A Study On Water Quality Of Malaprabha River Near Munavalli Town Of Belagavi District, Karnataka

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Abstract:
The paper deals with the study of the water quality of the Malaprabha River near Munavalli in Savadatti Taluk of Belagavi District. The Malaprabha River is a tributary of the Krishna River. River originates in the Western Ghat at kanakumbi village in Khanapur Taluk of Belagavi District. It flows for a distance of 304 km from kanakumbi-khanapur-Savadatti-Naragund-Pattadakal and finally joins Krishna river at Kudala Sangama in Bagalkot district. The monitoring of the water quality of the Malaprabh River was carried out on a seasonal basis for one year from November 2020 to October 2021. Five sampling sites were selected, one upstream and the rest four sites downstream of Munavalli town. Parameters like pH and temperature were measured on site and the remaining parameters like BOD, Chloride, Nitrate, Sulphate, Do, etc., were analyzed in the laboratory by following standard methods. This river water is contaminated with industrial effluents and anthropogenic activities like bathing, washing clothes, utensils, and vehicles etc., Thus, there is a need of monitoring the water quality of the river.

Keywords: Water quality, Malaprabha river, Munavalli upstream, Munavalli downstream, Western Ghat.

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1. INTRODUCTION

Water is the principal basic need of all life forms for their survival. The river is one of the major surface water resources available for drinking, irrigation of agricultural land, industrial use, domestic purposes like bathing, washing clothes, domestic animals, vehicles, and also for recreation activities. Though water covers two-thirds of the earth's surface, most of it is salty and not suitable for drinking. Only 2.7 percent of the available water on earth is fresh water and only 1 percent of the available freshwater can be accessed for use from rivers, lakes, and groundwater. This shows the quantity of availability of fresh water is very minimal and it also seeks our attention to save it from pollution.

Rivers provide transport facilities and convenient places to discharge waste therefore, most of the industries and cities have been built up on the banks of rivers. Many rivers are significantly polluted all around the world as a result of anthropogenic activities, agricultural waste runoff, and domestic and industrial waste discharge. Billions of gallons of water from cities and housing settlements, industries, and agricultural land are thrown into fresh water every day (1). The effluents discharged into the rivers contain toxic substances. These toxins affect the physicochemical factors of river water and thereby affect the flora and fauna of ecosystems. So, it is essential to evaluate river water for a better aquatic environment.

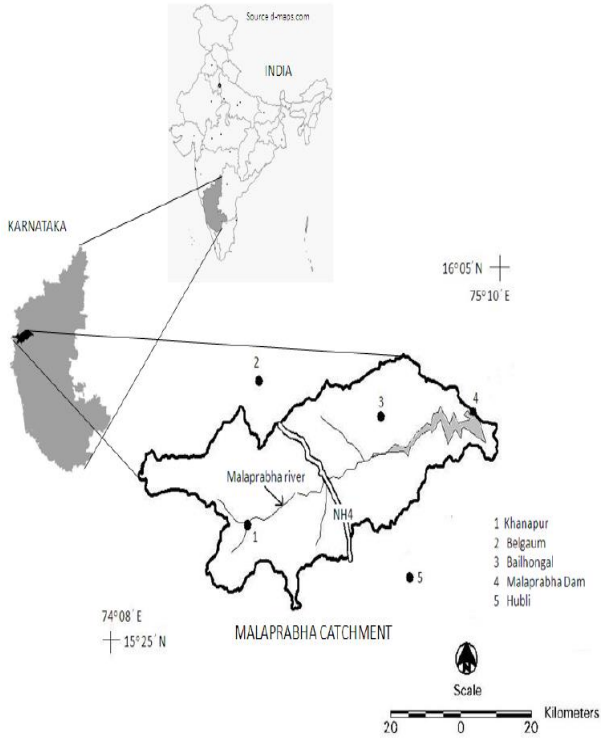
Datta and Datta (2) stated that various physical, chemical, and biological factors are the variables that govern the quality of drinking water. The main objective of monitoring the water quality of the river is to restore its water quality and to make its water suitable for drinking, irrigation, and recreation purposes. According to the World Commission on the Water for the 21st Century, more than half of the world's major rivers are so depleted and polluted that they endanger human health (3). Drinking water contaminated with municipal waste leads to cause several waterborne diseases like diarrhea, typhoid, cholera, etc., So it is essential to monitor the water quality of rivers regularly to protect biodiversity and ecosystems. Thus, it is an attempt to study the water quality of the Malaprabha River upstream and downstream near Munavalli of the Belagavi district.

