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Observations on the seasonal variations of Physico-chemical parameters of Ayiramthengu, the mangrove ecosystem

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Abstract
Mangrove ecosystems are considered to be the most productive and complex wetlands. Ayiramthengu is situated about 6 km west of Oachira town on the bank of the Kayamkulam estuary. The present study deals with the investigation of physico-chemical parameters. The study was conducted over three sites such as Cheriazheekal, Valiazheekal and Ayiramthengu during the year of 2016 for premonsoon, monsoon and post monsoon seasons. The study revealed that dissolved oxygen was found to be from 1.12 to 1.68mg/l during premonsoon and monsoon seasons in Valiazheekal region. A high value of salinity was also noticed in Ayiramthengu region. Hardness exhibited a decrease in premonsoon and monsoon season than that of post monsoon season. A remarkably higher value of turbidity ranging from 601NTU to 1044 NTU was also noticed. This indicates a sign of water quality degradation of the study area. The present investigation proves the need for conservation of this natural ecosystem in a sustainable manner.

Keywords: Mangrove, physico-chemical parameters, NTU, dissolved oxygen

1. Introduction
Water resources have been the most exploited natural system, since man strode the earth. As a result of increasing industrialization, urbanization, civilization and other developmental activities, natural water resources are being polluted by different sources. The pollutants emerging as waste to the water bodies are likely to create nuisance by way of physical appearance, odour, taste, quality and render the water harmful for utility. So there is an urgent need for the rapid monitoring of the quality of water resources. Rapid progress in industrialization, urbanization, and population explosion in the last few decades have resulted a dramatic increase in the demand for water.Good quality of water resources depends on a large number of physico-chemical parameters and the magnitude and source of any pollution load and to assess that, monitoring of water quality parameters is essential (Reddi *et al*., 1993) [8]. Mangrove ecosystem acts as a buffer between near shore and lagoon or estuarine environments with regard to the influence of freshwater discharge and salinity regime (Kathiresan and Bingham, 2001) [5]. Mangrove term describes a diverse group of tropical plants that are well adapted for the life in a tidal habitat (Sternberg *et al*., 2007) [10]. 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 (Kathiresan and Bingham, 2001) [5].

The most important variables which influence the mangrove are temperature, salinity, pH, dissolved oxygen, free carbon dioxide, primary productivity, Biological Oxygen Demand, Total Dissolved solids, salinity, hardness etc. Survival and development of regeneration and recruitment classes depend on salinity and solar radiation. Temperature and salinity determine the species composition, distribution and zonation. Physico-chemical parameters can affect the species diversity, presence and absence of species and pattern of distribution.

The objective of the present work was to study the major physical and chemical parameters and identification of fish species of Ayiramthengu mangrove ecosystem, Kollam District. Water samples were collected from three sites Cheriazheekal, Valiazheekal and Ayiramthengu. Physico-chemical parameters such as temperature, pH, turbidity, free O_2, salinity, hardness, dissolved O_2, primary productivity, total dissolved solids, Biological oxygen Demand were analysed.

Thus the study will remind the need for restoration of the damaged environment.

2. Materials and Methods

Ayiramthengu (90 6' to 90 8' N: 760 28' to 760 29' E) is situated about 6 km west of Oachira town on the bank of the Kayamkulam estuary. The mangrove here covers 20 acres of area. This long chain of mangrove vegetation is an extensive one left almost untouched by man along the Kerala coast. They are bounded on the east by Kayamkulam estuary, on the west by the Kollam. Alappuzha waterways connected to Arabian Sea, on the north and south by two canals. Flood waters of the Pampa and Achankovil rivers flow into the estuary through commercial canals which link the rivers. The estuary opens into the Arabian Sea at Valiazheekal. Cheriazheekal is characterized by influx of fresh water into the mangrove area. Valiazheekal represents an area of luxuriant mangrove growth showing entangled respiratory roots. This region serves as an ecotourist area with houseboats. Ayiramthengu represents the open area where tides and waves are predominant. It also serves as a vibrant fishing industry. Water samples were collected for the year 2016 covering three prominent seasons and physico-chemical parameters such as temperature, pH, turbidity, free O_2, salinity, hardness, dissolved O_2, primary productivity, total dissolved solids, Biological oxygen Demand were analysed following standard methods of APHA (1998) [1]. Fishes were collected and identification of the fish fauna in the study area was carried out by following the methods adopted by Day (1994) [2] and Jayaram (1999) [3].

