



Seasonal Variations in Physico-Chemical Characteristics of Rudrasagar Wetland - A Ramsar Site, Tripura, North East, India

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Abstract

The Present work deals with the study of water quality of Rudrasagar Wetland (Ramsar site no. 1572), Tripura with regards to various physico chemical parameters like water temperature, pH, turbidity, dissolved oxygen (DO₂), free carbon dioxide (FCO₂), total alkalinity (TA), electrical conductivity, total suspended solids (TSS), total dissolved solids (TDS), chloride(Cl), biochemical oxygen demand (BOD), chemical oxygen demand (COD), phosphate (PO₄³⁻) and nitrate(NO₃). The physico chemical characteristic of Rudrasagar Wetland is found to be highly fluctuated with seasonal variations during the present investigation. High value of dissolved oxygen obtained during winter months and shows inverse relation with water temperature. EC, TDS, Chloride, COD have had maximum concentrations in summer. The correlation coefficient showed positive and negative relationships among the parameters. The study revealed that the water quality is rich in TDS, Phosphate and Nitrate content which indicates that of Rudrasagar wetland is moderately eutrophicated.

Keywords: Water quality, Ramsar site, physico-chemical parameters, seasonal variations, correlation.

Introduction

Wetlands are probably the earth's most important fresh water resources which provides food and habitat for many aquatic life including threatened and endangered species. So, conservation of wetlands is very much essential as wetlands are one of the most threatened habitats of the world. The most important step for conservation of wetlands is to maintain a proper water quality¹. The water quality is directly related to the health of the water body. So, proper management in water quality of aquatic environment is very much essential. Some of the most recent works on water quality of various aquatic environments was those of Gopalkrushna², Offem *et al.*³, Vaishnav and Dewangan⁴, Iwuoha and Osuji⁵, Matini *et al.*⁶, Devi *et al.*⁷ and Tamrakar and Raj⁸.

The purpose of the present study is to observe water quality of Rudrasagar wetland by physico chemical procedures and to determine the changes in water quality parameters by seasons and to find the relationship between different physico chemical parameters.

Material and Methods

Study area: Tripura is a state in North-Eastern India which borders Bangladesh, Mizoram and Assam. It is surrounded by Bangladesh on its north, south and west. Climate is divided into three seasons, Summer (March –June), rainy (July – October) and winter (November – February).

The present study was conducted on the physico-chemical parameters of the Rudrasagar Wetland. The wetland is situated at a distance of about 50 km from the state capital of Tripura in

the Melaghar Block of Sipahijala District figure -1A and 1B. It is a freshwater wetland with an average depth of 1.8 m to 8.6 m. It was declared as Ramsar site on 08/11/2005 (Ramsar site no. 1572). Ministry of Environment and Forest, Government of India identified Rudrasagar as one of the wetlands of National Importance for conservation and sustainable use based on its bio-diversity and socio economic importance. Morphometric features of Rudrasagar Lake is given in table-1. Three main streams feed the water to the lake namely; Oacherra, Durlavnaraya Cherra and Kentali Cherra. The overflow gets discharged through Kachigang into the Gumati River.

According to the National Wetland Atlas⁹, Rudrasagar wetland is an unique habitat for many freshwater fishes along with some rare and endangered species. The lake support diverse aquatic vegetation. Siltation is one of the most important problems of this wetland.

Table-1
Morphometric features of Rudrasagar Lake

NAME	Rudrasagar wetland
Location	23°29'10" to 23°32'52" N Latitude 91°17'23" to 91°20'04" E Longitude
Wetland Type	Waterlogged (Natural)
Wetland Area	688 ha
Open water	
Post-monsoon	547 ha
Pre-monsoon	145ha
Vegetation	
Post-monsoon	141 ha
Pre-monsoon	543 ha
Overall Tubidity	Moderate High

Source National Wetland Atlas. 2013, MOEandF, Govt. of India

Sampling methods: The water samples were collected from Rudrasagar wetland at monthly intervals from March 2011 to February 2013 during 6.00 – 8.00 am in fresh unsullied plastic bottles. The closed bottle was dipped into the water and then the cap is opened and water is allowed to fill up the bottle absolutely. The cap is then closed and the bottle is brought out of the water.

Several physico-chemical parameters such as, water temperature, pH, turbidity, dissolved oxygen (DO_2), free carbon dioxide (FCO_2), total alkalinity (TA), electrical conductivity, total suspended solids (TSS), total dissolved solids (TDS), chloride (Cl), biochemical oxygen demand (BOD), chemical oxygen demand (COD), phosphate (PO_4^{3-}) and nitrate (NO_3), has been analyzed.

Analysis of water quality parameters: Water temperature is measured *in situ* by using hand mercury thermometer, pH was

estimated by Digital pH –meter (Systronics Type-335). Turbidity was measured by Water Analyzer, Model no. WQC-22A, Electrical conductivity was measured by conductivity meter. (Esico Microprocessor based conductivity meter, Model 1601), TDS was measured with the help of Digital TDS meter, for the estimation of other parameters, water sample is brought to the laboratory. The analysis of various physico-chemical characteristics of water were done as per the standard methods given by APHA (1998)¹⁰ and Trivedi and Goel (1984)¹¹. AR grade reagents, distilled water and Borosil glass wares were used for preparation of solutions and analysis.