2. MATERIALS AND METHODS

2.1 Study area

The Malaprabha River is one of the prominent rivers of North Karnataka. River Malaprabha is a tributary of the Krishna River. The river originates in the Western Ghat at Kanakumbi village which lies between 150 42"20'North latitudes and 74013"9' East longitude. The assessment of physico-chemical factors was carried out for one year i.e., from November 2020 to October 2021. The sampling site was selected near Munavalli of Malaprabha River, located between 150 51' 13" North latitude and 750 7' 13" East longitude (Map A). Five sampling sites were selected, one upstream(S I) and the rest four sites downstream(S II, S III, S IV & S V)of Munavalli town (Map B).

Study Area Maps



Map A: Location of the Malaprabha Catchment Area in Karnataka
(Source: d-maps.com)

Map B: Location of the Sampling Sites near Munavalli, Savadatti Taluk, Belagavi district, Karnataka.
(Source: Google satellitema)

2.2 Methodology

Water samples were collected on a seasonal basis i.e., Post monsoon(November 2020 to February-2021), Premonsoon (March-2021 to June-2021), and Monsoon(July-2021 to October-2021) seasons from 10.00 am to 4.00 pm and this was uniformly maintained throughout the study period. Water samples were collected by using clean and sterilized polyethylene carbonyl bottles of liters capacity. Parameters such as pH and temperature were measured on-site only and the remaining parameters, e., electrical conductivity (EC), Total Dissolved Solids (TDS), Dissolved Oxygen(DO), Free Carbon Dioxide (CO2), Salinity, Turbidity, Total Hardness (TH), Total Alkalinity (TA), Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), Chloride, Nitrate, Phosphate, Sulphate, Sodium, Potassium, Calcium, Magnesium, Heavy Metals (Zn, Cu, Fe, Mn & Pb) and Total Acidity (TA) were analyzed in the laboratory by following standard methods (4) and (5).

3. RESULTS AND DISCUSSION

The seasonal-wise data on physicochemical analysis has been presented in Tables – 1, 2 & 3, and Seasonal variations of physicochemical parameters are presented in Table 4. The physicochemical parameters of a natural water body significantly change seasonally. Some of the parameter values and the reason for variations are discussed below.

Temperature is one of the important physical parameters of the water body which governs the types of aquatic life that live in it and it also affects metabolism, reproduction, and emergence of aquatic life. As the temperature of the water body increases, dissolved oxygen decreases and pollutants can become more toxic. In the present study, the temperature ranged from 29.4o C to 31.7oC (winter season)35.2oC to 37.15oC (summer season), and 29.8oC to 34.1oC (monsoon season). Higher temperatures were recorded in summer (Fig. 1). Similar observations were made by Goudar et al (6) in the Tunga River of Shivamogga.

pH affects most chemical and biological processes In the water. It is one of the most important environmental factors limiting species distributions in aquatic habitats. Different species flourish within different ranges of pH. In the present study pH value ranged between 6.5 to 7.2 (winter Season), 6.7 to 7.4(summer season), and 6.9 to 7.4 (monsoon season). pH value indicates slightly acidic to alkaline condition and is found within the permissible limit of 6.5 to 8.5 as per BIS (7). The highest values for pH were observed in the monsoon season (Fig. 1) which indicates higher phytoplankton growth. With a higher phytoplankton growth, higher photosynthesis would be fixing more C and releasing H to the water column, collaborating with the change toward alkaline conditions (Horne and Goldman, 1994; Maberly,1996; Nazeen et al.,2019).

