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Physico - Chemical Analysis of Water Quality of Bhitarkanika Mangrove Forest, Odisha, India

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ARTICLE DETAILS

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ABSTRACT

Water quality plays a pivotal role in determining the health of mangrove ecosystems. Mangroves, which are mostly found in coastal areas, are highly sensitive to changes in salinity, nutrients levels, sedimentation and pollution. The elevated salinity or nutrient loading may cause stress on the plants leading to death of them and interrupting the entire ecosystem's biosphere. In addition, fluctuations of temperatures and oxygen shortages often caused by low-quality waters could also affect mangroves' resistance against climate change together with other factors that are poor for nature. Consequently, maintaining clean water is crucial for preserving mangrove forests as well as allowing their role as ecological units and benefits they offer to local societies along the coastlines. Bhitarkanika is the second largest mangrove ecosystem in India situated on the east coast of the country; mangrove ecosystem experiences a tropical monsoon climate, characterized by distinct wet and dry seasons. Physico-chemical analysis of water quality of Bhitarkanika mangrove forest, Odisha, India, was studied at four different seasons for a period of one year during April-2022 to March-2023. Surface water temperatures (^{0}C) varied from 28^{0}C to 30^{0}C respectively. Seasonal variations of different parameters investigated were as follows: pH (6.65 to 8.0), dissolved oxygen (6.0 to 7.0mg/l), biological oxygen demand (0.089 to 0.96mg/l), electrical conductivity (1086 to 21538 µmho/cm), hardness (200 to 3800mg/l), chloride (2045 to 8784mg/l). A seasonal variation in these parameters was observed throughout the study period and monthly comparisons were made as pre monsoon, post-monsoon, winter and summer.

1. Introduction

Bhitarkanika, located in eastern Orissa, India is one of the most popular and bio-diverse regions of wetlands comprising of the network of tidal rivers, riverine esterizes and the mangrove vegetation. This ecosystem's health substantially relies on the quality of water that spawns diverse plant and animal species, including threatened ones like the saltwater crocodile or migratory birds. For understanding how optimally Bhitarkanika is functioning, it is necessary to study the water properties of this region measuring the parameters like its pH, salinity, dissolved oxygen and nutrient / pollutant like heavy metal content.

They show how the biophysical systems and human undertaking like farming, fish farming and land clearance influence the water quality. The mangrove water was slightly alkaline and contained high amounts of pH, total hardness, calcium, magnesium, chloride, total inorganic and organic phosphate, ammonium, nitrite and nitrate (Amadi et al., 2010). Accordingly, through constant observation of the said variables, it becomes passable to formulate more robust conservation directions for the exceptional environmental and biological characteristics of Bhitarkanika. When river water

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mixes with seawater, a large number of physical and chemical processes take place, which may influence the water quality (Balasubramanian et al., 2005).

The hydrology of Bhitarkan is important due to its unique ecosystem, which includes mangroves, estuaries and wildlife species.Water quality has a direct impact on local ecosystems, including migratory birds new and saltwater crocodiles are two examples of endangered species It also informs conservation plans and sustainable management strategies to create important ecosystems that are simplifying the protection of this boundary by checking fluid patterns. The present investigation was undertaken to assess the pollution load if any, through estimation of physico-chemical parameters of aquaculture pond water discharged into Bhitarkanika mangrove ecosystem of Orissa for a period of one year from April 2022 to March 2023 to cover major four seasons; pre-monsoon, post-monsoon, winter and summer.

2. Materials and Methods

2.1 Site description

Bhitarkanika Mangrove Ecosystem is situated in the northeastern part of Odisha, India which is one of the flourishing and still unspoiled mangrove forest of area measuring 672 square kilometer. This special geography, which includes the rivers such as Brahmani and Baitarani, comprises tidal rivers, estuaries, and mangroves forests that ultimately define a plentiful bio-diversity. The flora is shared with species including the saltwater crocodile, Indian python, and different kinds of migratory birds (Chauhan, Rita & Ramanathan, Al. 2008). Therefore, the mangroves meet important ecological functions such as; mitigation of storm surges and habitat carbon storage. However, various socio-ecological threats to Bhitarkanika exist which include deforestation and aquaculture hence the need for conservation practices in an attempt to stabilize the ecosystem and preserve the natural balancing systems to their originality.

