International Research Journal of Environment Sciences ISSN 2319–1414
Vol. **3(5),** 1-7, May **(2014)** *Int. Res. J. Environment Sci.*

Statistical significance for Nutrient characteristics of Water around the Mangrove forests in Manakudy Estuary, Southwest coast of India

Sugirtha P. Kumar and M.S. Sheela
Department of Chemistry and Research center, Women's Christian College, Nagercoil 629 001, Tamilnadu, INDIA

Available online at: www.isca.in, www.isca.me
Received 10th January 2014, revised 31st March 2014, accepted 29th April 2014

Abstract

Present study focussed on the water quality status and nutrient characteristics in relation to various anthropogenic activities in Manakudy estuary. Measurements of temperature (Ambient, surface, and bottom) depth, calcium, magnesium, sodium, potassium, lithium, and inorganic nutrients (nitrate, nitrite, phosphate, phosphorous and nitrogen) were carried out in surface and bottom waters at six stations on the Manakudy estuary during January 2013 to June 2013. High temperature was observed in June comparing other month. The average depth was increased from 1.10 m to 1.29 m due to extensive sand mining. Ca, Mg, Na, K, and Li were significantly correlated between stations. Nitrogen was positively correlated with nitrite and phosphate nutrient. Nutrient ratio, N:P and Nitratre:Phosphate ratio were low in all station this indicate potential nitrogen limitation.

Keywords: Estuary, nutrients, mangroves.

Introduction

Estuaries and coastal areas are complex and dynamic aquatic environment[1]. When river water mixes with sea water, a large number of physical and chemical process take place, which may influence of water quality. The quality of surface water is a very sensitive issue. The natural processes, such as precipitation inputs, erosion, weathering of crustal materials, as well as the anthropogenic influences viz, urban, industrial and agricultural activities, calling for increasing exploitation of resources, together determine the quality of surface water in a region. Rivers play a major role in assimilation or carrying off of municipal and industrial waste water and run-off from agricultural land, the former constitutes the constant polluting source whereas the later is a seasonal phenomenon. To establish the spatial and temporal variations in water quality, regular monitoring programs are required.

Owing to the present position of sea-level, most rivers empty into estuaries or marginal seas rather than directly into the coastal ocean [2] . Furthermore, major urban centers are often located on estuaries. As a result, estuaries receive some of the highest inputs of nutrients (N and P) on an area basis of any class of ecosystems[3]. Understanding the behaviour of nutrients in estuaries has important implications for global nutrient budgets[4,5] and for controlling eutrophication of these systems[6].

Perhaps one of the most pivotal questions concerning nutrients in estuaries is the degree to which estuaries behave as traps, retaining and recycling nutrients within the system[7,8]. Related to this issue are the relative contributions of external nutrient supply and internal nutrient recycling to observed concentrations with in the estuary[9,10,11]. Estuaries receive substantial amount of nutrients as well as anthropogenic wastes from land and transferred towards inshore seas; estuaries also receive nutrients and organic matter from[12,13].

Hydrogen sulphide is a major pollutant of the water bodies; the blackening sediment in the polluted area was due to the local chemical reaction where sulphates get converted to sulphides[14]. Water quality is the physical , chemical and biological characteristics of water[15]. Environmental water quality, also called ambient water quality, relates to water bodies such as lakes, rivers and oceans. Water quality standards vary significantly due to different environmental conditions, ecosystems and intended human uses. Sediments are indicates of quality of overlying water and its study is a useful tool in the assessment of environmental pollution[16]. Environmental scientists focus on achieving goals for maintaining healthy ecosystems and may concentrate of the protection of population of endangered species and protecting human health. The increase of nitrate in water bodies such as river, lakes, estuaries and the coastal zone, can lead to eutrophication, meaning excess of nutrients followed by algal blooms, oxygen depletion and fish deaths. The monitoring of nitrites and nitrate in estuarine waters is an effective way to trace possible contamination sources. But estuarine waters are rather complex matrices as they change significantly with the proximity or distance from the sea end, both in terms of concentration values for many analytes and physico-chemical properties such as temperature, pH and conductivity.