Turbidity is a measure of the degree to which water loses its transparency due to the presence of suspended particulates such as clay, silt, and other organic or inorganic material. The more total suspended solids in the water, the cloudier or murkier it seems and the higher the turbidity will measure. In the present study, the Turbidity level ranged between 3.80 NTU to 8.50 NTU (winter season), 2.50 NTU to 6.12 NTU (summer season), and 13.80 NTU to 58 NTU (monsoon season). Maximum values were

recorded in the monsoon followed by the winter season(Fig. 1) Maximum NTU values during the rainy season are due to the rainfall that brings clay, silt, and other organic and inorganic materials from allochthonous sources into the river. The permissible limit for drinking water standard is 1 to 5 NTU. High turbidity results in lower amounts of sunlight reaching underwater plants. Less sunlight results in less plant growth and hence plants produce less oxygen, which reduces the oxygen availability to aquatic life. High turbidity also causes a decrease in fish species richness because of clogging of fish gills. Hindering visibility makes it difficult for predators to find prey.

Dissolved oxygen (DO) is essential for the survival of aquatic plants and animals. In the present study, DO values ranged between 6.95 mg/l to 7.25 mg/l (winter season), 6.12 mg/l to 6.93 mg/l (summer season), and 6.86 mg/l to 7.05 mg/l (monsoon season). Maximum values were observed in winter followed by monsoon (Fig.2). Minimum values were observed in summer because the solubility of oxygen decreases with an increase in temperature, it is similar to (8) and (9).

BOD is an important parameter for assessing water quality. The values of BOD and the water quality are inversely proportional to each other. The greater the BOD value, the lower its water quality because such water has more organic compounds that require more oxygen to decompose by aerobic microbes. Similarly, the lower the BOD value, the higher its water quality. In the present study, BOD values ranged between 4.0 mg/l to 9.0 mg/l (winter season), 3.0 mg/l to 20.0 mg/l (monsoon season), and during summer season its values were below the detectable limit, it could be the result of warmer water and much lower amount of water in summer than other times of the year. High BOD during monsoon season might be due to the decomposition of organic matter and the decay of vegetation (fig.2).

Chemical Oxygen Demand (COD) measures the amount of oxygen necessary to break down the organic substance (both biodegradable and non-biodegradable) in a water sample by a strong chemical oxidant. Higher COD levels mean a greater amount of oxidizable organic material in the sample, which will reduce dissolved oxygen levels. A reduction in DO can lead to anaerobic conditions, which is deleterious to higher aquatic life forms. In the present study, COD values ranged between 12 mg/l to24 mg/l (winter season), and 8 mg/l to 56 mg/l (monsoon season), and during summer its values were below the detectable limit, it could be the result of higher temperatures (Fig.2). Maximum values were observed in monsoon because monsoon showers brought nutrients from allochthonous sources into the systems (10). COD is an indicator of organic pollution, which is caused by the inflow of domestic, livestock, and industrial waste that contains elevated levels of organic pollutants (Ayati,2003).

