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STUDIES ON THE PHYSICO-CHEMICAL PARAMETERS TO ASSESS THE WATER QUALITY OF RIVER MAMPUZHA

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ABSTRACT

Aim: *The present investigation is an attempt to study the effect of pollutants in River Mampuzha for a period of three seasons.* ***Methods:*** *In this study Physicochemical parameters of surface water collected from eight different points (S1 to S8) on River Mampuzha were analyzed during rainy season (June-September), winter season (October-January) and summer season (February-May) of 2017-2018 to determine its water quality using standard methods.* ***Results:*** *The water P^H was found to range from 6.81 to 7.60 with a mean temperature range of 16-19^{0}C. Other physicochemical parameters monitored including total suspended solids, total dissolved solids, biochemical oxygen demand and chemical oxygen demand values exceeded the recommended level for surface water quality.* ***Conclusion:*** *It was inferred that the Mampuzha river is polluted by industrial effluent, sewage water and agricultural waste and is unsafe for human and animal consumptions.*

KEY WORDS

Mampuzha river, Physicochemical, Pollution, Water quality.

INTRODUCTION

Water is the most precious of all resources in the lifeline of all living organisms on earth. Rivers are an important part of earth's life cycle. They play an efficient and prominent role in sculpting earths topography by carrying huge quantities of water from land to sea. Rivers are the most important freshwater resources for man. Unfortunately, river waters are being polluted by indiscriminate disposal of sewage, industrial waste and increased human activities, which affects their physicochemical characteristics [1]. Pollution of the aquatic environment is a serious and growing problem. Increasing numbers and amount of industrial, agricultural and commercial chemicals discharged into aquatic environment have led to various deleterious effects on aquatic organisms including fish, accumulates pollutants directly from contaminated water and indirectly via the food chain [2,3]. The quality of water is usually determined by its physicochemical characteristics. It is well established fact that domestic sewage and industrial effluent discharged into natural water result in deterioration of water quality and cultural eutrophication [4]. The other important sources of water pollution include mass bathing, disposal of dead bodies, rural and urban waste matters, agricultural runoff and solid waste disposal [5]. The quality water is directly related to health and is important for determination of water utility, it is very essential and important to test the quality of the water before it is used for drinking, domestic, agricultural or industrial purposes. The utility of river water for various purposes is governed by physicochemical and biological quality of the water [6].

The Kerala State is blessed with 44 Rivers, however many of these are under threat due to anthropological activities like encroachment, sand mining, degradation of river banks, construction of bunds across the rivers and pollution. According to the report on "Environmental monitoring programme on water quality, 2012" by Kerala State Council for Science,

Technology and Environment, most of the rivers in Kerala shows evidences of organic pollution and biota is facing stress because of this [7].

Thus, Mampuzha River is extensively used for domestic, recreational, drinking and irrigation purposes in the area. To the River different municipal wastes are being disposed, cars are being washed, mostly children are using on it for showering and drink from the river. Therefore, there is a need for continuous monitoring of the pollutants load in this river water so as to safeguard public health treats from using this water. Thus, the present paper tries to focus on the physicochemical quality of Mampuzha River water and effect of pollutants.

1.1 Study area

The study was carried out in Mampuzha River, Kozhikkode, Kerala. Various samples were collected from the station kuttikattoor (sation1), Kannamchinnupalam (Station 2), Kunnathupalam (sation3), Palathum kandikadavu (Station 4), Kaduppini bridge (Station 5), Odumbra (Station 6), Mankav bridge (Station 7), Kallai (Station 8). The study was carried out in pre-monsoon (February-May), monsoon (June-September) and post-monsoon (October-January). Surface water samples were collected from the sampling stations.

Table 1. Surface water sampling locations of Mampuzha river basin.

S.NO	Stations	Latitude	Longitude
1	Kuttikattoor	N 11^0 25.75’	E 75^0 86.853’
2	Kannamchinnumpalam	N 11^0 24.857’	E 75^0 85.182’
3	Kunnathupalam	N 11^0 22.573’	E 75^0 83.467’
4	Palathumkandikadav	N 11^0 22.803’	E 75^0 82.064’
5	Kaduppini bridge	N 11^0 22.958’	E 75^0 80.919’
6	Odumbra	N 11^0 23.311’	E 75^0 80.543’
7	Mankav bridge	N 11^0 23.410’	E 75^0 80.362’
8	Kallai	N 11^0 23.670’	E 75^0 79.570’

