Alkalinity, Nitrate, Phosphate, Chloride, Sulphate, Organic Carbon, Total Nitrogen, Total Phosphorous and Textural Analysis of surface water and sediments collected from different months of Paraikulam pond were measured during June 2024-September 2024. (Monsoon Period) and February 2025-May 2025 (Pre-Monsoon Period). The present results reveal that the values of most physical and chemical parameters where higher in pre-monsoon period compared to monsoon period. Sediment pH was more acidic in Pre-monsoon season compared to monsoon season. Organic Carbon, Phosphorous, Nitrogen contents of sediment increased during Monsoon season. Changes in water and sediment chemistry might be responsible for the variations in the physical and chemical properties.

Keywords: Physico-chemical characteristics; water; sediment.

INTRODUCTION

Ponds represent the smallest lentic fresh water system, unlike the lakes and reservoirs. (Eugene. P. Odum, 1980). Ponds are temporary water bodies and can be perennial (or) non perennial depending on the source of water. Most of the pond water is stagnant, it is essential to study the characteristics of sediments and water quality, as the contaminants is bonded either organically (or) inorganically to the sediment. The geochemical composition of water and sediments is largely governed by the physicochemical characteristics of the depositional environment and associated natural biogeochemical processes such as digenesis, adsorption/desorption on/from organic matter, and precipitation/ dissolution of Fe/Mn oxhydroxides (Solai et al., 2010). The regular and periodic changes in the climate synchronized with season are ultimately reflected in the environment parameters also, which in turn have direct or indirect influence over plank tonic population (Saravanakumar et al., 2008).

Good water quality resources depends on a large number of physicochemical parameters and the magnitude and source of any pollution load; and to assess that, monitoring of these parameters is essential (Reddi et al., 1993). Assessment of water resource quality of any region is an important aspect of developmental activities of the region, because rivers, lakes and manmade reservoirs are used for water supply to domestic, industrial, agricultural and fish culture (Jackher and Rawat, 2003)

Chemical composition of water is a function of hydro geochemical processes acting in a given environment, thus, monitoring of water quality parameters provide important information for water management (Matthieu et al., 2005; USEPA, 1983). Skilful management of water bodies is required if they are to be used for such diverse purposes as domestic and industrial supply, crops irrigation, transport, recreation, and fisheries (Abel, 1996). Sediment is the loose sand, silt, clay and other soil particles that settle at the bottom of water bodies. (Davies and Abowei, 2009). Chemical elements are accumulated in the silt and bottom sediments of water bodies can migrate back into the water, i.e., silt can become a secondary source of heavy metal pollution. Clay contents of the soil showed a positive correlation with organic carbon in many ponds. The objective of this study is therefore, to determine physicochemical characteristics of Paraikulam Pond surface water and sediments during Pre-Monsoon and Monsoon seasons. The present baseline information of the physicochemical properties of water and sediment would form a useful tool for further ecological assessment and monitoring of the Pond quality.

MATERIALS AND METHOD

For quality parameters analysis of Paraikulam pond water samples were collected from different months. The study was carried out in pre-monsoon (FEB 2025-MAY 2025) and monsoon period (JUN 2024-SEP 2024). Surface water samples and sediment samples were collected from the Paraikulam pond in Kanyakumari district. For the analysis of physico-chemical parameters, the surface water samples collected in new white colored plastic containers with caps for the physic-chemical parameter study. The sediments were collected in plastic polythene cover with the help of Van Veen Grab. Preservation and transportation of the water samples to the laboratory were as per standard methods (Trivedy and Goel (1984) and APHA, 1998). The analysis is carried out for determination of physico-chemical properties of Paraikulam pond such as: TDS, DO, turbidity, pH, Temperature, Alkalinity, Nitrate, Phosphate and dissolved nutrients of surface water and sediments etc. Physicochemical parameters of these samples were determined by using standard procedure (Rain and Thatcher, 1990; Rao, 1993; Clescerl et al., 1993; Pelczer *et al.,* 1986; Jain and Jain, 2007)