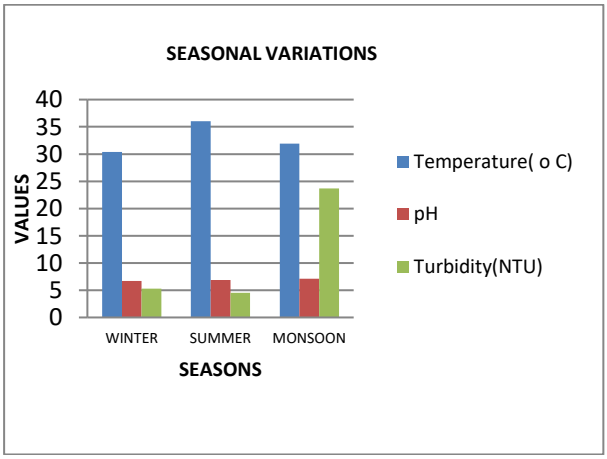


Figure 1.Seasonal variations in Temperature, pH and Turbidity

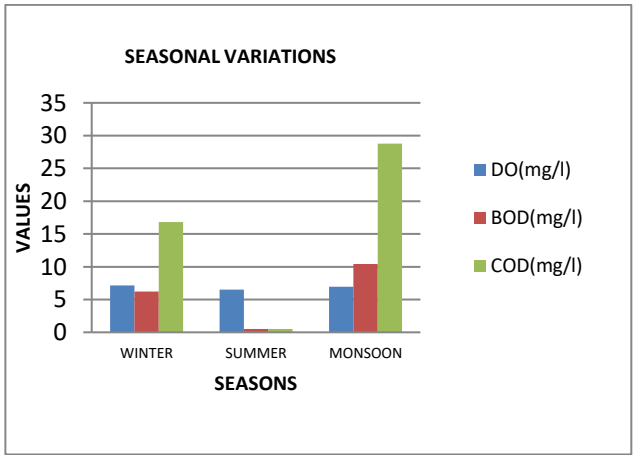


Figure 2. Seasonal variations in DO, BOD and COD

Total Dissolved Solids (TDS) consist of oxygen-demanding wastes, and disease-causing agents, which can cause immense harm to public health (11). TDS is the common indicator of polluted waters. In the present study, TDS values ranged between 90 mg/l to 123 mg/l (winter season), 100 mg/l to 164 mg/l (summer season), and 94 mg/l to 111 mg/l (monsoon season). Maximum values were recorded in summer followed by winter and monsoon. Similar observations were recorded by (12). Maximum values in summer may be due to the domestic sewage mixed with river water (Fig.3)

Electrical Conductivity (EC) is a measure of the ability of water to pass an electric current. EC rises as the concentration of dissolved salts and other inorganic chemicals in water increases. In the present study, EC values ranged between 173 mS/cm to 247 mS/cm (winter season), 222 mS/cm to 307 mS/cm (summer season), and 192 mS/cm to 223 mS/cm (monsoon season). Maximum values were recorded in summer, it may be due to the addition of sewage from the surroundings and due to anthropogenic activities (B.N Sunkad, 2013). The low value during the monsoon season was due to rain (Fig.3). The conductivity values decreased with an increase in rainfall. In the rainy season, the increased volume of water remarkably diluted the water (Izonfuo and Bariweni,2001).

Nitrates are essential plant nutrients, but in excess amounts, they can cause significant water quality problems. Together with phosphorous, nitrates in excess amounts can accelerate eutrophication, causing dramatic increases in aquatic plant growth and changes in the types of plants and animals that live in the stream. Higher concentrations of nitrates may be due to the discharge of sewage and industrial effluents into the river. Unpolluted natural water contains usually minute amounts of nitrate. In the present study, nitrate levels ranged between 0.58 mg/l to 2.30 mg/l (winter season), 1.46 mg/l to 2.66 mg/l (monsoon season), and in summer its values were found below the detectable limits (13). (Fig.4)

Sulfate occurs in natural waters because of two main sources, i e., Natural, and Anthropogenic. Natural sources include the dissolution of sulfate minerals (e.g., gypsum), oxidation of sulfide minerals (e.g., pyrite), precipitation and volcanic activity, etc., Anthropogenic sources contain sewage infiltration, fertilizers, synthetic detergents, industrial wastewater, mining drainage and so on (14). In the present study, sulfate values ranged between 9 mg/l to 16.6 mg/l (winter season), 13.4 mg/l to 23.8 mg/l (summer season), and 17.6 mg/l to 22.1 mg/l (monsoon season). High concentration of sulfate appearing in the summer season may be due to the discharge of industrial wastes into the river (Fig.4). Previous studies have shown that, when the human body takes in excessive sulfate, it will cause several diseases, e.g., diarrhea, dehydration and gastrointestinal disorders (15).

