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Assessment of physic-chemical parameters and water quality index of Viralimalai area near Koraiyar river Pudukkottai district, Tamil Nadu, India

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ABSTRACT

*Present work deals with the assessment of physico-chemical parameters of ground water samples were collected from Viralimalai area near Koraiyar River, Pudukkottai District, during the year 2013 in pre monsoon, monsoon and post monsoon seasons. The observed values of various physico-chemical parameters of water samples were compared with standard values recommended by WHO. A total of ten ground water samples were collected and the water chemistry of various parameters. pH, Electrical Conductivity (EC),Dissolved Oxygen (DO), Total Hardness (TH), Total Dissolved Solids (TDS), Biological oxygen demand (BOD), Chemical oxygen demand (COD), Bicarbonate (HCO_3), calcium (Ca), Chloride (Cl). Magnesium (Mg), sodium (Na), potassium (K), Sulphate (SO_4), and nitrate (NO_3), were analysed. The Calculated values of WQI are (**197.8**), (**208.3**) and (**178.0**) for pre monsoon, monsoon, and post monsoon respectively. The high value of WQI has been found to be mainly from the higher values of EC, TDS, TH, COD, Ca, HCO_3 and Cl in the ground water. It is shown that the water quality degradation is due to anthropogenic activities or discharge of untreated urban wastes.*

Keywords: Viralimalai area, physicochemical parameters, Water quality index.

INTRODUCTION

Quality drinking water is essential for life. Groundwater is almost globally important for human consumption as well as for the support of habitat and for maintaining the quality of base flow to rivers, while its quality assessment is essential to ensure sustainable safe use of the resources for drinking, agricultural, and industrial purposes. The drastic increase in population, urbanization and modern land use applications and demands for water supply has limited the globally essential groundwater resources in terms of both its quality and quantity. Quality is a function of the physical, chemical and biological parameters. The chemical character of any groundwater determines its quality and utilization. Naturally, ground water contains mineral ions. These ions slowly dissolve from soil particles, sediments, and rocks as the water travels along mineral surfaces in the pores or fractures of the unsaturated zone and the aquifer they are referred to as dissolved solids. Some dissolved solids may have originated in the precipitation water or river water that recharges the aquifer. The quality of groundwater depends on various chemical constituents and their concentration, which are mostly derived from the geological data of the particular region [3]. Water quality may be related to the suitability of water for a particular use or purpose. The quality of water is characterized by a range of physical, chemical and biological parameters, which arise from a variety of natural and human influences. Considering this aspect the present study assesses the quality of groundwater, which is the main source of drinking water.

MATERIALS AND METHODS

Groundwater samples were collected from Koraiyar River regions of viralimalai area Pudukkottai district. A total of 10 water samples were collected from groundwater in three different seasons pre monsoon, monsoon and post monsoon during the year 2013. Water samples of were collected in two liter polyethylene bottles. The physico-chemical parameters such as pH, Electrical Conductivity (EC),Dissolved Oxygen (DO), Total Hardness (TH), Total Dissolved Solids (TDS), Biological oxygen demand (BOD), Chemical oxygen demand (COD), Bicarbonate (HCO_3), calcium (Ca), Chloride (Cl). Magnesium (Mg), sodium (Na), potassium (K), Sulphate (SO_4), and nitrate (NO_3), of ground water samples were determined using standard procedures.

STUDY AREA

The study area is Viralimalai about located 35 km from Pudukkottai district and located near Koraiyar River. The district is bound on the north and northwest by Tiruchirappalli district, West and southwest by Sivaganga district, on the east and northeast by Thanjavur district and on the southeast by Bay of Bengal. Fig: 1 the population of the area is around 36,866. They are discharging the wastes and domestic sewages, untreated into the open lands them by polluting ground water through percolation. People of this area have depending only on the ground water as the main source for drinking and other purposes. Hence the present study has been undertaken to investigate the physico – chemical parameters using water quality index in and around viralimalai area.