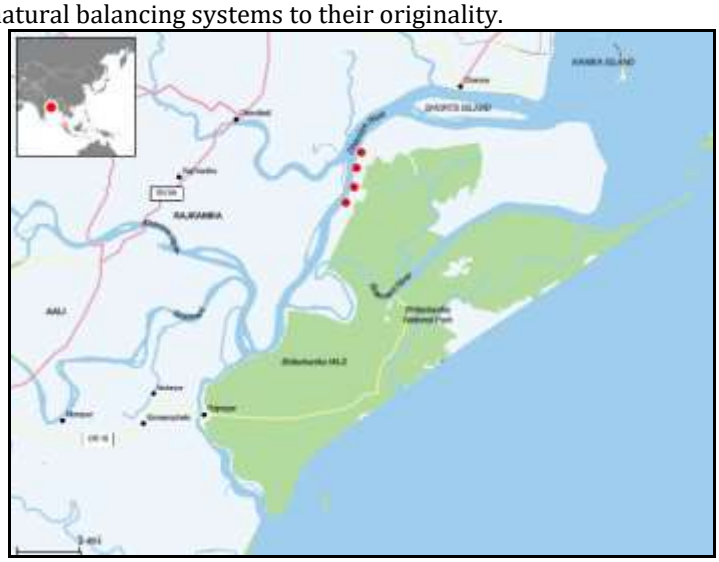


Fig. 1 Map of study area

2.1 Water analysis

Composite sampling method was used to collect water sample (approximately 1000 mL each) were cover four distinct seasons: winter (December–February), summer (March–May), the pre-monsoon season (June–August), and post-monsoon (September–November). Fifteen important parameters were selected for physicochemical water quality analysis: pH, temperature, total dissolved solids (TDS), electrical conductivity (EC), chloride ion (Cl^-) concentration, acidity, total alkalinity (TA), total hardness (TH), dissolved oxygen (DO) concentration, BOD, and COD, sulphate, nitrate, calcium, magnesium.Physico-chemical characteristics of water were estimated and followed as per standard protocol,respectively APHA, (2005), (Akshaya et al., 2014)

Table 1. Methods use for water sample estimation of parameters

Parameters	Description	Methods/ instruments
pH	The major of acidity (hydronium ion,H+) in the water.	pH meter
Temperature	Temperature exerts a major influence on the biological activities and growth.	Thermometer
Electrical conductivity (EC)	Measured with the help of EC meter which measures the resistance offered by the water between two platinized electrodes.	EC meter
TDS	The measure of the amount of particulate solids that are in the water.	TDS meter
Acidity	It is determined by simple dil. NaOH titration in presence of phenolphthalein and methyl orange	Titrimetric method

	indicators.	
Total alkalinity (TA)	It is determined by simple dil. HCl titration in presence of phenolphthalein and methyl orange indicators.	Titrimetric method
Chloride	Measured by titrating a known volume of sample with standardized silver nitrate solution using potassium chromate solution in water.	Titrimetric method
Total hardness (TH)	Total hardness in water is typically determined by the EDTA titration method (Ethylenediaminetetraacetic acid method).	Titrimetric method
Dissolved oxygen (DO)	It is commonly determined by the Winkler method	Titrimetric method
BOD	Determine by Dilution method	Five-day dilution method
COD	Determine using the dichromate method	Reflux digestion method
Calcium	Measured by complexometric titration with standard solution of ETDA using Patton's and Reeder's indicator.	Titrimetric method
Magnesium	Measured by complexometric titration with standard solution of EDTA using Eriochrome black T as indicator.	Titrimetric method
Sulphate	Determine involves precipitating sulphate ions from a water sample as barium sulphate ($BaSO_4$) and then measuring the mass of the precipitate	Gravimetric method
Nitrate	Phenol Disulfonic Acid is used to determine nitrate concentration in water	Phenol Disulphonic Acid (PDA) Method

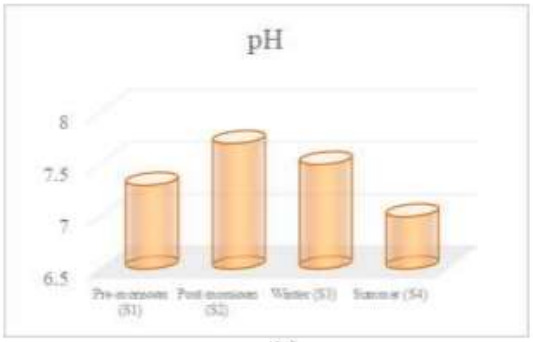
3. Results and Discussion

The physicochemical parameters, such as temperature, pH, DO concentration, BOD concentration, COD concentration, EC, Cl concentration, acidity, TA, TDS concentration, calcium & magnesium concentration, and TH, were recorded for different seasons and are shown in Table 1.