Statistical analysis: *Statistical analysis:* The correlation between various physico-chemical parameters of water samples were analyzed statistically conducting Pearson correlation analysis with the help of SPSS software (16.0).



Figure-1(A)
Rudrasagar Wetland

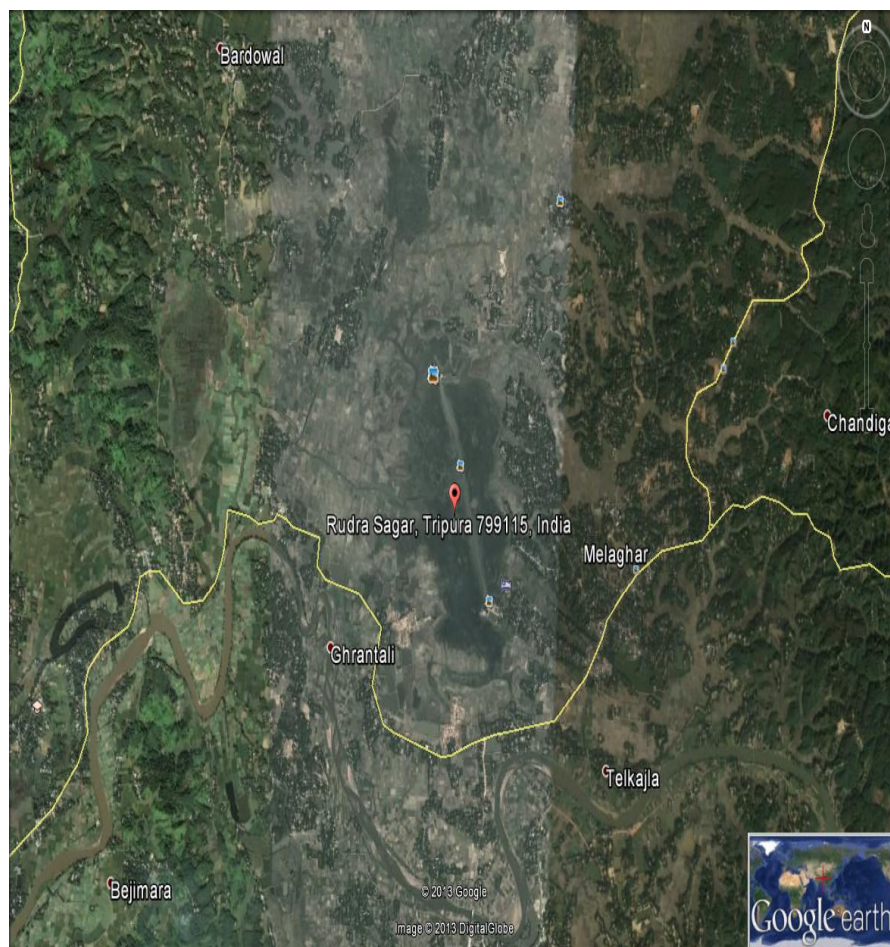


Figure-1(B)
Satellite image of the studied wetland

Results and Discussion

Physico-chemical parameters (Mean±S.D) of Rudrasagar wetland obtained during the present investigation (during March 2011 – Feb 2013), is presented in table-2.

Water Temperature : Water temperature is one of the essential parameter, since it influences the growth and distribution of flora and fauna. Oxygen status of any water body is greatly influenced by temperature¹²⁻¹³. Water temperature recorded as minimum value of 18.4 °C and maximum of 33.5°C during the two year study period (March 2011 to Feb 2013) with a mean value of 26.05°C ±4.26 table-2. The average water temperature observed during the first year study period was 25.88 °C±4.01 whereas during the second year of observation the mean water temperature was 26.05°C± 4.6. In the present investigation, minimum water temperature was obtained during winter season and maximum during summer figure-2. This investigation is also in close conformity with the finding of Kannan and Job¹⁴, Chaturbhuj *et al.*¹⁵, Mishra *et al.*¹⁶ and Arya *et al.*¹⁷. Water temperature shows high significant positive relationship (p<0.01 level) with turbidity (r=0.830), carbon dioxide (r=0.905), EC

(r=0.751), TSS (r=0.787), TDS (r=0.784), BOD (r=0.690), COD (r=0.832) and significant negative correlation with pH (r= - 0.590), DO (r= -0.890) and Total alkalinity (r= - 0.879) table-3.