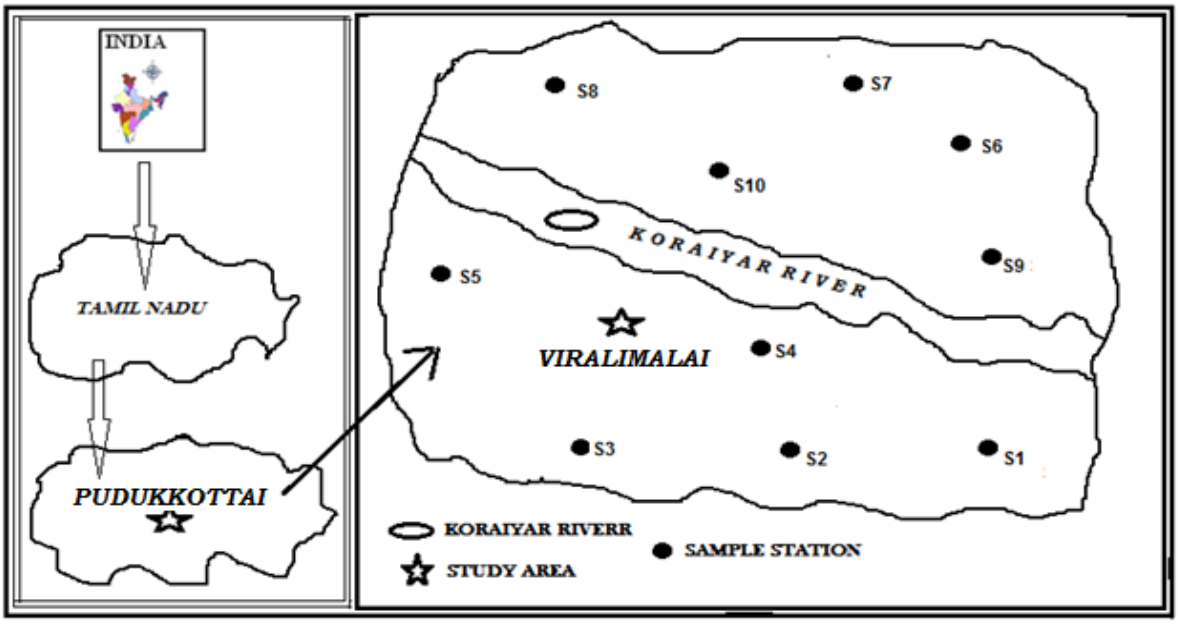


Fig: 1 LOCATION MAP OF THE STUDY AREA

RESULTS AND DISCUSSION

pH

The pH indicates the strength of the water to react with the acidic or alkaline material present in the water. It controls by carbon dioxide, carbonate and bicarbonate equilibrium. The combination of CO_2 with water forms carbonic acid, which affects the pH of the water. The pH values of the groundwater vary between 7.6 and 7.8 indicating slightly alkaline nature.

Electrical Conductivity

The EC is a measure of a materials ability to conduct an electric current so that the higher EC indicates the enrichment of salts in the groundwater [7]. Electrical conductivity in groundwater varies from 4277 ppm to 5145ppm. The high EC values may cause carcinoma and mortality problem.

Table: 1 Calculation of Water Quality index in Pre monsoon season during the year 2013

Parameters	Mean value in ppm (v_i)	Highest permitted value (WHO) (s_i)	Unit weight age (W_i)	$W_i \times Q_i$
pH	7.6	8.5	0.2692	24.06
EC	4818	600	0.0038	3.051
TDS	3353	500	0.0045	3.015
DO	12	5	0.4577	109.8
TH	586	500	0.0045	0.526
BOD	19	20	0.3814	63.22
COD	47	10	0.2288	107.5
HCO_3	48	240	0.0095	0.19
Ca	151	100	0.0228	3.442
Cl	355	250	0.0091	1.292
Mg	50	150	0.0152	0.501
Na	74	200	0.0114	0.421
K	21	12	0.0490	8.575
SO_4	68	500	0.0045	0.058
NO_3	18	50	0.0457	1.645

WQI $=\sum_{i=1}^{n}(Qi\ Wi)/\sum_{i=1}^{n} Wi$ **WQI = 197.8**

Table: 2 Calculation of Water Quality index in monsoon season during the year 2013

Parameters	Mean value in ppm (v_i)	Highest permitted value (WHO) (s_i)	Unit weight age (W_i)	$W_i \times Q_i$
pH	7.8	8.5	0.2692	24.70
EC	5145	600	0.0038	3.258
TDS	2007	500	0.0045	1.806
DO	7	5	0.4577	64.07
TH	703	500	0.0045	0.632
BOD	22	20	0.3814	41.95
COD	68	10	0.2288	155.0
HCO_3	545	240	0.0095	2.156
Ca	164	100	0.0228	3.740
Cl	354	250	0.0091	1.288
Mg	70	150	0.0152	0.709
Na	78	200	0.0114	0.444
K	36	12	0.0490	14.7
SO_4	73	500	0.0045	0.065
NO_3	18	50	0.0457	1.645

WQI $=\sum_{i=1}^{n}(Qi\ Wi)/\sum_{i=1}^{n} Wi$ **WQI = 208.3**

Dissolved oxygen

Dissolved oxygen is an important aquatic parameter, whose presence is vital to aquatic fauna. It plays crucial role in life processes of animals. In the present study the Dissolved oxygen values found from 7.0 ppm to 12.0ppm. Dissolved oxygen concentrate was 5ppm throughout the year the reservoir is productive for fish culture [9].

Total Dissolved Solids

The total dissolved solids (TDS) are the concentrations of all dissolved minerals in water indicate the general nature of salinity of water. The total dissolved solids in all the study area varies from 1579 ppm to 3353 ppm. All the ground water samples showed higher TDS values than the prescribed limit given by WHO (500) ppm. The higher TDS decreases palatability, and causes gastrointestinal irritation in the consumers [10]. But the prolonged intake of water with the higher TDS can cause kidney stones which are widely reported from different parts of the country [2].

Total Hardness

Hardness is an important criteria for determining the usability of water for drinking as well as for other domestic supplies as it causes unpleasant taste and reduces ability of soap to produce lather. The concentration of Total

Hardness varies from 586 ppm to703 ppm. All the samples showed high TH according to WHO. High concentration of hardness causes heart disease and kidney stone formation [15].