Chloride is a naturally occurring element that is common in most natural waters and is most often found as a component of salt (Sodium Chloride) or in some cases in combination with potassium or calcium. The presence of chloride ions in drinking water sources can be attributed to the dissolution of salt deposits, sewage contamination, water softeners, effluents from chemical industries, etc., In the present study, chloride values ranged between 18.59 mg/l to 19.57 mg/l (winter season), 25.93 mg/l to 36.69 mg/l (summer season), and 21.21 mg/l to 23.14mg/l (monsoon season). Higher chloride concentrations are recorded in the summer season, this may be due to increased temperature and evapo-transpiration of water (16). (Fig.4). Excess chlorides cause trouble in irrigation water and are also harmful to aquatic life (17).

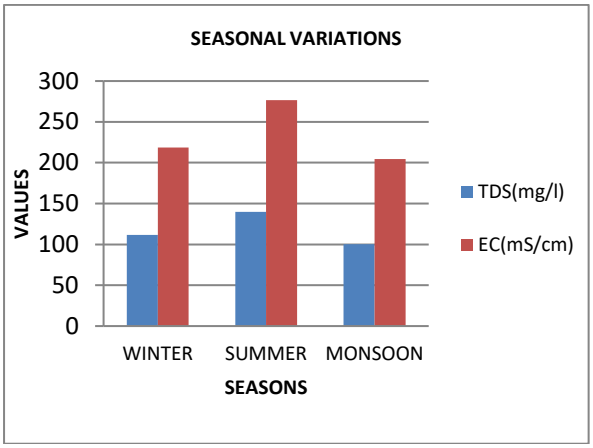


Figure 3.Seasonal variations in TDS and EC

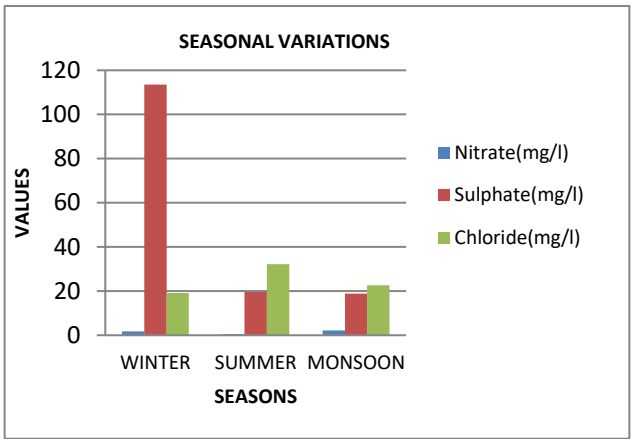


Figure 4. Seasonal variations in Nitrate, Sulfate and Chloride and EC

Total Hardness (TH) values were recorded from 77.5 mg/l to 106 mg/l (winter season), 97.6 mg/l to 139.8 mg/l (summer season) and 71.2 mg/l to 81.2 mg/l (monsoon season). Maximum values were recorded in summer followed by winter (Fig.5). Minimum values were observed in monsoon (18). The cause of hardness of water is due to the presence of bicarbonates, sulfates, and chlorides of calcium and magnesium (19). In the present study, Total Hardness values were found within the permissible limit of 200 mg/l to 600 mg/l as per BIS drinking water standards, 2012.

Calcium occurs in water naturally as a result of dissolution from rocks rich in calcium minerals. Industrial as well as water and wastewater treatment processes also contribute calcium to surface water. Calcium values fluctuated between 20.4 mg/l to 27.7 mg/l (winter season), 30.2 mg/l to 39.1 mg/l (summer season), and 19 mg/l to 23.7 mg/l (monsoon season). Seasonal calcium level is found to be maximum in summer and minimum in monsoon (Fig.5).

Magnesium is an essential nutrient for plants as well as for animals. Mg values ranged between 6.4 mg/l to 9.9 mg/l (winter season), 5.39 mg/l to 11.87 mg/l (summer season), and 3.8 mg/l to 7.7 mg/l (monsoon season). These values are well below the permissible limit for drinking purposes (Fig.5).