Site 1: (Cheriazheekal)

Site 2: (Valiazheekal)

Site 3: (Ayiramthengu)

Table I: Seasonal Variations or Physico-Chemical Parameters

Sl. No.	Parameters	Seasons	Site1	Site 2	Site 3	Average	Std. Dev
1.	Temperature (°C)	Premonsoon	31 °C	30 °C	31 °C	30.6	0.5
		Monsoon	32 °C	28 °C	32 °C	30.6	0.5
		Post monsoon	29 °C	28.1 °C	28 °C	28.3	0.55
2.	pH	Premonsoon	7.55	7.58	7.36	7.4	0.1
		Monsoon	8.08	7.3	7.26	7.5	0.4
		Post monsoon	7.44	7.41	6.91	7.2	0.2
3.	Turbidity (NTU)	Premonsoon	950	1044	795	929.6	125.7
		Monsoon	769	915	1036	906.6	133.6
		Post monsoon	929	744	601	758	164.4
4	Free CO_2 (Parts Per Million)	Premonsoon	44	132	176	117.3	67.2
		Monsoon	20.4	35.2	17.6	24.4	9.4
		Post monsoon	26.4	8.8	35.2	23.4	10.9
5	Salinity (mg/l)	Premonsoon	454.3	831.86	1350	878.7	449.6
		Monsoon	575.5	383.95	524.72	449.7	99.2
		Post monsoon	441.5	336.7	85.08	287.76	183.1
6.	Hardness (mg/l)	Premonsoon	560	540	640	580	52.9
		Monsoon	142	260	422	274.6	140
		Post monsoon	230	170	90	163	70.2
7	Dissolved O_2 (mg/l)	Premonsoon	2.24	1.68	3.2	2.3	0.7
		Monsoon	3.44	1.12	3.28	2.6	1.2
		Post monsoon	3.36	4.24	3.6	3.7	0.4
8	Gross Primary Productivity (mg C/L//hr)	Premonsoon	0.37	0.05	0.24	0.22	0.1
9	Net Primary Productivity (mg C/L/hr)	Monsoon	0.44	0.1	0.27	0.27	0.17
		Post monsoon	0.09	0.031	0.04	0.05	0.03
		Premonsoon	0.24	0.03	0.24	0.1	0.1
10	Total dissolved (mg/L)	Monsoon	0.12	0.024	0.03	0.05	0.05
		Post monsoon	0.04	0.031	0.04	0.14	0.1
		Premonsoon	4.8	4	5.4	4.7	4.7
11	BOD(mg/l)	Monsoon	12.4	9.8	12	11.4	1.4
		Post monsoon	1.2	2.2	0.8	1.4	1.4
		Premonsoon	0.48	0.32	1.28	0.6	0.5
		Monsoon	1.44	1.07	0.32	0.9	0.5
		Post monsoon	1.2	0.16	0.32	0.56	0.56

3. Results

The temperature of water sample in the premonsoon period ranges from 30 ºC to 31 ºC. A high range of temperature was shown in the site 1 and site 2 (31 ºC) and lowest was observed in the site 3 (30 ºC). In monsoon period, the temperature ranges from 28 ºC to 32 ºC. A high range of (28 ºC) temperature was shown in the site 1 and 2 (32 ºC) and lowest temperature was observed in the site 2.The temperature of water sample in the post monsoon period ranged from 28 ºC to 29 ºC. The high temperature was shown in the site 1 (29 ºC) and site 2 (28.1 ºC) and lowest temperature was in the site 2 (28.1 ºC) (Table 1) (Fig.1).

pH of the water sample was not much varied in Premonsoon season. The pH ranged from 7.58 to 7.36. A high range of pH was observed in the site II (7.58) and site 1 (7.55) and lowest pH was observed in the site III (7.36).The pH of water sample in the monsoon season ranged from 7.2 to 8.08. A high range of pH was shown in the site I(8.08) and lowest pH was observed in site III (7.26).The pH of water sample in the post monsoon ranged from 6.91 to 7.44.The three sites showing comparatively same range of pH(6.91,7.41 & 7.44) (Table 1) (Fig. 2).

