Comparison of Selected Soil Chemical Properties of Two Mangrove Areas of East Coast of Andhra Pradesh South India

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Abstract:- **The present study was carried out to determine the physico-chemical characteristics of sediments in two different mangrove areas located at the eastern mangroves region i.e Coringa Wild Life Sanctuary (CWS) and Seethanagaram Mangroves area (SMA) of Andhra Pradesh, South India. Tidal amplitude varied from 0.02 m to 3.54 m in both locations. Salinity varied from 32.0 to 42 ‰ in both collection area and the pH in the soil sediment ranged between 4.32 to 4.84 mg/L. Concentrations of nutrients viz. nitrate is more in CWS (mean 0.321 mg/L) compared to SMA (0.286 mg/L). Organic carbon was recorded as 4.28 % in CWS and 3.12% in SMA. Phosphates are 0.06 mg/L in first collection area and 0.04 in the second collection area. The silicate was found to be 1.1 in CWS and little bit high in SMA (1.62mg/L). The humic acid percentage was 2.32% in CWS and 1.1% in SMA. The nature of soil texture is characterized by the abundance of solty loam, silty clay and silty clay loam. All the physico-chemical parameters of the soil are shown significant relation by using t-test ($p \leq 0.05$).**

Keywords**: Mangroves, Physico-Chemical parameters, Soil Sediment.**

I. INTRODUCTION

Mangrove ecosystem acts as a buffer between near shore and lagoonal or estuarine environments with regard to the influence of freshwater discharge and salinity regime [1]. Mangroves are salt-tolerant plants occur in most tropical and subtropical regions of the world. These are serves as nursery, feeding and spawning grounds for the commercial fisheries. Fertility and healthiness of mangrove environment is reflected in productivity of phytoplankton and zooplankton as primary and secondary producers. Mangroves are rich in organic matter and nutrients and support very large biomass of flora and fauna. Mangroves are woody plants, which grown in loose wet soils of brackish-to-saline estuaries and shorelines. In India only 8% coastline is occupied by mangroves. The major products of general recycling of organic matter are detritus which is rich in enzymes and proteins and contains large microbial population [2], [3]. Bacterial activity is responsible for most of the carbon recycling in mangrove soil under both oxic and anoxic conditions. They can obtain high net primary production rates, and under certain conditions may export organic carbon to the adjacent aquatic environment either as leaf litter, particulate or dissolved organic matter [4]. The high productivity in mangrove ecosystems is often attributed to greater litter degradation rates and efficient recycling of nutrients, which are supplied by both autochthonous litter and allochthonous inputs from natural and anthropogenic sources [5], [6], [7]. The stability of the mangrove is influenced by salinity, soil type and chemistry, nutrient content and dynamics, physiological tolerance, predation and competition at local level [8]. Besides the environmental stress factors, habitat destruction through human encroachment has been the primary cause of mangrove loss. 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 [9]. Distribution of nutrients determines the fertility potential of a water mass [10], [11]. 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. The seasonal distribution, abiotic and biotic processes affect the nutrient cycle of different coastal environments [12]. The magnitude and periodicity of forces such as tides, nutrients, hydro-period and stresses such as cyclones, drought, salt accumulation and frost may largely determine the 'energy signature' in mangrove realm and the floral and faunal composition [13]. Good quality of water resources depends on a large number of physicochemical parameters and the magnitude and source of any pollution load and to assess that monitoring of these parameters is essential [14]. Assessment of water resource quality of any region is an important aspect of developmental activities of the region, because rivers, lakes and manmade reservoirs are used for water supply to domestic, industrial, agricultural and fish culture [15]. Larval retention and high productivity in mangrove-lined estuaries have been attributed to the abundant food supply in comparison to adjacent marine areas [16], [17].

Organic materials derived from decaying mangrove leaves are used as primary food source in sustaining larval and juvenile stocks. Influence of physical, chemical and biological variables on planktonic communities in mangrove waters are more pronounced than the nearshore coastal environment, resulting in seasonal changes of planktonic species composition and densities [18]. However, such studies have not been attempted in Coringa Wild Life Sanctuary (CWS) and Seethanagaram Mangroves area (SMA) of Andhra Pradesh, South India. Although a number of authors have studied the physical and chemical characteristics of some Indian estuaries and mangroves [19], [20], [21], [22], [23], [24], [25], [26], [27], [28], [29], [30]. Hence, the present investigation attempted to record physico-chemical characters of the soil sediment at two different mangrove areas.

