

Original Research Article

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Characterization of Surface Water and Ground Water Reservoirs

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ABSTRACT

The present study was carried out on characterization of surface water and groundwater reservoirs in Merched village near Raichur city in Karnataka. Surface water samples were collected from different locations of the Merched tank and groundwater samples were collected from the bore wells, hand pumps located at the command area of Merched tank during 2018-2019 in monsoon and post monsoon season. The collected water samples were analyzed for the water quality parameters like pH, EC, TDS, carbonate, bicarbonate, nitrate, phosphate, calcium, magnesium, sodium, BOD, COD, DO and turbidity by using standard methods. The results obtained were compared with drinking and irrigation water quality standards. The results showed that pH (ranges from 7.36 - 8.54) of surface water and ground water were slightly alkaline in nature. The EC and TDS of surface water and ground water were not within the drinking water quality standards. The results obtained for monsoon season, the mean value of BOD (562.31, 977 mg L⁻¹), COD (15270.44, 11138.63 mg L⁻¹), DO (7.72, 7.70 mg L⁻¹) and turbidity (11.20, 11.37 NTU) for surface water and ground water respectively. Similarly result obtained for post monsoon, the mean value of BOD (457.88, 904 mg L⁻¹), COD (7189.69, 9287.38 mg L⁻¹), DO (4.97, 4.93 mg L⁻¹) and turbidity (11.37, 11.20 mg L⁻¹) for surface water and ground water respectively. All the water quality parameters were within the recommended range of irrigation standards except the parameters BOD, COD, DO and turbidity.

Keywords

Surface water,
Groundwater,
Water samples

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Introduction

Water is one of the essential compounds for all living forms, so its pollution is considered as more important when compared with soil and air. It is the most effective dissolving agent, and suspends or absorbs many different compounds (Abbas *et al.*, 2012). Surface water and groundwater are the major sources of water. Globally, India accounts for 2.45 per cent of land and 4 per cent of water resources

but it represents 16 per cent of the world population. The estimated total utilizable water resource in the country is about 1123 BCM, it includes 690 BCM from surface and 433 BCM from ground.

Groundwater is a major source for irrigation. The annual groundwater recharge is about 433 BCM of which 212.5 BCM used for irrigation and 18.1 BCM for domestic and industrial use. Due to increasing population,

urbanization and all round development in the country, the per capita average annual freshwater availability has been reduced from 5177 m³ to 1869 m³ during 1951 to 2001 period. It is expected that will be further reduce to 1341 m³ in 2025 and 1140 m³ in 2050 (FAO, 2012). There is need for effective utilization of available water for different purpose.

Groundwater is one of the major water resources, used for domestic and industrial water supply as well as for irrigation purpose globally. The quality of groundwater is of utmost importance. In the recent years the risk of groundwater pollution has become one of the most important environmental concerns, particularly in developing countries. It can be contaminated either naturally or because of numerous type of human activities from residential, Municipal, commercial, Industrial and agriculture activities can all effect groundwater quality.

Materials and Methods

Study area

The study was conducted in area near the Raichur, located between Krishna and Tungabhadra rivers, is the headquarters of Raichur district. The study area included Merched tank, command area of Merched tank, that spreads adjacent to the Manchalapur village and it is located 10 km away from Raichur city (Fig. 1). The study area is situated in the North-Eastern dry zone (Zone-2) of Karnataka located at 16° 14'N latitude and 77° 19'E longitude and at an elevation of 380 m above mean sea level.

Average rainfall of the area is 875.3 mm. The monthly mean maximum and minimum temperatures of the area were recorded in May and January as 44.34°C and 10.39°C respectively. Merched tank is located at a

distance of 1 km from the downstream of Manchalapur tank. The total geographical area of Merched village is 16 km². The water present tank was commonly used for irrigation, fish rearing and domestic purpose. It is estimated that around 70.80 ha of land is being irrigated. Merched village consist of four open wells and five hand pumps.