Sodium in natural bodies of water comes from the weathering process of igneous rocks and evaporated minerals. Increased concentrations in surface waters may arise from sewage and industrial effluents. World Health Organization guideline limit for sodium in drinking water is 200 mg/l. In the present study, sodium values ranged between 14.91 mg/l to 18.21 mg/l (winter season), 18.99 mg/l to 30.41 mg/l (summer season), and 13.38 mg/l to 15.18mg/l (monsoon season). Higher sodium concentration was recorded in the summer season due to lower flow volume and evaporation (Fig.6).

Potassium occurs widely in the environment, including all natural waters. Potassium concentration is only 10% to 50% of the sodium concentration. In the present study, potassium values were recorded from 1.84 mg/l to 2.49 mg/l (winter season), 1.82 mg/l to 2.23 mg/l (summer season), and 2.46 mg/l to 2.80 mg/l (monsoon season). (Fig.6).

Iron (Fe) values fluctuated between 0.32 mg/l to 0.42 mg/l (winter season), 0.05 mg/l to 0.24 mg/l (summer season) and 0.55 mg/l to 5.39 mg/l (monsoon season). Seasonally maximum values were recorded in monsoon followed by winter. The iron content during the monsoon and winter seasons is higher than the guideline value of 0.3 mg/l (7). (Fig.6). In summer iron contents are within the permissible limits. The presence of a higher concentration of iron may be due to weathering of iron-rich minerals such as hematite, magnetite, etc., discharge of industrial effluents, and corrosion of old iron pipes during water distribution (CPCB, 2008;

WHO 2008; Shekhar and Sarkar,2013; Sarkar,2017). The presence of excess iron in drinking water causes muscle weakness, hypertension, constipation, general weakness, etc.

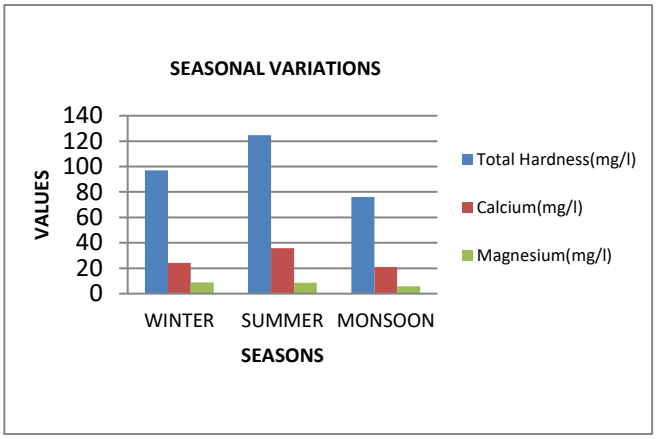


Figure 5. Seasonal variations in TH, Ca and Mg.

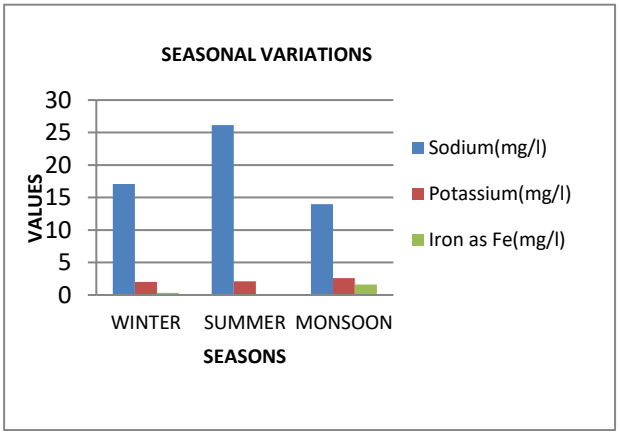


Figure 6. Seasonal variations in Na, K and Fe.

4. CONCLUSION

The study revealed that all the physico-chemical parameters of the Malaprabha River at Munavalli are below the permissible limits, except Iron, Turbidity, BOD, and DO in winter, DO in summer, and iron, Turbidity, COD, BOD, and DO in monsoon season. The reason for the excess quantity of the above-mentioned parameters in the river water is due to the discharge of domestic, livestock, anthropogenic, and industrial wastes. Anthropogenic activities must be reduced by creating awareness in the public about the importance of water quality for well-being. It should be achieved through the active involvement of local Municipal Corporations by establishing a body to organize awareness programs and monitor the river. An effective regulatory structure should be framed to limit the discharge of industrial effluents into their ecosystems. If the current situation is not managed properly, it could lead to irreversible ecological damage in the long run, which would be covered up by short-term economic success.

