RESEARCH PAPER | Engineering | Volume : 3 | Issue : 7 | July 2013 | ISSN - 2249-555X

Water Quality Analysis of Bhavanapadu (Mangrove) swamps Ecosystem, East coast of India

KEYWORDS: Halophytes, Heavy metals, Chlorophyll, phytoplankton, Coastal Area

Dr. G. V. Krishna Mohan
Department of Engineering Chemistry, KL Univeristy, Guntur-522 502, Andhra Pradesh, India

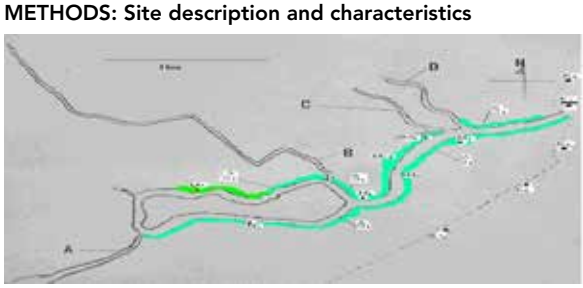
Dr. D. Gopala Krishna
Department of Engineering Chemistry, KL Univeristy, Guntur-522 502, Andhra Pradesh, India

ABSTRACT *Chemical and Biological parameters were analyzed at 17 stations in the mangrove ecosystem of the neighbouring Bhavanapadu estuary and bay to understand the present status of water quality and the impact of external terrigenous inputs during southwest monsoon in the study areas. High concentrations of Nutrients in the mangrove ecosystem compared to the bay and estuarine ecosystems revealed the importance of this zone as a source of Nutrients to the adjacent coastal ecosystems. Low SiO4 (9.26 µM), NO3 (6.49 µM) and PO4 (0.92 µM) values in these ecosystems are due to the enrichment of these Nutrients through external anthropogenic inputs even after the utilization by phytoplankton in the biological cycle. The mean Chl b=Chl a and Chl c=Chl a ratios 0.30 and 0.45 and high phaeopigments concentrations compared to Chl b and high ratios of Chl a=Pp suggests the possibility of the potential growth of phytoplankton populations in lower light intensity and low turbulent areas of these mangrove ecosystems.*

INTRODUCTION:

Mangrove forests are considered to be highly productive tropical ecosystems (Asma *et al* 2012). These areas are ecologically sensitive and provide physical protection for the community more importantly they are believed to play a major role in supporting tropical estuarine and coastal food webs (Kathiresan and Bingham 2001). It is a fact that the mangrove forests represent an important Carbon and Nutrient source to the adjacent lagoonal and coastal systems (Das et *al* 2009). However, it is noticed that the increasing pressure on mangrove forests due to urbanization, industrialization and intensive aquaculture poses a menace to this ecosystem.

METHODS: Site description and characteristics



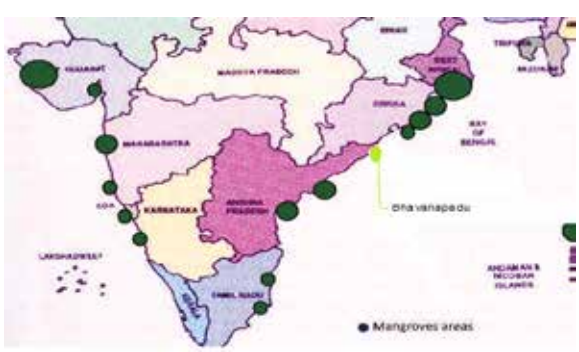


Figure 1. Study area of Bhavanapadu mangrove wetland, India and site of water source collection

K_1 to K_5 = to Bay region; G1 to G_5 = Estuary region; M1 to M_7 = Mangrove region

Comprises of seventeen stations covering the bay (station K_1-K_5), Estuary (station G_1-G_5) and the Mangrove region (station M_1-M_7). Geographically Bhavanapadu (18^0 32′ N and 84^0 17′ E) is a Panchayat village of Santhabommali Mandal of Srikakulam district, Andhra Pradesh. The samples were collected from surface and near bottom of the stations with the help of Niskin water samplers over a period of three successive days at all the 17 stations in the mangrove environment (Figure.1). The depth of the water column in the study area varied from 2-3 m. Salinity, DO, BOD, pH, Nitrate-Nitrogen (NO_3-N), Nitrite-Nitrogen (NO_2-N), Ammonia-Nitrogen (NH_4-N), Silicate-Silicon (SiO_4-Si), Phosphate-Phosphorous (PO_4-P), Total nitrogen and Total phosphorus were determined. Chlorophyll *a* (Chl *a*), Chl *b*, Chl *c* and phaeopigments were extracted in 90% acetone and measured Spectrophotometrically.