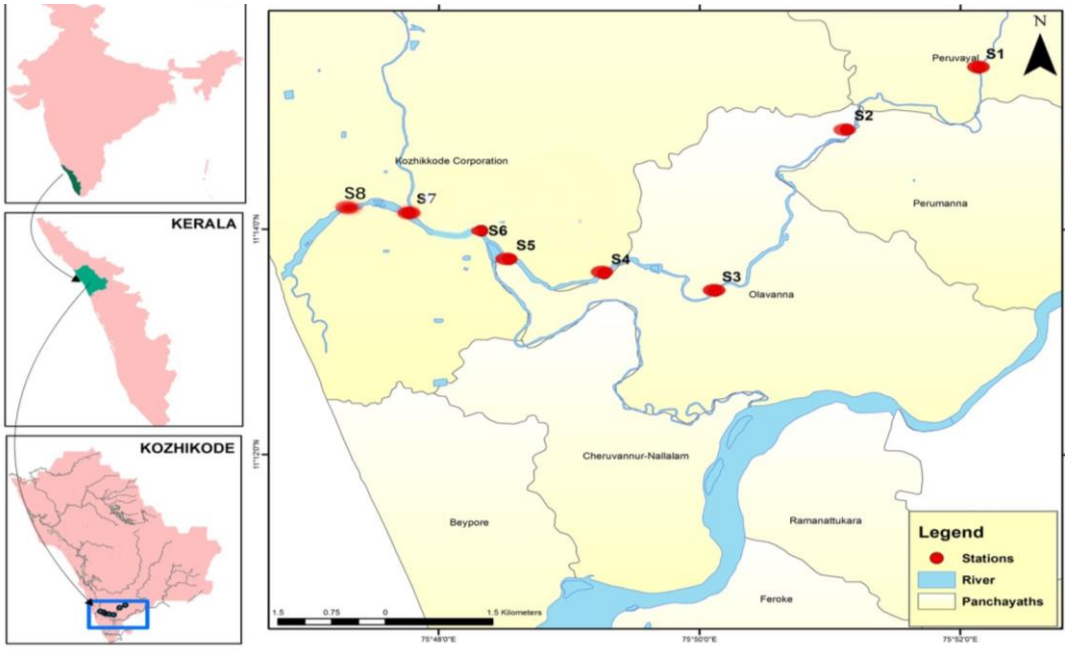

Figure 1: Map of the study area with water sampling sites, Mampuzha river, Kozhikkode

1. MATERIALS AND METHODS

2.1 Sample collection

Physicochemical parameters of water samples collected from eight different points on River Mampuzha were analyzed during pre-monsoon (February-May), monsoon (June-September) and post-monsoon (October-January) 2016. The samples were collected in-airtight plastic containers and transported to the laboratory where they were subjected to different analyses.

2.2 Temperature (T): The temperature is measured by using mercury filled Celsius thermometer with an accuracy of 0.1ºC.

2.3 pH: The pH is determined by Elico, model LI.120 Digital pH meter which gives direct value of pH.

2.4 Electrical Conductivity (EC): The conductivity is determined by using digital conductivity meter. The Conductivity meter used is Lavibond made Senso Direct Con.200.

2.5 Total suspended solids (TSS): Whatman filter paper rinsed in distilled water was dried in an oven at 105˚C for one hour and cooled in a desiccator. Its weight (W1) was determined using a weighing digital balance. 100 ml of water sample was filtered through the paper and dried at 105˚C for one hour. The weight (W2) of filter paper containing the residue was recorded and the total suspended solids calculated using (W2 − W1) × 100 mg/l.

2.6 Total dissolved solid (TDS): The 50 ml of water sample is filtered through ordinary filter paper and water is collected in the evaporating dish of known weight. Further it is heated and water is totally evaporated. Dissolved solid matter is present in the sample gets accumulated at the bottom of evaporating dish. The evaporating dish is cooled and weighed. By weight difference method the total dissolved solid is determined.

2.7 Total Alkalinity (TA): Total alkalinity were determined by titration methods [8]. To 50 ml of the water samples in clean 150 ml conical flask were added 3 drops of phenolphthalein indicator. The samples were titrated with 0.05 M H_2SO_4, until the colour disappeared. To the colorless solution, 3 drops of methyl orange indicator were added and titrated further until the color change from yellow to permanent reddish or orange red colour and the titre values were recorded and used to compute the alkalinity.