Description of study area: Manakudy estuary which has an area of about 150 ha is situated about 8 kilometers northwest of cape comorin in Kanyakumari District. It is the confluence of river pazhayar, which has its origin from the western ghats. The

Manakudy estuary is abound with varied habitats that include shallow open waters, sandy beaches, muddy flats, mangrove forest, river delta and sea grass. Mangroves are a significant ecosystem in the estuary with a luxuriant growth on the mud flats. The litter on the mangrove floor undergo humification and mineralisation and the nutrients are leached into the estuarine water due to surface run-off adding to the productivity of the estuary. To study the flux of nutrients six stations were selected around the mangrove forest.

Material and Methods

Sample collection: Physico-chemical features of the monthly samples of Manakudy estuary were recorded from January 2013 to June 2013 in the six stations. Surface water samples were collected in plastic containers and bottom samples were collected using a Meyer's Water Sampler.

Analytical Techniques: About 5 litre of water samples was collected from the six stations and brought to the research laboratory. Analysis of calcium and magnesium were done titrimetrically as described by Shapiro and Brannock (1956)[17]. Sodium, potassium and Lithium were determined flame photometrically (model systronic 128). Phosphorous, nitrate, and nitrite, were determined colorimetric method.

Results and Discussion

Estuarine wetlands are known to contribute to the maintenance of water quality. Because wetlands have a high rate of biological activity, they are effective in transforming many of the common pollutants found in coastal and estuarine waters into harmless by-products or essential nutrients which can be utilized for additional biological activity. Table 1 showed the mean and standard deviation of temperature, depth and extinction coefficient. The high ambient temperature (36.66^{0}C) was observed on march and low in may (28.91^{0}C). The average value of high surface temperature was observed in June (34.83^{0}C) and low in January (27.75^{0}C). The average value of high bottom temperature was observed on June (34.50^{0}C) and low in January (27.50^{0}C). The average depth was increased from 1.10 m to 1.29 m due to extensive sand mining. The average extinction coefficient value varied from 3.05-5.17.

