



Short Communication

Assessment of seasonal changes in water quality adjoining Thekkumbad mangrove – sacred grove ecosystem of Kannur district, Kerala, India

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Abstract

Thekkumbad Island, falling in Mattool panchayat of Kannur district, is characterized by the presence of a sacred grove - Thazhekkavu, rich in mangrove populations. This sacred grove is characterized by the presence of 11 true mangroves and 6 mangrove associates. The Valapattanam estuary provides tidal waters to these mangrove habitats. The present study attempts to assess the seasonal changes in water quality influencing the growth and establishment of mangrove diversity confining to this sacred grove. Water quality parameters adjoining the mangrove habitats were monitored on a monthly basis for assessing the seasonal changes. The results indicated that there is marked difference in water quality parameters in all the three seasons studied. Variations in salinity related parameters like hardness, calcium, magnesium, sodium and chloride were higher than that of other water quality parameters, which are indicative of the differences in salinity intrusion in these habitats, with respect to seasons. Water quality parameters of Site 1 was found to be highly influenced, which is indicative of their close proximity with the estuarine system.

Keywords: Mangrove habitats, Thekkumbad, Water quality, Salinity.

Introduction

Thekkumbad is a picturesque Island in Valapattanam River, situated at Mattool panchayath of Kannur district. Kannur district occupies the highest extent of mangroves in Kerala¹ and also showed a fivefold increase in the percentage data on comparing the previous reports based on mangrove afforestation². Thekkumbad is characterized by the presence of a biodiversity rich coastal sacred grove namely 'Thazhekkavu'. The Thekkumbad Thazhekkavu is bordered by Valapattanam River in the south, Pazhayangadi River in the east and backwater of the Arabian Sea in the west. Total area of Thekkumbad Thazhekkavu is 7.50 ha. and the area with vegetation is 6.50 ha.³. The Thekkumbad Island is supported by strong fences of mangroves that protect the Island from natural disasters. The total mangrove area is approximately 2788 m². The area composed eleven true mangrove species and six associates. This includes *Acanthus ilicifolius*, *Acrostichum aureum*, *Aegiceras corniculatum*, *Avicennia officinalis*, *Avicennia marina*, *Excoecaria agallocha*, *Kandelia candel*, *Rhizophora mucronata*, *Rhizophora apiculata*, *Sonneratia alba*, *Bruguiera cylindrica*, *Calamus rotang*, *Mimusops elengi*, *Pandanus tectorius*, *Clerodendron inerme*, *Cinnamomum zeylanicum* etc... The Valapattanam estuary provides tidal waters to these mangrove habitats. There are mainly two distinct pattern of arrangement noticed in this region, that is the seaward side is dominated by a long stretch of *Rhizophora mucronata* species while the opposite sides are characterized by mixed vegetation representing *Aegiceras corniculatum*, *Avicennia*

marina, *Avicennia officinalis*, *Bruguiera cylindrica*, *Excoecaria agallocha*, *Kandelia candel*, *Rhizophora apiculata* and some associates⁴. This mangrove association plays an important role in the purification of water present in the nearby wells.

The water quality, comprising the environmental master factors such as temperature, salinity, oxygen, besides organic matter, nutrients and trace metals, forms the basis for the mangrove ecosystems. The interactive physical, chemical and biological processes operating in this ecosystem sustain higher levels of productivity, as reflected in a wide spectrum of flora and fauna, leading to richness in biodiversity. The mangrove ecosystems are so specialized that any minor variation in their hydrological or tidal regimes causes noticeable damages, as observed in recent studies at several locations like Guiana, Gambia, Kenya, India, Bangladesh etc...

Even though mangrove forests are highly productive, various eco physiological attributes influencing their sustenance are needed to be thoroughly assessed. Evaluation in this direction is having great importance as these ecosystems are highly sensitive and fragile.

The water quality thus forms the basis for the floral and faunal diversity of mangrove ecosystems⁵.

The present study attempts to assess the seasonal changes in water quality influencing the growth and establishment of mangrove species like *Avicennia officinalis* (Site 1), *Bruguiera cylindrica* (Site 2), *Excoecaria agallocha* (Site 3), *Rhizophora*

mucronata (Site 4) and *Sonneratia alba* (Site 5) confining to this sacred grove.