Collection of water sample

Water samples were collected from the inlet of tank where the sewage enters into tank, two locations of water spreading area of the tanks and outlet of the Merched tank (fig. 2). Groundwater samples were collected from the bore wells, hand pumps located at the command area of Merched tank. The bore wells or open wells were selected randomly in Merched Village from which groundwater samples were collected (fig. 3).

The water samples were collected during post-monsoon (November to February) and Monsoon (June-October) in the medical grade autoclavable polyethylene bottles of 250 ml capacity and stored at 4°C in a refrigerator. Pre-monsoon (March – May) sample collection was not possible because during summer the tank was completely dry and samples were not available at that time for carrying out the study.

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Results and Discussion

pH and EC

pH is a measure of the hydrogen ion (H^+) activities that decide the acidic or alkaline condition of water. The mean pH recorded in the study area, highest in monsoon season (8.54 and 7.45) and lowest in post monsoon season (7.53 and 7.36) for both surface water and groundwater as depicted in fig.4. The recommended pH for irrigation water is in the range of 6.0-8.5. The results showed that, pH recorded in both the season were within the recommended range.

The slight alkaline nature of water may be due to the presence of bicarbonate ions, which was produced by the combination of CO_2 with water to form carbonic acid, which affects the pH of the water. The higher mean pH values during monsoon season revealed the aerobic conditions and lesser anthropogenic sources as compared to the post monsoon season. These results are agreement with the earlier finding of Augustine *et al.*, (2018).

EC gives the concentration of soluble salts present in the water. The value of mean EC is highest in monsoon season (1.72 and 170 dSm^{-1}) and lowest in monsoon season (1.51 and 1.38 dSm^{-1}) for both surface water and groundwater. The results showed that, mean EC value during both the season are found to be within the permissible limit standards for

irrigation purpose. Increase in mean EC value during the monsoon season was due to the increase in concentration of salts, organic and inorganic materials in the water from different sources (Augustine *et al.*, 2018).

Total dissolved solids (TDS)

TDS represent all the inorganic and organic substances contained in a wastewater in molecular and/or micro-granular form. The mean TDS value of monsoon season was 1137.09 $mg L^{-1}$ and 1175.57 in post monsoon season was 966.06 $mg L^{-1}$ and 918.87 $mg L^{-1}$ for surface water and ground water respectively as graphically represented in Fig. 3. The result reveals that the observed TDS is within the range of recommended TDS for irrigation purpose.

The mean TDS value in monsoon season was found more when compared with post monsoon season due to the addition of more amount municipal sewage to the water during monsoon season (Karthick *et al.*, 2016).

Carbonate and bicarbonate

Analyses were carried out to estimate carbonate, bicarbonate, nitrate and phosphate. The results are represented in the fig 5(a) and 5(b). The result revealed that for Surface water, the mean carbonate and bicarbonate value were highest in monsoon season compared to post monsoon season. For surface water, the carbonate concentration was recorded 2.41 $meq L^{-1}$ in monsoon season and absent in post monsoon and the value of bicarbonate in monsoon season and post monsoon season were 3.17 $meq L^{-1}$ and 4.75 $meq L^{-1}$ respectively.

For groundwater, the mean carbonate concentration was recorded 2.66 $meq L^{-1}$ in monsoon season and 0.63 $meq L^{-1}$ in post monsoon season. The mean bicarbonate

concentration was higher in post monsoon season (6.60 meq L^{-1}) compared to monsoon season (2.85 L^{-1}).

Nitrate and phosphate

The nitrate is essential compound for the plant. From the Table 12 (b), the nitrate concentration was recorded highest in post monsoon season (10.90 mg L^{-1}) and (4.90 mg L^{-1}) and lowest in monsoon season (9.83 mg L^{-1}) and (4.28 mg L^{-1}) for Merched tank and groundwater respectively. The presence of nitrate in the water sample at the present study, fulfill the need of nitrate required for the plant growth to some extent and hence nitrate application in the form fertilizer were reduced.

