Asian Journal of Advances in Research

11(4): 126-135, 2021

COMPARATIVE STUDY ON THE ALTERATIONS OF HYDROGRAPHICAL FEATURES OF ANJARAKANDY RIVER, KANNUR DISTRICT, INDIA

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AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Received: 04 September 2021
Accepted: 13 November 2021
Published: 16 November 2021

Original Research Article

ABSTRACT

Growing needs of human societies, had caused significant river alterations and ecosystem changes that had resulted in the contamination, biodiversity loss and general riverine ecosystem degradation. The Anjarakandi River is one of the two major rivers that flows through the Kannur District of Kerala in India. The river originates from the slopes of the Western Ghats bordering Wayanad and Kannur districts. The Anjarakandy river originates from the Kannoth Reserve Forest. The study of different water quality parameters helps in understanding the metabolic events of the aquatic system. Certain parameters such as Turbidity, pH, Temperature, Hardness, Chemical oxygen demand, Carbon dioxide, Salinity, Ammonia, Dissolved oxygen are necessary for the understanding of flora and fauna abundance and distribution with time. The present study indicated the variations of certain physico-chemical parameters of selected four stations of Anjarakandy River namely station 1 (Bavode), station 2 (Odakkadavu), station 3 (Peralassery), station 4 (Mambaram) with respect to two seasons. Salinity range indicates the concentration of chlorides. Moderately high level of salinity was observed in pre monsoon. Ammonia content was maximum in pre monsoon and minimum during post monsoon season. This may be due to saltwater intrusion and sand mining along the streams of the river. Construction of dams and impounding of reservoirs in the upstream sections for drinking water, irrigation and hydroelectric projects are most common human interventions on river systems. The study points out the need for judicious exploitation of resources without any damages that would definitely interrupt the sustainable ecological balance.

Keywords: Salinity; degradation; physico-chemical parameters; sustainability.

1. INTRODUCTION

Rivers, the icons for human civilization and culture, the natural corridors for energy, matter and species and the immediate source of freshwater for man, represents the very important life and dynamic systems. Progress of civilization, growing urbanization and apparent decline, indirect dependence of human being on river systems had contributed to changing perspective in the use of river resources. Interfering within river's domain has a long history, perhaps as old as human civilization itself. Today, many of the world's rivers and catchments are degraded due to intensive human impacts including damming, diversions, storages, clearing of vegetation and other habitat removal, introduction of invasive species and pollution.

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The river Anjarakandy is flowing through the Anjarakandy in Kannur district.It originates from Kannoth at 600m.The major tributaries of this river include KappuThodu and Idumba Thode. Average annual rainfall in this area is 3500mm.Navigable length of the river is 46 km that spread over nearly 200 acres,the cinnamon valley on the banks of the Anjarakandy river is the largest cinnamon plantation. In case of agricultural settings, river ecosystems are experiencing increased nutrient and sediment loads, altered flows, and habitat degradation, whereas in urban dominated areas, there are municipal drainage, industrial effluents, sewage discharge, waste water flow, increased impervious surfaces and infrastructural constraints on river channels which have led to the injection of chemical pollutants, river flow modification, and system instability. Besides, there are excessive sand mining from river bed and increasing exploitation of water for various purposes. All these activities together had caused irreparable damage to the riverine ecosystem. Now the situation has been so alarming that the river restoration is considered as an important task to be accomplished urgently with due care. The river restoration is primarily a series of activity meant to 'protect and rehabilitate the physical and biotic processes of a river in a way that is conducive to the progression of ecosystems towards their natural state' [1]. Rivers in Kerala are under stress due to large scale human intervention,that can be broadly categorised into two: (i) direct and (ii) indirect interventions [2]. Construction of dams and impounding of reservoirs in the upstream sections for drinking water, irrigation and hydroelectric projects are the most common human interventions on river systems. Kerala does not have sufficient reserves of construction grade sand. River-beds are continuously mined for sand. It has been reported that annual sand mining from the seven rivers debouching into the Vembanad lake was 6.63 million m3 against natural replenishment of 0.086 million m3 in the storage zone [3].