Table: 3 Calculation of Water Quality index in Post monsoon season during the year 2013

Parameters	Mean value in ppm (v_i)	Highest permitted value (WHO) (s_i)	Unit weight age (W_i)	$W_i \times Q_i$
pH	7.7	8.5	0.2692	24.38
EC	4277	600	0.0038	2.708
TDS	1579	500	0.0045	1.421
DO	7	5	0.4577	64.07
TH	697	500	0.0045	0.627
BOD	11	20	0.3814	20.97
COD	59	10	0.2288	134.5
HCO_3	829	240	0.0095	0.326
Ca	353	100	0.0228	2.28
Cl	464	250	0.0091	1.688
Mg	345	150	0.0152	3.496
Na	70	200	0.0114	0.399
K	25	12	0.0490	10.20
SO_4	54	500	0.0045	0.043
NO_3	33	50	0.0457	3.016

$WQI = \sum_{i=1}^{n}(Qi\ Wi) / \sum_{i=1}^{n} Wi$ **WQI = 178.0**

Table: 4 Mean WQI values for different seasons

S.No	Parametes	Premonson	Monson	Postmonson
1	**pH**	7.6	7.8	7.7
2	**EC**	4818	5145	4277
3	**TDS**	3353	2007	1579
4	**DO**	12	7	7
5	**TH**	586	703	697
6	**BOD**	19	22	11
7	**COD**	47	68	59
8	**HCO_3**	485	545	829
9	**Ca**	151	164	353
10	**Cl**	355	354	464
11	**Mg**	50	70	345
12	**Na**	74	78	70
13	**K**	21	36	25
14	**SO_4**	68	73	54
15	**NO_3**	18	18	33
Water Quality Index		**197.8**	**208.3**	**178.0**

BOD

Biochemical oxygen demand is defined as the amount of oxygen required by the microorganisms to stabilize biologically decomposable organic matter in waste water under aerobic conditions [14]. In the present study values of biochemical oxygen demand of water samples for different seasons in above the permissible limit 11.0 ppm to 22.0ppm .Probably the high BOD value is due to direct discharge of domestic waste water.

Chemical Oxygen Demand

Chemical oxygen is widely used as means measuring the organic strength of domestic and industrial waste water. COD values were in the range of 47.0ppm to 68.0 ppm. COD values of all ground water samples found above the permissible limited prescribed by WHO (10 ppm). This may be due to discharge of domestic sewage and industrial waste water to soil and water bodies. High COD may causes to affect the aquatic life [14].

Bicarbonate

Alkalinity is the measure of the capacity of the water to neutralize a strong acid. The alkalinity in the water is generally imparted by the salts of bicarbonates, silicates, together with the hydroxyl ions in free state [4]. The bicarbonate alkalinity varies from 485ppm to 829 ppm indicating that all the samples are above the permissible limit of WHO.

Calcium
The calcium is an important element to develop proper bone growth. The concentration of calcium varied from 151 ppm to 353 ppm, which is above the standard limit of 100 ppm indicating that all samples are above the maximum permissible limit. Prescribed by WHO [11].

Chloride
The concentration of Chloride in the study area varies from 354 ppm to 464 ppm. All samples are above the permissible limit given by WHO. Generally, chloride is considered as the important inorganic ions, which deteriorate the quality of drinking water at larger extent. For example, the Cl plays an important role in balancing level of electrolytes in blood plasma, but higher concentration can develop hypertension, risk of stroke, left ventricular hypertrophy, osteoporosis, renal stones and asthma [18].

Magnesium
The concentration of Mg, ranging from 50 ppm to 345 ppm, and all samples showed above the maximum permissible limit prescribed by WHO (150). Although, Mg is an essential ion for functioning of cells in enzyme activation, but at higher concentration, it is considered as laxative agent [12].

Sodium
Sodium is the sixth most abundant element in the earth's crust from rocks and soils. Not only seas, but also rivers and lakes contain significant amounts of sodium. Concentrations however are much lower, depending on geological conditions and waste water contamination [1]. The concentration of sodium is varied from 70 ppm to 78 ppm. All samples are within the maximum permissible limit prescribed by WHO.

Potassium
The concentration of potassium is varied from 21 ppm to 36 ppm. All the seasons above the permissible limit by WHO. Potassium is an essential element for humans, plants and animals, and derived in food chain mainly from vegetation and soil [6]. The main sources of potassium in ground water from rain water, weathering of potash silicate minerals and use of potash fertilizers irrigation.

Sulphate
The recommended desirable limit is 500 ppm. Sulphate occurs naturally in water as a result of leaching from gypsum and other common mineral [12]. The sulphate concentration varied between54.0 ppm to 73.0 ppm and found within the prescribed limit.

Nitrate
Nitrate is an essential input for the sustainability of agriculture [19]. However nitrate contamination of groundwater is a worldwide problem .The concentration of nitrate is varied from 18 ppm to 33 ppm. All the seasons showed below the permissible limit by WHO. Nitrate in groundwater is mainly derived from organic industrial effluents, fertilizer or nitrogen fixing bacteria, leaching of animal dung, sewage and septic tanks [5].

Water quality index
Water Quality index (WQI) is defined as a technique of rating that provides the composite influence of individual water quality parameter on the overall quality of water. It is calculated from the point of view of human consumption.

The Calculation Involves the Following Steps
First, the calculation of weight age of i^{th} parameter.
Second, the calculation of the quality rating for each of the water quality parameters.
Third, the summation of these sub-indices in the overall index.

The Weight age of i^{th} Parameter

$$W_i = k/S_i \quad (1)$$

Where W_i is the unit of weight age and S_i the recommended standard for i^{th} parameter (I = 11), k is the constant of proportionality

Individual quality rating is given by the expression

$Q_i = 100V / S_i$ (2)

Where Qi is the sub index of ith parameter, Vi is the monitored value of the ith parameter in mg/l and S_i the standard or permissible limit for the i^{th} parameter.

