Water quality analysis of Kappil backwaters

Praveena M.[1]& S. Santhosh[2]

[1]*Research scholar P. G. and Research Department of Zoology, N. S. S. College, Pandalam*

[2]*Asst. Prof. P. G. and Research Department of Zoology, N. S. S. College, Pandalam*

Abstract: *Water quality parameters (water temperature, pH, EC, Turbidity, TDs, Salinity, Nitrite, Nitrate, phosphate, DO, BOD) of Kappil backwaters of Thiruvananthapuram district of Kerala state was monitored form six selected stations for a period of one year (June 2015 to May 2016). Significant spatial variation in the distribution of physico-chemical properties was noticed in between all sampling stations. Average mean value of pH in the backwater system was recorded (6.43±1.04). Acidic nature of water was noticed in three stations throughout the period of study. Highest annual average value electrical conductivity was noticed in the bar mouth (station I) of the estuary (23.31±3.38) Both total dissolved solids and salinity was also recorded maximum values in station I. Maximum annual average turbidity value was observed in station VI (7.14±0.56). Nutrient parameters gained highest values in station IV. Annual average DO values found dangerously low in station IV (4.39±0.38) and Station V gained maximum value (9.51±0.48). The current study has revealed the striking difference in the distribution of water quality parameters and the degradation level of a tropical estuarine ecosystem on the south-west cost of India.*

Keywords: *Kappil backwaters, physico-chemical parameters, nutrients,*

Introduction: Water is the most important resource essential to sustain the life on earth. Maintaining the quality of water resources is necessary for the well being of all living organisms. Our planet is bestowed with water resources, but on these days only a few among them supports life in its full potential. Rapid economic growth in the recent years emerged to the industrialization and urbanisation which results in release of variety of pollutants in to the water bodies of all kinds. Such activities pose serious threat to aquatic ecosystems.

Backwaters, the connecting channel between water bodies of land and sea play an important role in water quality maintenance and preserve the water supply of adjacent resources (Nasir 2010). Backwaters are the most productive ecosystems with heavy nutrient supply, which facilitates healthy growth of flora and fauna (Nair 1995). However in these days estuarine ecosystems are under threat due to various reasons and the water quality of these aquatic ecosystems is under serious deterioration and these factors deeply impact the healthy growth of benthic organisms. The estuarine ecosystems in the southwest cost of India are also under threat due to the varying degree of pollution (Meera & Nandan 2010).

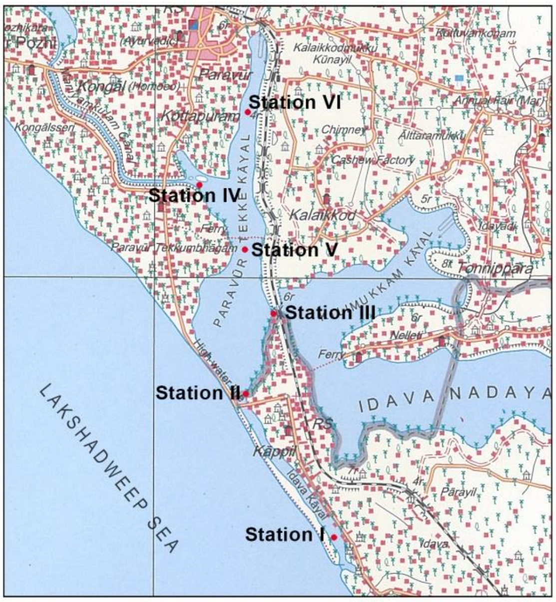
The major reason behind the water pollution is dumping of domestic waste materials and industrial effluents in to the natural water bodies. In Kerala, the estuarine ecosystem is in experience varying degrees of pollution. Cochin backwaters are under threat due to the release of both domestic waste and industrial effluents (CPCB, 1996, Martin et al., 2008 and Menon et al. 2000). Studies revealed the presence of acids, alkalis, suspended solids, fluorides, free ammonia, insecticides, dyes, trace metals and radioactive nuclei in Cochin backwaters (Kaladharan et al., 2011).

