Available online at http://www.journalijdr.com

IJDR

International Journal of
DEVELOPMENT RESEARCH

ISSN: 2230-9926

International Journal of Development Research
Vol. 4, Issue, 12, pp. 2702-2705, December, 2014

Full Length Research Article

ASSESSMENT OF WATER QUALITY IN TERMS OF PHYSICO-CHEMICAL PARAMETERS OF BHITARKANIKA MANGROVE SYSTEM, ODISHA, INDIA

[1]Fakir Charan Pradhan, [2,*]Nirmal Kumar Bhuyan, [3]Naba Kishore Pradhan and [4]Hemant Kumar Routroy

[1,4]Department of Chemistry, Ravenshaw University, Cuttack, 753003, India
[2]Water Quality Laboratory, Central Water Commission, Bhubaneswar, 751022, India
[3]Department of Chemistry, ITER, Sikshya O Anusandhan University, Bhubaneswar, India

ARTICLE INFO

Article History:
Received 07th September, 2014
Received in revised form
12th October, 2014
Accepted 20th November, 2014
Published online 27th December, 2014

Key words:
Mangrove Forest,
Bhitarkanika, Physico-Chemical Analysis,
Monsoon,
Pre-Monsoon and
Post-Monsoon.

ABSTRACT

The present study is aimed at assessing the physico chemical characteristics of water samples collected from the mangrove forest in Bhitarkanika. Mangrove forest is a component of wetlands that has been recognized as one of the most productive ecosystems. Physico-chemical analysis of water samples of Bhitarkanika mangrove forest, Odisha, India, was studied for a period of one year during January 2013 to December-2013. Atmospheric and surface water temperatures (◦C) varied from 19◦C to 33◦C and 22◦C to 29◦C respectively. Seasonal variations of different physico-chemical parameters investigated were as follows: pH (6.70 to 8.40), dissolved oxygen (3.25 to 8.58mg/l), biological oxygen demand (0 to 20.0 mg/l), electrical conductivity (56 to 290 µmho/cm), potassium (0.18 to 6.32 mg/l), calcium (2.32 to 48.24 mg/l), magnesium (0.82 to 119.5mg/l), sodium (4.32 to 342.06mg/l), bicarbonate (7.32 to 60.24mg/l), carbonate (BDL), chloride (4.64 to 362.40mg/l), sodium absorption ratio (0.62 to 842mg/l). A seasonal variation of these parameters was observed throughout the study period and monthly comparisons were made as monsoon, pre-monsoon and post- monsoon.

INTRODUCTION

Mangroves are coastal wetland forests established at the intertidal zones of estuaries, backwaters, deltas, creeks, lagoons, marshes and mudflats of tropical and subtropical latitudes. Approximately one fourth of the world's coastline is dominated by mangroves that are distributed in 112 countries and territories comprising a total area of about 181,000 km^2 Saravanakumar *et al*., 2008). 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) Mangroves forest grows well along the river bank, estuaries and coastal with the presence of brackish water or where saline and fresh water meets. Mangroves forest is a type of wetland and is considered as one of the most productive ecosystems in the tropic, high in value and has multiple roles and functions (Amita Sarkar and Bhavna Upadhyay, 2013). Mangrove has unique features and special adaptations like breathing roots, buttresses and aboveground roots that allow and enable them to live and survive in the mud, anaerobic condition; and salty water (APHA, 2005). The study of mangrove regions is necessary as they are highly productive and play an important role as breeding and nursery grounds for many commercially important fishes especially shrimps (Balasubramanian and Kannan, 2005). The regular and periodic changes in the climate synchronized with season are ultimately reflected in the environmental parameters also, which in turn have a direct or indirect influence over the planktonic population (Bergman, 2010). When river water mixes with seawater, a large number of physical and chemical processes take place, which may influence the water quality (Bragadeeswaran *et al*., 2007).

Corresponding author: Nirmal Kumar Bhuyan
Water Quality Laboratory, Central Water Commission, Bhubaneswar, 751022, India