The Water Quality Index (WQI) is then calculated as follows

$WQI = \sum_{i=1}^{n}(Qi\ Wi) / \sum_{i=1}^{n} Wi$ (3)

Where, Q_i is the sub index of i^{th} parameter. W_i is the unit weight age for i^{th} parameter, n is the number of parameters considered. Generally, the critical pollution index values is <75

Table: 5 Status categories of WQI

WQI	Quality of water
0 - 25	Very good
26 - 50	good
51 - 75	poor
Above 75	Very poor (unsuitable for drinking)

Fig: 2 Seasonal Variation of mean pH collected different season

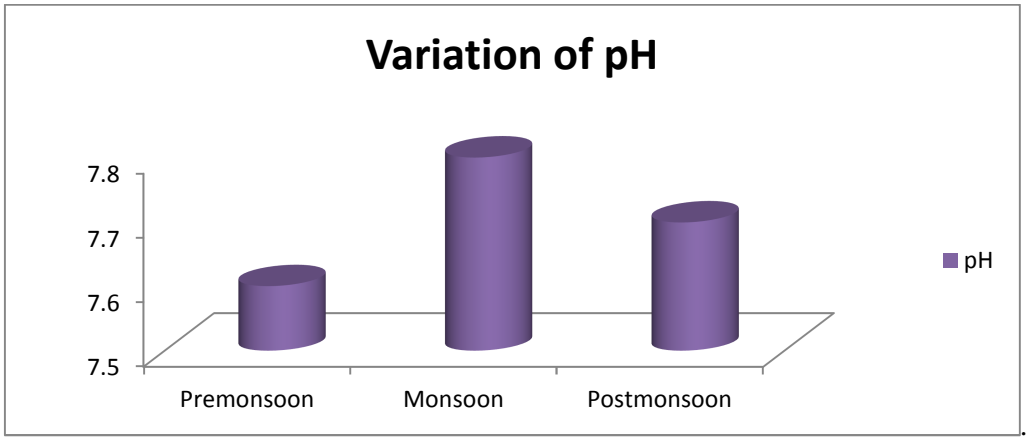


Fig: 3 Seasonal Variation of mean EC collected different season