Vembanadu Backwaters, one of the largest estuaries on the coast of Kerala is struggling in the midst of pollution. The water quality of this aquatic ecosystem is under threat due to the various organic and inorganic pollutants of different origin (Nasir, 2010). In a study conducted by Planning Commission of India during 2008, revealed that waste materials and sewage disposal from the tourism field leads to the serious deterioration of the lake and water quality of the lake appears to be too bad for supporting any useful flora and fauna. Ashtamudi backwaters of Kollam District are also under threats of pollution. The major factor responsible for the deterioration of this ramsar site is pollution and encroachment. Rapid growth of industries, tourism activities near to the coastal are and basin without proper effluent and waste treatment facilities are serious issues. This estuary is facing critical deterioration of the physicochemical quality of water. Impact of coconut husk retting and sewage disposal from houseboats together with encroachment were also studied and reported by Babu et.al (2010). The heavy metal pollution and its impacts on water quality of Ashtamudi estuarine system has been documented (Razeena and Sherly 2014) .

Kappil backwater is a shallow brackish water system, which lies between 8°77'75.90" to 8°78'88.13"N latitudes and 76°67'58.48" to 76°67'68.83"E longitudes. The main fresh water inflows of this back water system is a small river called Ayiroor Puzha. Unlike the other larger river systems of Kerala, the 17 km. long Ayiroor Puzha originates at Navayikulam, a midland part of Kerala and flows in to the Edava Nadayara Kayal. Ithikkara River, which originate from the Western Ghats and flows down to the Parvur Kayal is also a contributing factor for the ecology of Kappil backwaters. The lake shares its shores to both Kollam and Thiruvananthapuram districts. It is connected to Paravur kayal by Maniyamkulam canal. A natural pozhi (bar mouth) can be seen here, which connects Kappil Backwaters to the Arabian Sea. But during summer months a sand bar is formed in between the lake and the sea. Two boat clubs operated by the district tourism promotion councils of Kollam and Thiruvananthapuram districts are functioning here and facilitates boating for tourists. Some part of this backwater is widely used for husk retting. These areas are apparently polluted and secrete a foul smell. This backwater is often used for fishing, retting, recreation, aquaculture etc.

Materials and Methods:

Location Map



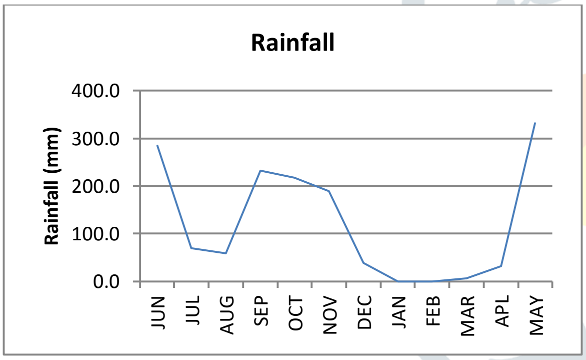
(Source: Survey of India, Poonkulam, Thiruvananthapuram)

To study the distribution pattern of water quality parameters of Kappil backwaters six stations were fixed. Rainfall data was collected for the study period from meteorological department to analyse the influence of rainfall in the distribution of physico-chemical parameters. Samples were analysed for physico-chemical (temperature, pH, electrical conductivity, turbidity, TDS, salinity, nitrite, nitrate, phosphate, DO and BOD The current study was carried to find out the distribution pattern of physico-chemical parameters in a tropical aquatic ecosystem. All the analyses were carried out following the standard methods (APHA, 2012).

Results & Discussion:

Rainfall data, obtained from meteorological department is presented in Figure 1. The study area received highest rainfall from the southwest monsoon. Highest rainfall of 331.9 mm was recorded in the month of May 2016. January, February and March 2016 were found as dry months with little or no little rainfall.