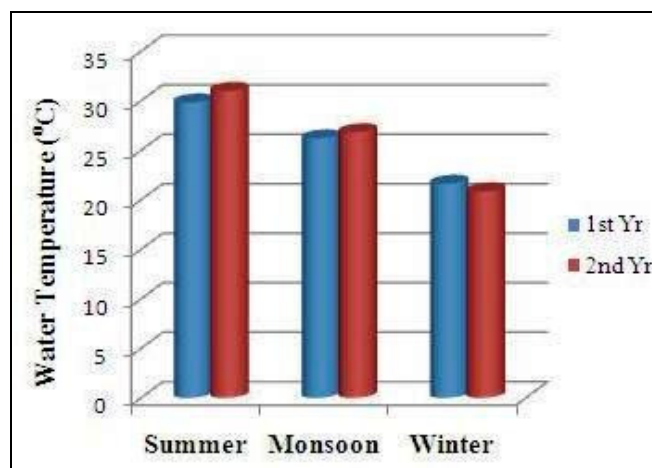


Figure-2
Average seasonal variations in Water Temperature of Rudrasagar Wetland during the two year study period

Table-2
Physico-chemical parameters (Mean±S.D) of Rudrasagar wetland during March 2011 – Feb 2013

Parameters	First year study period (March 2011 – Feb 2012)		Second year study period (March 2012 – Feb 2013)	
	Range	Mean ± SD	Range	Mean ± SD
Water Temperature (°C)	19.5 - 33.5	25.88 ± 4.01	18.4 - 33.0	26.22 ± 4.67
pH	7.3 - 8.44	7.8 ± 0.41	6.8 - 9.0	7.89 ± 0.606
Turbidity (NTU)	15.75 - 51.0	25.65 ± 9.27	14.86 - 47.0	25.78 ± 10.16
Dissolved oxygen (mg/L)	4.26 - 8.6	6.17 ± 1.37	3.8 - 8.27	6.26 ± 1.43
Free Carbon dioxide (mg/L)	1.5 - 6.8	3.47 ± 1.55	1.45 - 7.09	3.67 ± 1.94
Total alkalinity (mg/L)	127.3 - 252.0	193.5 ± 38.97	121.0 - 232.5	188.66 ± 36.45
Electrical conductivity (µ mho/cm)	40.0 - 126.0	83.17 ± 25.66	60.76 - 108.2	75.35 ± 16.6
Total Suspended Solids (mg/L)	40.0 - 100.25	73.64 ± 21.66	41.45 - 118.62	81.24 ± 27.6
Total Dissolved Solids (mg/L)	80.0 - 210.0	133.8 ± 38.36	100.0 - 216.0	165.9 ± 32.15
Chloride (mg/L)	24.0 - 34.12	28.71 ± 3.49	32.8 - 44.1	38.03 ± 3.49
BOD (mg/L)	1.22 - 4.2	2.48 ± 0.708	2.28 - 3.11	2.56 ± 0.22
Chemical Oxygen Demand (mg/L)	21.32 - 66.75	46.47 ± 15.7	26.63 - 101.6	50.078 ± 22.49
Phosphate (mg/L)	0.894 - 4.78	3.048 ± 1.32	0.52 - 5.36	2.31 ± 1.53
Nitrate (mg/L)	2.4 - 7.36	5.55 ± 1.54	2.8 - 8.1	5.54 ± 1.65

Table-3
Correlation matrix among the physico-chemical parameters of Rudrasagar wetland during March 2011 to February 2013

	WT	pH	TUR	DO ₂	FCO ₂	TA	EC	TSS	TDS	Cl	BOD	COD	PO ₄ ³⁻	NO ₃
WT	1	-.590**	.830**	-.890**	.905**	-.879**	.751**	.787**	.784**	.284	.690**	.832**	.457*	-.475*
pH		1	-.397	.554**	-.588**	.520**	-.550**	-.440*	-.380	-.161	-.286	-.477*	-.271	.461*
TUR			1	-.826**	.907**	-.876**	.564**	.671**	.765**	.345	.723**	.745**	.270	-.496*
DO ₂				1	-.906**	.895**	-.748**	-.785**	-.761**	-.240	-.563**	-.880**	-.436*	.529**
FCO ₂					1	-.917**	.699**	.793**	.795**	.391	.638**	.787**	.365	-.574**
TA						1	-.689**	-.675**	-.784**	-.400	-.712**	-.835**	-.221	.604**
EC							1	.447*	.572**	.070	.732**	.685**	.318	-.643**
TSS								1	.664**	.188	.326	.726**	.601**	-.128
TDS									1	.571**	.689**	.758**	.287	-.372
Cl										1	.333	.332	-.346	-.413*
BOD											1	.618**	.127	-.508*
COD												1	.220	-.495*
PO ₄ ³⁻													1	.360
NO ₃														1

*.Correlation is significant at the 0.05 level (2-tailed) **. Correlation is significant at the 0.01 level (2-tailed).

WT= Water Temperature, TUR= turbidity, DO₂=dissolved oxygen, FCO₂ = Free carbondioxide, TA= total Alkalinity, EC=electrical conductivity, TSS=total suspended solids, TDS= total dissolved solids, Cl= chloride, BOD = Biochemical Oxygen Demand, COD= Chemical Oxygen Demand, PO₄³⁻ = Phosphate, NO₃= Nitrate

pH: pH is the concentrations of hydrogen ions (H⁺) present in water and is a measure of acidity or alkalinity. During the present study period (March 2011 to Feb 2013), the pH of the Rudrasagar wetland was observed near neutral to alkaline ranging from 6.8 to 9.0 which was considered to be conducive for aquatic life¹⁸. The maximum pH recorded during winter season especially in the month of December 2012 (9.0) and minimum pH (6.8) was obtained during summer (April 2012) in the two year study period figure-3, with mean value of 7.8. ± 0.5 table- 2. These findings are also in accordance with Mishra *et al.*¹⁶, Adebisi¹⁹ and Tara *et al.*²⁰.