2.8 Total Hardness (TH): The water sample was thoroughly shaken and 25 ml was taken and diluted to 50 ml with distilled water. 2 ml of Phosphate buffer solution was added to bring the pH of the water sample to 10. Three drops of eriochrome black indicator was also added. This was titrated with 0.01 mol/L EDTA to a blue colour end point. Hardness was then calculated as in APHA,2005.

2.9 Dissolved oxygen (DO): Dissolved Oxygen was determined using Azide modification of Winkler's method [8]. 200 ml of water sample was carefully transferred into a 300 ml BOD bottle. 1 ml of manganese sulphate solution was added followed by 1 ml of alkaline azidade reagent. The resulting mixture was titrated against 0.025 N sodium thiosulphate to the end point where there was colour change. The titre value was recorded as DO.

2.10 Biochemical oxygen demand (BOD): Biochemical Oxygen Demand was determined using Azide modification of Winkler's method. The procedure in determining dissolved oxygen above was repeated and the DO recorded on day one was named Do. Another BOD bottle was similarly prepared and incubated at 20˚C for 5 days in the dark. On the completion of 5 days, the bottle was decanted of water and to the precipitate was added 2 ml of orthophosphoric acid. This was shaken gently and titrated with sodium thiosulphate to the end point where there was change in colour. The titre value was recorded as dissolve oxygen on day five (D5). BOD was then calculated as difference between the dissolve oxygen on day one and that on day five.

2.11 Chemical Oxygen Demand (COD): Chemical Oxygen Demand was determined as described in Standard Methods [8]. To 50 ml of the water sample in a reflux flask was added 10 ml potassium dichromate solution with 1g mercuric sulphate and thoroughly mixed. Four sterile glass beads were added to control the boiling of the solution. 10 ml concentrated sulphuric acid containing silver sulphate was added carefully through the open end of the condenser and mixed by swirling. The reflux apparatus was ran for 1 hour and allowed to cool. The flask was removed and its content diluted to 150 ml with distilled water. To the resulting solution was added 3 drops of ferroin indicator. This was titrated with standard ferrous ammonium sulphate to an end point where blue-green colour just changed to reddish-brown. A blank with 50 ml distilled water in

place of water sample was treated equally and the chemical oxygen demand (COD) was then calculated.

2.12 Total hardness, Calcium (Ca) and Magnesium (Mg): Total hardness, calcium and magnesium was determined by EDTA titration methods using suitable indicators [8].

2.13 Pottasium (k): Pottasium was determined in surface water samples by using flame photometer (make: systronics)

2.14Chloride values (Cl_2): Chloride values were determined by argentometric method [8].1 ml of potassium chromate indicator were added into 50 ml of water sample and titrated with silver nitrate solution, until a brick red colour appeared. The blank titration was also carried out.

2.15Sulphate values (SO_4): Sulphate values were determined by Gravimetric/ Turbidimetric method using Bacl2 as precipitant. 50 ml of the sample were measured into a 250 ml beaker, and diluted to 150 ml with distilled water. 1 ml HCl (concentrated) and 4 drops of methyl orange indicator were added. 10 ml of 10% Barium chloride solution were added and then boiled for 5 minutes. These were left over- night and then filtered using filter-paper. Distilled water was used to rinse the filter paper to make it free from chloride. The filter paper was dried at 80˚C in an oven, ignited at 800˚C in a furnace (Lenton furnaces, England) for 1 hour, cooled in a desiccator and weighed. The igniter cooling and weighing were repeated to give constant value. Sulphate content of the water sample was then calculated.

2.16Phosphate (PO_4): Phosphate were determined by colorimetric method. To 2 ml aliquot of the water sample in a 25 ml volumetric flask was added one drop of phenolphthalein indicator followed by 2 ml of ammonium molybdate and then 1 ml of freshly diluted stannous chloride solution. These were made up to 25 ml volume with distilled water and mixed thoroughly. After 5 - 6 minutes and before 20 minutes, the colour intensity (absorbance) was measured at a wavelength of 660 nm in a Spectrophotometer.