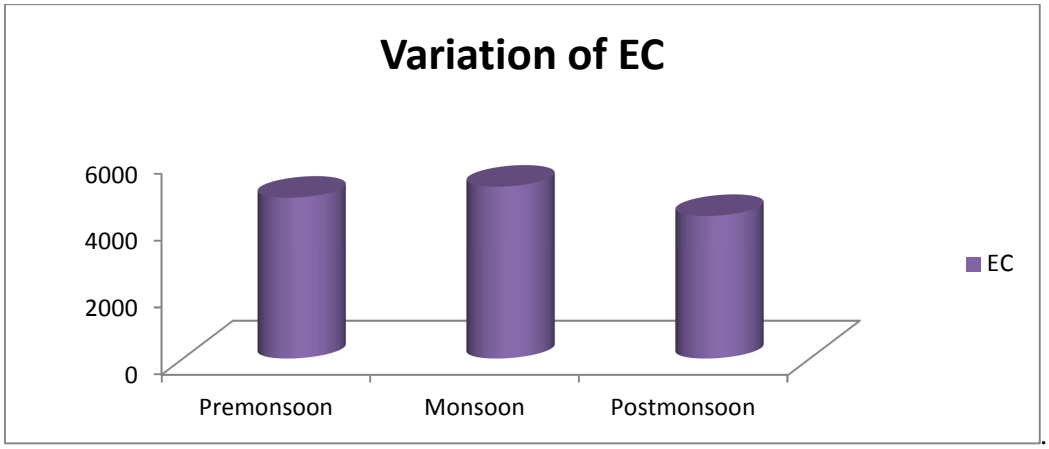


Fig: 4 Seasonal Variation of mean TDS collected different season

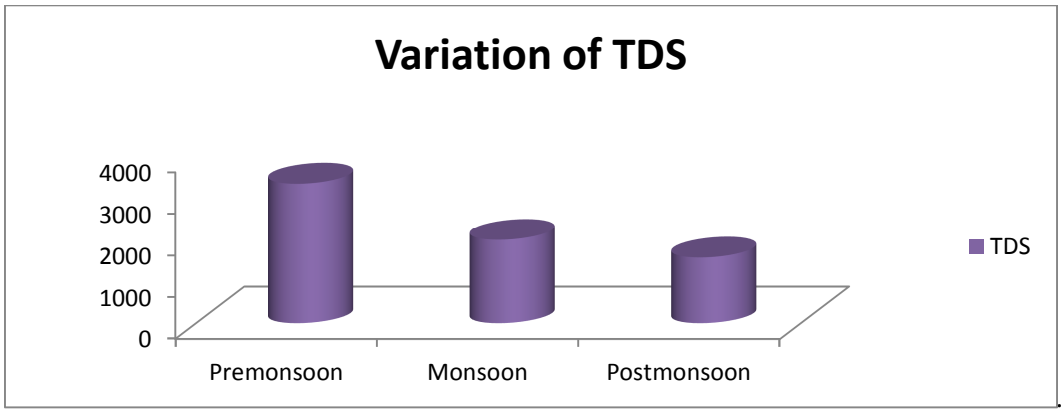


Fig: 5 Seasonal Variation of mean DO collected different season

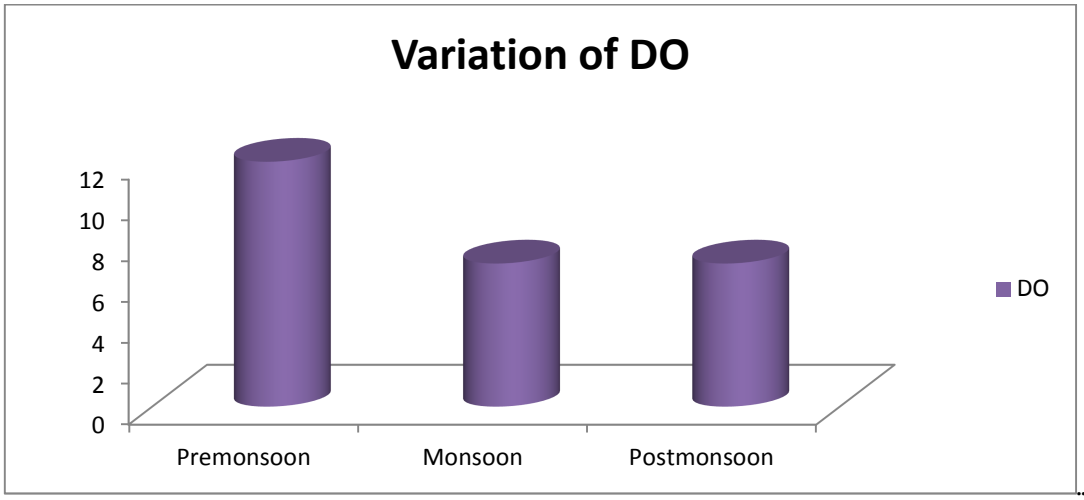


Fig: 6 Seasonal Variation of mean TH collected different season

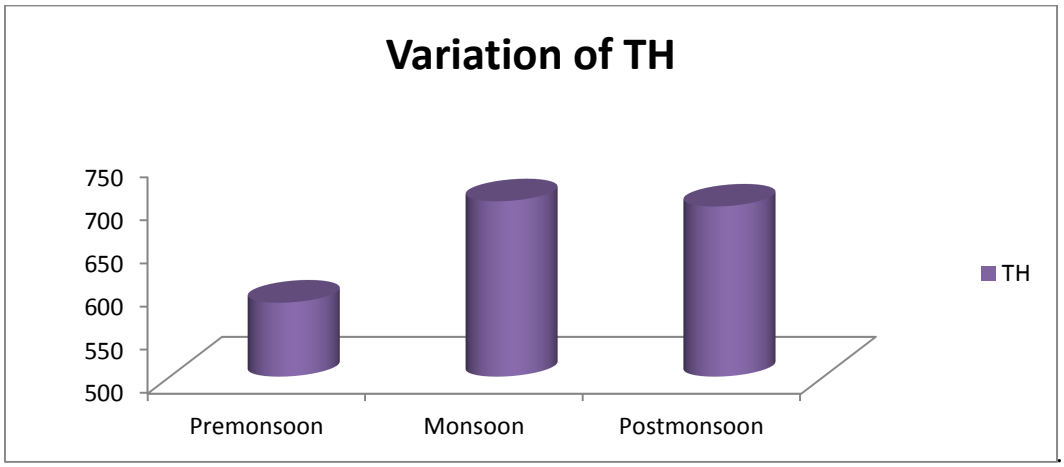


Fig: 7 Seasonal Variation of mean BOD collected different season

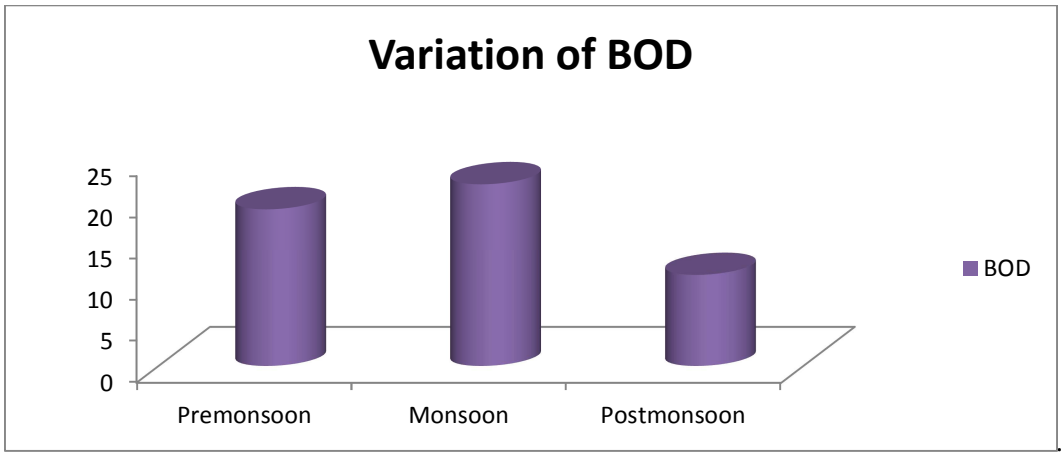


Fig: 8 Seasonal Variation of mean COD collected different season

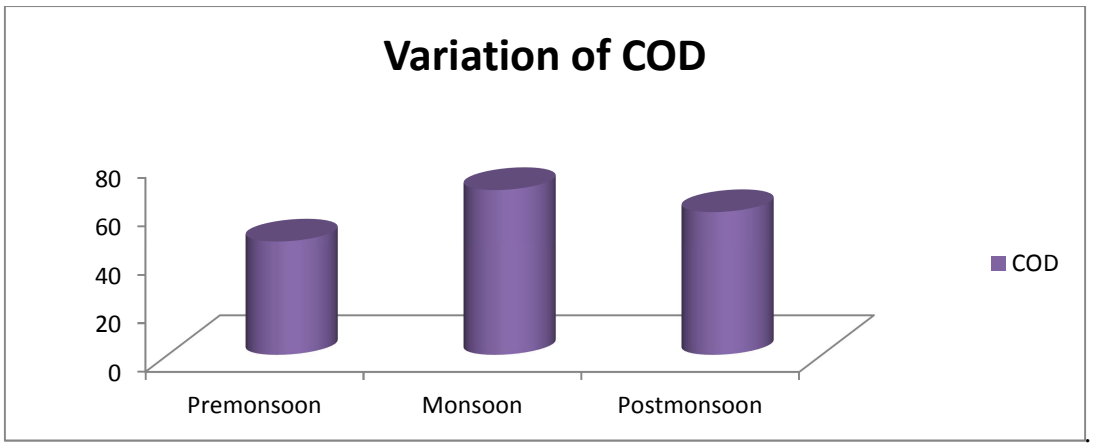