From the perusal of literature, it was found that not much was known about the physico-chemical analysis of Anjarakandy river. The river originates from the slopes of the Western Ghats bordering Wayanad and Kannur districts. The 48 km long river flows in the western direction emptying into the Arabian Sea at Dharmadom.Kannur district is mainly drained by the Valapattanam and Anjarakandy rivers. The drainage area of the river in Kerala is 1321 sq.km. In this context, the present study deals with the assessment of certain physico-chemical parameters of Anjarakandy river that would form a reminder to impart the need to conserve this fascinating ecosystem. Water samples were collected from four different sites of Anjarakandy River. These regions were facing threat due to high anthropogenic activities. The regions selected for study are:1.Bavode 2.Odakkadavu 3.Peralassery 4.Mambaram.

2. MATERIALS AND METHODS

The Anjarakkandy river originates from Kannoth forests (600 m height) in Thalasseri taluk and passes through Kannavam, Kadamkunnu and Vemmanal before it joins the Lakshadweep Sea. The main

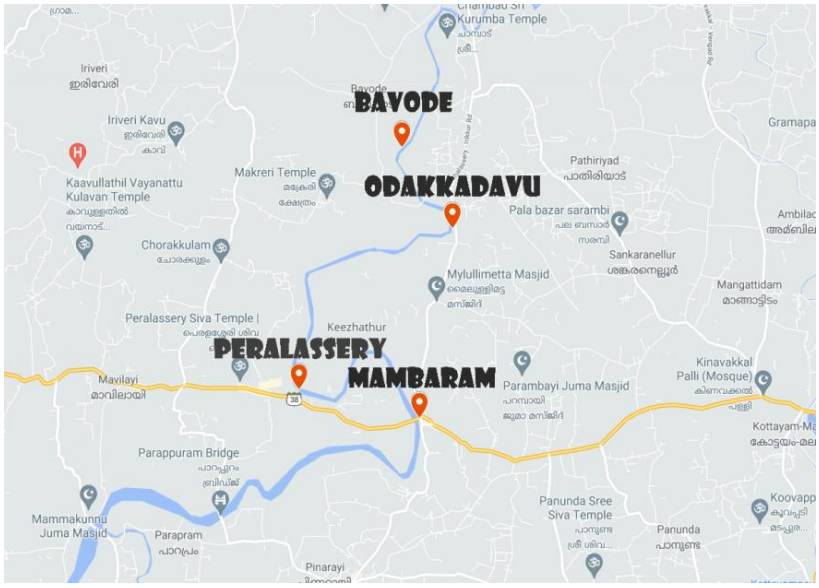

Image 1. Map showing the selected study sites in Anjarakandy River

tributaries are Idumbathodu and Kapputhodu. The river has a total length of 48 km, and the navigable length is about 27.2 km. Water samples were collected during the year 2020-2021 during pre-monsoon and post-monsoon season from the study area and the physico-chemical parameters were analysed by standard methods [4]. The Anjarakandy River is one of the two major rivers that flow through the Kannur District of Kerala, India. The river originates from the bottom of Kutimalai in the protected forest areas of Kannur district. The cinnamon valley spread over nearly 200 acres on the banks of the Anjarakandy *river* is considered to be the largest cinnamon plantation in Asia. The water samples were collected in clean plastic containers of 2-litre capacity and transported to the laboratory for doing physico-chemical analysis [4].

2.1 Station 1(Bavode)

Bavode is a small Village/hamlet in Edakkad Block in Kannur District of Kerala State, India. It comes under Anjarakandy Panchayath. It belongs to North Kerala Division. It is located 13 km towards East from District headquarters Kannur. It is near to Arabian sea. The river is the major source of water for agriculture. It also shares aesthetic value for boating. It is surrounded by thick vegetation like coconut tree, fields etc. Children usually spend their time in fishing and swimming. During summer season people from nearby houses wash clothes.

Image 2. Showing the vegetation at BAVODE

2.2 Station 2(Odakkadavu)

Odakkadavu is a small village situated in Kannur district. It is surrounded by coconut palms. People usually dumps plastic bottles from nearby shops. There is a local tobacco manufacturing building in the banks of river. Vegetation is seen opposite bank of river.

2.3 Station 3(Peralassery)

Peralassery is a Panchayath and a census town in Kannur district in the Indian state of Kerala, on the bank of Anjarakandy river.The hanging bridge of Peralassery is a notable tourist attraction. Built across the Anjarakandy river, this is one of the few hanging bridges in Kannur district. The nearest town and railway stations are Thalassery which is 14 km (8.7 mi) and Kannur which is15 km (9.3 mi) away. It is thickly vegetated area. It is best place for fishing.