II. Materials and Methods

The present study was conducted at Coringa Wild Life Sanctuary (CWS) and Seethanagaram Mangroves' Area (SMA) of Andhra Pradesh in South India. The main reason for the selection of this area is that two locations are proximity to open coast and the level of anthropogenic pressure. The soil samples were collected up to 30 cm depth at 20 different locations in each area. The samples were dried and sieved through 20 mm nylon mesh for further process. For the analysis of nutrients, surface water samples were collected in clean polypropylene/glass containers and kept in an ice box and transported immediately to the laboratory. Sediment samples were collected using a Peterson grab (size 0.08 m2). The water and sediment temperature were measured using standard mercury bulb thermometer of 0.02o C accuracy. The Soil pH was determined by Kalra [31]. The Organic Carbon was determined by Walkley & Black [32].The nitrates were estimated by "Cd" redactor method. The phosphates were estimated by Ascorbic acid method, the silicates were estimated by Molybdosilicate method by standerd methodology (APHA, 1998) [33]. The humic acid was estimated by calorimetric method [34]. Simple correlation (r) was made for statistical interpretation of the physico-chemical characteristics and two-way analysis of variance (ANOVA) was employed to find out variations in all hydrographic parameters between stations and seasons.

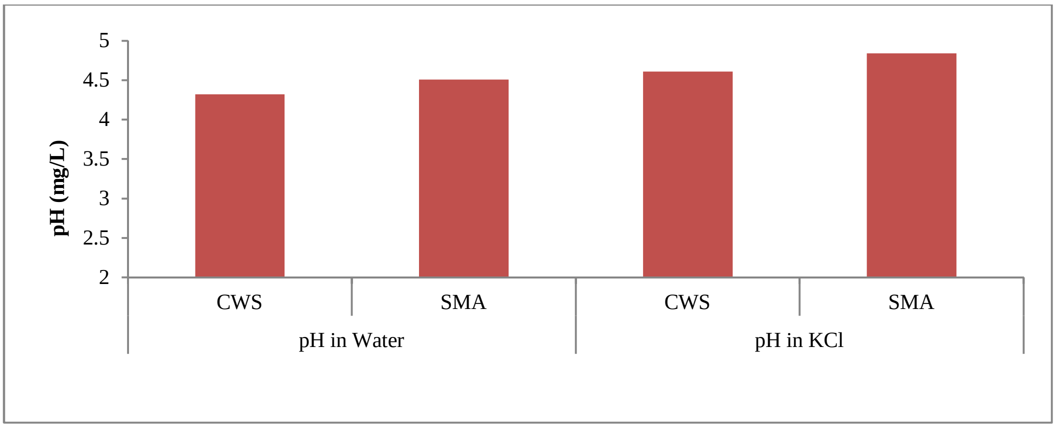
III. Results and Discussion

The tidal amplitude in both the east and west coasts of India are influenced by wind tides. The tides in the study sites are mixed semi diurnal type with a large diurnal inequality and varying amplitude. Andhra Pradesh coast experiences very high tides perhaps the highest that occur anywhere along the Indian coasts [35]. However, in the both study area the tidal amplitudes were 3.54±0.02 m. The surface water temperature varied from 15 to 40oC during winter and summer seasons. Salinity varied from 32 to 42 ‰ during monsoon and summer seasons. The minimum salinity was presumably due to the influence of heavy rainfall and the resultant river run-off, which is a regular annual event in this area during monsoon. Salinity acts as a limiting factor in the distribution of living organisms, and its variation caused by dilution and evaporation is most likely to influence the fauna in the intertidal zone [36]. Generally, changes in salinity of brackish water habitats such as estuaries, backwaters and mangrove are due to influx of freshwater from land run off, caused by monsoon or by tidal variations. In the present study, the CWS showed more acidic than SMA because of low salinities and also more decomposed organic matter. The pH of the soil significantly effect on the plant growth (Graph -1). It the present study it is found that the salinity was low because in the area less frequency of tidal inundation and also with increasing the distance from the coast was observed (Graph -1). The pH of the soil significantly effect on the plant growth (Graph -1). During the present study more acidic values are recorded in both stations. 4.32 mg/L was recorded in CWS soil when it is diluted in water, if it diluted in Potassium chloride (KCL) solution, 4.61 mg/L of pH was observed. In SMA area the soil was contain 4.51 mg/L of pH was observed in water dilution state and 4.84 mg/L of pH was recorded in KCl dilution. The mean value of the both the area were recorded more acidic because the mangrove soil is always alkaline as reported by various authors [37], [38]. The low value of pH indicating acidic condition recorded during monsoon months may be due to the oxidation of Fe SO4 and Fe S to H2SO4 [39]. Hema and Ghose reported that the