Fig: 9 Seasonal Variation of mean Bicarbonate collected different season

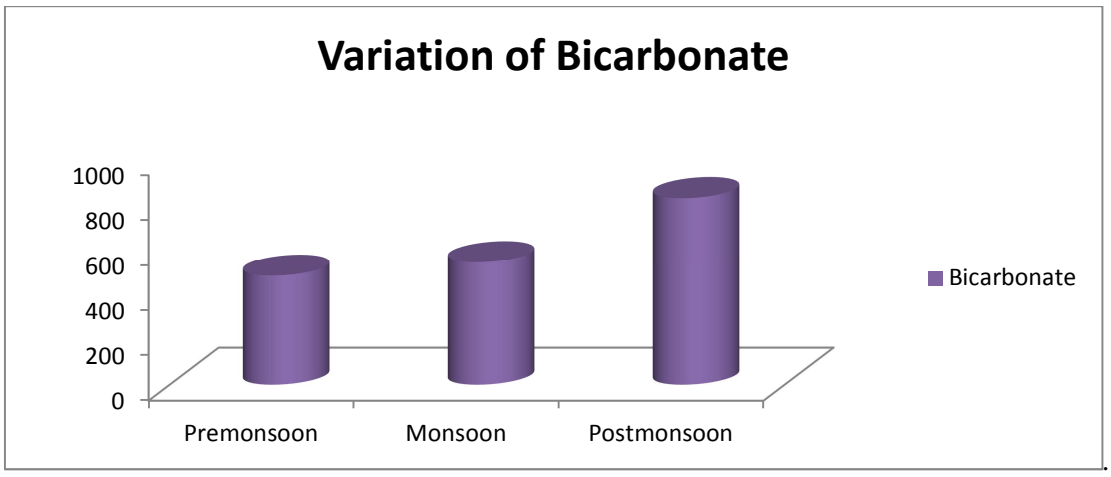


Fig: 10 Seasonal Variation of mean Calcium collected different season

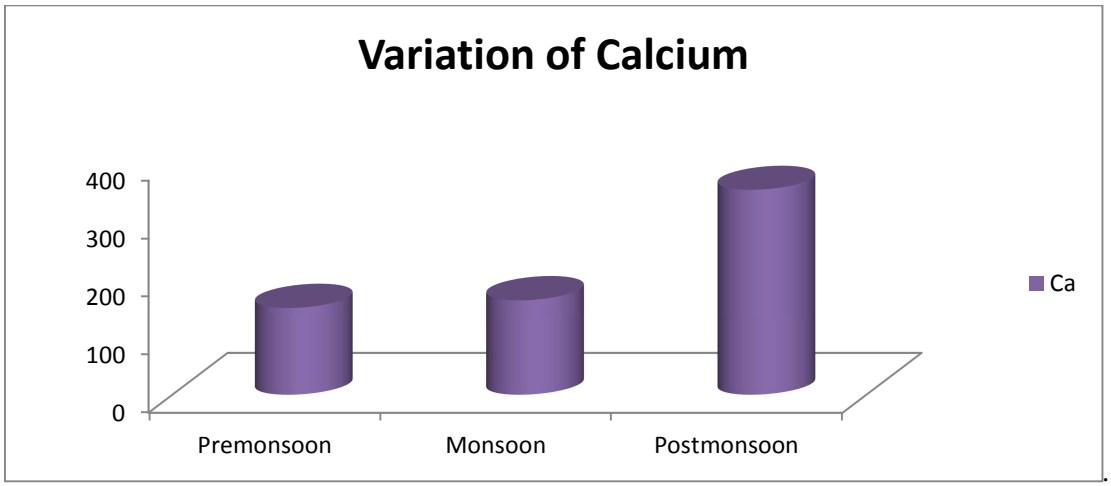


Fig: 11 Seasonal Variation of mean Cl collected different season

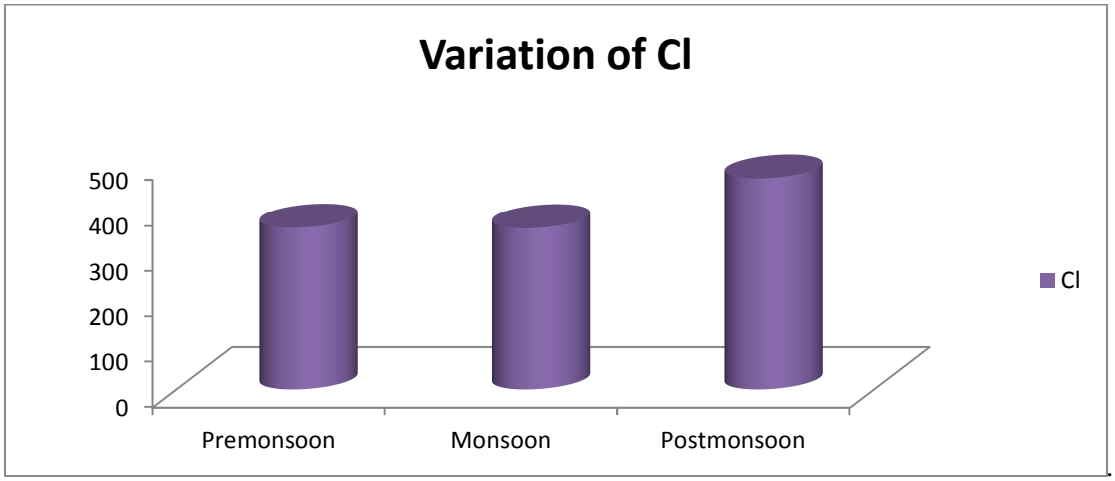


Fig: 12 Seasonal Variation of mean Mg collected different season

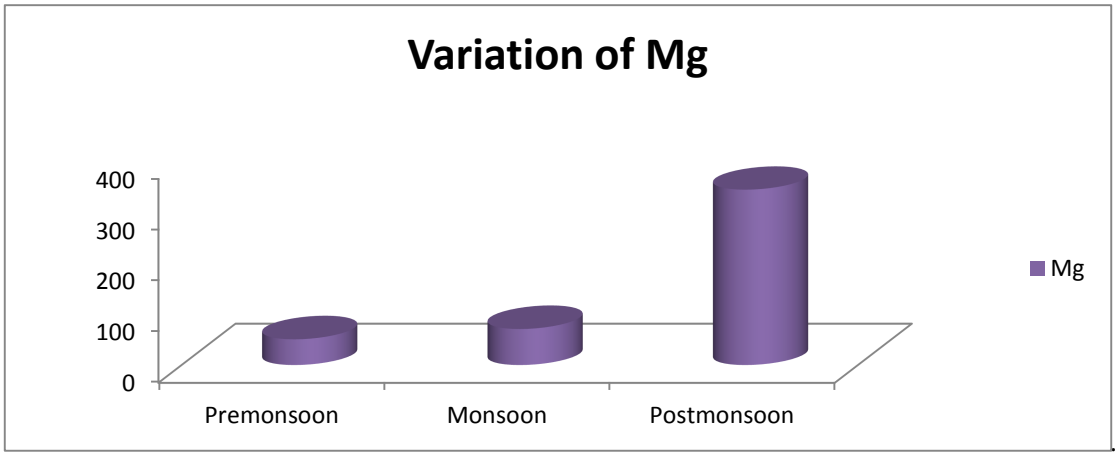


Fig: 13 Seasonal Variation of mean Na collected different season

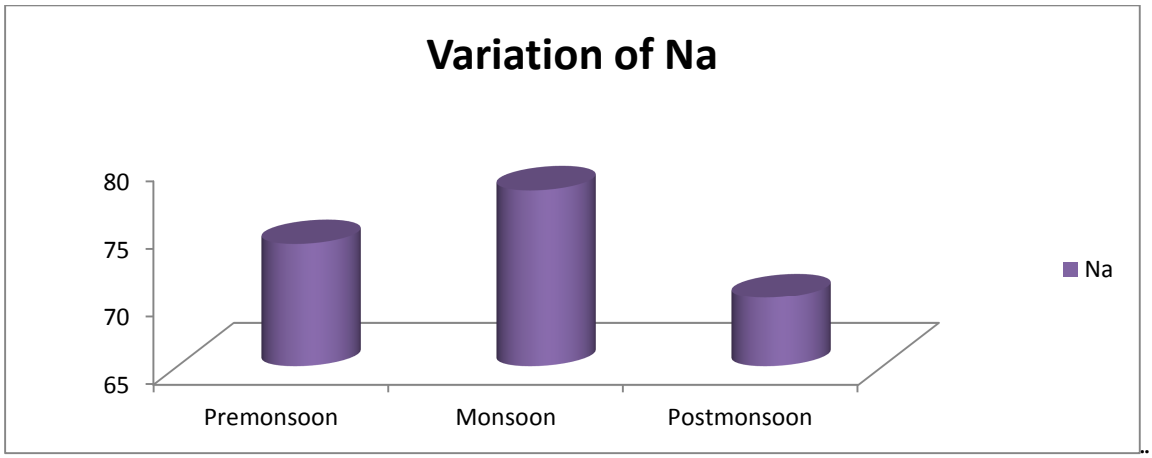