RESULTS AND DISCUSSION

Temperature

Physicochemical parameters results for water during the Pre-Monsoon and Monsoon seasons are presented in Tables 1 and 2, respectively. The measured temperature of the water reflected the changes corresponding to the sampling seasons. The surface water temperature varied from 29.7 to 33^{o}C during Pre-Monsoon season and 29 to 29.5 ^{o}C in the Monsoon season. During the pre-monsoon period highest temperature was vertical temperature could be due to open nature of the site and due to the hot climate in the pre-monsoon.

pH

In natural waters, the pH scale runs from 0 to 14. A pH value of 7 is neutral; a pH less than 7 is acidic and greater than 7 represents base saturation or alkalinity. The principal component regulating ion pH in natural waters is the carbonate, which comprises Co_2, H_2Co_3 and HCo_3 (APHA, 1995). pH varied from 7.6 – 8.5 during pre-monsoon season and 7.6 - 7.9 in the monsoon season. Lower values in pH are indicative at high acidity, which can be caused by the deposition of acid forming Substances in precipitation. A high organic content will tend to decrease the pH because of the carbonate chemistry. As microorganisms break down organic material, the by product will be CO_2 that will dissolve and equilibrate with the water forming carbonic and (H_2CO_3). Most metals will become more soluble in water as the pH decreases.

TDS

Water with a high total dissolved solids indicated more ionic concentration, which is of inferior palatability

and can induce an unfavorable physicochemical reaction in the consumers. Kataria *et al.,* (1996) reported that increase in value of TDS indicated pollution by extraneous sources. The TDS ranged from 40.2-42 mg/L in pre-monsoon season and 31.2-31.8 mg/L during the monsoon season. Total dissolved solid (TDS) values were observed to have decreased during monsoon season. High levels of dissolved and suspended solids in the water systems increase the biological and chemical oxygen demand, which deplete the dissolve oxygen level in the aquatic system.

Turbidity

Turbidity ranged from 5.5-6.8 NTU in pre-monsoon season and 10-16 NTU during the monsoon season. Increase in water turbidity level during the monsoon season may be attributed to discharge and subsequent sedimentation of suspended particulates from fertilizers, and domestic wastes discharged in to the pond as result of rainfall might have also contributed to increase in turbidity contents.

Coductivity

Electrical conductivity (EC) varied from 53 – 55 µs/cm in pre-monsoon season and 37 - 45 µs/cm in monsoon season. The low EC value recorded during monsoon season might be due water dilution, while the higher EC recorded in pre-monsoon season may be attributed to reduced water volume and high rate of evaporation.

Dissolved Oxygen

Dissolved oxygen (DO) ranged from 12 - 16 mg/L in pre-monsoon season and 4.0 - 4.8 mg/L during the monsoon season. The depletion in DO levels during monsoon season indicated that deoxygenation rate due to biological decomposition of Organic Matter is higher than the reoxygenation from atmosphere (Das and Achary, 2003).

Alkalinity

Alkalinity ranged from 24 - 31 mg/L in pre-monsoon season and 25 - 28 mg/L during the monsoon season. The low alkalinity value recorded during monsoon season might be due water dilution. Total alkalinity observed in the present study is well within the prescribed standards of drinking water (> 120mg/liter) alkalinity is imparted more by the presence of CO_2 suggesting the decay of organic matter is the prominent activity elevating alkalinity in natural waters.

Nitrate

Distribution of nutrient is mainly based on a season. Fresh water flow from farm land showed both spatial and temporal variation. The nitrate values ranged from 3.8 to 4.8 mg/L in pre-monsoon season and 5.42 to 5.9 mg/L during the monsoon season. The nitrate is usually derived from anthropogenic sources like agricultural fields and domestic sewage containing nitrogenous compounds which increased during monsoon season due to rainfall.