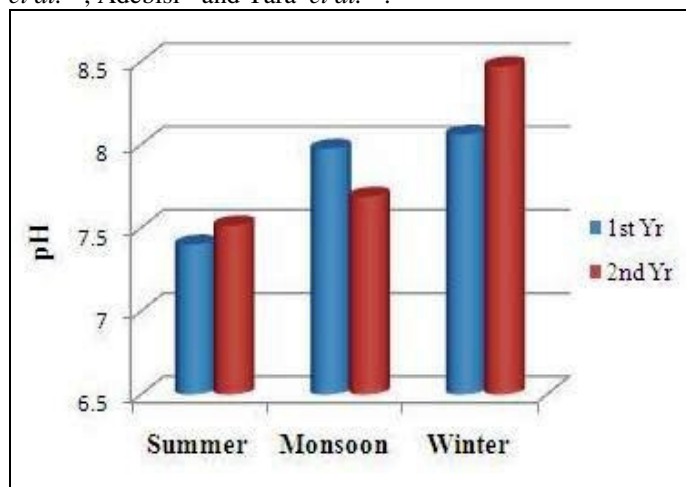


Figure-3

Average seasonal variations in pH of Rudrasagar Wetland during the two year study period

Turbidity: Turbidity reduces the amount of light penetrating the water due to the presence of various suspended particles such as clay, silt, plankton, algae, etc. These suspended particles absorb more light and results in rising of the water temperature. In the first year of investigation, turbidity revealed a wide range of variation with a minimum of 15.75 NTU and that of maximum of 51.0 NTU. Whereas during the second year of observation the range obtained was 14.86 to 47.0 NTU. The Turbidity of water during the study period shows high significant positive relationship ($p < 0.01$) with water temperature ($r = 0.830$), Carbon dioxide ($r = 0.907$), EC ($r = 0.564$), TSS ($r = 0.671$), TDS ($r = 0.765$), BOD ($r = 0.723$), and COD ($r = 0.745$) and high significant negative correlation ($p < 0.01$) with DO ($r = -0.823$) and total alkalinity ($r = -0.876$) table-3. In the present investigation, the turbidity of water was found maximum during the summer season and least turbidity was obtained during winter figure-4. Similar findings have been projected by offem *et al.*³ and Tamrakar and Raj⁸.

Dissolved Oxygen (DO₂): Dissolved oxygen is regarded as one of the best indicator to assess the health of a water body²¹. Minimum DO₂ of water was recorded in the month of May 2011 (4.26 mg/L) and maximum in December 2011 (8.6 mg/L) during the first year of investigation. During the second year of study, the minimum DO₂ value obtained was 3.8 mg/L (March

2012) and maximum of 8.6 mg/L (December 2011). The overall mean during the entire study period was 6.22 mg/mL. The DO₂ of water of Rudrasagar wetland was high in winter months and comparatively lower during monsoon and lowest concentration of DO₂ recorded in the summer months in both the year of investigation figure-5. Hazelwood and Parker (1961)²² stated that, the maximum dissolve oxygen in winter may be due to low atmospheric temperature and minimum dissolve oxygen in summer may be due to high metabolic rate of organisms. This was supported by the observations made by Tara *et al.*²⁰, Edmondson²¹, Hazelwood and Parker²², Manawar²³, Parikh and Mankodi²⁴ and Pathak and Mankodi²⁵. In the present investigation, dissolved oxygen of Rudrasagar wetland shows high significant negative correlation ($p < 0.01$) with Water temperature ($r = -0.890$), turbidity ($r = -0.826$), FCO ($r = -0.906$), TDS ($r = -0.761$), TSS ($r = -0.785$), BOD ($r = -0.563$), COD ($r = -0.880$) and high significant positive relation ($p < 0.01$) with pH ($r = 0.554$), total alkalinity ($r = 0.895$) table-3.

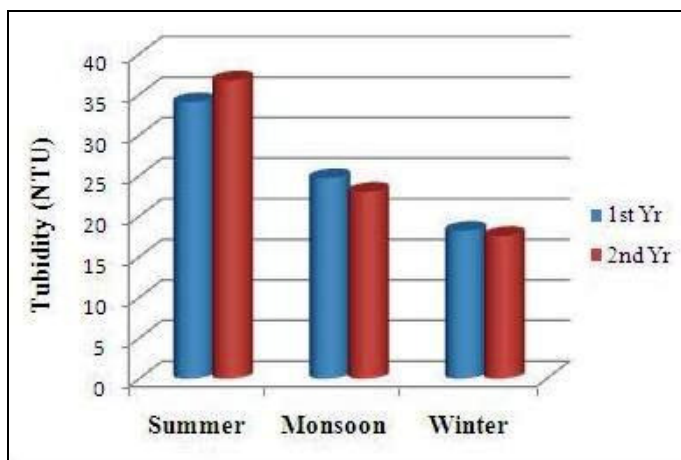


Figure-4

Average seasonal variations in Turbidity of Rudrasagar Wetland during the two year study period