variability in organic carbon content shows variation which indicates the anthropogenic activities and land uses in the area have influence on the distribution of OC. [40]. The anthropogenic activities in the CWS such as aquaculture (fish & shrimp farming) effluents domestic effluent are more from the nearby villages. The CWS area shown 4.28 % of organic carbon (OC) and in SMA area it was recorded as 3.12 % (Graph -2). More organic carbon (OC) is recorded in CWS are because receiving of OC inputs derived from both terrestrial and aquatic origins than SMA. The nitrate levels (Graph -3) were more (0.321 mg/L) at CWS may be due to the increased phytoplankton excretion, oxidation of ammonia and reduction of nitrate and by recycling of nitrogen and also due to bacterial decomposition of planktonic detritus present in the environment [23] and at SMA the nitrates were recorded as low (0.286 mg/L) due to less freshwater inflow and high salinity [41], [42]. The highest phosphate (0.06 mg/L) and nitrate values recorded in CWS during monsoon season may be attributed to heavy rainfall, land runoff, its autochthonous origin and weathering of rocks liberating soluble alkali metal phosphates (Graph -4), the bulk of which are carried into the mangrove waters [21], [43]. Another possible way of nitrate entry is through oxidation of ammonia form of nitrogen to nitrite and then consequently to nitrate [25]. The low values recorded during non-monsoon period may be due to utilization by phytoplankton as evidenced by high photosynthetic activity and the dominance of neritic seawater having negligible amount of nitrate [21].

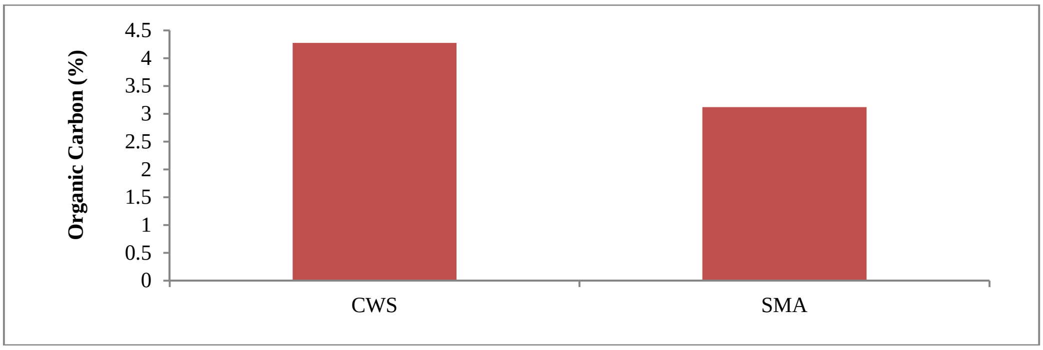
The CWS were shown high level phosphates, these phosphate concentrations depends upon the concentration in the freshwater that mixed with the seawater and also the more dead and decomposed organic matter on surface layers. The silicate content was higher than that of the other nutrients (NO3, NO2 and PO4) and the levels were low at CWS may be utilised by phytoplankton for their biological activity. In the present study the total organic carbon value was low during monsoon and high during winter season. An abundant supply of organic matter in the water column, relatively rapid rate of accumulation of fine grained inorganic matter and low O2 content of the water immediately above the bottom sediments would favor high organic matter in the bottom sediments [44]. The organic carbon in lake sediments is derived from primary production within the aquatic ecosystem (autochthonous sources) and also from terrestrial biota (allochthonous sources) by transport of leached and eroded material into the lake [45]. Therefore, the high organic carbon in the mangrove waters may be due to the mangrove and terrestrial detritus present in the suspended matter [46]. In addition to this an increase in organic matter content in the sediments may be due to the fine nature of sediments (Clayey and silt sediments) and high rate of sedimentation [47].and decomposition of mangrove foliage and other vegetative remains in the sediments [1],[48]. Concentrations of silicates are high (1.62 mg/L) in SMA compared to CWS area (1.10 mg/L). The humic acid was shown variation and more at CWS (2.32%) which indicate the organic rich sediment mangrove area [19]. Soil texture revealed dominance of silty loam and silty clay in all the stations in all the months with no much variation among them (Graph -5 & 6). This consistently high silty loam values may be attributed to the winnowing activity of sediment transport system. Absence of perennial flow of freshwater in costal districts along with lack of wave induced sand transport from open sea also may be the reason for this uniformity in soil texture.