In Premonsoon turbidity of water ranged from 795 NTU to 1044 NTU. A high range of turbidity was shown in site II (1044 NTU) and lowest was obtained in site III (795 NTU).Turbidity of water in monsoon season ranged from 769NTU to 1036NTU. A high range of turbidity was shown in site III (1036NTU) and lowest was observed in site I (769). Turbidity of water in post monsoon season ranged from 929NTU to 601NTU. Maximum range was observed in site I (929NTU) and minimum range was observed in site III (601NTU) (Table 1) (Fig.3).

The free carbon dioxide in the Premonsoon season ranged from 44ppm to176ppm. Maximum range observed in site III(176ppm) and minimum range observed in site I (44ppm).The free carbon dioxide in the monsoon season ranges from 17.6ppm to 35.2ppm.Maximum range was observed in site II(35.2ppm) and minimum range observed in site III(17.6ppm).The free carbon dioxide in the post monsoon season showed a value ranging from8.8 to 35.2. Maximum range was observed in site III(35.2ppm) and minimum range observed in site II(8.8ppm) (Table 1) (Fig.4).

Salinity of water sample in the Premonsoon season ranges from 454.3mg/l to 1350mg/l. Maximum range was obtained in site III(1350mg/l) and minimum range obtained in site I(454.3mg/l).Salinity of water sample in the monsoon season ranges from 383.95mg/l to 524.72mg/l. Maximum range was observed in site I (575.91mg/l) and minimum range observed in site II (383.95mg/l).Salinity of water sample in the post monsoon season ranges from 85.08 mg/l to 441.5mg/l. Maximum range was obtained in site I (441.5mg/l) and minimum range obtained in site III(85.08mg/l) (Table 1) (Fig.5).

Hardness of water sample in the Premonsoon season range from 540mg/l to 640mg/l. Maximum range was observed in site III(640mg/l) and minimum range observed in site II(540mg/l).Hardness of water sample in the monsoon season was nearly 148mg/l to 422mg/l. Maximum range was observed in site III (422mg/l) and minimum range observed in site I (142mg/l). Hardness of water sample in the post monsoon season ranges from 90 mg/l to 230mg/l. Maximum range was observed in site I (230mg/l) and minimum range observed in site III(90mg/l) (Table 1) (Fig.6).

Dissolved oxygen of water sample in the Premonsoon season ranges from 1.68mg/l to 3.2mg/l. Maximum range was observed in site III(3.2mg/l) and minimum range observed in site II(1.68mg/l).Dissolved oxygen of water sample in the monsoon season ranges from 1.12mg/l to 3.44 mg/l. Maximum range was observed in site I (3.4mg/l) and minimum range observed in site II (1.12mg/l). Dissolved oxygen of water sample in the post monsoon season ranges from 3.6mg/l to 4.24mg/l. Maximum range was observed in site II (4.24mg/l) and minimum range observed in site III(3.6mg/l) (Table 1) (Fig.7).

Gross primary productivity in the Premonsoon season ranges from 0.05 mgC /l//hr to 0.77 mgC/l//hr. Maximum range was observed in site III (0.77mgC/l//hr) and minimum range observed in site II(0.05mgC/l//hr).Gross primary productivity of water sample in the monsoon season ranges from 0.1mgC/l//hr to 0.44mgC/l//hr. Maximum range was observed in site I (0.44mgC/l//hr) and minimum range observed in site II(0.01 mgC/l//hr). Gross primary productivity of water sample in the post monsoon season ranges from 0.09 mgC/l//hr to 0.24mgC/l//hr. Maximum range was observed in site II (0.24mgC/l//hr) and minimum range observed in site I(0.09mgC/l//hr) (Table 1) (Fig.9).