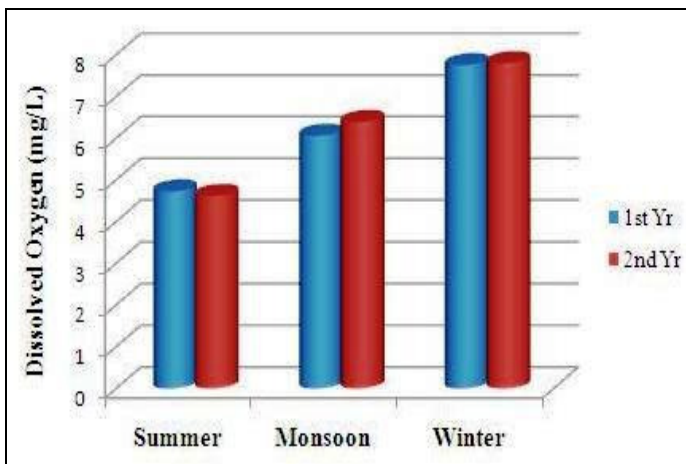


Figure-5

Average seasonal variations in DO₂ of Rudrasagar Wetland during the two year study period

Free Carbon dioxide (FCO₂): Carbon dioxide in a water body may be derived from the atmospheric sources, biotic respiration, inflowing ground water which seep into the pond, decomposition of organic matter due to bacteria and may also from within the water body itself in combination of other substances mainly calcium, magnesium etc. the present study revealed that lowest value of FCO₂ was recorded for the month of February 2013 which was 1.45mg/L whereas the highest FCO₂ was recorded in the month of May 2012 (7.09 mg/L.) during the two year study period with a mean value of 3.57 mg/L table-2. So, the present study revealed that higher concentration of FCO₂ is obtained during the summer season and lowest value in winter figure-6. Tara *et al.*,(2011)²⁰, Jain and Seethapati (1996)²⁶ and Qadri and Shah, (1984)²⁷ observed higher value of FCO₂ during summer. FCO₂ shows high significant negative correlation ($p < 0.01$) with pH ($r = -0.588$), total alkalinity ($r = 0.917$) table-3.

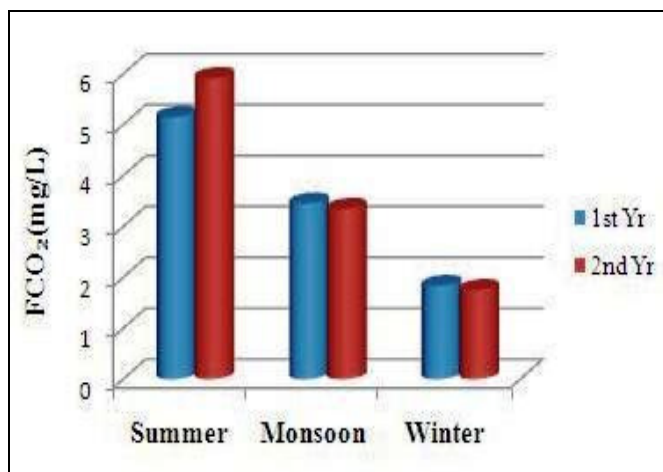


Figure-6

Average seasonal variations in FCO₂ of Rudrasagar Wetland during the two year study period

Total Alkalinity (TA): Total alkalinity is imparted by presence of bicarbonate, carbonate and hydroxide and less frequently in wetland by borate, silicate and phosphate. The CO₂- HCO₃⁻-CO₃²⁻ equilibrium system is the major buffering mechanism in freshwater²⁸. Total alkalinity obtained in the range of 127.3 mg/L to 252.0 mg/l and 121 mg/L to 232.5 mg/l in the first and second year of study period respectively. The highest value shows during the winter months and lowest in the summer months during both the study period figure-7. Similar trend was reported by Dhembare²⁹. It is seen that total alkalinity shows high significant negative correlation ($p < 0.01$) with water temperature ($r = -0.879$), turbidity ($r = -0.876$), conductivity ($r = -0.917$), TSS ($r = -0.675$), TDS ($r = -0.784$), BOD ($r = -0.712$) and COD ($r = -0.835$) table-3.

Electrical conductivity (EC): Electrical conductivity is a numerical expression of the ability of a water sample to carry an electric current. EC values of Rudrasagar wetland were in the range of 40 (μ mho/cm) to 126 (μ mho/cm) during the present

study (March 2011-Feb 2013) showing average value of 79.26 μ mho/cm (table-2). Seasonal variations of the present investigations revealed that EC was high during summer seasons and low during winter seasons figure-8. This result is supported by the findings of Narayana *et al.*³⁰, Kedar *et al.*³¹ and Rao *et al.*³². In the present study EC showed high significant positive correlation ($p < 0.01$) with water temperature, turbidity, FCO, TDS, TSS, BOD and COD whereas EC showed negative correlation ($p < 0.01$) with pH, DO, TA and Nitrate table-3.