2.17Nitrate (NO_3): Nitrate were determined by modified Kjeldahl method [9].50 ml of water sample and 4 ml of salicylic acid/sulphuric acid were added in the digestion flask and swirled thoroughly to achieve homogenous mixture. 0.5 g of sodium thiosulphate was added and the mixture was heated cautiously until frothing has ceased. 1.1 g of potassium sulphate catalyst mixture was added and heated until the digestion mixture became clear. The mixture was boiled for up to 2 hours. It was ensured the temperature did not exceed 400˚C. The digested mixture was allowed to cool and 20 ml distilled water was added slowly while shaking. 10 ml of boric acid was added, diluted with 20 ml distilled water and the flask was placed under the condenser of the distillation apparatus. 20 ml of sodium hydroxide was added through the funnel of the apparatus. About 50 ml of condensate was distilled and a few drops of Boric acid indicator added. This was titrated with 0.01 mol/L sulphuric acid to a violet end point. The titre values were recorded and used to calculate nitrate content.

2.18Metal Ions (Fe): Metal ions are detected by flame photometry and atomic absorption Spectroscopy. The absorption of energy by ground state atoms in the gaseous state forms the basis of atomic absorption spectroscopy. When a quantitative analysis is to be performed, the sample is atomized and the absorption is measured exactly in same condition.

3 RESULT AND DISCUSSION

The results obtained from analysis of water samples of river Mampuzha are shown in table 1. The reported values refer to the average value of water samples collected in different seasons at different areas along the stretch of Mampuzha river. The results indicate that the quality of water varies considerably from location to location. A summary of the findings is given below:

3.1 Temperature: Temperature is an important water quality parameter and is relatively easy to measure. Water bodies will naturally show changes in temperature seasonally. The variations in temperature of Mampuzha River water in the studied area shows wide difference in the range between 16 to 31^{0}C. During the summer season highest temperature was noticed, It could be due to open nature of the site and due to the hot climate in the summer season. Water temperature broadly varied from 16ºC at station 1 to 19ºC at station 8 during rainy season and in winter season it varies from 25 ^{o}C to 29 ^{o}C and during summer season it varies from 28 ^{o}C to 31 ^{o}C.

3.2pH: In natural waters, the pH scale runs from 0 to 14. pH value of 7 is neutral; a pH less than 7 is acidic and greater than 7 represents base saturation or alkalinity. The principal component regulating ion pH in natural waters is the carbonate, which comprises Co_2, H_2CO_3

and HCO_3 [8].pH values vary from a minimum of 6.7 and a maximum of 8.5.

3.3 Electrical Conductivity (EC): The mean EC values significantly different from each other at 95% confidence level and are higher than the prescribed limit set by WHO for drinking purposes and below the limit set by FAO for irrigation indicating the presence of high amount of dissolved inorganic substances in their ionized form [10].The conductivity ranged from 112mmhos/cm to 3350mmhos/cm, 164 to 49730mmhos/cm and 198 to 50400 mmhos/cm respectively at station 1 to 8 stations during rainy, winter and summer seasons. High conductivity during summer season might be attributed to saline intrusion from sea at mampuzha and slight reduction in the station during rainy might be due to fresh water input from rain. There was a positive correlation between conductivity and TDS of the water samples.

3.4 Total suspended solids (TSS): Total suspended solid content of water depends on the amount of suspended particle, soil and silt which is directly related to turbidity of water. The present study shows that the value of TSS varies from7 to 34 in rainy season, 12 to 185 in winter season and 19-285 in summer season. These values are attributed to the surface runoff and disposals of domestic sewage.

3.5 Total dissolved solid (TDS): In the present study the average values for TDS at eight sites varies from 140 to 33456 mg/L and exceed the maximum permissible limits of WHO for the drinking purpose. Higher values of TDS is seen at station 6 and lower values are seen at station 1. Downstream of river have higher TDS level compared to upstream. Higher TDS can be toxic to aquatic life through increases in salinity or changes in the composition of the water. Primary sources for higher TDS in the river water might be due to agricultural runoff, discharge of domestic waste from the town and other human activities like washing of different vehicle at and around the river [11]. According to [12] increase in value of TDS indicated pollution by extraneous sources. The high amount of dissolved, suspended and total solids of samples adversely affects the quality of running water and it is unsuitable for any other purpose irrigation and drinking.