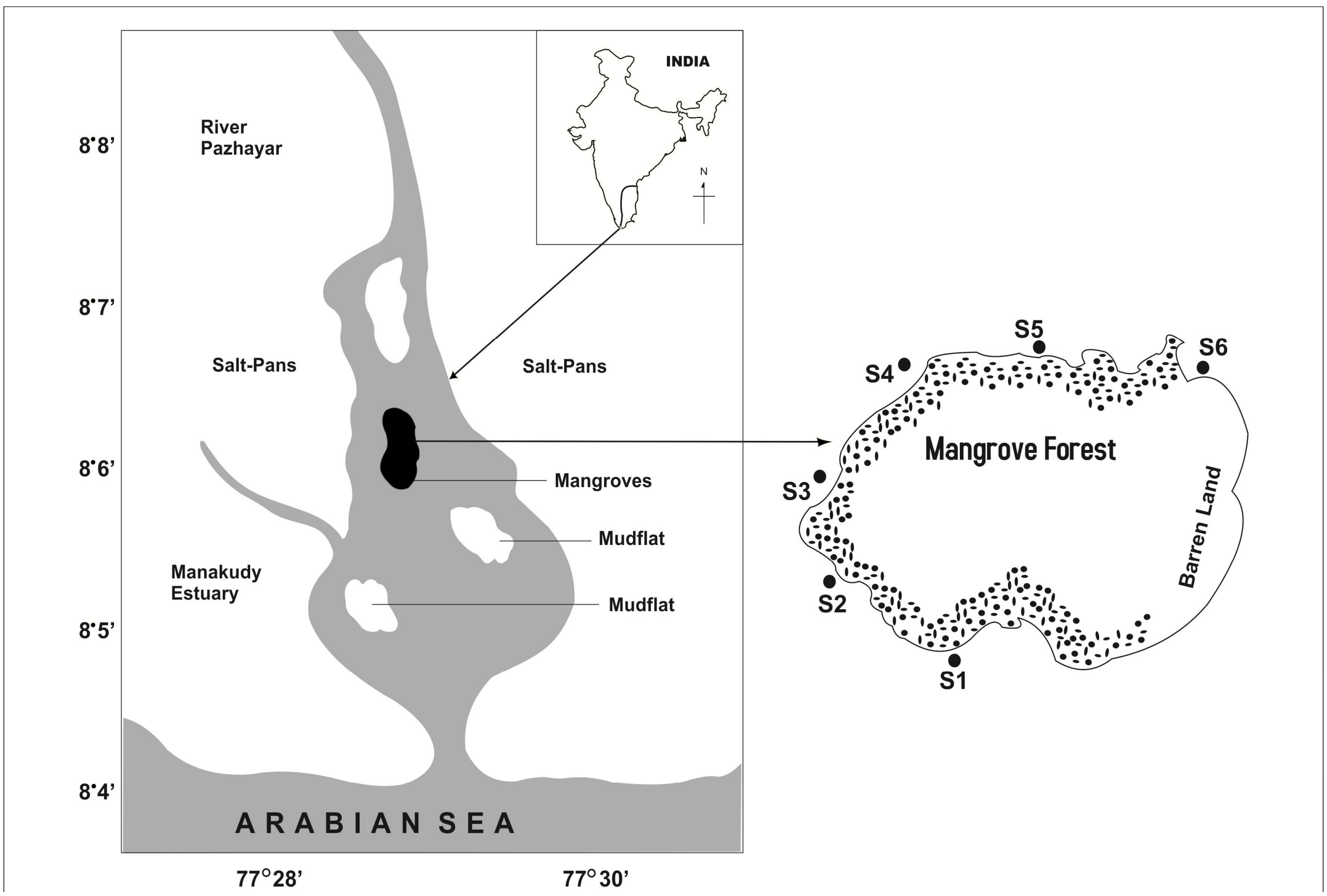

Figure-1
Location of the study area

The variation of parameters of surface and bottom waters between stations were shown in figure 1 and 2. In surface water calcium was high in station 3 (283.3 mg/l) but in bottom was calcium was high in station 6 (256.6mg/l). In surface water Magnesium was high in station 4 (631.8 mg/l) but in bottom water it was high in station 2 (625.6 mg/l). In surface and bottom waters sodium was high in station 6 (14366mg/l, 14500mg/l respectively). In surface water potassium was high in station 6 (4383mg/l) but in bottom water it was high in station 5 (4016mg/l). In surface water Lithium was high in station 1(0.617mg/l) but in bottom water it was high in station 3 (0.450mg/l).

Table 1
Mean and standard deviation of temperature, depth and extinction coefficient

Months	Temperature (^{0} C)			Depth (m)	Extinction coefficient (k)
	Ambient	Surface	Bottom		
January	29.25 ± 1.78	27.75 ± 0.52	27.50 ± 0.55	1.27 ± 0.23	3.05 ± 0.85
February	34.33 ± 1.40	31.33 ± 0.40	30.91 ± 0.49	1.18 ± 0.21	3.25 ± 0.72
March	36.66 ± 3.15	31.50 ± 0.94	31.33 ± 1.03	1.10 ± 0.17	5.17 ± 1.41
April	33.08 ± 1.02	31.25 ± 0.41	31.16 ± 0.51	1.16 ± 0.16	3.13 ± 0.79
May	28.91 ± 1.06	28.33 ± 1.16	28.25 ± 0.98	1.12 ± 0.16	3.67 ± 1.38
June	35.75 ± 1.47	34.83 ± 1.63	34.50 ± 1.87	1.29 ± 0.08	3.48 ± 0.71