Phosphate

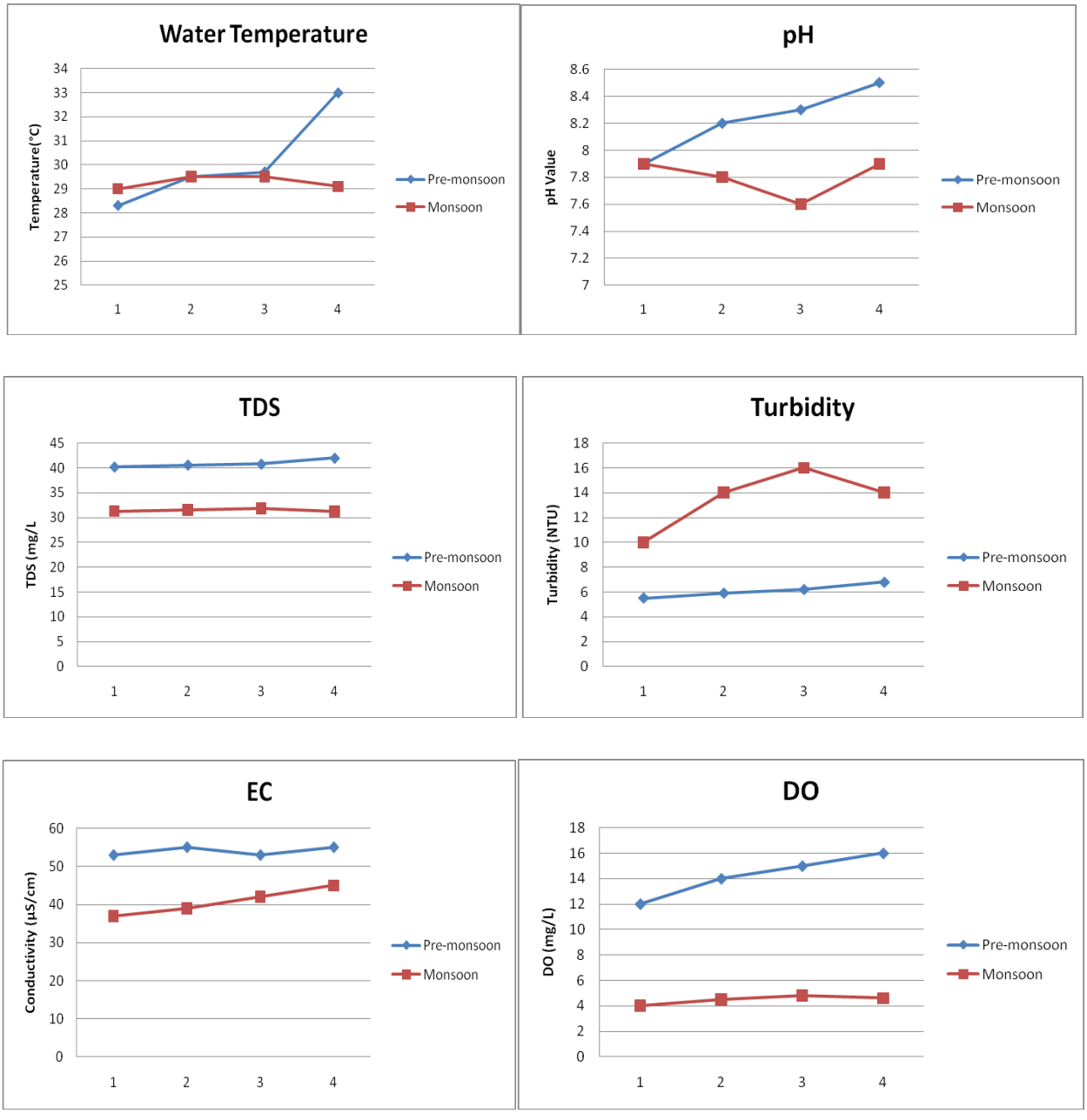
Phosphate varied from 1.29 to 1.38 mg/L in pre-monsoon season and 2.80 to 2.89 mg/L during the monsoon season. Higher concentration of phosphate observed during the monsoon season might be an intrusion and transportation from land into the pond. The phosphate is usually derived from anthropogenic sources like domestic sewage and agricultural fields containing fertilizer compounds which increased during monsoon season due to rainfall.