3.6 Total alkalinity (TA): Total alkalinity of rivers is mainly carbonates and bicarbonates in any the samples which may be resulted due to the weathering of rocks, waste discharge and microbial decomposition of organic matter in the water body. In the study area, average alkalinity values from upstream to the downstream vary from 29 to 157,18 mg/L. Average alkalinity observed from station 1 to station 4 is well within the prescribed standards of drinking water (> 120mg/liter). Station 5 to station 8 have high alkalinity values and is above the prescribed limit set by [13]. Thus, the river is unsuitable for domestic purposes. In a similar study, higher TA values than the accepted values are reported by [14,15,16] and lower values by [17,18,19]

3.7 Total hardness (TH): Total hardness ranges from 36to 7000 mg/L. Based on hardness, water classified into three different categories: soft water (0 to 75 mg/L), moderately hard water (76 to 150 mg/L) and hard water (151 to 300 mg/L) [16]. Accordingly, Mampuzha River categorized as hard water. The recorded values for TH for all studied sites, except Station 1 and station 5 are higher than the permissible limit of [13]. Higher TH values are mainly due to weathering of Ca and Mg-rich rocks in the area [20]. The data indicate that the Mampuzha River water is unsuitable for drinking purposes.

3.8 Dissolved oxygen (DO): Dissolved oxygen is essential for aquatic life. The decomposing organic matter, mineral waste, dissolved gases, agricultural runoff, and industrial waste results to get lower DO levels [21,22]. Concentration levels of DO below 5.0 mg/L adversely affect aquatic life [23]. High DO range noticed in the present study during monsoon was indicative of the influence of rain flushing the water of Mampuzha River**.** The maximum 5.90 mg/l oxygen content of water was recorded in rainy season and minimum 1.02mg/l in summer season.

3.9 Biochemical Oxygen Demand (BOD): BOD showed fluctuation between 2.10 mg/liter and 9.81mg/liter.The values except for S1 are above the recommended values of [13] and FAO [24]. This could be an indication of organic pollution due to the load of waste from the market place of the city and different agricultural fertilizers brought by the runoff. Generally, the COD values are higher than BOD in the river. Increased levels of BOD and COD decrease the dissolved oxygen content in the river water [25]. Basically, BOD is directly related to the extent of pollution of waste water, sewage and industrial effluents. More BOD of sample, more will be pollution caused by it.

3.10 Chemical Oxygen Demand (COD): COD is related to organic and inorganic pollutants which causes

unfavorable conditions for the growth of microorganisms. The permissible limit is 10 mg/L [13]. Average COD concentration for Mampuzha River water is ranging from 6.65 to 26.55mg/L, higher than the [13] value. The minimum C.O.D. was recorded in winter season and maximum in rainy season. The COD values were found to be much higher than BOD values, indicating considerable presence of chemically oxidizable matter, most of which were non-bio degradable.

3.11 Calcium (Ca) and Magnesium (Mg): Calcium and magnesium are among the most common constituents present in natural water and their salts are important contributors to the hardness of water. In the present study, average calcium and magnesium contents in mg/L were ranged from 13.56 to 641 and 0.72 to 1071, respectively. Caand Mg is higher than the permissible limit except station 1. Higher values for Ca are related to sewage and weathering Ca- rich rocks or cementing materials [8].

3.12 Potassium (K): Level of potassium ranges from an average of 18.54 to 2664 mg/l. Maximum level (4895 mg/l) was recorded at station 6 during summer season (Feb-may). Lowest level (1.64) was recorded at station 1 during rainy season.

3.13 Chloride (Cl_2): High chloride content in river waters may indicate pollution by sewage, industrial waste or intrusion of seawater into fresh water bodies. The average values recorded for Mampuzha River water is in the range of 30 to 18930 mg/L. Upstream river water is significantly different from the downstream. Higher chloride concentration in the downstream might be due to the discharge of domestic sewage containing a large amount of chlorides [22]. According to the guidelines of [13]and FAO [24,13] the values are not within the acceptable limits except for S1.

3.14 Sulphate (So_4): It is one of the major anions in natural waters and is contributed by industrial and household discharges. The values for Mampuzha River ranges from 8.76 to 2523 mg/L, which is beyond the acceptable limit set by [13] except the station 1. Highest values are found in station 2. These higher values are related to the discharge of sulphate containing sewages from the city and surface runoff that contain organic fertilizers from agricultural activities undertaking on the river side.

3.15 Phosphate (Po_4): The main environmental impact associated with phosphate pollution is Eutrophication. Phosphate in water fluctuated between 0.01 to0.21mg/l. High phosphate level is found in station 4 and low level is found in station 1.