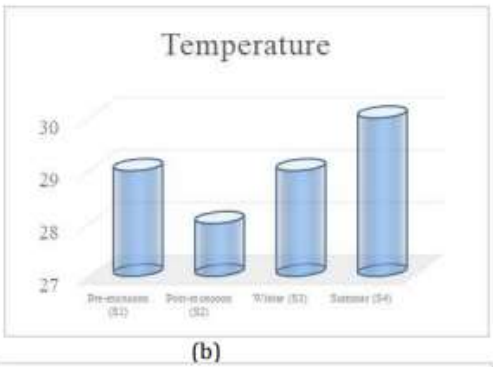
Table 2. Physico-chemical analysis of water sample

Sr. No.	Parameters	Pre-monsoon (S1)	Post-monsoon (S2)	Winter (S3)	Summer (S4)
1	pH	7.3	7.7	7.5	7.0
2	Temperature (^{0}C)	29	28	29	30
3	EC (µMho/cm)	1086	18461	19580	21538
4	TDS (Mg/L)	30000	10000	12000	14000
5	Acidity	80	50	60	40
6	Alkalinity (Mg/L)	570	420	250	113
7	Chloride (Mg/L)	2480	2045	8784	6600
8	Total Hardness (Mg/L)	200	350	5000	3800
9	DO (Mg/L)	6.0	6.2	7.0	6.0
10	BOD (Mg/L)	0.66	0.096	0.089	0.967
11	COD (Mg/L)	276	84	260	288
12	Calcium (Mg/L)	320	220	690	750
13	Magnesium (Mg/L)	120	130	310	350
14	Sulphate (Mg/L)	0.024	0.053	0.061	0.104
15	Nitrate (Mg/L)	1.067	0.349	0.469	0.513

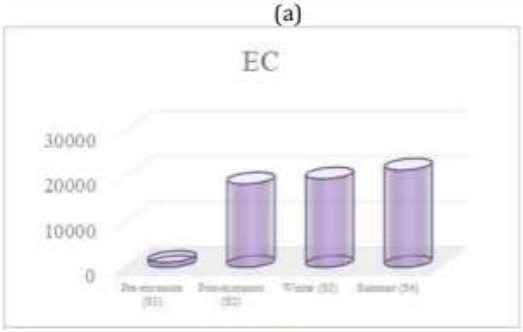
The mangrove water was slightly acidic and contained high amounts of pH. Dissolved oxygen was high during monsoon and low during summer and pre monsoon, Biological oxygen demand was low during monsoon and high during pre monsoon and summer, calcium, magnesium, sulphate, hardness and chloride were low during pre-monsoon and high during summer. The electrical conductivity was maximum in the summer and minimum in the monsoon. Most of the parameters tested were slightly higher in summer than the monsoon seasons. Temperature is an important biologically significant factor, which plays an important role in the metabolic activities of the organism (Sirajudeen and Mohamed Mubashir, 2013). Air temperature ranged from 29^{0}C (monsoon and winter) to 30^{0}C (summer). Air temperature reaches its maximum during summer and minimum during monsoon and winter.


pH
8
7.5
7
6.5

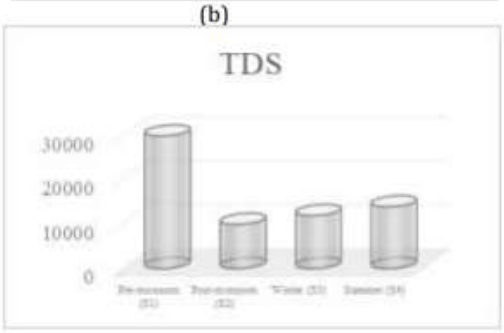
(a)


Temperature
30
29
28
27

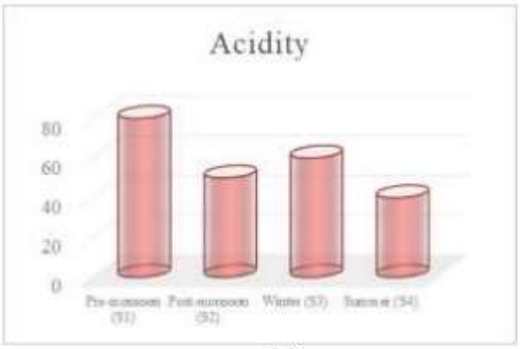
(b)