Net primary productivity in the Premonsoon season ranges from 0.03mgC /l//hr to 0.24mgC/l//hr. Maximum range was observed in site I and III (0.24mgC/l//hr) and minimum range observed in site II(0.03mgC/l//hr).Net primary productivity of water sample in the monsoon season ranges from 0.024mg C/l//hr to 0.12mgC/l//hr. Maximum range was observed in site I (0.12mgC/l//hr) and minimum range observed in site II (0.024mgC/l//hr). Net primary productivity of water sample in the post monsoon season ranges from 0.00.04 mgC/l//hr to 0.031mgC/l//hr. Maximum range was observed in site II (0.031mgC/l//hr) and minimum range observed in site I and III(0.04mgC/l//hr) (Table 1) (Fig.8).

Total dissolved solids of water sample in the Premonsoon season ranges from 4mg/l to 5.4mg/l. Maximum range was observed in site III(5.4mg/l) and minimum range observed in site II(4mg/l).The value of Total Dissolved solids content in Premonsoon season observed was about 4mg/l to 5.4mg/l. Maximum value was noticed in site III (5.4mg/l) and minimum in site II (4mg/l).Total dissolved solids of water sample in the monsoon season ranges from 9.8mg/l to 12.4mg/l. Maximum range was observed in site I (12.4mg/l) and minimum range observed in site II (9.8mg/l). Total dissolved solids of water sample in the post monsoon season ranges from 0.8mg/l to 2.2mg/l. Maximum range was observed in site II (2.2mg/l) and minimum range observed in site III(0.8mg/l) (Table 1) (Fig.10).

Biological oxygen demand of water sample in the Premonsoon season ranges from 0.32mg/l to 1.28mg/l. Maximum range was observed in site III(1.28mg/l) and minimum range noticed in site II(0.32mg/l). Biological oxygen demand of water sample in the monsoon season ranges from 0.32mg/l to 1.44mg/l. Maximum range was observed in site I (1.44mg/l) and minimum range noticed in site III (0.32mg/l). Biological oxygen demand of water sample in the post monsoon season ranges from 0.16mg/l to 1.2mg/l. Maximum range was observed in site II (1.2mg/l) and minimum range noticed in site III(0.16mg/l) (Table 1).

Around 13 species of fishes were identified. This fish fauna in this mangrove belong to 4 orders such as Perciformes (8 species), Cypriniformes (1 species), Mugiliformes (1 species), Beloniformes (1 species) (Table 2).