Image 3. Showing the vegetation at Odakkadavu

Image 4. Hanging bridges at Peralassery

2.4 Station 4(Mambaram)

Mambaram is a small town situated on the shores of Anjarakandy river in Thalassery taluk, Kannur district, Kerala state, South India. It is a thickly populated town. A new bridge has constructed across the river and opened in 2021. Underwater foundation is constructed in river more than one year, blocking the flow of water, which will cause a serious threat to ecosystem.

Image 5. Showing new bridge construction at Mambaram

3. RESULTS

The study of physico-chemical parameters of selected four stations of Anjarakandy river, station 1 (Bavode), station 2 (Odakkadavu), station 3 (Peralassery), station 4 (Mambaram) of two seasons were analysed and compared. The physico-chemical parameters of each stations exhibited variations in each period.

3.1Temperature

Based on it, the temperature showed a minimum range of 28^{o}C and exhibited maximum range of 33^{o} C. All these stations showed an average temperature range from 28^{o} C – 33^{o} C. There was only a slight variation in temperature. A high range of temperature in pre monsoon season was observed in station 4(33^{o}C) and low range was showed in station 1(31.2^{o}C). The temperature of water sample in the post monsoon period ranges from 28^{o}C to 29^{o}C (Table 1 and Fig. 1). The mean ± standard deviation ranges from 28.45 ± 0.45 to 31.95 ± 0.66.

3.2 pH

pH range was slightly acidic and neutral in nature in all stations in all seasons. From the study, in pre-monsoon and post-monsoon season shows the same pH. The pH ranged from 6.5 to 7. A higher level of pH was observed in station 2 and 4 (7) and lower pH level in station 1 and 3 (6.5). The average range of pH in all these seasons ranged from 6 to 6.01 (Table 1 and Fig .2). In pre monsoon period mean± standard deviation was about 6.75 ± 7. In post monsoon period mean ± standard deviation was about 6.75 ± 7.

3.3 Transparency

Transparency range showed variations in all the seasons. Maximum transparency value was noticed about 112cm in station 4 of post monsoon season. The minimum range was 81.5cm in station 3 of pre monsoon season. The average range of transparency was 91.25 to 100.25cm. In pre monsoon season the transparency of water range from 81.5 to 112cm, high range of transparency was shown in station 4 (111.5cm) and lowest was obtained in station 2 (81.5cm). Transparency of water in post-monsoon season ranged from 85 to 112cm. A high range of transparency was shown in station 4 (112cm) and lowest was observed in station 1 (85cm) (Table 1 and Fig. 3). The mean ± standard deviation was about 91.25 ± 11.91 to 100.25 ± 9.93.

3.4 Salinity

Salinity of water sample in the pre-monsoon season ranges from 118.406 mg/ml to 1318.167 mg/l. Maximum range was obtained in the station 4 (1318.167 mg/l) and minimum range obtained in station 1(118.406 mg/l). Salinity of water sample in the post-monsoon season range from 28.824 mg/l to 1234.983 mg/l. Maximum range was observed in station 4 (1234.983 mg/l) and minimum range observed in station 1 (28.824 mg/l) (Table 1 and Fig. 4). The range of mean ± standard deviation was about 491.93 ± 488.82 to 395.15 ± 492.61.

3.5 Carbon Dioxide

Carbon dioxide of water sample in pre-monsoon season ranges from 1.76 mg/ml to 5.28 mg/ml. Maximum range in station 4 (5.28 mg/l) and minimum range was observed in station 2 (1.76mg/l). Carbon dioxide of water sample in post monsoon season range from 4.4 mg/ml to 9.68 mg/l. Maximum range was observed in station 4 (9.68mg/l) and minimum range observed in station 2 (4.4mg/l) (Table 1 & Fig. 5). The maximum range of mean ± standard deviation was found in post monsoon period (6.82 ± 1.905) and minimum range was observed in pre monsoon period (3.74 ± 1.301).

3.6 Ammonia

Ammonia of water sample in the pre-monsoon season ranged from 25.5 mg/ml to 51 mg/ml. Maximum range was observed in the station 4 (51 mg/l) and minimum range obtained in station 1 (25.5 mg/l). In monsoon season the maximum range was observed in station 3 (55.5 mg/l) and minimum range obtained in station 4 (38 mg/l). Ammonia of water sample in the post monsoon season range from 17 mg/ml to 42.5 mg/ml. Maximum range was observed in station 4 (42.5 mg/ml) and minimum range was obtained in station 2 and 3 (17 mg/ml). Maximum range of standard deviation was observed in post-monsoon season (10.41) and minimum range in pre monsoon period (9.503) (Table 1 and Fig 6). In pre monsoon period the mean ± standard deviation was observed to be nearly 38.25 ± 9.503. In post monsoon period the range of mean ± standard deviation was about 25.5 ± 10.41.