3.16Nitrate (NO_3): The concentration of nitrates is used as indication of level of micronutrients in water bodies and has ability to support plant growth. High concentration of nitrate favored growth of phytoplankton. The concentration of nitrate in Mampuzha River water is ranging from 0.37 to 5.19 mg/L.Eutrophication is usually the result of nitrate and phosphate contamination and is a significant reduction of water quality. The cause of high level of nitrate may be as a result of extensive farming taking place at the bank of the river.

3.17 Iron (Fe): Total iron concentration varied from 0.51 to 4.33 mg/l in rainy season, 0.54 to 5.16 mg/l in winter season and 0.51 to 6.12 mg/l in summer season. The highest concentration is at station 6 considering the standard limit (0.3mg/l) of dissolved iron prescribed by WHO,1984. The high rate of surface run off might be attributed to the high iron content in waters.

Table 2: Physico-chemical characteristics of Mampuzha river at different sampling stations during rainy season

S.NO	PARAMETERS	S1	S2	S3	S4	S5	S6	S7	S8
1	**Temp**	16±0.10	16±0.17	17±0.06	18±0.12	19±0.09	**19±0.08**	19±0.15	19±0.07
2	**P^H**	6.7±0.24	6.81±0.07	6.90±0.05	6.83±0.04	6.86±0.09	**7.60±0.07**	6.90±0.07	7.2±0.11
3	**EC**	112±3.14	116±7.11	704±5.15	378±4.12	712±4.09	**3350±3.10**	942±2.05	2740±2.03
4	**TSS**	7.0±0.27	7.0±0.18	10.0±0.06	8.0±0.25	19.0±0.21	**34.0±0.19**	24.0±0.17	30.0±0.19
5	**TDS**	82.0±0.24	86.0±0.18	499±0.09	271.0±0.19	502±0.11	**2290±0.10**	505±0.12	1860±0.09
6	**TA**	25.80±0.15	26.80±0.11	34.40±0.15	30.10±0.11	55.90±0.10	**124.10±0.11**	60.20±0.08	90.30±0.08
7	**TH**	36±0.11	**210±0.12**	100±0.08	76±0.10	48±0.08	205±0.05	128±0.15	190±0.09
8	**DO**	5.90±0.04	5.70±0.03	5.10±0.05	5.48±0.07	4.60±0.02	**1.26±0.01**	3.98±0.03	2.26±0.04
9	**BOD**	2.68±0.01	6.48±0.05	7.51±0.04	4.48±0.03	7.92±0.05	**9.36±0.10**	8.46±0.09	9.12±0.08
10	**COD**	7.97±0.05	19.1±0.16	20.9±0.15	12.8±0.11	24.6±0.18	**28.65±0.24**	26.5±0.20	27.98±0.21
11	**Ca**	12.80±0.10	17.60±0.12	14.40±0.11	17.60±0.14	40.0±0.31	55.0±0.48	48.0±0.39	**64.0±0.56**
12	**Mg**	0.97±0.05	0.98±0.02	15.55±0.12	7.78±0.06	16.52±0.13	79.20±0.63	58.32±0.33	**97.20±0.75**
13	**K**	1.64±0.07	1.65±0.04	4.70±0.09	3.61±0.01	7.30±0.02	**22.60±0.18**	10.10±0.09	17.30±0.12
14	**Cl_2**	23.31±0.19	27.19±0.22	182.59±1.42	89.36±0.72	240.87±2.45	**1265.40±12.61**	1010.10±10.22	1165.50±11.23
15	**SO_4**	8.76±0.05	**148.40±1.33**	33.04±0.28	21.12±0.17	9.16±0.07	41.44±0.38	37.76±0.32	106.80±0.98
16	**PO_4**	0.01±0.01	0.02±0.01	0.03±0.02	**0.10±0.04**	0.04±0.03	0.05±0.02	0.02±0.01	0.06±0.03
17	**NO_3**	0.37±0.22	0.62±0.55	0.66±0.59	0.63±0.60	0.84±0.73	**3.78±0.02**	1.07±0.01	1.38±0.01
18	**Fe**	0.51±0.02	0.81±0.03	0.76±0.04	1.08±0.01	1.23±0.01	**4.33±0.03**	1.54±0.01	2.70±0.02

a) All Values are mean ± SD, n=5 expressed as mg/l except EC (mmhos/cm)

Table 3: Physico-chemical characteristics of Mampuzha river at different sampling stations during winter season