Figure 1



Water temperature: During the study period water temperature was ranged between 27.5°C to 32°C (figure 2). Maximum temperature was monitored during pre-monsoon season and minimum during monsoon season in all stations. Meera & Nandan (2010) reported minimum temperature during rainy season and maximum in summer months from Cochin backwaters. Similar distribution pattern of water temperature was also noticed by Satheesh et al., (2009) from Pondicherry Mangroves and by Geetha(1997) from Ashtamudy Lake. Water temperature is also depends on atmospheric temperature, geographic location, depth of the streams etc. Maximum temperature during May 2016 may be due to the solar radiation and stagnant condition of water.

Figure 2

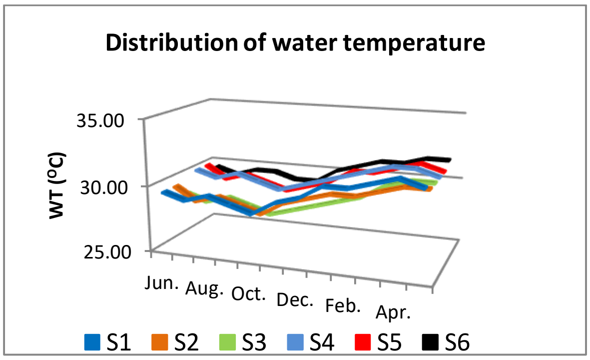
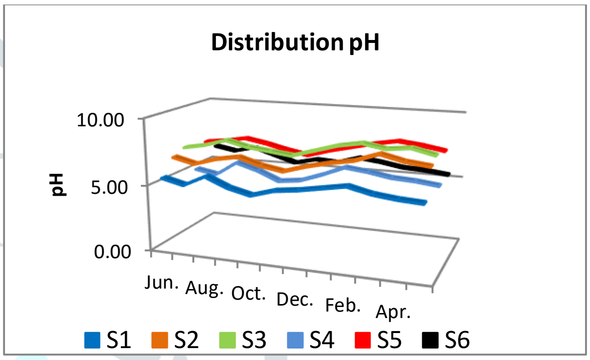
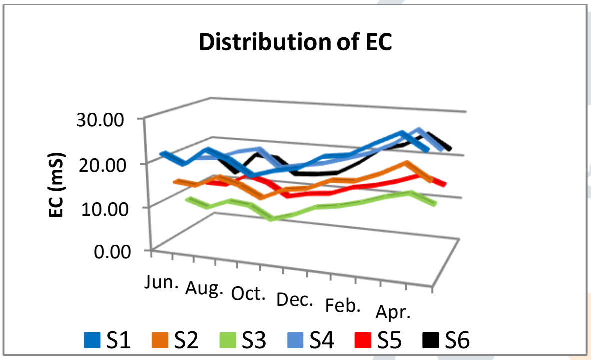


Figure 3



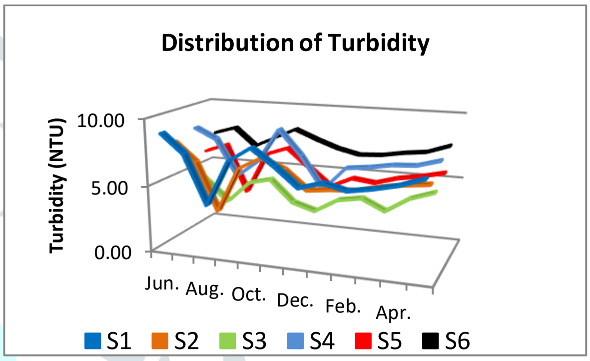
pH: pH is an important factor in water quality assessment and it indicates the acidic basic nature of the aquatic system (Koshy; 2013). Like other toxic substances pH also affects aquatic organisms (Rand and Petrcelli, 1985). In the present study it was found that there were a marginal variation in pH between stations and months. The highest value was measured in station III (8.4) during February 2016 and the lowest value was measured in station IV (4.6) during October 2015 (Figure 3). The highest annual mean was recorded in station III (7.7±0.45) and the lowest was in station IV (5.3±0.48). The highest monthly mean values were recorded in February (6.9±1.09), while lowest values were in October 2015 (5.9±0.94). The results of the analysis shows that stations II, III and V gained a better pH values while compared to other stations. Maximum pH values were found in summer months in all stations except station VI. Seasonal average values of pH showed a highest level during pre-monsoon period in first five stations. But station VI gained higher pH during monsoon season. pH values showed decreasing tendency from the beginning of southwest monsoon. From this result, it can be assumed that inflows from the surroundings with pollutants are the main reason behind the higher acidic pH nature of the Kappil backwaters. Large quantities of suspended humic materials transferred from rivers, streams and other land drainages to the estuarine environment could be resulted in to the lower water pH during monsoon season. This was reported in many earlier studies (AnilaKumary et. al. 2007, Meera; 2010, Jayachandran; 2011).