3.7 Chemical Oxygen Demand

Chemical Oxygen Demand of water sample in pre monsoon season ranges from 1.6 mg/l to 3.2 mg/l. Maximum ranges was obtained in station 1 and 3 (3.2 mg/l) and minimum was obtained in station 2 and 4 (17.7 mg/l). Chemical oxygen demand of water sample in post monsoon season ranges from 1.6 mg/l to 4.8 mg/l. Maximum range was observed in station 3 (4.8 mg/l) and minimum range was observed in station 4 (1.6 mg/l) (Table 1 & Fig. 8). The mean ± standard deviation was range from 2.4 ± 0.8 to 3.2 ± 1.13.

Table 1. Seasonal variations of physico- chemical parameters

PARAMETERS	SEASONS	STATION 1	STATION 2	STATION 3	STATION 4	MEAN±SD
Temperature ^{O}C	Pre monsoon	31.2	32	31.6	33	31.95±0.66
	Post monsoon	28	28.8	28	29	28.45±0.45
pH	Pre monsoon	6.5	6	5.5	5	5.75±0.55
	Post monsoon	7	7	6.5	6	6.625±0.41
Transparency (cm)	Pre monsoon	84	88	81.5	111.5	91.25±11.91
	Post monsoon	85	99	105	112	100.25±9.93
Salinity (mg/ml)	Pre monsoon	118.406	140.801	390.352	1318.167	491.93±488.82
	Post monsoon	28.824	60.817	255.979	1234.983	395.15±492.61
Carbon dioxide (mg/ml)	Pre monsoon	3.52	1.76	4.4	5.28	3.74±1.301
	Post monsoon	6.16	4.4	7.04	9.68	6.82±1.905
Ammonia (mg/ml)	Pre monsoon	42.5	34	25.5	51	38.25±9.503
	Post monsoon	25.5	17	17	42.5	25.5±10.41
Dissolved oxygen (mg/ml)	Pre monsoon	5.74	3.4	2.4	3.04	3..65 ±1.52
	Post monsoon	6.08	5.44	5.44	3.68	5.16±0.89
COD (mg/ml)	Pre monsoon	3.2	1.6	3.2	1.6	2.4±0.8
	Post monsoon	3.2	3.2	4.8	1.6	3.2±1.13