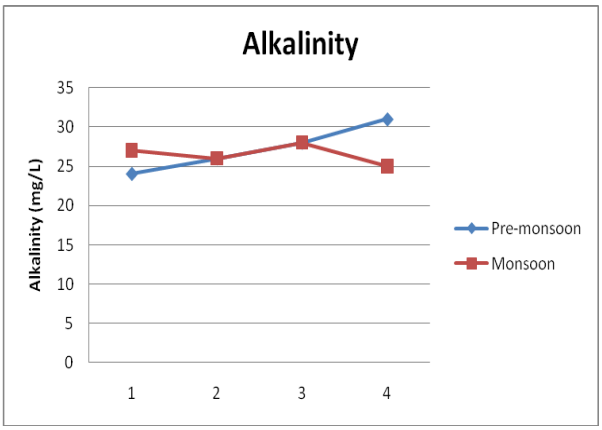
Chloride

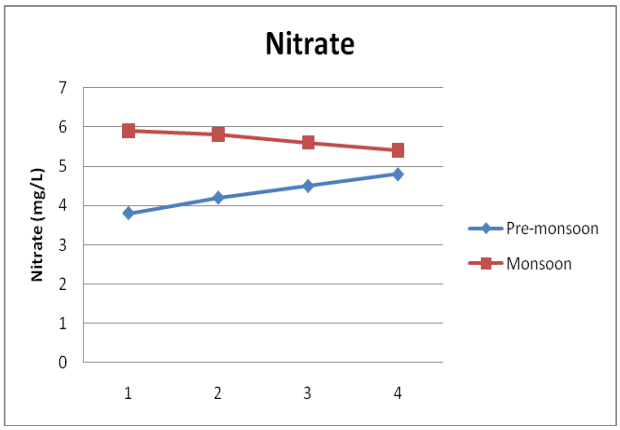
Chloride is present in nearly all natural water with varying concentration, depending on the geochemical condition of the area. Concentration of chloride above 250 mg/L can impact distinct salty taste (Das and Achary, 2003). Chloride varied from 58 to 62 mg/L in pre-monsoon season and 57 to 59 mg/L during the monsoon season. Chloride exhibited wide and high concentration range. This may be attributed to anthropogenic origin. The decrease in water chloride level during the monsoon season might be as a result of increased volume and subsequently dilution of water body from rainfall.

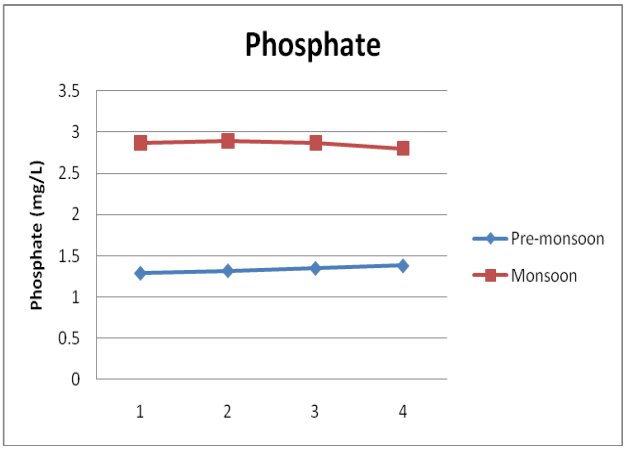
Sulphate

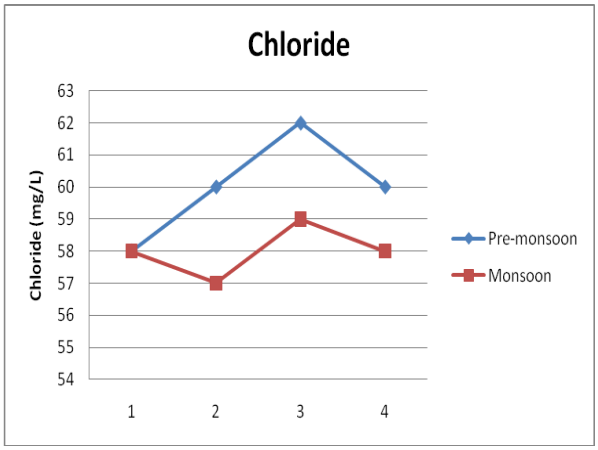
High concentration of SO_4^{2-} could cause a cathartic action on human beings and can also cause respiratory Problems. Water sulphate varied from 0.53-0.57 mg/L in pre-monsoon season and 0.6-6.07 mg/L during the monsoon season. Increase in water sulphate contents during the monsoon season may be attributed to increase in concentration and runoff waters from agricultural lands might have also contributed to over all sulphate in the pond water.