RESULTS AND DISCUSSION:

Salinity showed highest values (31.4 dS/m) at K_5 nearer to the coastal environment associated with low SiO_4 (9.26 *µM)* and PO_4 (0.92 *µM)* concentrations. Lowest value of salinity (0.27 dS/m) was noticed in Bhavanapadu mangrove environment (M_5-M_7), accompanying high SiO_4 (139.0 *µM)* concentration due to the freshwater zone of this aquatic environment. Low DO (1.39mg 1^{-1}) values in station M_6-M_7 may be due to the stagnant and non using conditions of the water with increasing waste load in the mangrove environment. This in turn enhances the concentrations of ammonia (14.2 *µM)* and nitrite (6.49 *µM)* at these (M_6-M_7) stations. High NO_3 (21.4 *µM)* and SiO_4 (142.0 *µM)* concentration observed in the estuarine station (G_4) indicated the impact of terrestrial runoff. (Table1.)

Table.1. Mean values (±SD) of water parameters in the three regions in Bhavanapadu Estuarine Mangrove area.

Parameters	Bay region	Estuary region	Mangrove region
NO_2-N (µM)	1.33±0.56 (0.50 - 2.24)	1.23±0.39 (0.68 -1.72)	3.41±1.6 (1.21-6.49)
NO_3-N (µM)	6.03±3.55 (0.86 - 12.5)	17.18±2.64 (13.9-21.4)	11.15±2.42 (7.47 - 16.2)
NH_4-N (µM)	1.51±0:60 (0.82 -2.49)	1.13±0.54 (0.33 - 2.25)	4.83±3.4 (0.79 - 14.2)
PO_4-P(µM)	2.54±1.68 (0.92- 6.9)	3.05±1.09 (1.76- 4.53)	3.17±0.99 (1.89-5.85)

Volume : 3 | Issue : 7 | July 2013 | ISSN - 2249-555X

SiO_4-Si (µM)	33.93±17.37 (9.26 - 57.7)	90.38±35:39 (42.5-142.0)	102.35±25:73 (68.6 -139.0)
TN (µM)	59.95±40.79 (13.7 - 120.0)	26.44±8.65 (15.8-42.6)	43.02±45:94 (21.3 -196.0)
TP (µM)	7.46±3.85 (2.01 - 15.5)	8.4±3:99 (3.69 -16.2)	10.52±5.01 (2.46 - 21.7)
pH	7.55±0.28.7 (7.10- 7.93)	52±0.22.7 (7.2 - 7.8)	42±0.13 (7.19 - 7.58)
Salinity (PSU)	21.06±6.76 (11.9- 31.4)	3.87±3.9 3 (0.27- 9.65)	29±3.88 (0.27 - 9.48)
DO ($mg1^{l-1}$)	7.03±0.93 (5.85-8.65)	5.87±0.33 (5.49 - 6.38)	2.88±1.55 (1.39 -5.45)
BOD (mg 1^{-1})	4.88±1.13 (2.88 - 5.85)	2.32±0.5 (1.52 - 2.8)	4.79±0.74 (3.68-6.12)
Chl a ($mg1^{-1}$)	12.49±9.55 (0.68 - 25.9)	5.23±4.84 (0.86 - 15.9)	(2.36 - 16.2) 5.42±4.74
Chl b (mg 1^{-1})	1.1±1.21 (0.04 - 4.08)	0.61±0.85 (ND- 2.41)	1.48±1.44 (ND - 4.53)
Chl c ($mg1^{-1}$)	1.83±2.03 (0.15-7.17)	0.87±0.94 (ND - 2.6)	(0.05-12.9) 2.88±3.14
Pp ($mg1^{-1}$)	7.92±7.22 (0.44 -21.1)	2.2±2.28 (ND -7.05)	3.16±1.72 (0.88- 6.25)