Figure 4



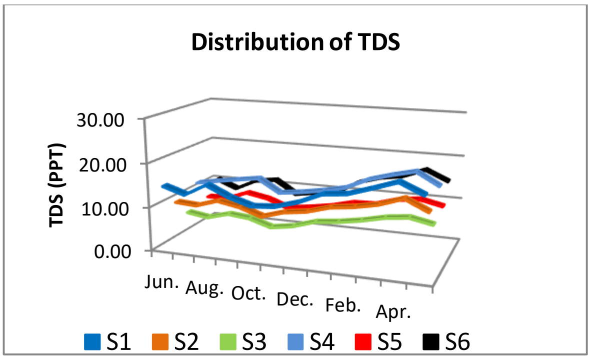
Electrical conductivity: It measures the capacity of water to transmit electricity. It is an indirect method to monitor the dissolved ionic substances in a water body as electrical current is transferred by the ions in water. The distribution of EC in the Kappil backwaters is presented in figure 4. All stations showed a parallel flow of EC. Highest values were recorded in station I and IV during the entire period of study. In the present study the highest value of EC was recorded in station I (29.87 mS) during April 2016 and it may be due to the heavy salinity and the accumulation of organic and inorganic materials, as it is the bar mouth of the estuary. Conductivity is directly proportional to the salt load in a water body and is an index of ionic content of the aquatic ecosystem (Olatayo. 2014). The lowest value was found in station III (6.06 mS) during October 2015. Higher values in all Stations were found during the summer months. Average annual mean was also very high in station I (23.31±3.38). Seasonal average values were also reached in its peak during pre-monsoon season in all stations and it may be due to the evaporation of water. Similar trend in the distribution EC was noticed by Mary Helen (2009) in Poovar estuary. Maximum and minimum EC values during pe-monsoon and monsoon was also reported from Ashtamudi backwaters by Seema (2015).

Figure 5



Turbidity: Maximum turbidity was monitored during October 2015 in station IV (8.70 NTU) and minimum in station II (2.90 NTU) during August 2015 (Figure 5). Water samples from Kappil backwaters were found more turbid during monsoon months. The re-suspension of bottom sediment by tidal stirring action during the monsoon season was documented by Thasneem (2016) from Cochin backwaters. Bijoy Nandan et. al. (2014) has also observed similar condition in Kodangallur-Azhikode estuary. Highest annual average mean value was observed in station I (6.68±1.33) and lowest in station III (4.39±0.91). Maximum monthly mean value was found during June 2015 (7.48±1.15) and minimum during December 2015 (4.85±1.30).