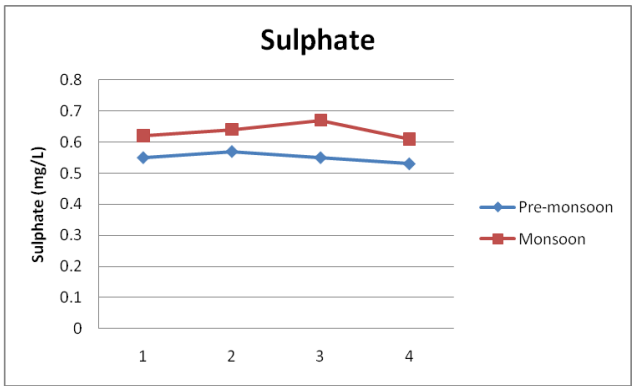












SEDIMENT

Sediment physicochemical properties results are presented in Tables 3 and 4.

Sediment Chemistry

Percentage composition of sediments showed a minimum of 67.93% sand and maximum of 69.40% during pre- monsoon and a minimum of 38.36% sand and a maximum of 39.49% during monsoon. Silt content varied from a minimum of 6.97% and a maximum of 6.99% during pre-monsoon and a minimum of 55.98% silt and a maximum of 58.98% during monsoon. Clay contents varied from a minimum of 25.01% clay and a maximum of 26.35% during pre-monsoon and a minimum of 5.75% clay and a maximum of 5.95% during monsoon. Increase in silt contents during the monsoon season may be attributed to increase in concentration and the sediment deposited which depicts the organic matter input due to obvious weed growth and vegetation respectively in the water on the pond and its subsequent degradation in the system. During monsoon clay seemed to be washed by the rain and therefore the dominance of sand.

pH

Physicochemical properties of sediment (pH) were generally higher during the monsoon season. At low pH, hydrogen ion competes with metal cations adsorbed into sediment surface leading to their remobilization into the water column. The relatively low value of pH (7.4-7.9) during the pre-monsoon season could be as a result of the oxidation of FeS to H_2SO_4 (Ramanathan, 1997). Variations in pH might also be attributed to redox changes in sediments and water column apart from the influence of fresh water (Holmer et al., 1994).

Organic carbon

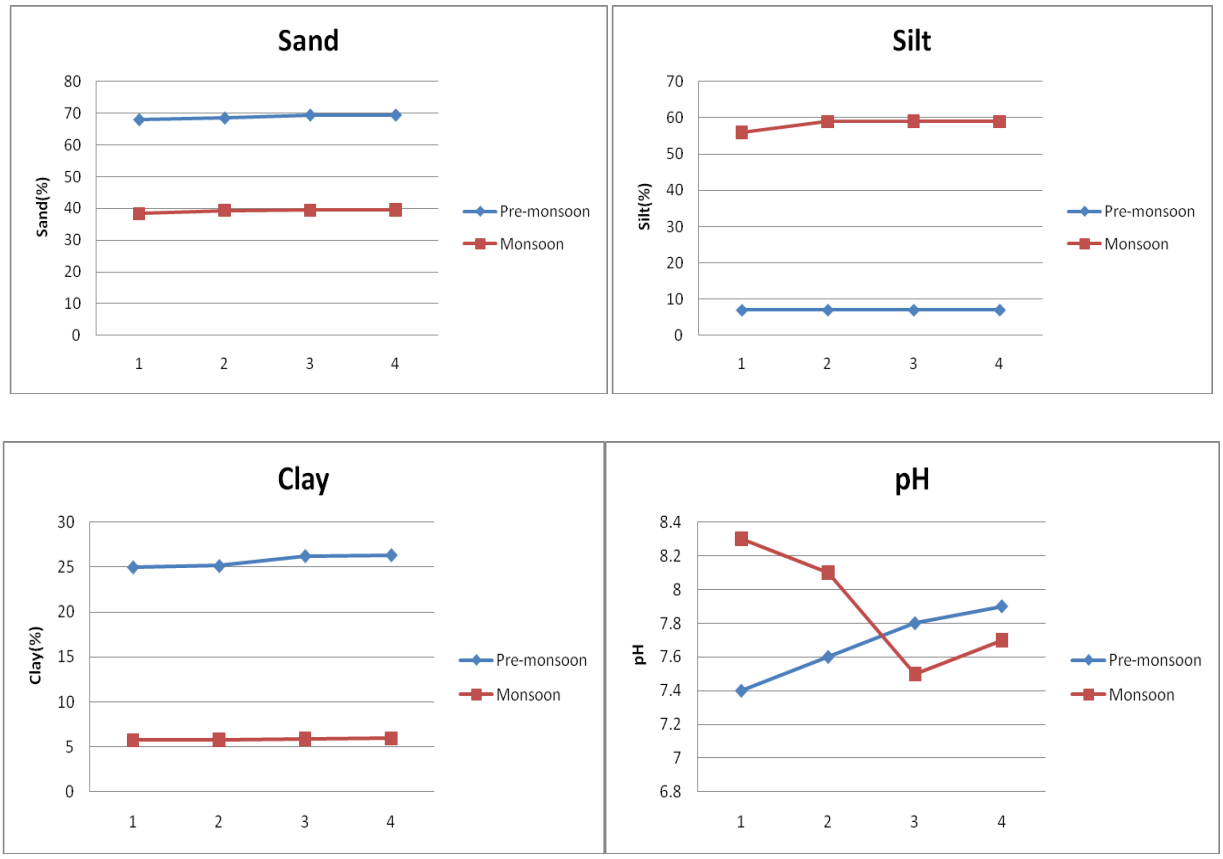
The percent organic carbon in sediments ranged from 1.048-1.053 % in pre-monsoon season and 1.532-1.573% during the monsoon season. Organic debris might have surface run off with rain water and attributed to increase in % organic carbon in monsoon season.