Fig.6 (b) show, the mean phosphates level was the highest in the monsoon season (14.71 mg L^{-1}) and (3.90 mg L^{-1}) and lowest in post monsoon season (0.49 mg L^{-1}) and (5.78 mg L^{-1}) for Merched tank and groundwater respectively. The mean Phosphate value was found to be more during monsoon season when compared with post monsoon, due to the addition of domestic waste water, particularly those containing detergents as well as runoff from various sources containing fertilizers to the tank (Augustine *et al.*, 2018).

Concentration of cation

The cations present in water samples are calcium, magnesium and sodium. The concentration of calcium, magnesium and sodium in water samples are depicted in the fig 5. For Merched tank, the calcium concentration recorded in the post monsoon and monsoon season was 7.79 mg L^{-1} and 2.65 mg L^{-1} respectively. Magnesium concentration in monsoon season and post monsoon season were 12.43 mg L^{-1} and 4.60 mg L^{-1} respectively.

Characterization of groundwater, showed that the concentration of calcium were 6.61 mg L^{-1} in monsoon season and 4.81 mg L^{-1} in post monsoon season, whereas magnesium were found 3.83 mg L^{-1} in post monsoon season and 3.44 mg L^{-1} in monsoon season respectively (Fig 5).

High value of calcium and magnesium is due to the domestic waste water and effluent present in the sewage or due to the cationic exchange with sodium, however low value do not mean that it is not influenced by the pollutant but it may be due to the reverse cationic exchange with sodium.

The sodium concentration was 0.92 mg L^{-1} and 0.54 mg L^{-1} in post monsoon season and 3.80 mg L^{-1} and 0.75 mg L^{-1} in monsoon season for Merched tank and groundwater respectively.

Biochemical oxygen demand (BOD₅), chemical oxygen demand (COD) and dissolved oxygen (DO)

The mean BOD₅ was the highest 562.31 mg L^{-1} and 977.04 mg L^{-1} monsoon season compared 457.88 mg L^{-1} and 904.92 mg L^{-1} in post monsoon season for Merched tank and groundwater respectively. The BOD at both the seasons appeared to be higher than the irrigation standard of 100 mg L^{-1} . BOD₅ recorded the highest in the rainy season because of disproportionately higher inflow of sewage.

And the dilution of tank water could not have a remarkable reduction in the BOD₅ concentration as there would also be high rate of decomposition of organic matter which tends to quickly deplete the oxygen concentration and got stabilised during the post monsoon season. The results revealed that BOD₅ was not significantly varied between both monsoon and post monsoon

seasons ($F=0.857$, $p=0.284$). Similar trend of results were observed by Karthick *et al.*, 2011.

The mean COD recorded was the highest in monsoon season ($15270.44 \text{ mg L}^{-1}$ and $11138.63 \text{ mgL}^{-1}$) compared to post monsoon seasons (8573.00 mgL^{-1} and $7189.69 \text{ mg L}^{-1}$) for both Merched tank and groundwater respectively. The higher COD level indicates the greater amount of oxidizable organic material in the water sample, which will reduce dissolved oxygen level. It leads to the anaerobic conditions, which is deleterious to higher aquatic life forms.

Turbidity

Turbidity is the elementary measure of the suspended solids in the wastewater and generally measured using principle of scattering of light. During the post monsoon season, mean turbidity was found to be 7.72 NTU and 13.04 NTU and in monsoon season 4.97 NTU and 8.17 NTU for Merched tank and groundwater respectively as depicted in fig 6. Turbidity was found relatively high in monsoon season due to addition of dissolved fertilizers, pesticides, herbicides and other particles from the agriculture land to the tank (Augustine *et al.*, 2016)

Table.1 Standard methods used for water quality parameter analysis and water quality standards