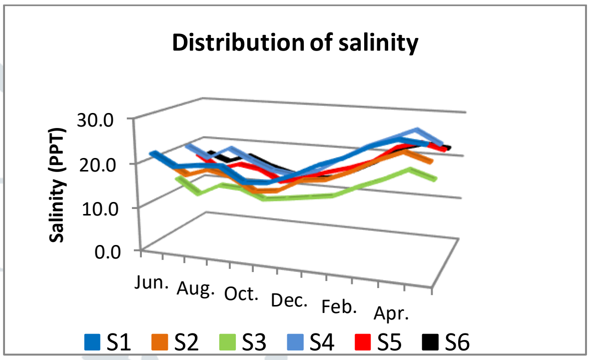
Figure 6



TDS: In the present study it was found that TDS followed the trend of EC in all stations. Results showed that it has been highly influenced by the rainfall. TDS broadly varied between 4.27 PPT (Station III) to 20.19 PPT (Station I) and is presented in figure 6. The lowest value of TDS was measured during October 2015 in all stations. The highest average annual mean was found in station 1 (15.45±2.55) and the lowest was found in station 3 (6.85±1.81). The effect of saline intrusion from the sea is very high at station I and it also contributes to the higher TDS values. Similarly in station IV, the saline water inflow from Paravur kayal is also affected the TDS values. Seasonal mean value of TDS was very high during pre-monsoon and low during monsoon months. Similar distribution trend was observed by Sumesh (2013) in Thekkumbhagom kayal of the Ashtamudi estuary. A lower TDS value during monsoon months is mainly due to the dilution of dissolved salts through fresh water influx. Similar pattern in TDS distribution was also observed by Koliyarans Rokade (2008) in Powailake, Mumbai and Soundarapandian et. al. (2009) in Uppanar estuary.

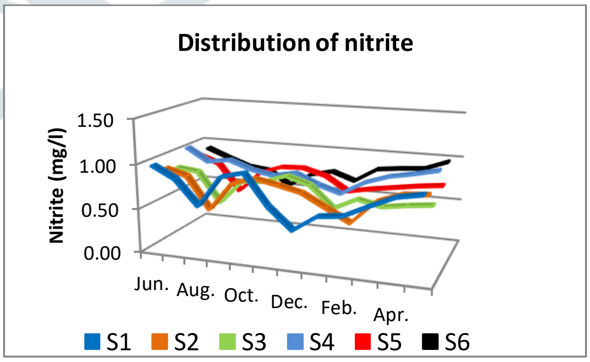
Salinity: The salinity level in Kappil backwaters broadly varied between 10.6 ppt (Station II) to 28.8 ppt (Station I) and is presented in Figure 7. Sumesh (2013) noted a salinity range of 12% to 34% in Thekkumbhagom kayal. Santhanam and Perumal (2003) in Vellar estuary showed a salinity range between 3% to 34%. In the present study the higher values of salinity recorded during non-monsoon months might be due to the limited fresh water inflows and high evaporation rate. The lower values were found during monsoon period and it may be due to the heavy inflow from rainfall. Fluctuations in salinity values between months among the study period showed that rainfall has a marginal influence on salinity.

Figure 7



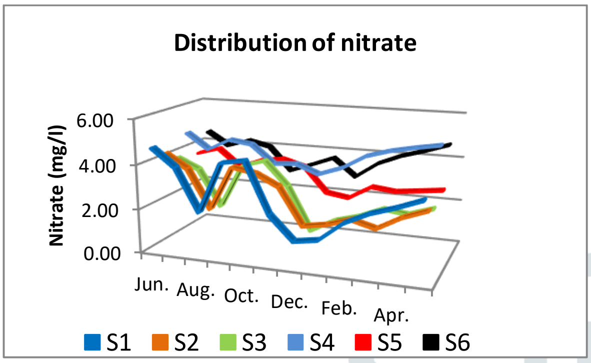
Nitrite: The distribution of nitrite in water samples of EdavaNadayarakayal ranged from 0.41mg/l to 1.02 mg/l. The highest value was recorded in station IV during June 2015. Highest average monthly mean value of nitrite was also recorded in June 2015 (0.92±0.07) and lowest in February 2016 (0.60±0.04).