Fig: 14 Seasonal Variation of mean Potassium collected different season

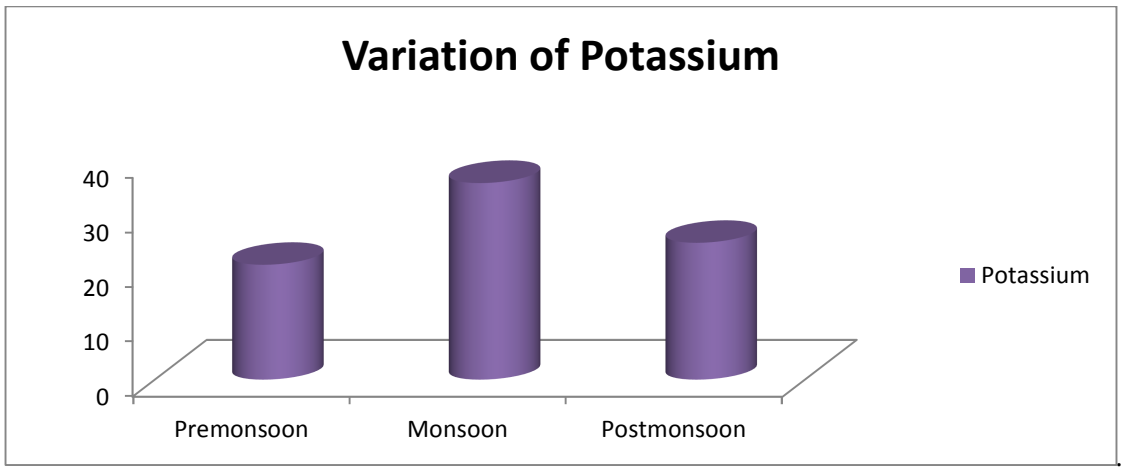


Fig: 15 Seasonal Variation of mean Sulphate collected different season

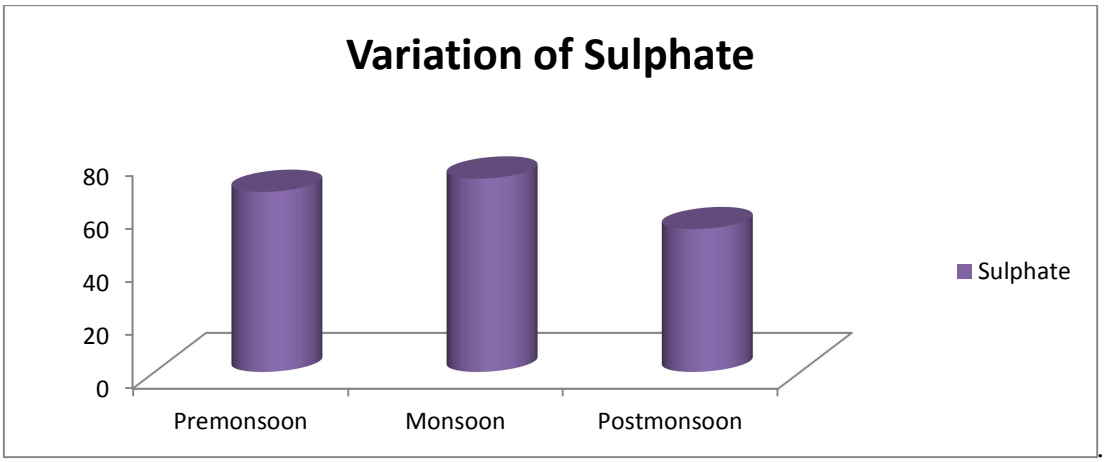
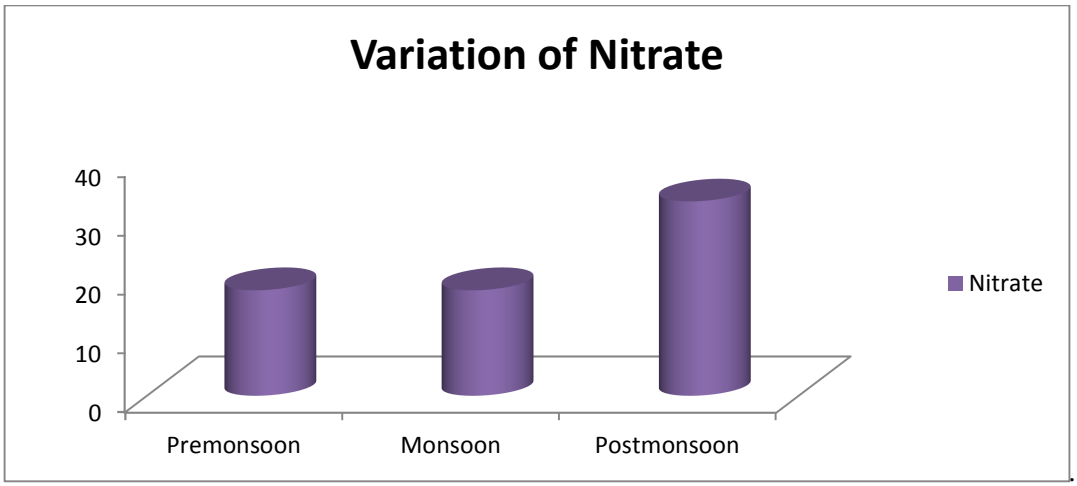


Fig: 16 Seasonal Variation of mean Nitrate collected different season



CONCLUSION

The ground water samples were collected from ten different places in and around Viralimalai area of Pudukkottai district. The samples were subjected to physic - chemical analysis and compared with WHO. The Calculated values of WQI are (**197.8**), (**208.3**) and (**178.0**) for pre monsoon, monsoon, and post monsoon respectively. The high values of WQI have been found to be mainly from the higher values of EC, TDS, TH, COD, Ca, HCO_3 and Cl in the ground water. The excessive level of many physicochemical parameters with respect to majority of the ground water samples studied in the present investigation render them unfit for human consumption and in certain cases not even suitable for irrigation purposes. Hence it is suggested that water from these sources should be pretreated before consumption.

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