IV. Conclusion

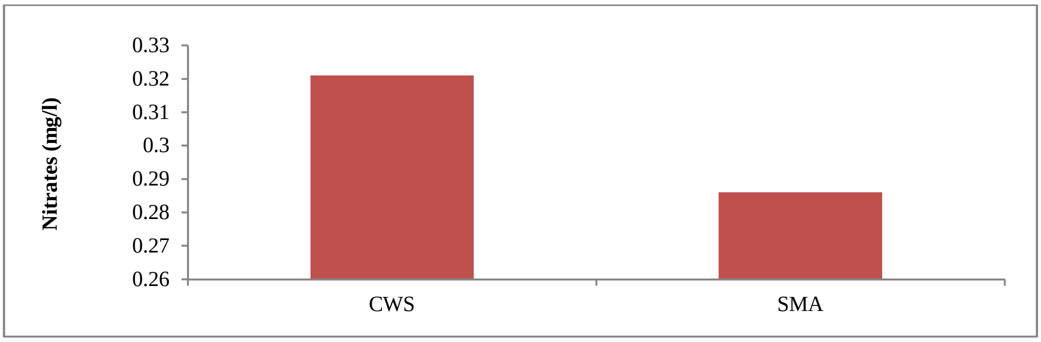
The present experimental observation of the physico-chemical characteristics of soil sediment and soil texture would form a useful tool for further ecological assessment and monitoring of these coastal ecosystems of eastern values of Andhra Pradesh, India. The present study was concluded that pH, NO3, PO4, Si, OC and humic acid were shown variation at both areas and parameters were indicates at the CWS was more influenced by fresh water influx and the SMA was influenced by tidal amplitude.



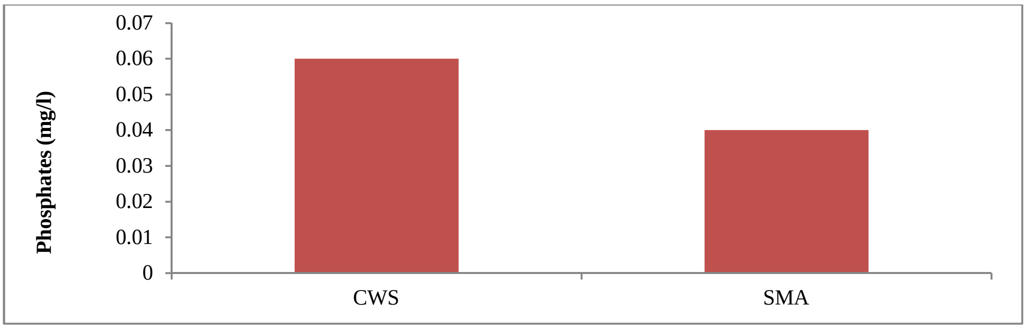
Graph -1: Comparison of pH in water and KCl of two different mangrove areas and shown significance difference using t-test at p≤ 0.05