Sl. No.	Parameter	Methods	Drinking water quality standards	Irrigation water quality standards	Units
1	pH	Glass electrode method	6.5-8.5	6.5-8.5	-
2	Electrical Conductivity	Conductivity bridge method	0.256	2.0	dS m^{-1}
3	Total Dissolved Solids	Gravimetric method	500	2100	mg L^{-1}
4	Carbonates and Bicarbonates	Titrimetric method	-	-	meq L^{-1}
5	Nitrate	Kjeldhal method	45	50	mg L^{-1}
6	Phosphate	Stannous chloride method	-	-	mg L^{-1}
7	Calcium and magnesium	Versante Tiration	75 and 30	-	mg L^{-1}
8	BOD5	Incubation method	2	100	mg L^{-1}
9	COD	Mercury free digestion method	-	-	mg L^{-1}
10	DO	Titrimetric method	5	6	mg L^{-1}
11	Turbidity	Nephelometric method	5	-	NTU
12	Sodium	Spectrophotometric method	-	-	mg L^{-1}

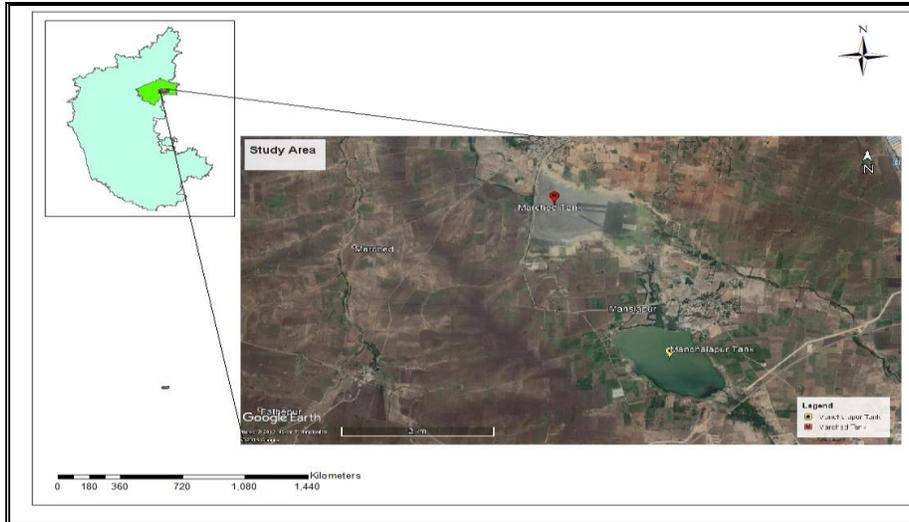


Fig.1 Location of study area in Karnataka map



Fig.2 Satellite image of the Merched tank obtained from Google earth

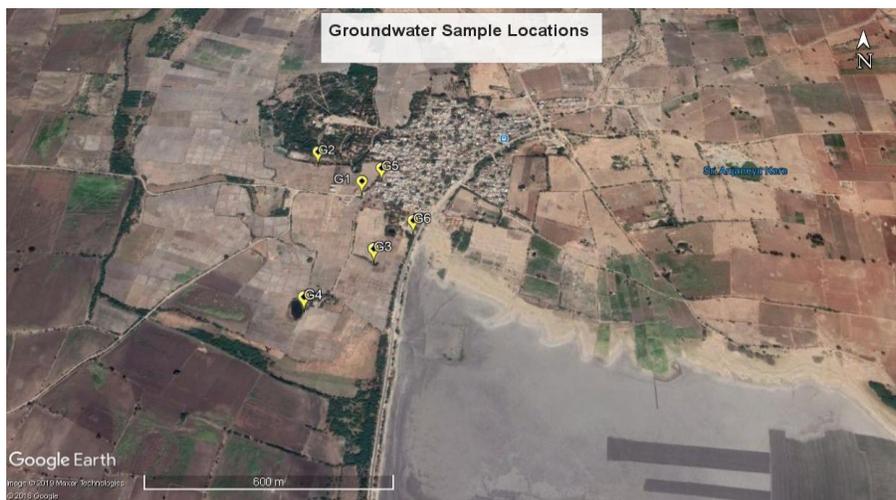


Fig.3 Different locations of groundwater resources like bore well and hand pump

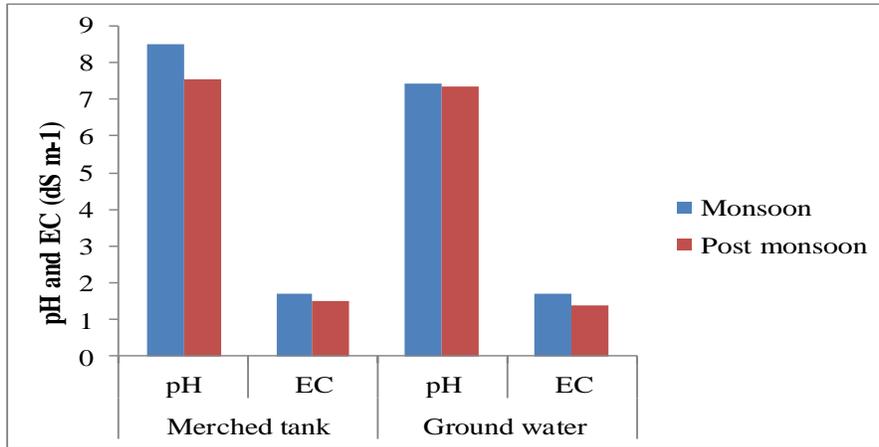


Fig.4 Concentration of pH and EC (dS m⁻¹) of samples in monsoon and post monsoon season

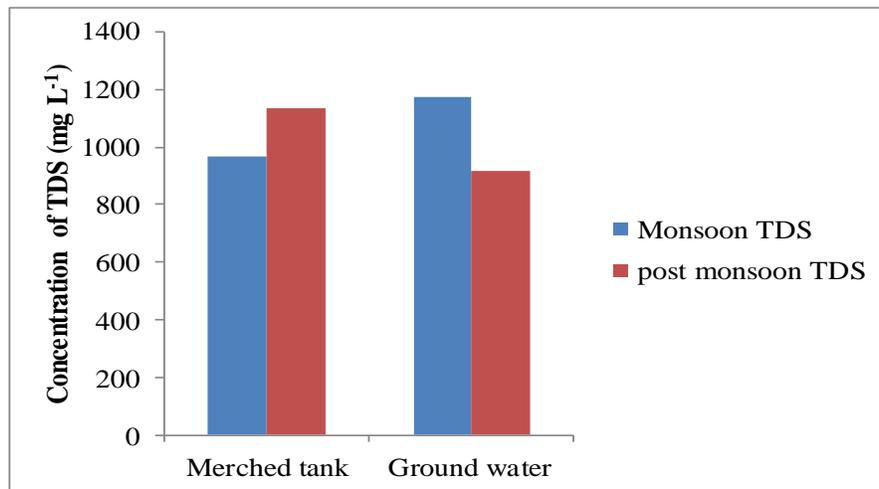


Fig.5 Concentration of TDS of samples in monsoon and post monsoon season

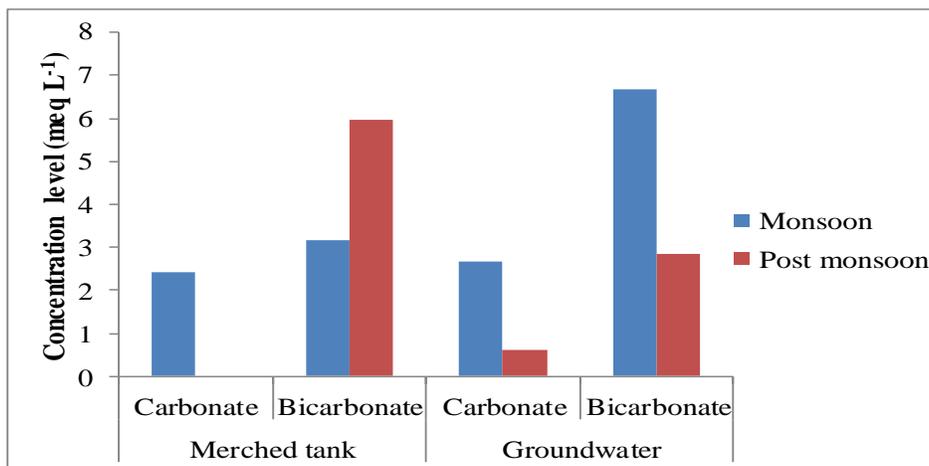


Fig.6 Concentration of carbonate and bicarbonate (meq L⁻¹) of samples in monsoon and post monsoon season