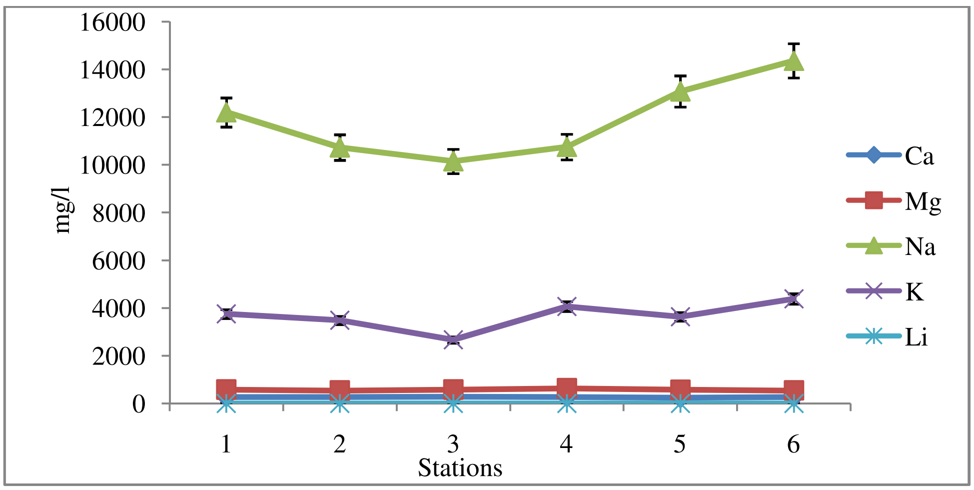

Figure- 2
Variation of parameters in stations (surface water)

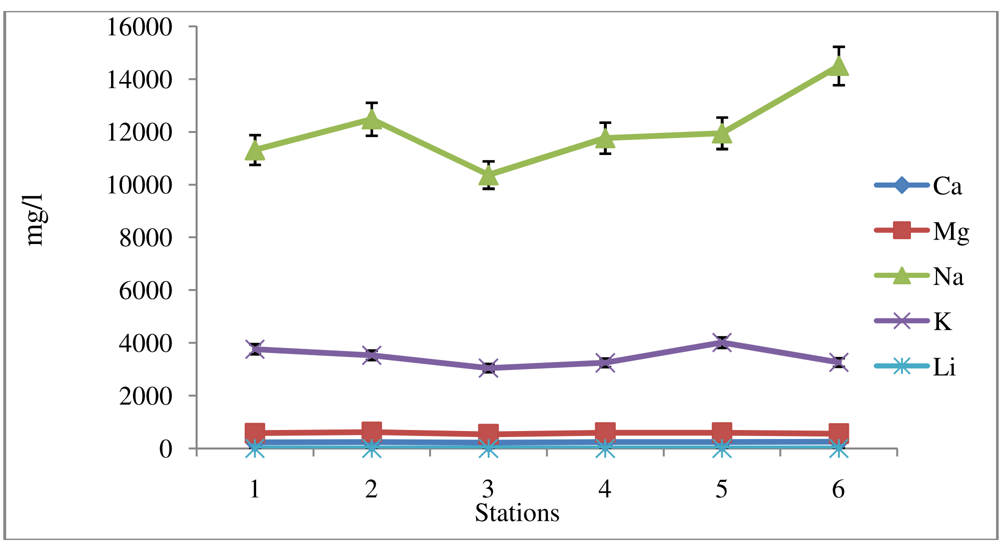

Figure- 3
Variation of parameters in stations (bottom water)

The various parameters of surface and bottom waters in the six stations were subjected to two way ANOVA and it was found that they are significantly correlated and shown in table 2 and 3.

Statistical nutrient significance: Paired sample test between month and stations in surface and bottom waters were showed in table 4 and 5. Between month and station nitrogen was significant ($p<0.05$).