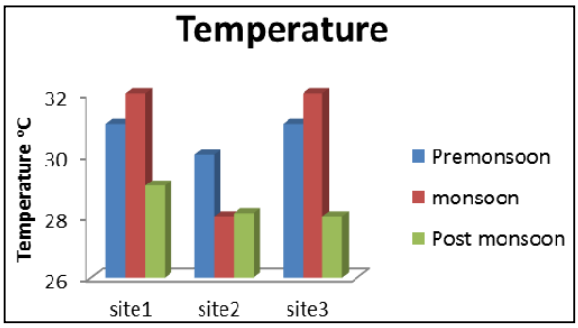

Fig 1: Graph showing seasonal variations of temperature

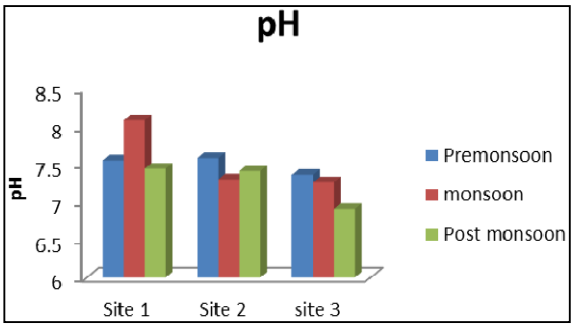

Fig 2: Graph showing seasonal variations of pH

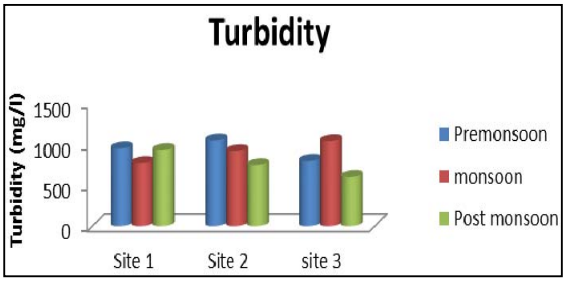

Fig 3: Graph showing seasonal variations of Turbidity

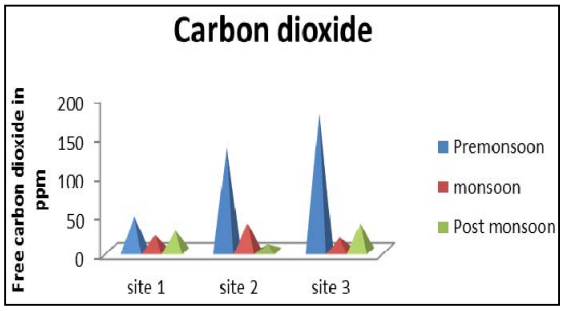

Fig 4: Graph showing seasonal variations of carbon dioxide

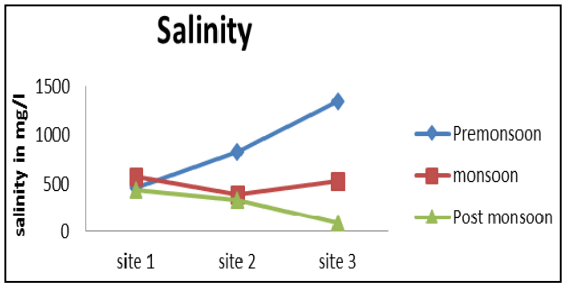

Fig 5: Graph showing seasonal variations of Salinity

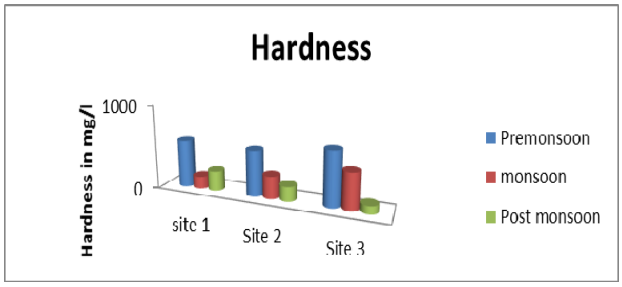

Fig 6: Graph showing seasonal variations of Hardness

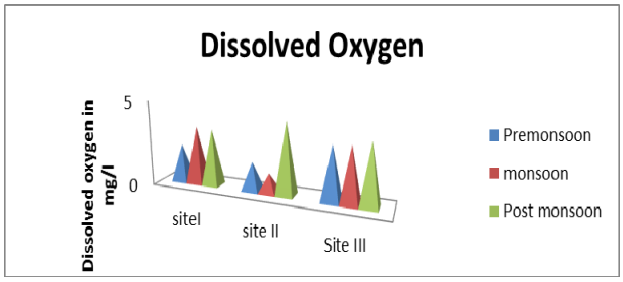

Fig 7: Graph showing seasonal variations of Dissolved Oxygen

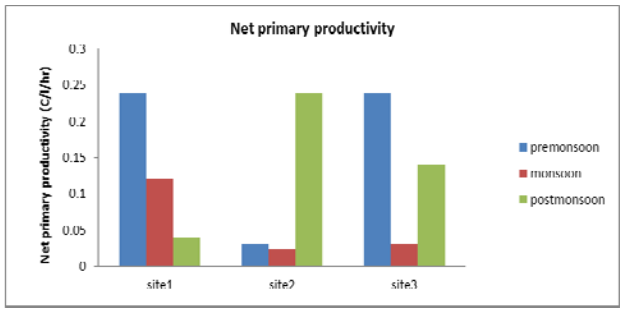

Fig 8: Graph showing seasonal variations of Net primary productivity

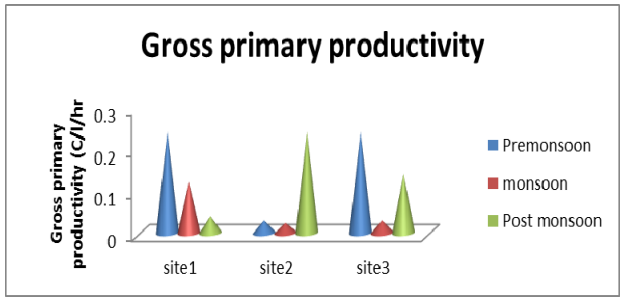

Fig 9: Graph showing seasonal variations of Gross primary productivity

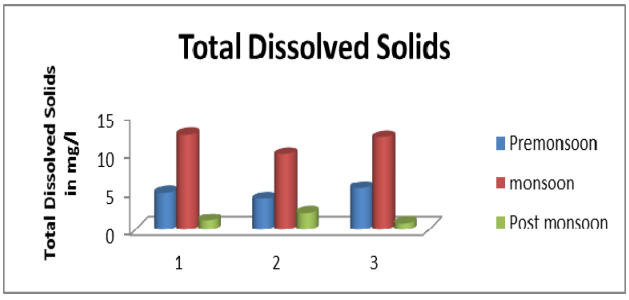

Fig 10: Graph showing seasonal variations of Total dissolved solids

List of Fishes Identified

Table 2

Sl. No	Scientific Name	Family	Class	Order
1	*Etroplus suratensis*	Cichlidae	Actinopterygii	Perciformes
2	*Etroplus maculates*	Cichlidae	Actinopterygii	Perciformes
3	*Oreochromis mossambicus*	Cichlidae	Actinopterygii	Perciformes
4	*Puntius carnaticus*	Cyprinidae	Actinopterygii	Cypriniformes
5	*Secutor bindus*	Leiognathidae	Actinopterygii	Perciformes
6	*Mugil cephalus*	Mugilidae	Actinopterygii	Mugiliformes
7	*Xenentodon cancilla*	Lepisosteidae	Actinopterygii	Beloniformes
8	*Anabas testudineus*	Anabantidae	Actinopterygii	Perciformes
9	*Channa striatus*	Channidae	Actinopterygii	Perciformes