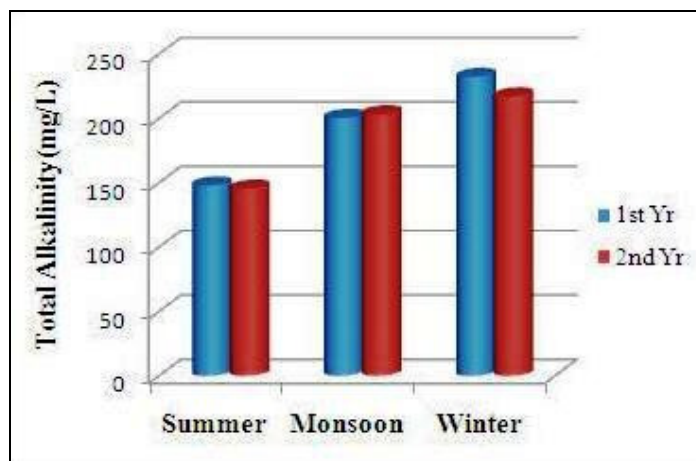


Figure-7

Average seasonal variations in TA of Rudrasagar Wetland during the two year study period

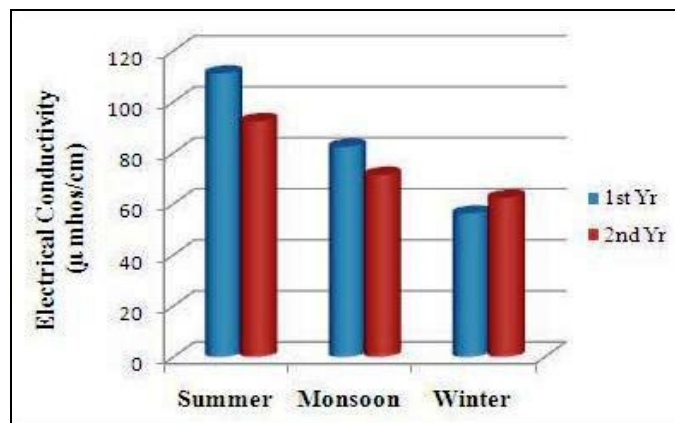


Figure-8

Average seasonal variations in EC of Rudrasagar Wetland during the two year study period

Total Suspended Solids (TSS): In the present study period i.e. March 2011 - Feb 2013, total suspended solids showed high significant positive relationship ($p < 0.01$) with Water Temperature ($r = 0.787$), turbidity ($r = 0.671$), TDS ($r = 0.664$), FCO ($r = 0.793$), COD ($r = 0.601$), it showed high significant negative relationship ($p < 0.01$) with DO ($r = -0.785$) and total alkalinity ($r = -0.675$), it showed significant negative relationship with pH ($r = -0.440$) table-3. The maximum value of T.S.S was observed in the month of April 2012 (118.62 mg/L) and

minimum value was recorded in December 2011 (40 mg/L) during the two year study period. The overall mean was 77.44 ± 24.5 (mg/L). The present study displayed that, the average TSS values were maximum during monsoon and minimum during winter in the first year and TSS recorded maximum concentration in summer season and minimum value of TSS was obtained during winter season in the second year of observation figure-9. This investigation is in close conformity with the finding of Parikh and Mankodi²⁴.

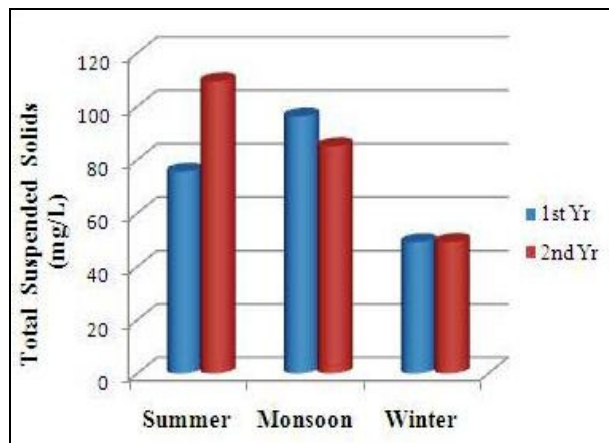


Figure-9

Average seasonal variations in TSS of Rudrasagar Wetland during the two year study period

Total Dissolved Solids (TDS): Total dissolved solids is the measure of the combined content of all inorganic and organic substances in a water sample. In the first year of investigation (March 2011- Feb 2012), the TDS displayed a wide range of variations with a minimum value of 80 mg/L and maximum of 216 mg/L. Whereas during the second year period (March 2012- Feb 2013), the range of the concentration of TDS of Rudrasagar wetland obtained, was 100 – 216 mg/L. The TDS of water during the study period shows high significant positive relationship ($p < 0.01$) with Water temperature ($r = 0.784$), turbidity ($r = 0.765$), carbon dioxide ($r = 0.795$), EC ($r = 0.572$), TSS ($r = 0.664$), chloride ($r = 0.571$), BOD ($r = 0.689$), and COD ($r = 0.758$) and high significant negative correlation ($p < 0.01$) with DO ($r = -0.761$) and total alkalinity ($r = -0.784$) table-3. In the present investigation, the total dissolved solids of Rudrasagar wetland was found maximum during the summer season and least TDS was obtained during winter figure-10. Narayana *et al.*³⁰ and Jacklin and Balasingh³³ also reported maximum concentration of TDS during summer.