Materials and methods

Study area: The geographical position of the study area was N-11° 58 '2.5" and E -75° 17'46.6". Sampling locations within the study area are depicted in following Figure-1.

Sampling and analysis: Surface water samples were collected on a monthly basis from all the five locations of Thekkumbad

Thazhekkavu, for a period of one year from June 2013 to July 2014. The water samples were collected in previously washed plastic bottles, which were rinsed with the sample at the collection site. The collected samples were subjected to analysis of quality parameters like pH (Systronics, 6373), Turbidity (Digital Nephelometer, 341), Sodium (Flame Photometer, Systronics, 128) using standard analytical instruments. Parameters like Total Alkalinity, Total Acidity, Total Hardness (Calcium and Magnesium) and Chloride content were assessed following APHA⁶.



Figure-1: Sampling locations within the Thekkumbad- Thazhekkavu mangrove ecosystem.

Results and discussion

The average values and standard deviation of water quality parameters of the present study in the five sites of Thekkumbad

Thazhekkave have been enlisted below in the Table-1, 2 and 3 and the discussion on those related parameters are done subsequently for the selected site.

Table-1: Water quality parameters in Pre Monsoon Season.

Parameters	Site 1	Site 2	Site 3	Site 4	Site 5
pH	7.8 ± 0.28	7.5 ± 0.33	7.3 ± 0.27	7.7 ± 0.38	7.7 ± 0.6
Turbidity	3 ± 0.78	2.8 ± 1.63	3 ± 1.13	18.7 ± 14.5	7.4 ± 8.65
Acidity	44 ± 6.22	57.2 ± 6.22	50.6 ± 9.33	35.2 ± 11.64	50.6 ± 18.14
Alkalinity	215 ± 21.21	170 ± 0	195 ± 21.21	190 ± 78.10	220 ± 21.60
Hardness	7060 ± 0	6830 ± 1173.8	7560 ± 141.42	7360 ± 260	7475 ± 490
Calcium	492.6 ± 50.98	508.6 ± 5.66	580.7 ± 141.6	480.6 ± 21.19	480.6 ± 37.57
Magnesium	1419.4 ± 30.97	1353.7 ± 289.2	1487.6 ± 51.65	1499.8 ± 72.02	1527.8 ± 102.18
TS	42300 ± 141.42	45800 ± 3677	44700 ± 5939.7	39933.3 ± 702.38	43950 ± 3696.4
TDS	41600 ± 565.69	45700 ± 3818.38	41400 ± 21712.06	39266.7 ± 702.38	41800 ± 4982.64
TSS	700 ± 707.1	100 ± 141.4	3300 ± 4384.1	666.7 ± 1154.701	2150 ± 1914
Chloride	25134 ± 2610.63	24566 ± 12367.93	25702 ± 602.46	25063 ± 122.98	25489 ± 1996.4
Sodium	27.2 ± 3.54	28.9 ± 1.34	26.9 ± 1.414	24.9 ± 1.70	26.2 ± 1.22

Table-2: Water quality parameters in Monsoon Season.

Parameters	Site 1	Site 2	Site 3	Site 4	Site 5
pH	5.52 ± 1.57	6.42 ± 0.33	5.73 ± 0.94	4.99 ± 1.83	6.38 ± 0.59
Turbidity	12 ± 10.88	4.27 ± 0.58	3.7 ± 2.99	7.93 ± 6.44	5.9 ± 4.77
Acidity	29.33 ± 17.78	30.8 ± 13.2	22 ± 7.62	24.2 ± 12.25	25.67 ± 8.89
Alkalinity	113.33 ± 40.41	450 ± 531.13	110 ± 17.32	86.67 ± 41.63	106.67 ± 41.63
Hardness	42 ± 14.42	53.33 ± 20.43	50.67 ± 38.18	144 ± 109.12	102.67 ± 61.72
Calcium	10.96 ± 2.45	16.17 ± 9.23	6.94 ± 0.46	16.17 ± 6.49	11.76 ± 3.03
Magnesium	3.57 ± 2.98	3.18 ± 2.49	8.12 ± 9.11	25.26 ± 22.65	17.86 ± 14.21
TS	800 ± 721.11	1200 ± 916.52	333.33 ± 115.47	1266.67 ± 1171.89	1266.67 ± 416.33
TDS	400 ± 400	466.67 ± 461.88	200 ± 200	1066.67 ± 986.58	1133.33 ± 305.51
TSS	400 ± 346.41	733.33 ± 1101.51	133.33 ± 115.47	200 ± 200	133.33 ± 115.47
Chloride	293.47 ± 35.74	459.13 ± 207.89	379.53 ± 173.25	899.33 ± 171.78	762.07 ± 70.05
Sodium	6.2 ± 2.82	19.33 ± 10.30	6.07 ± 2.25	40.13 ± 9.84	34.27 ± 15.54