Figure 8



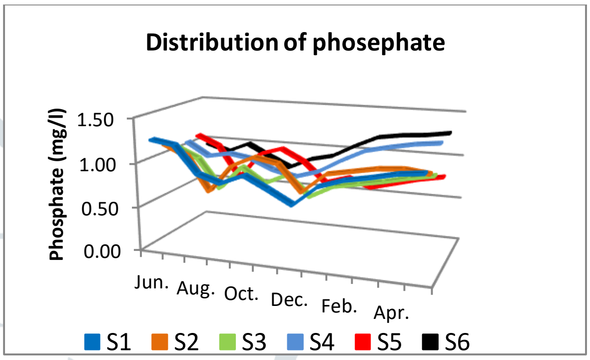
Highest annual mean value of nitrite was noticed in station IV (0.84±0.11) and lowest was recorded at station III (0.70±0.12). The average annual and monthly mean value of nitrite was recorded below 1 mg/l during the study period. Nitrite content was high during rainy season and trends to lower levels towards reaching summer months and it may be due to the lack of fresh water inflow. The same condition was noticed in Thengapattanam estuary by G. Anitha (2014). Higher values in monsoon and lower values in summer season was also reported by Karuppiah (2011), Prabu (2008) and Manikannan (2011).

Figure 9



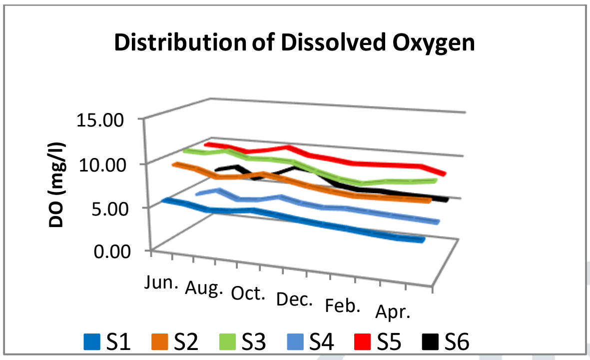
Nitrate: Generally nitrate content in the water samples ranged between 1.02 mg/l to 5.02 mg/l (Figure 9). Maximum value was recorded at station IV during May 2016 and minimum value was at station III during December 2015. Highest annual mean value was also recorded at station IV (4.27±0.55) and lowest was at station 3 (2.60±0.97). Likewise the distribution of nitrites, nitrates also showed hike in rainy months. Highest monthly mean value of nitrate was found during June 2015 (4.28±0.47) and lowest during December 2015 (2.16±1.11). Monsoon months recorded higher values in comparing with summer months. This means that the backwater gets heavy nitrate concentration from the nearby inflows. Water discharge from agriculture land such as paddy field, coconut plantation is also contributes to the higher nitrate values. Maximum nitrate value during monsoon and minimum value during pre-monsoon was reported by Soundarapandian et al., (2009). In Uppanar Estuary, Cuddalore. Similar conditions were also reported by Haridevi (2013) from Cochin backwaters. Domestic sewages and organic pollutants also have an effect on nitrate values. Station IV is a canal mounth which connects Kappil backwaters to Paravoor Kayal is a dumping yard of various organic and inorganic waste materials. Decomposition of such organic waste materials resulted to the higher nitrate values. Formation of nitrate through decomposition of organic waste materials was reported in Pennar estuary by Ravaniah et al., (2010).