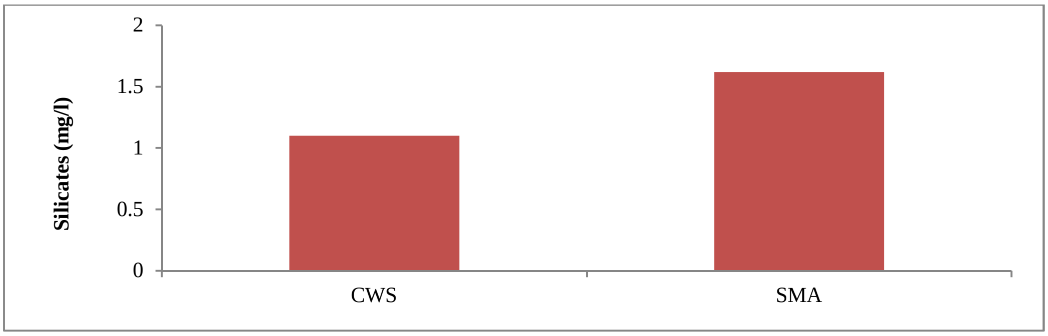
Graph -2: Comparison of Organic Carbon of two different mangrove areas and shown significance difference using t-test at p≤ 0.05



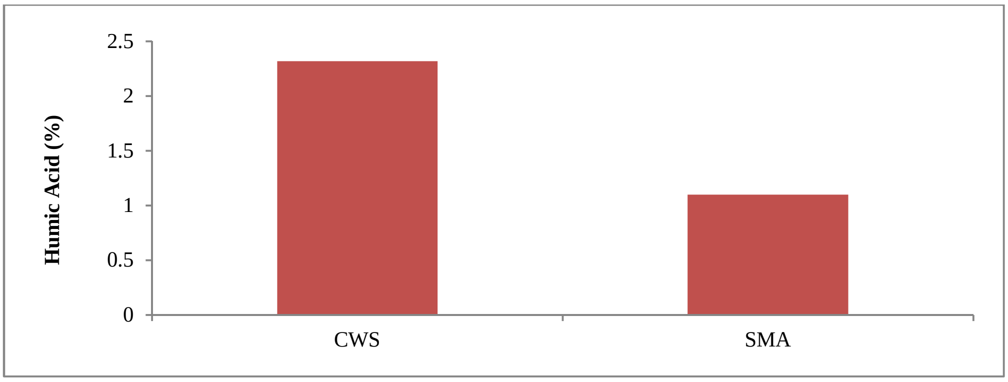
Graph -3: Comparison of Nitrates of two different mangrove areas and shown significance difference using t-test at p≤ 0.05



Graph -4: Comparison of Phosphates of two different mangrove areas and shown significance difference using t-test at p≤ 0.05



Graph -5: Comparison of Silicates of two different mangrove areas and shown significance difference using t-test at p≤ 0.05



Graph -6: Comparison of humic Acid of two different mangrove areas and shown significance difference using t-test at p≤ 0.05