Study Area

Geographically Bhitarkanika is located between $20^0 4'$ and $20^0 8'$ N latitudes and $86^0 45'$ to $87^0 50'$ E longitudes in the Kendrapada district of Odisha. It is the second largest mangrove ecosystem in India and consists mangrove forests, rivers, creeks, estuaries, backwater, accreted land and mud

flats. Bhitarkanika mangroves were declared as Wildlife Sanctuary with an area of 672 sq km in 1975. The core area 145 sq km of the sanctuary has been declared as Bhitarkanika National Park in 1992. It is a tide-dominated mangrove with areas of high tidal range of semidiurnal; with mean tide level 1.5 to 3.4M. These area exibit bidirectional tidal fluxes and thus forms extensive, low gradient inter-tidal zones available for mangrove colonization (Chadha *et al*., 1999). It supports a rich floral diversity with about 62 species of mangroves. The average annual rainfall is about 1670mm of which about 70% is received during August to September. In summer, the temperature ranges from 30^0C to 20^0C (day and night respectively) whereas during winter it is 20^0C to 15^0C. The relative humidity remains between 75-80% throught the year. The sediments are devided in to two categories, 'newer alluvium' and Pleistocene forms named "older alluvium" (GSI, 1974). The recent sediments are represented by sand, silt and clay with assorted boulders and pebbles, which are dark and loosely compacted with high moisture content. The Pleistocene deposits comprise of clay, sand, silt and kankar, with locally cemented pebbles and gravels. These are reddish brown due to high degree of oxidation (APHA, 2005).

MATERIALS AND METHODS

Samples were collected throughout the year on the first working day of every month from three zones estuarine, mangrove region and bay region. The three regions viz. estuarine, mangrove and bay are well marked in the system. Estuarine region is the entry point of Brahmani- Baitarani Rivers to mangrove area and is the area of intermixing of fresh water with tidal water. Mangrove area represents the area dominated by dense mangrove vegetation. The Bay region represents the area close to Bay of Bengal i.e. the entry point of tidal water. Samples were collected in well cleaned polypropylene bottles at low tide so as to minimize the tidal fluctuations. The average of the observed results are considered for data analysis. All the measurements were done following the standard methods (APHA 2005). pH and dissolved oxygen were measured immediately after sampling at the field itself. Samples were subjected to filtration before chemical analysis. TDS was determined by gravimetric process while total hardness was determined by EDTA titrimetric method. The Winkler's alkali iodide-azide method was followed for the estimation of D.O. and B.O.D. Nitrate was estimated by Orion make ion meter.

RESULTS AND DISCUSSION

The mangrove water was slightly alkaline and contained high amounts of pH, sodium, chloride, sodium absorption ratio and dissolved oxygen. Dissolved oxygen was high during monsoon and low during post monsoon and pre monsoon, Biological oxygen demand was low during monsoon and high during post monsoon and pre monsoon, calcium, magnesium, potassium, bicarbonate were low during monsoon and high during post monsoon and pre monsoon. The electrical conductivity was maximum in the pre monsoon, and minimum in the monsoon. Carbonate was absent in all the sites during the study period. Most of the parameters tested were slightly higher in summer than the monsoon seasons. In general, the characteristics of water tested in all the seasons were varied. The physico-chemical parameters showed variations in different seasons in the study region depending on the topography. 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 22^oC (monsoon) to 30^oC (pre monsoon). Air temperature reaches its maximum during summer and minimum during monsoon and winter. The surface water temperature varied from 20^oC (monsoon) to 26^oC (pre monsoon). There was a steady increase in temperature from March to May, which peaked during May. All the stations showed similar trend with similar seasonal changes. Generally surface water temperature is influenced by the intensity of solar radiation, evaporation, isolation, fresh water influx and cooling and mix up with ebb and flow from adjoining neritic waters (Govindasamy *et al.,* 2000). In the present study, summer peaks and monsoonal troughs in air and water temperature were noticed, as observed earlier in the west coast of India (Saravanakumar *et al*., 2008).

The pH values were varied from 6.65 (in site-2 in the month of Oct) to 8.42 (in site-3 in the month of April) during post monsoon and summer season. pH in surface waters remained alkaline and slightly acidic throughout the study period in all the stations with the maximum values occurring in the summer and minimum values occurring in the monsoon and post monsoon seasons. Generally, fluctuations in pH values during different seasons of the year is attributed to factors like removal of CO_2 by photosynthesis through bicarbonate degradation, dilution of seawater by freshwater influx, reduction of salinity and temperature and decomposition of organic matter (Upadhyay, 1988*;* Rajasegar, 2003). The recorded high pH values might be due to the influence of seawater penetration and high biological activity (Balasubramanian and Kannan, 2005); similar results were reported by Velsamy *et al.* 2013. The electrical conductivity was found to be maximum in the month of May i.e. 3529.1 (ms-1) and minimum in the month of July i.e. 1012.32 (ms-1).