10	*Gnathanodon speciosus*	Carangidae	Actinopterygii	Perciformes
11	*Ambassis commersoni*	Chandidae	Actinopterygii	Perciformes

4. Discussion

The conservation, management and sustainable development of the mangroves depend on the maintenance of hydro-geochemical characteristics of the system. Mangroves can establish and grow under a relatively wide range of flooding and salinity conditions but is generally restricted to the intertidal zone where there is less competition with freshwater plants. Mangroves have developed a series of physiological and morphological adaptations that have allowed them to successfully colonize these environments. 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. Besides the environmental stress factors, habitat destruction through human encroachment has been the primary cause of mangrove loss.

Water temperature is an important factor affecting various physico- chemical as well as biological activities (Malhotra & Sinha, 2007) [6]. Water temperature ranged between (28-^{o}C-32 ^{O}C). Maximum temperature was recorded on monsoon period and minimum during post monsoon. Surface water temperature may be influenced by the solar radiation and evaporation.

In Premonsoon turbidity of water ranged from 795 NTU to 1044 NTU. A high range of turbidity was shown in site II (1044 NTU) and lowest was obtained in site III (795 NTU). Turbidity of water in monsoon season ranged from 769NTU to 1036NTU. A high range of turbidity was shown in site III(1036NTU) and lowest was observed in site I (769). Turbidity of water in post monsoon season ranged from 929NTU to 601NTU. Maximum range was observed in site I (929NTU) and minimum range was observed in site III (601NTU).