Figure 10



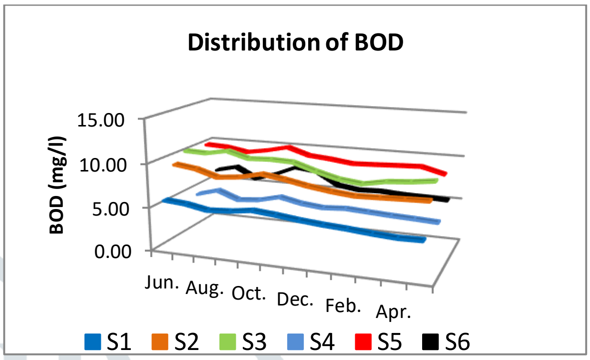
Phosephate: The observed variation of phosphate was ranged from 0.62 mg/l to 1.27 mg/l. Maximmum value was observed at station IV during may 2015 and minium value was found at station V during August 2015. Highest monthly mean value of phosphate was recorded in June 2015 (1.10±0.10) and lowest value was found during December 2015 (0.74±0.12). Highest average annual mean value of phosphate was found at station IV (1.01±0.16) and lowest was recorded at station 5 (0.82±0.16). Annual average mean value of phosphate was seen more or less similar in all stations. However slightly high concentration of phosphate values were recorded at station IV and VI. This may be due to the heavy retting activities in these stations. Maximum values were found during pre-monsoon season in all stations except station V. Station V gained maximum values during monsoon season. In all stations phosphate values showed an increasing tendency by the end of post-monsoon season. Increasing tendency of phosphate values during summer months may be due to the exchange of phosphorous between sediments and overlaying water. The low consumption of planktons and precipitating condition also contributes higher phosphate values during summer season. Such a condition was also noticed in the Edava Nadayara kayal by Madhukumar (1996).

Figure 11



Dissolved Oxygen: Dissolved oxygen (DO) is an important parameter in water quality analysis. It determines a water body's ability to support aquatic life. Water gets oxygen directly from atmosphere and also from the photosynthesis process of aquatic plants and algae. Depletion in DO can severely affect the aquatic organisms. Aquatic communities can't sustain where DO levels are too low (VEMM. 2006). DO also increase the self purification capacity of water. DO levels of water body decreased by respiration and decomposition of organic matter. Here in the study highest DO was noticed during August 2015 in station III (10.64 mg/l) and lowest value was found in station IV during May 2016 (3.88 mg/l). Average annual mean was high in station 5 (9.51±0.48) and was very low in Station 4 (4.39±0.38). Highest monthly average value was got in October 2015 (7.92±2.17) and the lowest was in May 2016 (6.46±2.33). Maximum DO values were obtained during monsoon season followed by post-monsoon and pre-monsoon. Similar observations were reported from Cochin backwaters by Bindu (2005). Maximum quantity of dissolved oxygen during the monsoon season due to the fresh water influx was also reported from Manakudy estuary, Kanyakumari (Kannappan. 2015). Decreasing tendency of dissolved oxygen during pre-monsoon months is mainly due to the increase in temperature and salainity. (Sastry, and Chandramohan, 1990).

Figure 12



BOD: BOD is the quantity of oxygen consumed by the microorganisms during the decomposition of organic matter. Measuring BOD is one of the easiest ways to assess the level of organic pollution (VEMM. 2006). Hike in BOD levels resulted to the depletion in the availability of oxygen and is harmful to the fish and many aquatic insects. The highest BOD value was found in station IV during April 2016 (12.5 mg/l) and the lowest value was found in station III during August 2015 (2.12 mg/l). The average annual mean value was very high in station IV (11.23±0.74) and the lowest average annual mean was noted in station III (3.59±0.80). Highest monthly average was noted in February 2016 (8.20±3.21) and lowest was in August 2015 (7.02±3.41). Throughout the period of study maximum BOD values were recorded in station I and II. Maximum BOD values during pre-monsoon season and minimum during monsoon was also reported from Dharma estuary (Prasanna and Ranjan. 2010).

Conclusion: All physical and chemical parameters in Kappil backwaters showed significant variation between stations, months and seasons. pH values were found very low in three stations throughout the period of study. Lower pH in station I & IV might be due to the accumulation of waste materials. Intense retting activity was resulted in to the lower pH in station VI. Maximum EC levels in station I & IV were mainly due to the heavy saline intrusion. Amongst 6 sampling stations 3 stations recorded poor water quality and these three stations gained maximum nutrient values. Dissolved oxygen level was recorded better values in station II, III and V. The present study revealed the varying degree of water quality parameters of Kappil backwaters and showed deterioration level of a tropical brackish water aquatic ecosystem.

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