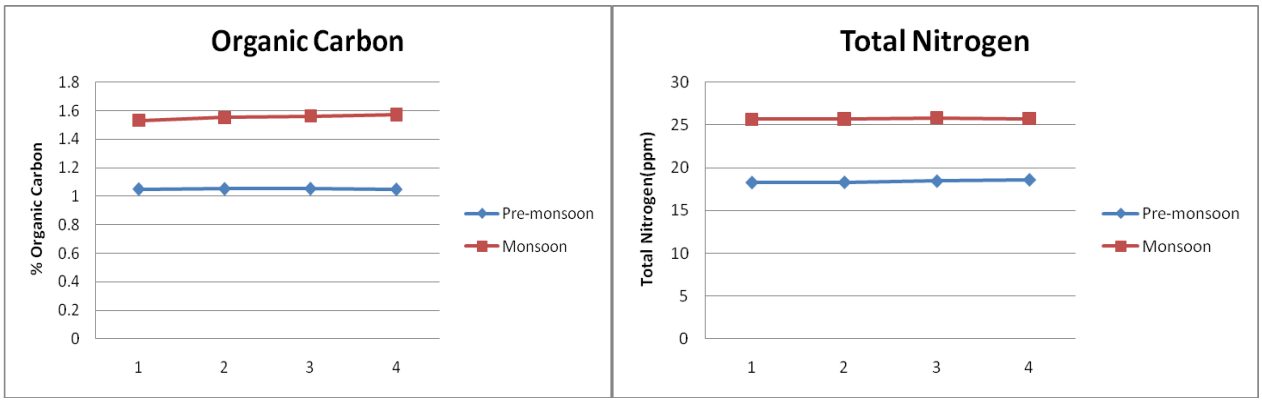
Total nitrogen

Total nitrogen concentration in sediments ranged from 18.29-18.60 ppm in pre-monsoon season and 25.66-25.85ppm during the monsoon season. However, total nitrogen concentration in sediments showed an increase during monsoon possibly due to addition of nitrogenous pollutants through the runoff water.

Total phosphorous

Total phosphorous concentration in sediments ranged from 2.73-2.93 ppm in pre-monsoon season and 3.72-3.92 ppm during the monsoon season. Discharge and subsequent sedimentation of suspended particulates from phosphate and nitrogen fertilizers, and domestic wastes discharged into the pond as a result of rainfall might have also contributed to the increase in sediment phosphorous contents.