Chloride (Cl): Chloride is considered as one of the most important inorganic anion in water. It occurs naturally in all types of water due to its high solubility. Its concentrations in freshwater is generally taken as an indicator of sewage pollution¹³. In the present investigation, minimum chloride was recorded during monsoon season and maximum during the summer season figure-11. Chaturbhuj *et al.*¹⁵, Mishra *et al.*¹⁶, Arya *et al.*¹⁷ and Jana³⁴ also reported similar results in their study.

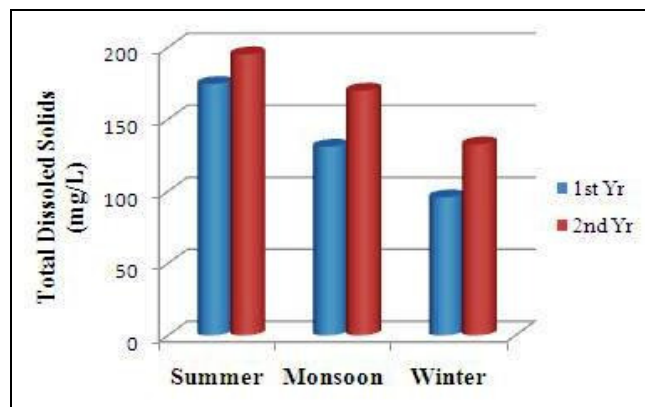


Figure-10

Average seasonal variations in TDS of Rudrasagar Wetland during the two year study period

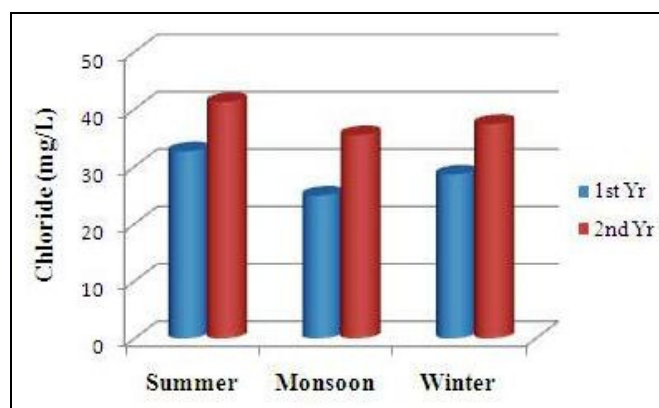


Figure-11

Average seasonal variations in Chloride of Rudrasagar Wetland during the two year study period

Biochemical Oxygen Demand (BOD): BOD is an indication of the organic load and it is a pollution index especially for water bodies receiving organic effluent³⁵. In the first year of investigation (March 2011- Feb 2012), the BOD value ranges between 1.22 to 4.2 mg/L. Whereas during the second year period (March 2012- Feb 2013), the range of the concentration of BOD of Rudrasagar wetland obtained, was 2.28 to 3.11 mg/L. the overall mean was 2.52 ± 0.51 for the entire two year of study (March 2011 to February 2013) table-2. The BOD of water during the study period shows high significant positive correlation ($p < 0.01$ level) with Water temperature ($r = 0.690$), turbidity ($r = 0.723$), carbon dioxide ($r = 0.368$), EC ($r = 0.732$) and TDS ($r = 0.689$) and high significant negative correlation with DO ($r = -0.563$), COD ($r = 0.618$) and total alkalinity ($r = -0.712$). BOD showed significant negative correlation with Nitrate ($r = -0.508$) during the study period (table-3). In the present investigation (March 2011 to Feb 2013) B.O.D. values of Rudrasagar wetland was reported high during summer season followed by monsoon and least in winter season figure-12. These findings are also in accordance with Pal³⁶ and Paul and Mukherjee³⁷.

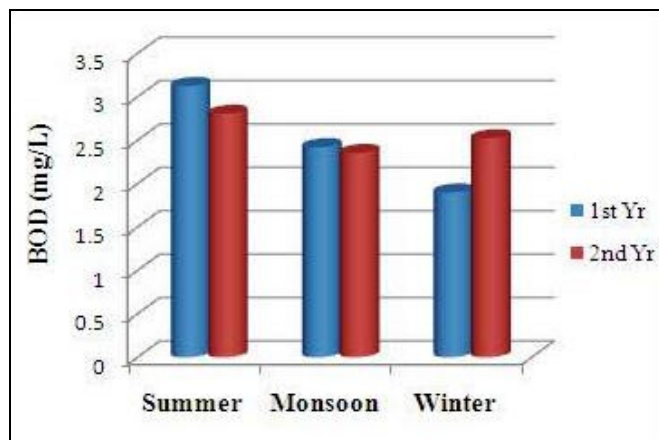


Figure-12

Average seasonal variations in BOD of Rudrasagar Wetland during the two year study period

Chemical Oxygen Demand (COD): The high COD values indicate that some degree of non-biodegradable oxygen demanding pollutants were present in the water. In the present investigation, the maximum COD value recorded 66.75 mg/L and minimum value of COD obtained was 21.32 mg/L in the first year. During the second year COD value ranged between 26.63 to 101.6 mg/L. the overall mean value obtained was 48.27 mg/L during the two year observation (table-2). COD showed highly significant negative correlation ($p < 0.01$) with DO ($r = -0.880$), total alkalinity ($r = -0.835$) and pH ($r = -0.477$) and high significant positive correlation ($p < 0.01$) with Water temperature ($r = 0.832$), turbidity ($r = 0.745$), CO ($r = 0.787$), EC ($r = 0.787$), TDS ($r = 0.758$) and BOD ($r = 0.618$) during the investigation (table-3). Seasonal variation revealed that COD values were higher during summer seasons and lower during winter figure-13. This result is supported by the findings of Rao *et al.*³².