EC
30000
20000
10000
0

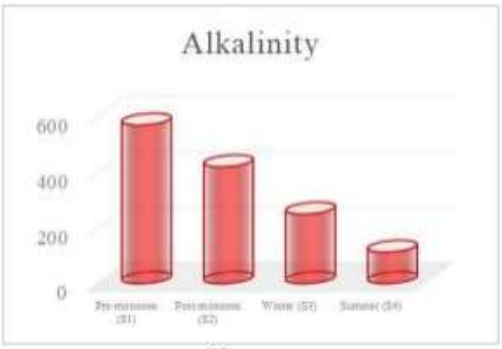
(c)


TDS
30000
20000
10000
0

(d)


Acidity
80
60
40
20
0

(e)


Alkalinity
600
400
200
0

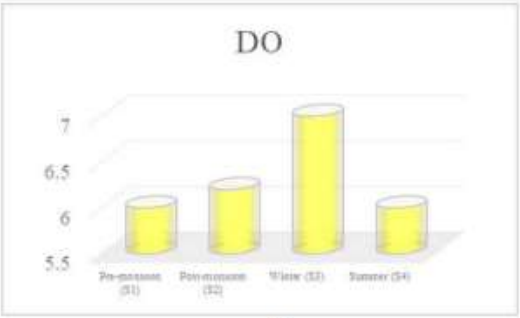
(f)


Chloride
10000
5000
0

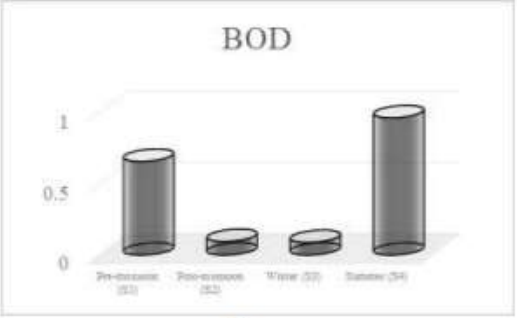
(g)


Hardness
6000
4000
2000
0

(h)


DO
7
6.5
6
5.5

(i)


BOD
1
0.5
0

(j)