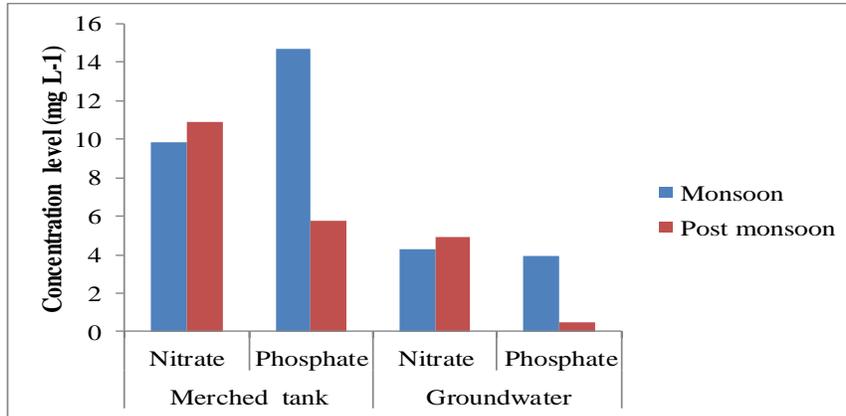


Fig.7 Concentration of nitrate and phosphate (mg L⁻¹) of samples in monsoon and post monsoon season

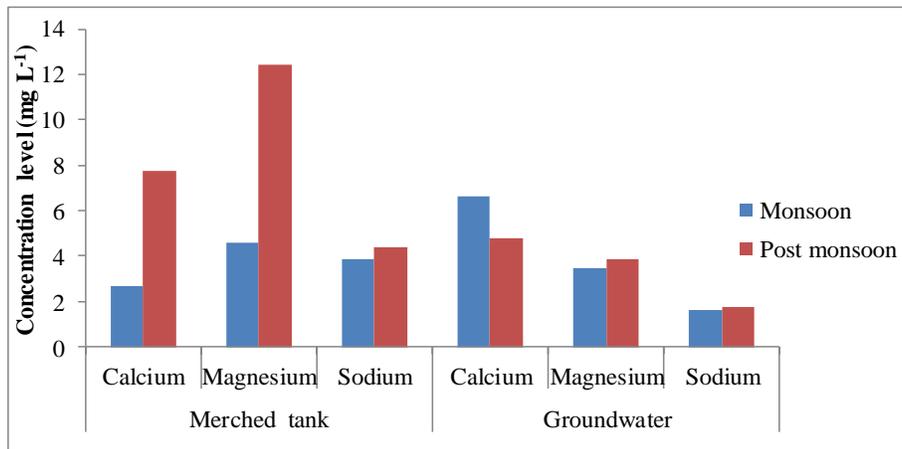


Fig.8 Concentration of calcium, magnesium and sodium (mg L⁻¹) of samples in monsoon and post monsoon season