The maximum and minimum values of electrical conductivity is due to fresh water influx and mix up with ebb and flow. The conductivity usually depends upon the dissolved nutrients and other dissolved ions. Higher conductivity have been reported after the disposal of paper mill effluents in Krishna river (Trivedy, 1988) and (Khatavkar, and Trivedi, 1992) also reported higher conductivity value in natural freshwater after discharge of sugar factory effluents. Similar results were reported by Prabhahar *et al.,* 2011; Rita Chauhan *et al., 2008.* The maximum value of dissolved oxygen concentration was observed in site- 2 in the month of July i.e. 11.78 mg/l (monsoon) where as the minimum value of dissolved oxygen was found in the site-3 in the month of May i.e.3.25mg/l (summer). Season-wise observation of dissolved oxygen showed an inverse trend against temperature and salinity. It is well known that temperature and salinity affect dissolution of oxygen in seawater (Vijaya Kumar *et al.,* 2000). In the present investigation, higher values of dissolved oxygen were recorded during monsoon months in all the stations and relatively lower values were found during summer which could be mainly due to reduced agitation and turbulence of the coastal and estuarine waters. Higher dissolved oxygen concentration observed during the monsoon season might be due to the

Physico chemical characteristics of the water (Mean values and standard deviation)

Parameters	Site-1(E)	Site-2(M)	Site-3(B)
Air Temperature	27.03±1.51	25.23±1.26	26.23±1.13
Water Temperature	24.68±1.68	24.6±1.65	24.68±1.52
$_{P}^{H}$	7.48±0.51	6.35±0.32	7.81±0.45
Electrical Conductivity	1816.62±118.63	2210.17±116.77	3217.40±211.59
Dissolved Oxygen	6.36±1.12	7.63±1.46	5.28±1.58
Biological Oxygen Demand	0.81±0.32	0.98±0.46	1.06±0.73
Potassium	9.34±2.13	6.38±2.53	6.12±3.56
Calcium	18.63±13.18	12.43±11.67	16.21±15.03
Magnesium	42.12±18.02	24.53±19.23	42.25±42.96
Sodium	268.31±132.14	118.23.73±92.4	273.87±278.98
Bicarbonate	4.21±1.16	4.63±1.25	3.65±1.28
Carbonate	00	00	00
Chloride	226.32±92.57	263.25±74.09	157.55±108.6
Sodium absorption ratio	163.42±128.09	116.23±226.3	247.23±122.34

Note: All the parameters are expressed in mg/l except air and water temperature (°C), electrical conductivity (µmho/cm).

cumulative effect of higher wind velocity coupled with heavy rainfall and the resultant freshwater mixing. Similar results were reported by Saravanakumar *et al.* (2008), Satheeshkumar and Anisa Khan, 2009. The maximum value of B.O.D was observed in site- 3 in the month of October i.e. 3.65 mg/l where as the minimum value of B.O.D was found in the site-1 in the month of August i.e.0 mg/l. BOD is an indicator for the amount of the biodegradable organic substances. BOD also accounts for the oxygen that is required in organic matter decomposition (Amadi *et al.,* 2010). B.O.D depends on temperature, extent of biochemical activities, concentration of organic matter and such other related factors in monsoon period (Muduli Bipra Prasanna *et al*., 2010). BOD value will rise when there is more organic matter such as leaves, wood, waste water or urban storm water runoff took place at the river water (Seca Gandaseca *et al*., 2011). The maximum calcium content was found in site-1 i.e.42.34 mg/l in the month of April and minimum value found in site-2 i.e.0.503 mg/l in the month of August. Calcium values are indicative of intense of chemical weathering in the Indian sub continent. Calcium concentration is highest in estuaries due to the influx of riverine source. Similar results were reported by Rita Chauhan *et al.,* 2008 and Gadhia *et al.,* 2012.

Magnesium content varies among different sites. Maximum values of magnesium were observed during the month of March in site- 3 i.e. 109.5 and the minimum values were observed during the month of August in site- 3 i.e. 0.25mg/l. Similar results were reported by Ramamurthy *et al.,* 2012. The maximum potassium content observed during the month of December in site-1 i.e. 9.74 mg/l and minimum potassium content observed during the month of August in site-3 i.e.0.12 mg/l. The highest concentration appeared in the winter and the lowest concentration was observed in the rainy season. According to surface water standard, the K^+ in fresh water should be 2.3 mg/l (Garrels; Mackenzie, 1971). Seawater contains about 400 mg/l potassium. A study conducted by *Bergman, J., 2010* disclosed that seawater contains 392 mg/l of K. Rivers generally contain about 2-3 mg/l of potassium. This difference is mainly caused by a large potassium concentration in oceanic basalts. In the present study, the potassium values in all stations and all seasons were slightly high.