Value in the parenthesis show range value; +/- denotes increase or decrease, Values are mean ± SE

The waters in bay and Bhavanapadu estuarine environment were found well oxygenated with the DO value ranging from 5.98 to 8.65 and 5.49 and 6.38mg l^{-1} respectively. However, in the mangrove environment oxygen concentrations varied between 1.39 and 5.45mg l^{-1}. Low DO values (1.39-2.26mg l^{-1}) were observed especially in Bhavanapadu mangrove areas. However, the stations in Mangrove region (M_1-M_2) river mangrove systems experience high oxygen conditions (mean 5.45mg l^{-1}) since the river opens on one side into bay and the other side into the Bay of Bengal at Meghavaram. High values of BOD (2.88-5.85mg l^{-1}) in the bay indicate the influence of domestic and agricultural wastes carried through the Bhavanapadu passing through the Tekkali Township adjoining the bay.

High BOD with low DO values in Bhavanapadu (M_3-M_7) mangrove systems may be due to contamination, either by the inflow of wastes from terrestrial runoff or of anthropogenic in origin, and is a cause of concern. In general, high concentrations of nutrients were noticed in the mangrove environment compared to bay and Bhavanapadu estuarine system (Table 1). The average concentrations of NO_2; NH_4; PO_4, and SiO_4 were in the increasing order from bay, Bhavanapadu estuary and mangrove environment. More or less similar same concentrations of NO_3 have been noticed both in the Bhavanapadu estuary and in the mangrove environment. From the values of total nitrogen and inorganic nitrogen (NO_2, NO_3 and NH_4) in the study area, the percentage of organic nitrogen was estimated.

The percentage composition of inorganic nitrogen in the Bhavanapadu estuarine was 73.93% of the total nitrogen whereas it was 45.06% in the mangrove environment which, clearly indicated that the mangrove ecosystems are better enriched with organic nitrogen (54.94%) compounds compared to the estuarine environment (26.07%). The percentage of inorganic phosphorous (33%) of the total phosphorous was more or less similar in all the three regions. In the present study, the ecosystem was found to be nutrient rich, and the ratios of N: P (4: 1) as well as TN: TP (3: 1) were low. Linear regression analyses were carried out to find out the relationships between salinity, DO and nutrients; and among the nutrients themselves (Table 2).

Table 2. Regression analysis (R^2) values among different parameters of Bhavanapadu Mangrove area.

Parameters	R^2 values (n = 32)
Salinity vs. nitrite	0.28 ls
Salinity vs. DO	0.49 ls
Salinity vs. ammonium	0.22 ls
Salinity vs. nitrate	0.32 ls
Salinity vs. phosphate	0.18 ls
Salinity vs. silicate	0.66 ls
Nitrate vs. phosphate	0.0004 ns
Nitrate vs. silicate	0.19 ls

ls = less significant, ns = no significant

Significant positive correlations with high R^2 values especially for salinity *vs.* SiO4 (R^2 = 0.66) and DO (R^2 = 0.49) indicate the influence of freshwater discharge in these ecosystems. Less significant correlations were noticed in case of salinity *vs.* PO_4 (R^2 = 0.18) and NO_3 (R^2 = 0.32) and among the nutrients themselves (NO_3=PO_4: R^2 = 0.0004; NO_3=SiO_4: R^2 = 0.19). This lack of significant correlations indicated the influx of anthropogenic inputs and waste discharges containing nitrogen and phosphorous compounds from river runoff into these environments. Further, from this analysis, the Si :N:P ratios for the bay (18 : 4 : 1), Bhavana Padu estuarine region (32 : 6 : 1) and mangrove environment (34 : 4 : 1) were obtained and the average Si :N:P ratio in the entire study area was found to be 29 : 4 : 1 which is comparatively lower than the normal Redfield ratios, and could be attributed to enrichment of these nutrients (NO_3 and PO_4 compared to SiO_4) through external inputs.