REFERENCES

[1] Ramanathan, A.L.: Sediment characteristics of the Pichavaram mangroveenvironment, southeast coast of India. Ind. *J. Mar. Sci.*, 26, 319-322 (1997).
[2] Saenger P, Hageral E J and Davie J D S (1983). "Global Status of Mangrove Ecosystems". *IUCN, Avedu Mont Blano*, **1196**, Gland, Switzerland.
[3] Holguin G, Bashan Y and Vazavez P (2001). "The Role of Soil Microorganism in the Productivity, Conservation and Rehabilitation of Mangrove Ecosystem: An Overview," *Biology of Fertile Soils*, **33** (4), 265- 278.
[4] Lee S Y (1995). "Mangrove out welling: a review". *Hydrobiologia*, **295**, 203–212.
[5] Lee S Y (1990). "Primary productivity and particulate organic matter flow in an estuarine mangrove-wetland in Hong Kong". *Marine Biology*, **106**, 453–463.
[6] Kazungu J, Dehairs F and Goeyens L (1993). "Distribution of particulate and organic material in Gazi Bay". In: Dynamics and Assessment of Kenyan Mangrove Ecosystems, Commission of the European Communities, Woitchik, A.N. (Ed.), Project TS2-0240-C (GDF), Final Report, 175–193.
[7] Bouillon S, Koedam N, Raman A V and Dehairs F (2002). "Primary producers sustaining macro-invertebrate communities in intertidal mangrove forests". *Oecologia*., **130**, 441–448.
[8] Smith K A, Ball T, Conen F, Dobbie K, Massheder J and Rey A (2003). "Exchange of greenhouse gases between soil and atmosphere: interactions of soil physical factors and biological processes". *European Journal of Soil Science*, **54**, 779-91.
[9] Kathiresan K and Bingham B L. (2001). "Biology of mangroves and mangrove ecosystems". Adv. *Marine Biol.*, **40**, 81-251.
[10] Panda D, Tripathy K, Patnaik D K, Choudhury S B, Gouda R and Panigrahy R C (1989). "Distribution of nutrients in Chilka lake, east coast of India". *Ind. J. Mar. Sci.*, **18**, 288.
[11] Bragadeeswaran S., M. Rajasegar M, Srinivasan and Kanaga Rajan U (2007). "Sediment texture and nutrients of Arasalar estuary, Karaikkal, southeast coast of India". *J. Environ. Biol*., **28**, 237-240.
[12] Choudhury S B and Panigrahy RC (1991). Seasonal distribution and behaviour of nutrients in the creek and coastal waters of Gopalpur, east coast of India. *Mahasagar-Bull. Nat. Inst. Oceanogr*., **24**, 81-88.
[13] Guide (2000). "An ecological study of Kachchh mangroves and its associated fauna with reference to its management and conservation". Gujarat Institute of Desert Ecology (GUIDE) Submitted to Gujarat State Forest Department -Phase I report, 74.
[14] Reddi K R, Jayaraju N, Suriyakumar I and Sreenivas K (1993). "Tidal fluctuation in relation to certain physio-chemical parameters in Swarnamukhi river estuary, East coast of India". *Ind. J. Mar. Sci.*, **22**, 232-234.
[15] Jakher G R and Rawat M (2003). "Studies on physico-chemical parameters of a tropical lake, Jodhpur, Rajasthan". *India. J. Aqua. Biol.*, **18**, 79-83.
[16] Robertson A I, Alongi D M and Boto K G (1992). "Food chains and carbon fluxes. In: Tropical mangrove ecosystems coastal and estuarine series". *American Geophysical Union, Washington*, 293-326.
[17] Robertson A I and. Blabber S J M (1992). "Plankton, epi-benthos and fish communities". In: Tropical mangrove ecosystems (Eds.: A.I. Robertson and D.M. Alongi). *Coastal Estuar. Stud*., **41**, 173-224.
[18] Kannan L and. Vasantha K (1992). "Micro phytoplankton of the Pichavaram mangroves, southeast coast of India. Species composition and population density". *Hydrobiology*, **247**, 77-86.
[19] Mishra, Sujatha D, Panda and. Panigrahy R C (1993). "Physico-chemical characteristics of the Bahuda estuary (Orissa), east coast of India". *Ind. J. Mar. Sci*., **22**, 75-77.
[20] Satpathy, K.K.: Seasonal distribution of nutrients in the coastal waters of Kalpakkam, east coast of India. Ind. J. Mar. Sci., 25, 221-224 (1996).
[21] Das J, Das S N and Sahoo R K (1997). "Semidiurnal variation of some physicochemical parameters in the Mahanadi estuary, east coast of India". *Indian J. Mar. Sci*., **26**, 323-326.
[22] Padma S and Periakali P (1999). "Physico-chemical and geochemical studies in Pulicate lake, east coast of India". *Ind. J. Mar. Sci*., **28**, 434-437.