Table-1: WINTER /POST MONSOON SEASON (NOVEMBER 2020 TO FEBRUARY 2021) PHYSICO-CHEMICAL PARAMETERS OF MALAPRABHA RIVER AT MUNAVALLI.

SL.NO	PARAMETERS	S1	S2	S3	S4	S5
1	Temperature(^{0} C)	29.4	31.7	30.8	30.0	30.3
2	Ph	7.2	6.5	6.5	6.6	6.7
3	Turbidity(NTU)	8.50	3.80	4.20	5.90	4.40
4	DO(Dissolved Oxygen)(mg/l)	7.18	6.95	7.08	7.19	7.25
5	BOD(Biological Oxygen emand)(mg/l)	7	6	5	4	9
6	COD(Chemical Oxygen Demand)(mg/l)	20	16	12	12	24
7	TDS(Total Dissolved Solids)(mg/l)	90	123	109	116	119
8	EC(Electrical Conductivity)(mS/cm)	173	247	222	213	238
9	Nitrate as No_3(mg/l)	0.58	1.86	1.92	2.00	2.30
10	Sulfate as So_4(mg/l)	9.00	16.68	11.85	14.15	15.99
11	Chloride as Cl(mg/l)	18.59	18.59	19.57	19.57	19.57
12	Total Hardness(mg/l)	77.52	106	102	97.92	102
13	Calcium as Ca(mg/l)	20.42	27.77	25.32	22.87	24.50
14	Magnesium(mg/l)	6.44	8.92	9.42	9.91	9.91
15	Sodium(mg/l)	14.91	18.21	17.73	16.75	17.81
16	Potassium(mg/l)	1.85	2.49	1.96	1.84	1.91
17	Iron as Fe(mg/l)	0.42	0.32	0.32	0.36	0.29

(**Abbreviation:** NTU- Nephelometric Turbidity Unit, EC –mS/cm(Micro Siemens/Centimeter).

Table-2: SUMMER /POST MONSOON SEASON (MARCH 2021 TO JUNE 2021) PHYSICO-CHEMICAL PARAMETERS OF MALAPRABHA RIVER AT MUNAVALLI

SL.NO	PARAMETERS	S1	S2	S3	S4	S5
1	Temperature(^{0} C)	36.7	37.15	35.2	35.25	35.8
2	Ph	7.4	6.75	6.8	7.0	7.0
3	Turbidity(NTU)	4.20	6.12	5.20	4.60	2.50
4	DO(Dissolved Oxygen)(mg/l)	6.36	6.12	6.81	6.43	6.93
5	BOD(Biological Oxygen Demand)(mg/l)	BDL	BDL	BDL	BDL	BDL
6	COD(Chemical Oxygen Demand)(mg/l)	BDL	BDL	BDL	BDL	BDL
7	TDS(Total Dissolved Solids)(mg/l)	100	128	155	153	164
8	EC(Electrical Conductivity)(mS/cm)	222	244	305	307	305
9	Nitrate as No_3(mg/l)	BDL	BDL	BDL	BDL	BDL
10	Sulfate as So_4(mg/l)	13.40	17.01	19.34	23.88	23.88
11	Chloride as Cl(mg/l)	25.93	29.84	35.71	32.78	36.69
12	Total Hardness(mg/l)	97.68	117.66	135.42	133.20	139.86
13	Calcium as Ca(mg/l)	30.22	38.22	34.67	36.44	39.11
14	Magnesium(mg/l)	5.39	5.39	11.87	10.25	10.25
15	Sodium(mg/l)	18.99	25.69	26.92	28.83	30.41
16	Potassium(mg/l)	1.82	2.10	2.19	2.18	2.23
17	Iron as Fe(mg/l)	0.15	0.05	0.24	BDL	BDL

(**Abbreviation:** BDL- Below Detectable Limit, NTU- Nephelometric Turbidity Unit, EC –mS/cm (Micro Siemens/Centimeter).