Similar results were reported by Mohammad Rahman *et al., 2013*. The maximum sodium content observed during the month of January in site-1 i.e. 878.04c mg/l and minimum sodium content observed during the month of August in site-2 i.e. 0.017 mg/l. Higher value of sodium (mg/l) during post monsoon season due to high salinity and low value during monsoon season due to rain and flow of river water (*Gadhia et al., 2012*. The high sodium values are largely due to the proximity of sea. The present data also reveals the potassium was lower than the sodium. This may be due to preferential adsorption and incorporation into silicate minerals. Similar results were reported by Rita Chauhan *et al.,* 2008. The maximum bicarbonate content observed during the month of May i.e. 6.29 mg/l in site-2 and minimum bicarbonate content observed during the months of July i.e. 1.40 mg/l in site-3. The high value in summer is due to the mixing of sea water and low value during rainy season is due to inflow of fresh water. The presence of high amount of bicarbonate indicates very hard water which is very hazardous for ecosystems (Mohammad M. Rahman *et al.,* 2013).

The carbonate content was absent in all the sites and in all the seasons. The values of chlorides range from 2.83 mg/l to 380.70 mg/l. The maximum value (380.7 mg/l) was recorded in the month of April in site-1 (summer) and minimum value (2.83 mg/l) in the month of August in site-2 (monsoon). Chloride contents tend to vary inversely to the rate of flow of water (Amita Sarkar and Bhavna Upadhyay, 2013). The chlorides, in high concentration, indicate presence of organic matter (Dhanpakiam *et al.,* 1999). The value of chloride was higher during pre monsoon which might be due to high salinity, tidal flow and less fresh water mixing. Low value was observed during monsoon season due to rain and more mixing of fresh water from river (Gadhia *et al.,* 2012). In the present study maximum value of chloride reaches in summer. Similar results were reported by Swaranlatha and Narsing Rao, 1998. The maximum sodium absorption ratio was observed during the month of January i.e.1300.9 mg/l in site-1 and minimum sodium absorption ratio was observed during the month of August i.e. 0.02 mg/l in site-2. As the season changes there is a fluctuation in the physicochemical characters of the water, this will be due to ebb and flow, flushing of rain water, change in the temperature and salinity

as season changes. In addition, intense pollution from both agricultural inputs and shrimp culture ponds deteriorate the water quality of mangrove ecosystem. The present information of the physico-chemical characteristics of water would form a useful tool for further ecological assessment and monitoring of these coastal ecosystems.

REFERENCES

Amadi, A.N., Olasehinde, P.I., Okosun, E.A. and Yisa, J. 2010. Assessment of the Water Quality Index of Otamiri and Ramiriukwa Rivers. *Phys. Int.,* 1:116-123. DOI: 10. 3844/ pisp.2010.116.123.

Amita Sarkar and Bhavna Upadhyay. 2013. Assessment of the Variations in Physico-Chemical Characteristics of Water Quality of the Wetlands in District Mainpuri (U.P.) India. *International Journal of Geology, Earth and Environmental Sciences,* Vol. 3 (1), pp.95-103, ISSN: 2277-2081.164.274.

APHA, 2005. Standard methods for examination of water and wastewater, *American Public Health Association, New York*.

APHA, 2005. Standard methods for the examination of water and waste water, edition American Public Health Association.

Balasubramanian, R. and Kannan, L. 2005. Physico chemical characteristics of the coral reef Environs of the Gulf of Mannar Biosphere Reserve, India. Int. *J. Ecol. Environ. Sci.,* 31, 265-271.

Bergman, J. 2010. Is the Sodium Chloride Level in the Oceans Evidence for Abiogenesis? *Answers Res. J.,* 2010, *3*, 159-

Bragadeeswaran, S., Rajasegar, M., Srinivasan, M. and Kanaga Rajan, U. 2007. Sediment texture and nutrients of Arasalar estuary, Karaikkal, southeast coast of India. *J. Environ. Biol.,* 28, 237-240.

Chadha, S., Kar, C. S. and Bhitarkanika, 1999 . Myth and Reality, (Natraj Publishers, Dehradun India) pp 102-105

GSI: 1974 Geological Survey Of India Miscellaneous publications no 30

Saravanakumar, A., Rajkumar, M., Sesh Serebiah, J. and Thivakaran, G.A. 2008. Abundance and seasonal variations of phytoplankton in the creek waters of western mangrove of Kachchh-Gujarat. *Journal of Environmental Biology*, 29(2) 271-274.

****