The low N: P ratio in these aquatic environments may be due to the slow regeneration of NO_3 compared to PO_4. Chlorophyll is considered as the most reliable index of phytoplankton biomass. Also, Chl *a:* phaeopigments ratio provides the first hand information on the physiological status of phytoplankton. Hence, these pigments were studied simultaneously along with the phytoplankton composition and density. The high concentrations of Chl *a* observed in all the three regions may be due to the monsoonal runoff where in high concentrations of nutrients are brought into these environments stimulating a rich phytoplankton growth (Kathiresan, K. 2009).

Average values of Chl *a* and phaeopigments (12.49 and 7:92 µg 1^{-1}) were higher in bay compared to Bhavanapadu estuarine regions (5.23 and 2:2 µg 1^{-1}) and mangrove environment (5.42 and 3:16 µg 1^{-1}). Low phaeopigments values in Bhavanapadu estuary and mangrove regions compared to bay, indicated less degradation of Chl *a* in these two regions. Higher fractions (mean) of phaeopigments (3:16 µg 1^{-1}) compared to Chl *a* (5:42 µg 1^{-1}) in the Bhavanapadu region indicate the presence of more detrital matter in these nonturbulent conditions which could be attributed to decomposition of organic matter, from the sediment and community structure, harbouring in the surrounding water. The mean values of Chl *b*=Chl *a* and Chl *c*=Chl *a* ratios were 0.30 and 0.45, and agrees fairly well with the earlier reported results from other marine environments (Kathiresan, K. 2011), suggesting the possibility of potential growth of phytoplankton biomass in lower light intensity and low turbulent areas. The mean concentrations of Chl *b* were 1.1, 0.61 and 1:48 µg 1^{-1} in bay, Bhavanapadu estuary region and mangrove area, respectively. The presence of Chl *b* in the estuarine mangrove systems suggested that green algae also contributed significantly to primary production. Higher phaeopigments concentrations (7.92, 2.2, 3:16 µg 1^{-1}) compared to Chl *b* (1.1, 0.61, 1:48 µg 1^{-1}) and high ratios of Chl *a*= phaeopigments (2.0, 2.21, 2:45 µg 1^{-1}) in the three regions indicated the growth of phytoplankton in the low light intensity and low turbulent waters of mangrove ecosystems.

Volume : 3 | Issue : 7 | July 2013 | ISSN - 2249-555X

CONCLUSION:

The present water quality of Bhavanapadu mangrove ecosystem reveals that salinity plays a dominant role in controlling the water chemistry. In addition; intense pollution from both agricultural inputs and industrial pollution deteriorate the water quality of mangrove ecosystem.

ACKNOWLEDGEMENTS:

This work was carried out with financial assistance provided by (MOEF) New Delhi (Project No.22/26/2004–CSC (M) dt 24-2-2005). Facilities at the Department of Environmental Sciences, Andhra University and local village peoples of Bhavanapadu, Srikakulam (District) were utilized and we are grateful to the authorities' concerned.

REFERENCE

1. Das S, Vincent JR: Mangroves protected villages and reduce death toll during Indian super cyclone.Proc Nat Acad Sci. 106 (2009) 7357–7360. | 2. Kathiresan K. and B.L. Bingham: Biology of Mangroves and Mangrove Ecosystems. Advances in Marine Biology. 40 (2001) 81-251. | 3. Kathiresan, K: Mangrove Ecosystems. Distribution of Mangroves. In: Kathiresan, K. and Ajmal Khan, S. (Ed.) "International Training Course on Coastal Biodiversity in Mangrove Ecosystems", Annamalai University, Parangipettai, India (2009). | 4. Kathiresan: Mangrove Ecosystems. Available: http://ocw.unu.edu/international-network-on-water-environment-and-health/unu-inweh-course-1-mangroves/Distribution-of-mangroves.pdf, (2011). | 5. Wan Izatul Asma Wan Talaat, Norhayati Mohd Tahir, Mohd Lokman Husa: "The Existing Legislative, Administrative and Policy Framework for the Mangrove Biodiversity Management & Conservation in Malaysia" Journal of Politics and Law Vol. 5, No. 1 (2012) 180–188 ; ISSN 1913-9047 E-ISSN 1913-9055. |