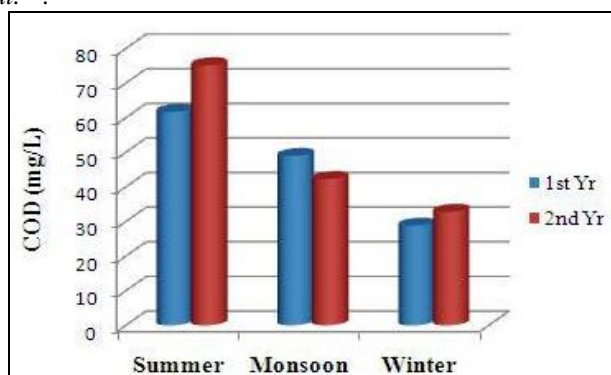


Figure-13

Average seasonal variations in COD of Rudrasagar Wetland during the two year study period

Phosphate (PO_4^{3-}): Present investigations displayed that phosphate obtained in the range of 0.894 to 4.78 mg/L in the first year and 0.52 to 5.36 mg/L during the second year of observation. The overall mean value obtained as 2.68 ± 1.44

table-2. The value of phosphate was found maximum during monsoon and it falls down during the winter season figure-14. The study also supports the findings of Kannan and Job¹⁴, Mishra *et al.*¹⁶ and Parikh and Mankodi²⁴. In the present investigation phosphate of Rudrasagar wetland showed high significant positive correlation with TSS ($r = 0.601$) and significant positive correlation with water temperature ($r = 0.457$) and shows significant negative correlation with DO ($r = -0.436$) table-3.

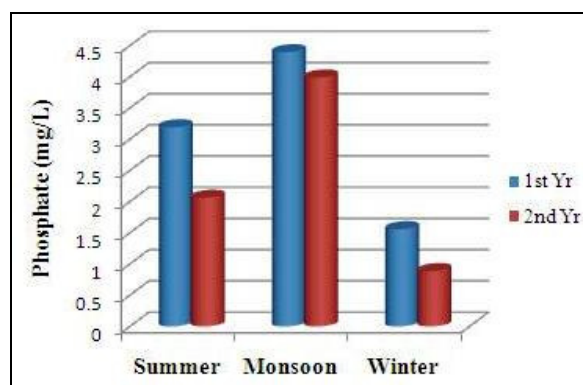


Figure-14

Average seasonal variations in PO_4^{3-} of Rudrasagar Wetland during the two year study period

Nitrate (NO_3^-): The most chemically stable form of nitrogen is nitrate. High nitrate concentration can result in excess algal blooms in water body. Fertilizers, decayed vegetables and animal matter are the principle sources of nitrates in a water body. In the present study (March 2011 – Feb 2013), the maximum value of nitrate was recorded as 8.1 mg/L in the month of August 2012 and minimum value observed in May 2011 (2.4 mg/L) with a mean value of 5.54 table-2. Seasonal observations revealed that, values of nitrate were maximum during monsoon and minimum during summer season figure-15. Similar results have been reported by Pathak and Mankodi²⁵ and Rajashekhar *et al.*³⁸.

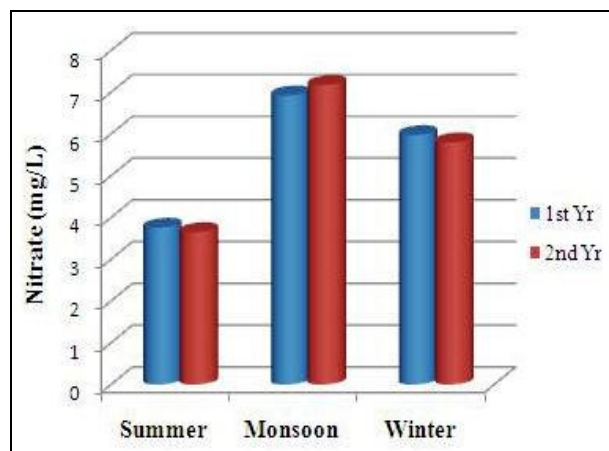


Figure-15

Average seasonal variations in NO_3^- of Rudrasagar Wetland during the two year study period

Conclusion

The study shows that the water of Rudrasagar wetland exhibits high concentration of TSS, TDS, nitrate, phosphate etc. High phosphate and nitrate value indicates that the wetland is moderately eutrophicated. Fluctuations in various physico-chemical parameters were observed during summer, monsoon and winter seasons. The correlation coefficient indicates positive and negative correlation of physico-chemical parameters with each other. This study may be helpful in optimum utilization and sustainable management of the wetland. Desiltation of the Rudrasagar wetland is suggested. Dewatering should be practiced at regular intervals to control the nutrients level and silt deposition.

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