[23] Govindasamy C., Kannan L and Jayapaul A (2000). "Seasonal variation in physico – chemical properties and primary production in the coastal water biotopes of Coramandal coast, India". *J. Environ. Biol*., **21** (1): 1 –7.
[24] Rajesh K M, Gowda G and Mridula R. Mendon (2002). "Primary productivity of the brackish water impoundments along Nethravathi estuary, Mangalore in relation to some physico-chemical parameters". *Fish. Technol*., **39**, 85-87.
[25] Rajasegar M (2003). "Physico-chemical characteristics of the Vellur estuary in relation to shrimp farming". *J. Environ. Biol.*, **24**, 95-101.
[26] Rajasekar K T, Peramal P and Santhanam P (2005). "Phytoplankton diversity in the coleroon estuary, southeast coast of India". *J. Mar. Biol. Ass. India*, **47**, 127-132.
[27] Sridhar R T, Thangaradjou S, Senthil Kumar and Kannan L(2006). "Water quality and phytoplankton characteristics in the Palk Bay, southeast coast of India". *J. Environ. Biol.*, **27**, 561-566.
[28] Ajithkumar TT., Thangaradjou T and Kannan L (2006). "Physico-chemical and biological properties of the Muthupettai mangrove in Tamil Nadu". *J. Mar. Biol. Ass. India*, **48**, 131-138.
[29] Anilakumary KS., Abdul Aziz P K and Natarajan P. (2007). "Water quality of the Adimalathma estury, South west coast of India". *J. Mar. Biol. Ass. India*, **49**: 1-6.
[30] Asha P S and Diwakar (2007). "Hydrobiology of the inshore waters off Tutcorin in the Gulf". *J. Mar. Biol. Ass. India*, **49**, 7-11.
[31] Kalra Y P (1995). "Determination of pH of soils by different methods: Collaborative study". *J. AOAC Int*. **78**: 310-321.
[32] Walkley A and Black I A (1934). "An examination of the Degtjareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method". *Soil Science*, **37**, 29-38.
[33] APHA (1998). "Standard methods for the Examination of water and waste water". **20**th Edition, Washington, D.C.
[34] David H H, Ray Tucker M, Catherine E S (2013). "Crop Fertilization Based on North Carolina Soil Tests". August 2013.
[35] Gupta Sen and Geetanjali Deshmukhe (2000). "Coastal and maritime environments of Gujarat: Ecology and economics". *Gujarat Ecological Society, Vadodara, Gujarat*. 148.
[36] Gibson R N (1982). "Recent studies on the biology of intertidal fishes". *Oceanogr. Mar. Biol. Ann. Rev*., **20**, 363-414.
[37] Tam N F Y, Li S H, Lan C Y, Chen G Z,. Li M S and Wong Y S (1995). "Nutrients and heavy metal contamination of plants and sediments in Futian mangrove forest". *Hydrobiologia*, **295**, 149-158.
[38] Tam, N Y F and Wong Y S (1998). "Variations of soil nutrient and organic matter content in a subtropical mangrove ecosystem". *Water Air Pollut*., **103**, 245-261.
[39] Holmer M, Kristensen E, Banta G, Hansen K, Jensen M H and Bussawarit N (1994). "Biogeochemical cycling of sulfur and iron in sediments of a south-east Asian mangrove, Phuket Island, Thailand". *Biogeochem*., **26**, 145-161.
[40] Raza M, Mohamad Pauzi Zakaria and Nor Rasidah Hashim (2011). Spatial and Temporal Variation of Organic Carbon in Mangrove Sediment of Rembau-Linggi Estuary, *Malaysia World Applied Sciences Journal*, **14**, 48-54.
[41] Mani P and Krishnamurthy K (1989). "Variation of phytoplankton in a tropical estuary Vellar estuary, Bay of Bengal, India)". Int. Revue. Ges. *Hydrobiol.*, **74**, 109-115.
[42] Murugan A and Ayyakkannu K. (1991). "Ecology of Uppanar backwater, Cuddalore. I. Physico-chemical parameters". *Mahasagar-Bull. Natl. Ins. Oceanogr*., **24**, 31-38.
[43] Gowda G, Gupta T R C, Rajesh K M, Gowda H, Lingadhal C and Ramesh A M (2001). "Seasonal distribution of phytoplankton in Nethravathi estuary, Mangalore". *J. Mar. Biol. Ass. India*, **43**, 31-40.
[44] Sverdrup, V., M.W. Johnson and R.H. Fleming: The oceans, their physics, chemistry and general biology. Prentice Hall, New York. p. 1087 (1942).
[45] Likens, G E (1972). "Nutrients and eutrophication". Special symposium *American society of Limnology and Oceanography*, Lawrence. 3.
[46] Jagtap TG (1987). "Seasonal distribution of organic matter in mangrove environment of Goa". *Ind. J. Mar. Sci.*, **16**, 103-106.
[47] Raghunath R and Sreedhara Murthy T R (1996). "Carbonate and organic matter studies of the shelf of Kasargod, west coast of India". *Ind. J. Mar. Sci*., **25**, 355-357.
[48] Saravanakumar A, Rajkumar M, Sesh Serebiah J and. Thivakaran G A (2008). "Seasonal variations in physico-chemical characteristics of water, sediment and soil texture in arid zone mangroves of Kachchh-Gujarat". *Journal of Environmental biology*, **29**(5) 725-732.