Table-3: RAINY/ MONSOON SEASON (JULY 2021 TO OCTOBER 2021) PHYSICO-CHEMICAL PARAMETERS OF MALAPRABHA RIVER AT MUNAVALLI

SL.NO	PARAMETERS	S1	S2	S3	S4	S5
1	Temperature(^{0} C)	29.8	33.2	34.1	32	30.8
2	Ph	7.1	6.9	7.0	7.1	7.4
3	Turbidity(NTU)	58	13.80	17.80	14.80	14.30
4	DO(Dissolved Oxygen)(mg/l)	6.95	7.05	6.86	6.95	7.05
5	BOD(Biological Oxygen Demand)(mg/l)	20	6	3	10	13
6	COD(Chemical Oxygen Demand)(mg/l)	56	16	8	28	36
7	TDS(Total Dissolved Solids)(mg/l)	111	95	94	100	102
8	EC(Electrical Conductivity)(mS/cm)	223	195	192	208	204
9	Nitrate as No_3(mg/l)	2.66	1.46	2.19	2.33	2.26
10	Sulfate as So_4(mg/l)	22.12	17.60	18.98	17.72	17.72
11	Chloride as Cl(mg/l)	23.14	21.21	22.18	23.14	23.14
12	Total Hardness(mg/l)	79.20	75.24	81.18	71.28	73.26
13	Calcium as Ca(mg/l)	22.20	23.78	19.82	19.03	19.82
14	Magnesium(mg/l)	5.77	3.85	7.70	5.77	5.77
15	Sodium(mg/l)	15.18	13.98	13.77	13.38	13.51
16	Potassium(mg/l)	2.80	2.46	2.52	2.60	2.70
17	Iron as Fe(mg/l)	5.39	0.55	0.85	0.61	0.69

(**Abbreviation:** NTU- Nephelometric Turbidity Unit, EC –mS/cm(Micro Siemens/Centimeter).

TABLE 4: AVERAGE SEASONAL VARIATIONS IN PHYSICO-CHEMICAL PARAMETERS OF MALAPRABHA RIVER AT MUNAVALLI

SL.NO	PARAMETERS	WINTER	SUMMER	MONSOON
1	Temperature(^{0} C)	30.44	36.02	31.98
2	Ph	6.7	6.99	7.1
3	Turbidity(NTU)	5.36	4.52	23.74
4	DO(Dissolved Oxygen)(mg/l)	7.13	6.53	6.97
5	BOD(Biological Oxygen Demand)(mg/l)	6.2	BDL	10.4
6	COD(Chemical Oxygen Demand)(mg/l)	16.8	BDL	28.8
7	TDS(Total Dissolved Solids)(mg/l)	111.4	140	100.4
8	EC(Electrical Conductivity) (mS/cm)	218.6	276.6	204.4
9	Nitrate as No_3(mg/l)	1.73	BDL	2.18
10	Sulfate as So_4(mg/l)	13.53	19.50	18.82

11	**Chloride as Cl(mg/l)**	**19.17**	**32.19**	**22.56**
12	**Total Hardness(mg/l)**	**97.08**	**124.76**	**76.03**
13	**Calcium as Ca(mg/l)**	**24.17**	**35.73**	**20.93**
14	**Magnesium(mg/l)**	**8.92**	**8.63**	**5.77**
15	**Sodium(mg/l)**	**17.08**	**26.16**	**13.96**
16	**Potassium(mg/l)**	**2.01**	**2.10**	**2.61**
17	**Iron as Fe(mg/l)**	**0.34**	**0.088**	**1.61**

(**Abbreviation:** BDL- Below Detectable Limit, NTU- Nephelometric Turbidity Unit, EC –mS/cm (Micro Siemens/Centimeter).

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