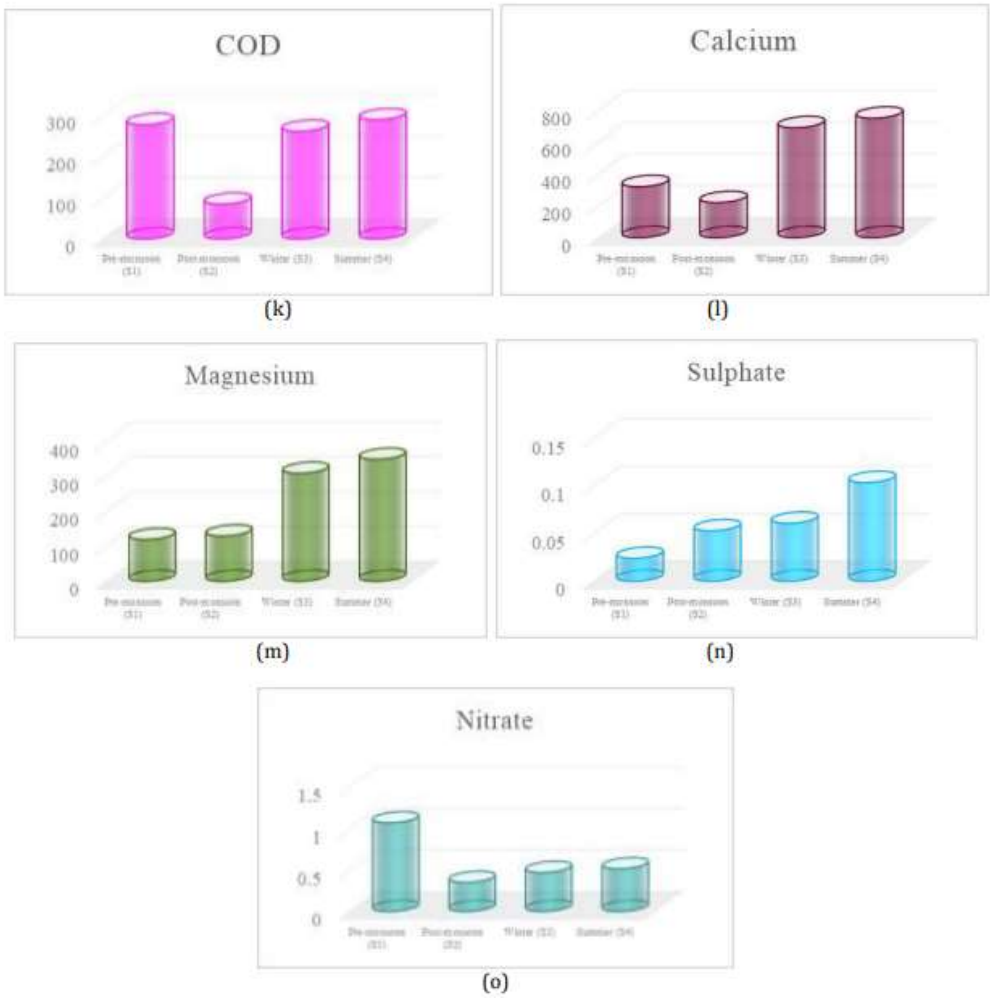


Fig.2 - (a) to (o) are the variation in Physico-Chemical parameters of different soil samples

Pearson's correlation analysis measures the closeness of the relationship between chosen variables. If the correlation coefficient is nearer to +1 or –1, it shows the perfect linear relationship between the two variables (Bhutiani et al., 2018; Bellizzi et al., 1999). The parameters such as hardness, chloride, calcium, magnesium are highly correlated with each other whereas TDS, EC, acidity, alkalinity are negatively correlated. Temperature, BOD, COD, nitrate and sulphate are positively related.

The physico-chemical analysis of water in Bhitarkanika, a critical wetland ecosystem, provides valuable insights into the health and sustainability of its aquatic environment. The results from the study highlight the variability in key parameters such as pH, dissolved oxygen, salinity, and nutrient concentrations, which are influenced by both natural processes and anthropogenic activities. water quality currently supports its diverse flora and fauna, proactive measures are necessary to ensure its long-term ecological balance. Sustainable management practices, along with regular monitoring, will be crucial in preserving this vital ecosystem against the pressures of environmental change and human interference.

4. Conclusion

As the season's changes, the physicochemical properties of water fluctuate, influenced by shifts in temperature, rainfall, and tidal patterns. In the wet season, increased freshwater inflow typically lowers salinity levels and raises nutrient concentrations, which can alter aquatic life and impact overall water quality. On the other hand, during the dry season, higher salinity and reduced water flow can concentrate pollutants and limit nutrient availability, disrupting the ecological balance. Understanding these variations in water characteristics is crucial for ongoing ecological assessments and the effective monitoring of coastal ecosystems.

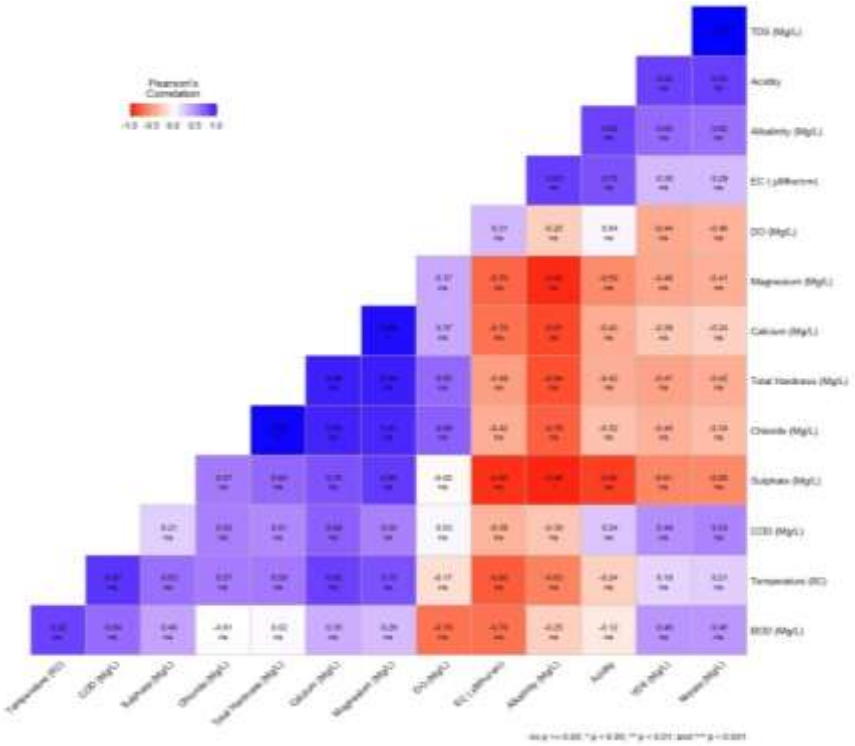


Fig.3 - Relationship between physico-chemical characteristics

5. Acknowledgement
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