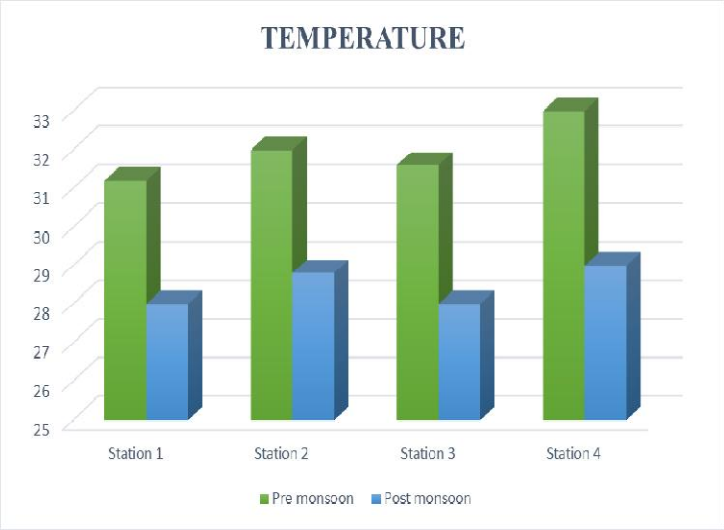

Fig. 1.Graph indicating temperature variations

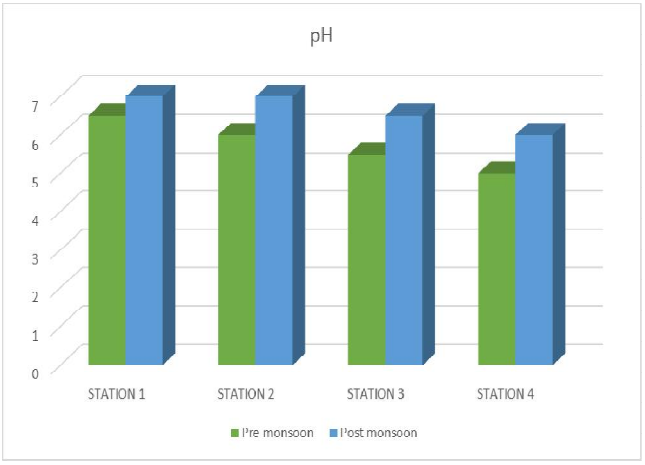

Fig. 2. Graph indicating pH variations

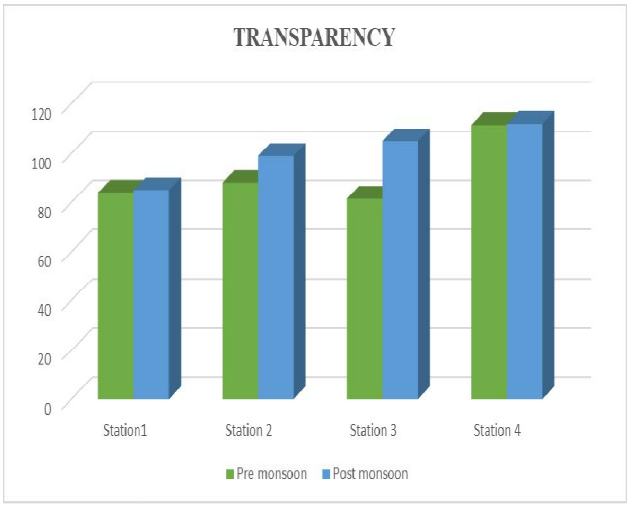

Fig. 3. Graph indicating transparency variations

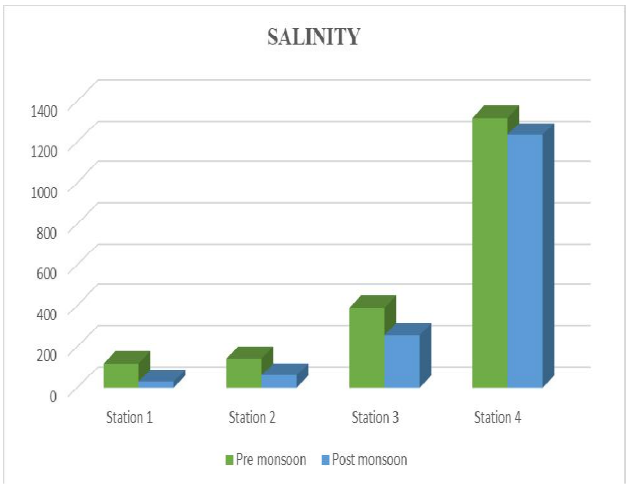

Fig. 4. Graph indicating salinity variations

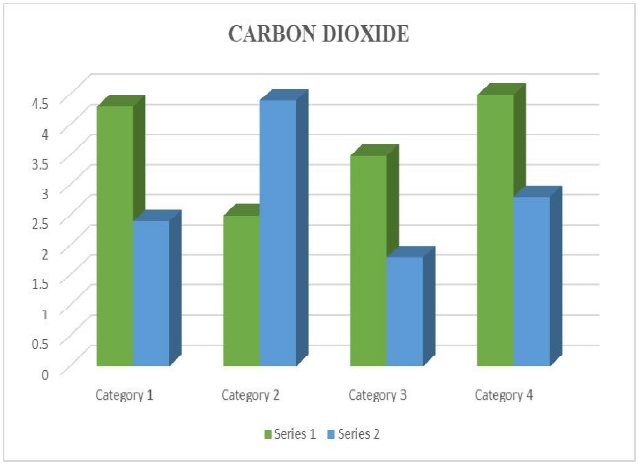

Fig. 5. Graph indicating CO_2 variations

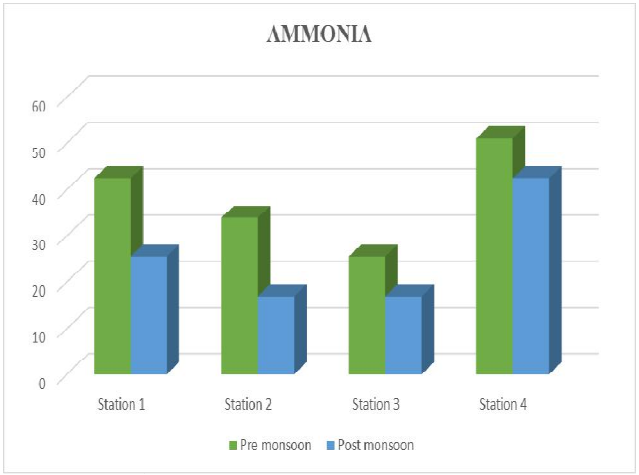

Fig. 6. Graph indicating ammonia variations

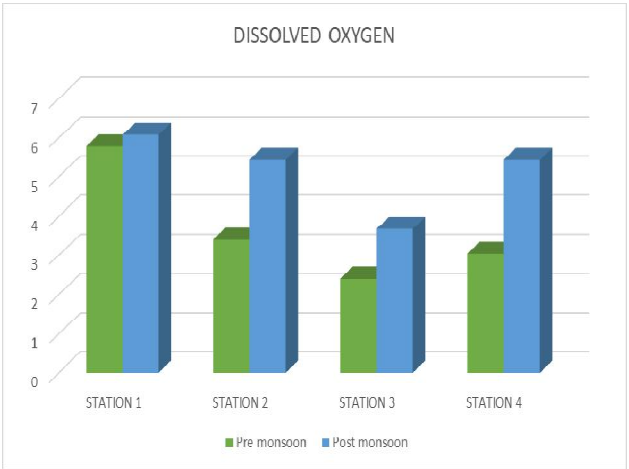

Fig. 7. Graph indicating DO variations

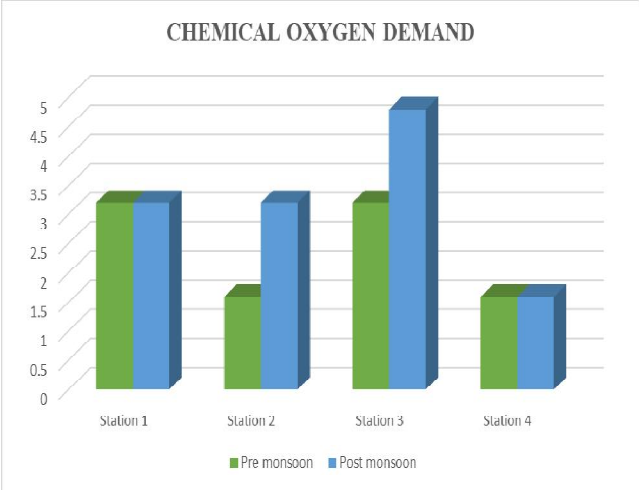

Fig. 8. Graph indicating COD variations

4. DISCUSSION

Temperature has an important role in physical, chemical, and biological properties of water. Temperature has direct influence on aquatic biota. The water quality may depend on the changes in temperature [5]. All living organisms have an optimum temperature for their better survival. The temperature ranged between 28^0C-33^OC. The maximum temperature was recorded on pre monsoon period and minimum during the post monsoon. Considering the four stations, highest temperature was observed in station 4 (33^OC) during the pre-monsoon season. Presence of rich vegetation will reduce the temperature. Water temperature controls the rate of all chemical reaction; affect the fish growth, reproduction and immunity [6].

pH is one of the physical properties of water. All the aquatic organisms have an optimum pH known as minimum pH. A slight variation in the pH can change the acidity or basicity of water. According to the WHO (2003) normal pH range of the water should be between 6.2-8.5. In the present study all stations showed acidic pH. Acidic pH affects the photosynthetic activity (Zahid *et al*., 2016). High organic content will tend to decrease the pH. Most metals will become soluble in acidic pH which negatively affects the health of the organisms (Sujitha *et al.,* 2012). The maximum pH was recorded in station 1 and 4 during the pre-monsoon and post-monsoon period.

Transparency is the measurement of light penetration in the water body. Due to the presence of suspended solids like silts, clays, industrial waste, sewage will cause the transparency in water. Light penetration in to the bottom of the water surface will be prevented by the transparent condition of the water which affect the benthic organisms and primary productivity (Gopalkrushna, 2011). The average range of transparency was 81.5 cm-112 cm. The maximum range of transparency was recorded in station 4 (112 cm) during the post monsoon period and minimum range was recorded in station 3 (81.5 cm) during the pre-monsoon period.