Table-2
Two way ANOVA of parameters between stations in surface water

Source of Variation	SS	df	MS	F	P-value	F crit	Remarks
Stations	4236170	5	847234	1.568598	0.214314	2.71089	NS
Parameters	6.08E+08	4	1.52E+08	281.3304	2.85E-17	2.866081	*
Error	10802436	20	540121.8				
Total	6.23E+08	29					

*Significant at 5% level

Table -3
Two way ANOVA of parameters between stations in bottom water

Source of Variation	SS	df	MS	F	P-value	F crit	Remarks
Stations	2122783	5	424556.6	1.03644	0.423532	2.71089	NS
Parameters	6.27E+08	4	1.57E+08	382.3954	1.39E-18	2.866081	*
Error	8192597	20	409629.9				
Total	6.37E+08	29					

*Significant at 5% Level

Table -4
Paired Samples Test between months

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Nitrate surface - Nitrate bottom	-1.08	1.65	0.67	-2.81	0.65	-1.5	5	0.171
Pair 2	Nitrogen surface - Nitrogen bottom	-0.57	0.24	0.10	-0.83	-0.31	-5.67	5	0.002
Pair 3	Nitrite surface - Nitrite bottom	-0.10	0.41	0.17	-0.54	0.34	-0.58	5	0.585
Pair 4	Phosphate surface - Phosphate bottom	-0.00	0.07	0.02	-0.07	0.07	-0.11	5	0.912
Pair 5	Phosphorous surface - Phosphorous bottom	-0.02	0.16	0.06	-0.19	0.14	-0.36	5	0.729

Table -5
Paired Samples Test between stations

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Nitrate surface - Nitrate bottom	-0.92	2.88	1.17	-3.95	2.10	-0.78	5	0.467
Pair 2	Nitrogen surface - Nitrogen bottom	-0.58	0.31	0.12	-0.91	-0.25	-4.61	5	0.006
Pair 3	Nitrite surface - Nitrite bottom	0.01	0.39	0.16	-0.39	0.42	0.10	5	0.921
Pair 4	Phosphate surface - Phosphate bottom	-0.00	0.03	0.01	-0.04	0.03	-0.22	5	0.833
Pair 5	Phosphorous surface - Phosphorous bottom	-0.01	0.04	0.01	-0.06	0.03	-0.92	5	0.396

In estuarine ecosystems, the major source of nutrients are from rivers, ground water, atmosphere, and sediments[18]. The nutrient load from river influx was extreme depending on the allchthonous and allchthonous precipitations in the basins. Rapid nutrent inputs are of considerable importance since they can modify the phytoplankton community structure[19]. Estuaries receive nutrients from rain water[20]. Nutrients and other suspended solids brought into the estuary those results in decreased light penetration and high flushing time lead to subsequent decrease in primary production. Pearson correlation of nutrients in surface and bottom water between month and station were shown in table 6 and 7. Between stations nitrogen surface and nitrogen bottom was positively correlated at 0.05 level. Nitrogen bottom was positively correlated with nitrite surface at 0.05 level. Phosphate surface was positively correlated with phosphorous surface and bottom at 0.05 level. Between month nitrite surface was positively correlated with nitrogen surface and bottom at 0.01 level and with phosphate surface at 0.05 level. Nitrogen surface was positively correlated with nitrogen bottom at 0.01 level and with phosphate surface at 0.05 level. Nitrogen bottom was positively correlated with phosphate surface and bottom at 0.05 level. Phosphate surface was positively correlated with phosphate bottom at 0.01 level.

Nutrient ratios: N: P ratio and Nitrate: Phosphate ratio of surface and bottom water between stations and month were shown in table 8 and 9. In stations all the N:P ratio was below in Redfeild ratio . The low N:P ratio indicated potential nitrogen limitation of phytoplankton production. This might affect the biological state of the ecosystem, in particular the phytoplankton biomass, species composition and eventually food web dynamics. All the nitrate: phosphate ratio was below in Buddy ratio. Between stations N:P ratio was high in station 6 both surface (9.2:1) and bottom (10.2:1) water and Nitrate:Phosphate ratio was high in S6 (5.4:1) in surface water and in bottom water it was high in S3 (7.7:1). Between month N:P ratio was high in March on suface water (10.4:1) and April (10.3:1) on bottom water and Nitrate:Phosphate ratio was high in May (6.1:1) in surface water and April (7.6:1) in bottom water.