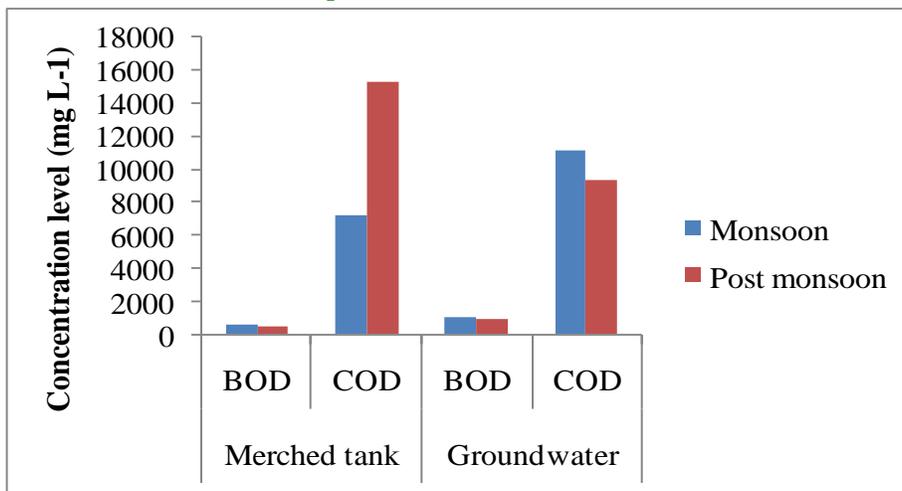


Fig.9 Concentration BOD and COD (mg L⁻¹) of samples in monsoon and post monsoon season

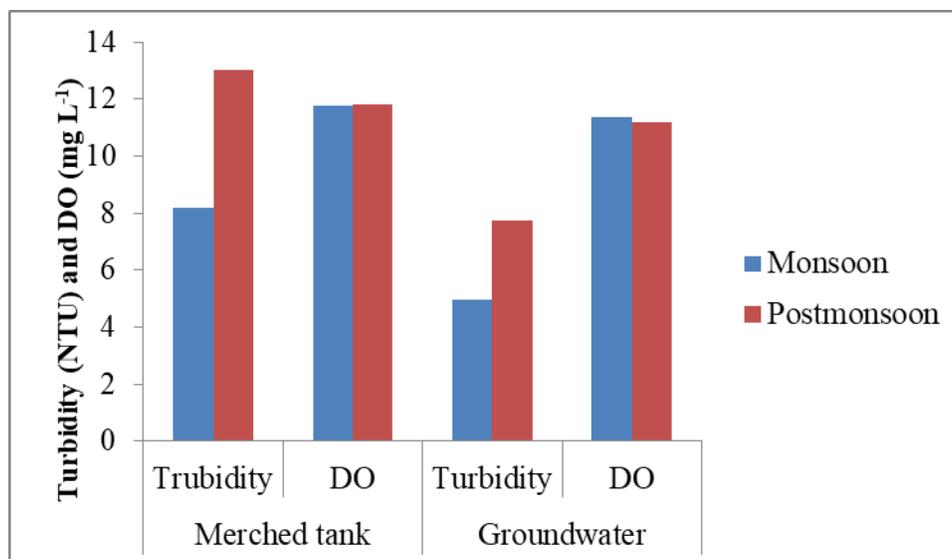


Fig.10 Concentration turbidity (NTU) and DO (mg L⁻¹) of samples in monsoon and post monsoon season

The mean turbidity value was high compared to the recommended value. The higher turbidity affects organisms that are directly dependent on light, like aquatic plants because it limits their ability to carry out photosynthesis. This in turn, affects fishes that depend on these plants for food and oxygen. Dissolved oxygen is an important parameter to indicate the purity and reactivity of water.

During the present study, the DO concentration in wastewater was found 11.37 mg L⁻¹ and 11.80 mg L⁻¹ in monsoon season and 11.20 mg L⁻¹ and 11.78 mg L⁻¹ in post monsoon season (Table 14). Dissolved oxygen was highest in post monsoon season compared to monsoon season.

Water is the prime requirement for the existence of life. Increasing in the population, urbanization and expansion in agriculture lead to the deterioration of surface water and groundwater. The quality of water is equally important as that of quantity. The surface water and groundwater quality was deteriorated by the mixing of municipal sewage effluent. The study results revealed

that all the water quality parameters of the within the permissible standards of irrigation and drinking except the DO, COD, BOD and turbidity. The surface water is used for irrigation purposes and also as source for fish farming. Because of high Dissolved Oxygen (>5 mg L⁻¹) concentration in tank water it is not safe for aquatic life.

The anions like nitrate, phosphate present in the water samples used for the irrigation fulfills the requirement for some extent. The present study was concluded that before usage of water for drinking and irrigation purpose proper treatments (physical treatments which includes filtration, screening, settling etc and chemical treatments includes coagulation, addition of alum etc) improve water quality which can be beneficial for agricultural production and fish rearing purpose.

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