Salinity determines the salt concentration in the water. Increased salt content water will not be used in drinking or irrigation (WHO, 1997). Maximum range of salinity was recorded in station 4 (1318.167mg/l) during the pre-monsoon period and minimum during post-monsoon period. Flocculation of fine materials allows more penetration of salts in to the water.

Carbon dioxide is essential for the photosynthetic activity and aquatic vegetation. It is also required for the phytoplankton. By the process of decomposition and respiration carbon dioxide is formed. Carbon dioxide depletion will affect the aquatic ecosystem. Fish diversity and aquatic biota are adversely affected [5]. The maximum carbon dioxide range was recorded in station 4 (9.68mg/ml) of the post monsoon period and the minimum range was recorded in station 2 (1.76 mg/ml) of pre-monsoon period. Carbon dioxide will affect the aquatic pH. It will result in the formation of carbonic acid and cause changes in water equilibrium [7].

Ammonia is released in to the water by organic decomposition and also by the metabolic waste of aquatic organisms. The conversion of organic nitrogen in to inorganic ammonia is called ammonification or mineralization and is brought

about by heterotrophic bacteria, actinomycetes and fungi [8]. The maximum range of ammonia was observed in station 1 (51mg/l) during pre-monsoon period. The minimum range was obtained in station 2 and 3(17 mg/l).

For indicating the water quality and organic pollution, dissolved oxygen is an important parameter. Large fish population depends the minimum amount of dissolved oxygen. Dissolved oxygen level below 3 mg/l leads to the death of fishes and affects the reproduction and spawning. Low level of dissolved oxygen directly affects the fish community [9]. House hold wastes are the main source of the pollution.

Chemical Oxygen Demand of water sample in pre-monsoon season ranged from 1.6 mg/l to 3.2 mg/ml. Maximum range was obtained in station 1and 3 (3.2 mg/l) and minimum was obtained in station 2 and 4 (1.6 mg/l). Chemical oxygen demand of water sample in post monsoon season ranged from 1.6 mg/l to 4.8 mg/l. In post-monsoon season the maximum range was observed in station 3 (4.8 mg/l) and minimum range was observed in station 4 (1.6 mg/l).

5. CONCLUSION

The present study indicated the seasonal variations of physico-chemical parameters of selected four stations of Anjarakandy River namely station 1 (Bavode), station 2 (Odakkadavu), station 3 (Peralassery), station 4 (Mambaram). The study indicates that there was a pronounced variation of most of the water quality parameters with variation in season. The temperature range was high in pre monsoon period and minimum during the post monsoon season. pH was slightly acidic to neutral in all stations of all seasons. Pre-monsoon and post monsoon season showed similar range of pH. Moderately high levels of transparency were observed in post monsoon period. Salinity range indicates the concentration of chlorides. Moderately high level of salinity was observed in pre monsoon. Carbon dioxide content will affect the pH range. Increased carbon dioxide affects the pH which affects the biota of that region which was observed during post-monsoon season. Ammonia content was maximum in pre monsoon and minimum during post monsoon season. The quality of fresh water is vitally important. We depend on surface and ground water sources for our drinking water. We also need water to generate energy, to grow crops, to harvest fish, to run machinery, to carry wastes, to enhance the landscape and for a great deal more. Many human activities and their by – product have the potential to pollute water. Pollutants from such activities may enter surface or ground water directly, may move slowly within the ground water to emerge eventually in surface water, may run off the land or may be deposited from the atmosphere. In recent days water pollution is due to the alteration in physical, chemical and biological characteristics which may lead to harmful effect on human and aquatic biota. 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 areas are polluted because of the high amount of the waste accumulation. Polluted conditions will equally affect both the human being as well as the other living organisms. It will cause harmful effect on our environment. There are numerous causes including increasing number of industries and various other anthropogenic activities in the neighbouring regions, global climatic changes that lead to the degradation of the quality of water. This study will be helpful for finding the important values of our natural recourses and will remind the need for conserving the biodiversity. The study will help to remind the need for conservation of water bodies. It is important that a concerted effort is made to address the issues related to sustainability of the Anjarakandy River by considering the ecosystem deterioration as a component of a suite of anthropogenic activities.

ACKNOWLEDGEMENT

The author is extremely grateful to the PG & Research Department of Sree Narayana College, Kannur for the facility rendered during the tenure of the work.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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