S.NO	PARAMETERS	S1	S2	S3	S4	S5	S6	S7	S8
1	**Temp**	25±0.10	27±0.17	28±0.06	27±0.12	28±0.09	27±0.08	28±0.15	**29±0.07**
2	**P^H**	6.94±0.24	7.16±0.07	7.28±0.05	7.02±0.04	7.36±0.09	**7.52±0.07**	7.46±0.07	7.49±0.11
3	**EC**	164.9±0.27	40400±0.18	40020±0.06	6106±0.25	44790±0.21	**49730±0.19**	44850±0.17	47189±0.19
4	**TSS**	12.0±0.27	106±0.18	37±0.06	21±0.25	116±0.21	**185±0.19**	169±0.17	171±0.19
5	**TDS**	153±0.24	16350±0.18	37890±0.09	5770±0.19	38300±0.11	**44740±0.10**	42500±0.12	47230±0.09
6	**TA**	26.80±0.15	121.20±0.11	120.74±0.15	60.37±0.11	123.52±0.10	**132.06±0.11**	124.51±0.08	128.28±0.08
7	**TH**	40±0.11	**6000±0.12**	1195±0.08	580±0.10	180±0.08	5800±0.05	4600±0.15	5000±0.09
8	**DO**	5.54±0.03	3.58±0.01	3.98±0.02	4.50±0.03	3.39±0.02	**1.20±0.01**	3.26±0.02	2.21±0.01
9	**BOD**	2.10±0.01	4.89±0.03	5.41±0.04	3.31±0.02	5.81±0.04	**8.91±0.05**	6.48±0.04	7.28±0.05
10	**COD**	5.9±0.04	12.1±0.09	13.9±0.11	8.5±0.07	14.3±0.12	**23.8±0.18**	19.2±0.15	20.2±0.14
11	**Ca**	13.50±0.10	480.0±4.10	176±1.45	64±0.53	544±4.98	640.0±5.86	560±5.12	**880±7.83**
12	**Mg**	0.09±0.02	680.40±6.23	330.50±2.95	102.06±1.13	777.60±7.36	1069.2±18.63	874.80±8.42	**1166.0±15.71**
13	**K**	25.0±0.20	162.0±1.42	128.0±0.98	32.0±0.23	190.0±1.85	**3075.5±3.11**	220±2.10	2175.0±18.96
14	**Cl_2**	31.99±0.25	13996.5±112.65	5598.0±42.56	1819.55±14.74	14196.5±123.85	**25793.5±211.56**	19195±153.49	20395.0±198.71
15	**SO_4**	8.95±0.03	**2000±19.96**	1000±10.65	194.80±1.87	1500±12.75	1810±16.49	1536±13.72	1970±17.68
16	**PO_4**	0.02±0.01	0.04±0.02	0.03±0.02	**0.15±0.10**	0.06±0.03	0.07±0.05	0.02±0.01	0.09±0.06
17	**NO_3**	0.94±0.03	1.39±0.04	1.17±0.05	1.09±0.03	2.03±0.01	**4.10±0.07**	2.24±0.03	3.10±0.02
18	**Fe**	0.54±0.01	2.82±0.02	2.61±0.02	2.41±0.04	3.23±0.03	**5.16±0.04**	3.31±0.01	4.78±0.03

b) All Values are mean ± SD, n=5 expressed as mg/l except EC (mmhos/cm)

Table 4: Physico-chemical characteristics of Mampuzha river at different sampling stations during summer season