Table-3: Results of water quality parameters in Post- Monsoon Season.

Parameters	Site 1	Site 2	Site 3	Site 4	Site 5
pH	7.31 ± 0.46	7.08 ± 0.52	7.31 ± 0.89	7.72 ± 0.33	6.8 ± 0.37
Turbidity	10.7 ± 5.50	6.73 ± 4.85	8.5 ± 5.14	22.23 ± 10.54	26.5 ± 4.65
Acidity	33.73 ± 16.66	45.47 ± 11.07	40.33 ± 28.37	39.6 ± 8.8	57.2 ± 20.16
Alkalinity	160 ± 10	186.67 ± 11.55	158.33 ± 7.64	153.33 ± 37.86	176.67 ± 35.12
Hardness	2738.67 ± 3612.62	2056.67 ± 2740.37	2517.33 ± 3555.42	2410 ± 3233.99	2528 ± 3186.84
Calcium	320.64 ± 157.7	275.48 ± 235.07	248.09 ± 214.42	273.88 ± 136.76	309.95 ± 144.59
Magnesium	472 ± 801.51	333.38 ± 546.27	462.17 ± 772.06	420.38 ± 711.26	427.2 ± 701.14
TS	38066.67 ± 10625.13	31066.67 ± 25787.85	28933.33 ± 23591.81	37933.33 ± 20151.76	31733.33 ± 10400.64
TDS	23600 ± 20318.46	29533.33 ± 24442.86	26466.67 ± 21712.06	33066.67 ± 15505.27	30466.67 ± 11036.91
TSS	14466.67 ± 23151.96	1533.33 ± 2318.05	2466.67 ± 3074.63	4866.67 ± 4957.15	1266.67 ± 702.38
Chloride	22057.33 ± 7485.82	16164.33 ± 12367.93	16543 ± 13201.42	17418.67 ± 7446.99	19714.33 ± 3931.59
Sodium	1147 ± 689.98	1027.33 ± 897.54	999.67 ± 813.55	1022.67 ± 541.63	1213.33 ± 366.92

pH: pH is an important factor in chemical and biological system of natural water, as the toxicity of many compounds is greatly affected with the change of hydrogen ion concentration. In this present investigation, all the selected sites of Thekkumbad Thazhekkave showed moderate variations in the average values of pH. It ranges from 7.3 to 7.8 in pre monsoon, 4.99 to 6.42 in the monsoon and 6.8 to 7.72 in the post monsoon season in the selected sites. From this it can be found out that the pH values are mostly alkaline in pre and post monsoon seasons than monsoon season.

Turbidity: The Turbidity of any water sample is the reduction of transparency due to the presence of particulate matter, finely divided organic matter, plankton, urban runoff etc⁷. In the present study, the higher turbidity was evident in the post monsoon season than that of other two seasons. The average value of turbidity ranges from 2.8 to 18.7 NTU in pre monsoon, 3.7 to 7.93 NTU in monsoon season while it is in the range of 6.73 to 26.5 NTU in the post monsoon season.

Acidity: Presence of free CO₂ may be due to dissolution from atmosphere, decomposition of organic matter and respiration of aquatic plant. Here the mean value of free CO₂ in pre monsoon ranges from 35.2 to 57.2 mg/l, monsoon season ranges from 22 to 30.8 mg/l, while in post monsoon season it is in the range of 33.73 to 57.2 mg/l. This imparts acidity to the water because of the formation of carbonic acid.