Analysis of dissolved oxygen revealed that in pre monsoon season the dissolved oxygen range from (1.6 mg/l-3.2 mg/l) and maximum was observed in site III (3.2 mg/l) and minimum in site II (1.68 mg/l). (Kannan and Bhutiani, 2003) [4] have also noticed a similar depletion of oxygen content of the water due to the organic breakdown of silts and detritus. The increased value of dissolved oxygen in the water may be due to photosynthetic production of oxygen by the phytoplankton and the benthic algae. During monsoon the dissolved oxygen was maximum at site I and minimum at site II. In site II the amount of dissolved oxygen observed as 1.12mg/l. The amount of dissolved oxygen may be reduced by the organic breakdown of the detritus. Also in post monsoon season dissolved oxygen is maximum at site II and minimum at site III. The dissolved oxygen content was higher in site II (4.24mg/l) due to the photosynthetic activity of phytoplankton. Temperature and salinity influences the dissolved oxygen content. As reported by (Saravana kumar *et al.,* 2008) [9] the higher value of dissolved oxygen due to the cumulative effect of higher wind velocity with heavy rainfall and the resultant fresh water mixing and ferruginous impact of sediments. The increasing of dissolved oxygen in the mangrove forest was caused by oxygen exchanging at the root system of mangrove.

Aquatic organisms are affected by pH because most of their metabolic activities are pH dependent (Wang *et al.,* 2004) [11]. pH value gives an idea about the extent of pollution. pH of the water ranged from 7.691-8.08. Higher pH value was observed during monsoon. According to (Rajasegar 2003) [7], the fluctuations in pH values during different seasons of the year can be attributed to factors like removal of carbon dioxide by photosynthesis through bicarbonate degradation, dilution of salinity and temperature, decomposition of organic matter.

During pre- monsoon season, Biological oxygen demand was found to be 0.48 mg/l in site I,0.32mg/l and 1.28mg/l in site II and site III respectively. Maximum Biological oxygen demand was observed in site III and minimum in site II. Biological oxygen demand is an indicator of organic pollution in the water. In monsoon Biological oxygen demand maximum in site I (1.28mg/l) and minimum at site II. In postmonsoon season, maximum Biological oxygen demand was found in site I about 0.16mg/l and 0.32mg /l in site II and also site III respectively. The decaying organic matter abundance in the mangrove increases the organic load resulting in very high Biological oxygen demand, it cause depletion of Dissolved oxygen level. Biological oxygen demand is a parameter that affect the availability of Dissolved oxygen and pH values.

The value of Total Dissolved solids content in Premonsoon season observed was about 4mg/l to 5.4mg/l. Maximum value was noticed in site III (5.4mg/l) and minimum in site II (4mg/l). Total dissolved solids content of all inorganic and organic substances contained in a liquid in molecular, ionized or micro-granular (colloidal sol) suspended form. The value of Total Dissolved solids content in monsoon season observed was about 9.8mg/l to 12.4mg/l. Maximum value was noticed in site I (12.4mg/l) and minimum in site II (9.8mg/l). Total dissolved solids of water sample in the postmonsoon season ranges from 0.8mg/l to 2.2mg/l. Maximum range was observed in site II (2.2mg/l) and minimum range observed in site III(0.8mg/l).

5. Conclusion

The present study gives an account of the water quality of Ayiramthengu mangrove forest. The study highlights that there is a pronounced variation of most of the water quality parameters with variation in seasons. Moderately high level of hardness and salinity were observed in premonsoon and monsoon. In addition the present study indicates a high level of turbidity and Total dissolved solids observed in both

premonsoon and monsoon seasons. This study indicates that the water quality of Ayiramthengu area on a whole is deteriorating continuously. There are numerous causes including uncontrolled deforestation, increasing number of industries and various other anthropogenic activities in the neighbouring regions, global climate change that are responsible for deteriorating the water quality of this mangrove. This would produce devastating changes in the diversity of fishes. In natural systems, water always flows from upstream to downstream and it is very important to maintain this flow in order to retain a good ecological balance. The study will help to remind the need for conservation of this mangrove ecosystem.

6. Acknowledgement
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