S.NO	PARAMETERS	S1	S2	S3	S4	S5	S6	S7	S8
1	**Temp**	28±0.82	29±0.53	30±1.18	31±0.76	29±0.35	**31±0.61**	30±0.57	29±0.43
2	**P^H**	6.95±0.38	7.35±0.41	7.48±0.47	7.09±0.42	7.49±0.35	**8.50±0.49**	7.58±0.36	8.02±0.50
3	**EC**	198.8±10.08	44000±175.04	40800±156.13	10100±86.41	49770±222.23	**50400±237.67**	49870±192.07	50010±263.13
4	**TSS**	19±0.59	190±10.46	56±2.61	32±1.07	211±12.59	**285±16.02**	243±14.25	265±13.04
5	**TDS**	185±9.36	19320±92.57	48860±199.01	7875±65.91	49975±177.05	**53340±216.27**	50230±219.33	55260±309.97
6	**TA**	36.70±0.93	155.25±8.06	159.34±8.27	91.48±6.28	185.4±9.11	**215.4±14.08**	198.5±11.03	205.4±12.06
7	**TH**	46±1.23	**7000±67.09**	1785±49.19	790±38.08	210±11.03	6900±61.11	6100±63.27	6500±68.01
8	**DO**	5.41±0.19	2.98±0.11	3.21±0.19	4.20±0.22	2.65±0.15	**1.02±0.09**	1.48±0.10	1.30±0.18
9	**BOD**	2.40±0.22	5.12±0.27	5.81±0.25	2.90±0.29	6.94±0.31	**9.81±0.44**	7.86±0.36	8.12±0.41
10	**COD**	6.1±0.32	14.9±0.73	15.2±0.77	6.4±0.39	18.71±0.81	**27.2±1.17**	20.6±1.01	23.8±1.09
11	**Ca**	14.40±0.69	544±25.02	84±4.83	620±27.48	640±29.11	850±35.67	780±33.08	**980±38.12**
12	**Mg**	1.1±0.09	840±35.27	810±29.05	496±22.07	1490±48.43	1675.4±49.25	1535±45.11	**1950±52.97**
13	**K**	29±1.14	485±21.07	376±19.86	88±5.67	595±25.39	**4895±71.22**	610±26.65	4685±61.23
14	**Cl_2**	35.98±2.96	15762.4±91.20	7562.8±65.18	1987.54±43.29	20130.2±154.07	**29733.5±149.65**	23175±155.05	26783.2±162.34
15	**SO_4**	8.99±0.46	**2523±48.02**	750±30.11	410.80±22.06	1610±37.24	2322±49.01	1873±34.87	2100±45.04
16	**PO_4**	0.04±0.02	0.12±0.07	0.06±0.01	**0.21±0.06**	0.16±0.05	0.19±0.04	0.05± 0.02	0.17±0.03
17	**NO_3**	0.98±0.09	2.98±0.15	1.51±0.11	1.83±0.13	3.10±0.18	**5.19±0.22**	3.95±0.19	4.18±0.28
18	**Fe**	0.51±0.35	3.13±0.26	2.82±0.19	2.71±0.17	4.12±0.31	**6.12±0.44**	4.23±0.38	5.64±0.43

c) All Values are mean ± SD, n=5 expressed as mg/l except EC (mmhos/cm)

TABLE 5: average values of the Physico-chemical at different sampling stations

S.NO	Parameters	S1	S2	S3	S4	S5	S6	S7	S8
1	Temp	23	24	25	25.3	25.3	**26.3**	25.6	25
2	P^H	6.86	7.10	7.22	6.98	7.23	**7.87**	7.31	7.57
3	EC	158.5	28172	27174	5528	31544	**34493**	31887	33313
4	TSS	12	101	34	20	115	**168**	147	155
5	TDS	140	11918	29083	4638	29592	**33456**	31069	34783
6	TA	29.7	101.08	104.82	60.65	121.6	**157.18**	127.7	141.3
7	TH	40.6	**4403**	3020	482	146	4301	1776	3896
8	DO	5.61	4.08	4.09	4.72	3.54	**1.16**	2.90	1.92
9	BOD	2.39	5.49	6.24	3.56	6.89	**9.36**	7.60	8.17
10	COD	6.65	15.3	16.6	9.20	19.2	**26.55**	22.10	23.99
11	Ca	13.56	347.2	91.46	233.8	408	515	462.6	**641**
12	Mg	0.72	506.90	385.35	201.90	761.37	941.20	822.70	**1071**
13	K	18.54	216.20	169.56	41.20	264	**2664**	280	2292.43
14	Cl_2	30.42	9928	4447	1298.80	11520	**18930**	14460	16114
15	SO_4	8.90	**1557**	594.34	208.90	1039.72	1391.14	1148	1392.26
16	PO_4	0.023	0.06	0.04	**0.153**	0.086	0.10	0.03	0.10
17	NO_3	0.64	1.66	1.11	1.183	1.99	**4.35**	2.42	2.88
18	Fe	0.54	2.25	2.06	2.06	2.86	**5.20**	3.02	4.37

d) All Values are mean ± SD, n=5 expressed as mg/l except EC (mmhos/cm)

4 CONCLUSIONS

Various anthropogenic activities are showing its impacts on the water quality of Mampuzha river. First four stations showed moderate pollution and the downstream of Mampuzha river is highly polluted. The implications of these findings may be that people dependent on this river water for domestic use and for agricultural uses like fishing and farming may be exposed to public health risks. It is essential to rescue the Mampuzha river and its aquatic life from the current hazard-posing environmental problems.

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