Total Alkalinity: Alkalinity is a measure of ability to neutralize acids. It was found in the range of 170 to 220 mg/l in pre monsoon season, 86.67 mg/l to 450 mg/l in monsoon season and 153.33 mg/l to 186.67 mg/l in Post monsoon. Excess alkalinity gives bitter taste to water and reacts with cations forming precipitates. The alkalinity varies in accordance with the fluctuation in the pollution load⁸.

Total Hardness: Hardness is a very important parameter in decreasing the toxic effect of poisonous element. The major cations imparting hardness are calcium and magnesium. The anions responsible for hardness are bicarbonate, carbonate, sulphate and chlorides.

Hardness in the present study was found to be in the range of 6830 to 7560 mg/l in pre monsoon season, 42 mg/l to 144 mg/l in monsoon and 2056.67 mg/l to 2738.67 mg/l in Post-monsoon season. Thus hardness was found to be very high in Pre-monsoon. It may be mainly due to rocks bearing salts of Calcium and Magnesium.

Calcium: Calcium is one of the most abundant elements found in the natural water. It is the important ion in imparting the hardness to the water. Here the mean calcium value ranges from 480.6 to 580.7 mg/l in pre monsoon, 6.94 to 16.17 mg/l and 248.09 to 320.64 mg/l in monsoon and post- monsoon respectively.

Magnesium: Magnesium also occurs in all kinds of natural waters, but its concentration remains generally lower than the calcium. Like calcium, it is also an important cation imparting hardness to the water. Magnesium in the present study was found to be in the range of 1353.7 to 1527.8 in pre monsoon, 3.18 mg/l to 25.26 mg/l in monsoon and 333.38 mg/l to 472 mg/l in Post-monsoon season.

Total Solids: The mean value of Total solids in the study area in pre, monsoon and post monsoon seasons ranges from 39933.3 to 45800 mg/l, 800 mg/l to 1266 mg/l and 28933.33 mg/l to 38066.67 mg/l respectively.

Total Dissolved Solids: The average value of Total Dissolved Solids in pre monsoon ranges from 39266.7 to 45700 mg/l, monsoon season ranges from 200 mg/l to 1133.33 mg/l and in Post monsoon it ranges from 23600 mg/l to 33066.67 mg/l.

Total Suspended Solids: In the present study the mean value of Total Suspended Solids in Thekkumbad Thazhekkave ranges from 100 to 3300 mg/l, 200 mg/l to 733.33 mg/l and 1266.67 mg/l to 14466.67 mg/l in Pre monsoon, Monsoon and Post monsoon respectively.

Chloride: It occurs naturally in all types of waters. In natural fresh waters, its concentration remains quite low. The most important source of chloride in natural waters is the discharge of sewage⁹. In very high concentration it gives a salty taste to the water. Present data displayed that the average concentration of chloride in the study area ranges from 24566 to 25702 mg/l in pre monsoon, 293.47 mg/l to 899.33 mg/l in monsoon and 16164.33 mg/l to 22057.33 mg/l in post monsoon season.

Sodium: Sodium is also one of the important cations occurring naturally. Salts of Sodium are highly soluble in water. A water with a high sodium content also not suitable for agriculture as it tends to deteriorate the soil for crops. Sodium associated with chlorides and sulphates make the water unpalatable. Here the average value of sodium concentration ranges from 24.9 to 28.9 mg/l, 6.07 mg/l to 40.13 mg/l and 999.67 mg/l to 1213.33 mg/l in Pre monsoon, monsoon and in post monsoon respectively.

Conclusion

Water quality parameters adjoining the mangrove habitats of Thekkumbad Thazhekkavu were analyzed on a monthly basis for assessing the seasonal changes. On the basis of above discussion it can be concluded that the comparison of five sites of Thekkumbad Thazhekkavu with respect to the seasonal changes revealed that all the five sites show marked variation in most of the water quality parameters. Variations in salinity related parameters like hardness, calcium, magnesium, sodium and chloride were higher than that of other water quality parameters, which are indicative of the differences in salinity intrusion in these habitats, with respect to seasons. Water quality parameters of Site 1 (*Avicennia officinalis*) was found to

be highly influenced, which is indicative of their close proximity with the estuarine system. It is indicative that the mangrove species occupying the sites have wider tolerances to varying levels of salinity related parameters.

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