Table-6
Pearson correlation of nutrients in surface and bottom waters between stations (mg/l)

	1	2	3	4	5	6	7	8	9	10
1	1									
2	0.075	1								
3	0.762	-0.306	1							
4	0.746	0.019	0.913*	1						
5	0.573	0.264	0.676	0.850*	1					
6	-0.076	-0.356	-0.279	-0.346	-0.643	1				
7	0.166	-0.625	0.043	-0.325	-0.442	0.336	1			
8	-0.116	-0.503	-0.447	-0.402	0.060	-0.485	0.120	1		
9	-0.272	0.241	0.172	0.384	0.403	-0.478	-0.849*	-0.314	1	
10	-0.292	0.482	-0.234	0.080	0.000	0.130	-0.858*	-0.389	0.692	1

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

Table - 7
Pearson correlation of nutrients in surface and bottom waters between months (mg/l)

	1	2	3	4	5	6	7	8	9	10
1	1									
2	0.283	1								
3	0.999**	0.270	1							
4	0.927**	0.219	0.936**	1						
5	0.614	-0.030	0.608	0.779	1					
6	-0.619	0.213	-0.591	-0.459	-0.494	1				
7	0.842*	0.509	0.856*	0.912*	0.537	-0.194	1			
8	0.784	0.550	0.794	0.857*	0.508	-0.225	0.976**	1		
9	0.255	-0.737	0.289	0.398	0.358	-0.193	0.164	0.056	1	
10	0.257	-0.559	0.238	0.307	0.729	-0.697	-0.091	-0.112	0.444	1

*Correlation is significant at the 0.05 level (2-tailed), **Correlation is significant at the 0.01 level (2-tailed), 1-Nitrate surface, 2-Nitrate bottom, 3-Nitrogen surface, 4-Nitrogen bottom, 5-Nitrite surface, 6-Nitrite bottom, 7-Phosphate surface, 8-Phosphate bottom, 9-Phosphorous surface, 10-Phosphorous bottom.

Table - 8
N: P ratio and Nitrate: Phosphate ratio of surface and bottom water between stations

Stations	**Nitrogen/Phosphorous**		**Nitrate/Phosphate**	
	Surface	**Bottom**	**Surface**	**Bottom**
S1	7.4:1	8.2:1	4.6:1	5.7:1
S2	5.7:1	6.1:1	1.6:1	2.6:1
S3	5.6:1	9.1:1	3.3:1	7.7:1
S4	6.1:1	8.2:1	3.4:1	5.6:1
S5	8.1:1	11.6:1	4.5:1	2.6:1
S6	9.2:1	10.2:1	5.4:1	4.2:1

Table- 9
N: P ratio and Nitrate: Phosphate ratio of surface and bottom water between months

Stations	**Nitrogen/Phosphorous**		**Nitrate/Phosphate**	
	Surface	**Bottom**	**Surface**	**Bottom**
January	5.7:1	7.08:1	4.6:1	5.6:1
February	7.6:1	8.1:1	5.8:1	7.4:1
March	10.4:1	9.5:1	5.3:1	7.04:1
April	9.4:1	10.3:1	4.6:1	7.6:1
May	6.3:1	5.1:1	6.1:1	5.3:1
June	5.2:1	9.02:1	5.3:1	5.08:1

Conclusion

The various parameters of surface and bottom waters in the six stations were subjected to two way ANOVA and it was found that they are significantly correlated. Between month and station, nitrogen was significant ($p<0.05$). Nitrogen was positively correlated with nitrite and phosphate. In stations, all the N:P ratio was below in Redfeild ratio . The low N:P ratio indicated potential nitrogen limitation of phytoplankton production. All the nitrate: phosphate ratio was below in Buddy ratio.

Acknowledgement

The first author (SPK) is thankful to UGC for financial support through major research project. The authors thank the authorities of Women's Christian College for necessary facilities.

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