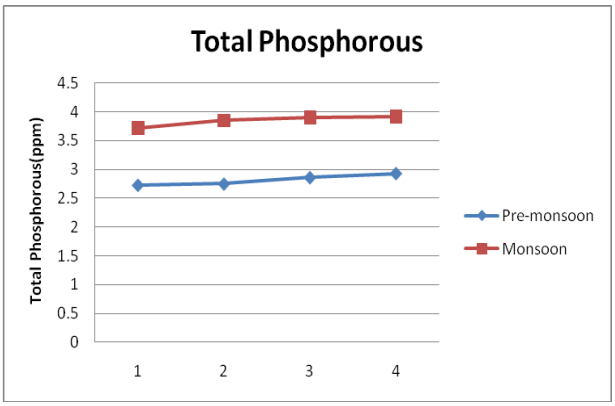


Table 1. Physicochemical parameters of Paraikulam pond water during pre-monsoon season

PARAMETERS	Months:2025			
	FEB	MAR	APR	MAY
Tempreture (ºC)	28.3	29.5	29.7	33
pH	7.9	8.2	8.3	8.5
TDS (mg/L)	40.2	40.6	40.8	42
Turbidity (NTU)	5.5	5.9	6.2	6.8
EC (µS/cm)	53	55	53	55
DO (mg/L)	12	14	15	16
Alkalinity (mg/L)	24	26	28	31
Nitrate (mg/L)	3.8	4.2	4.5	4.8
Phosphate (mg/L)	1.29	1.32	1.35	1.38
Chloride (mg/L)	58	60	62	60
Sulphate (mg/L)	0.55	0.57	0.55	0.53

Table 2. Physicochemical parameters of Paraikulam pond water during monsoon season

PARAMETERS	Months:2024			
	JUN	JUL	AUG	SEP
Tempreture(ºC)	29.0	29.5	29.5	29.1
pH	7.9	7.8	7.6	7.9
TDS (mg/L)	31.3	31.5	31.8	31.2
Turbidity (NTU)	10	14	16	14
EC (µS/cm)	37	39	42	45
DO (mg/L)	4.0	4.5	4.8	4.6
Alkalinity (mg/L)	27	26	28	25
Nitrate (mg/L)	5.9	4.8	5.6	5.4
Phosphate (mg/L)	2.87	2.89	2.87	2.80
Chloride (mg/L)	58	57	59	58
Sulphate (mg/L)	0.62	0.64	0.67	0.61

Table 3. Physicochemical parameters of Paraikulam pond sediment during pre-monsoon season

PARAMETERS	Months:2025			
	FEB	MAR	APR	MAY
Sand (%)	67.93	68.45	69.40	69.40
Silt (%)	6.97	6.99	6.98	6.99
Clay (%)	25.01	25.15	26.25	26.35
pH	7.4	7.6	7.8	7.9
Organic Carbon (%)	1.050	1.052	1.053	1.048
Total Nitrogen (ppm)	18.29	18.31	18.45	18.60
Total Phosphorous(ppm)	2.73	2.75	2.86	

Table 4. Physicochemical parameters of Paraikulam pond sediment during monsoon season

PARAMETERS	Months:2024			
	JUN	JUL	AUG	SEP
Sand (%)	38.36	39.36	39.45	39.49
Silt (%)	55.98	58.91	58.98	58.93
Clay (%)	5.75	5.81	5.91	5.95
pH	8.3	8.1	7.5	7.7
Organic Carbon (%)	1.532	1.552	1.562	1.573
Total Nitrogen (ppm)	25.66	25.70	25.85	25.73
Total Phosphorous(ppm)	3.72	3.85	3.90	3.92

CONCLUSION

Physicochemical characteristics of surface water and sediment varied according to season. Variations according to sites did not adhered to any specific trends. Physicochemical properties of water significantly increased during the pre-monsoon season, except for nitrate, phosphate, sulphate and

turbidity. Sediment pH, Organic Carbon, nitrogen and phosphorous contents increased during the monsoon season. The probable source of the pollutants is anthropogenic influences, practically from fertilizer and pesticides used in agriculture.

Declaration of competing interest

The authors declare no conflicts of interest.

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