



Seasonal variation of groundwater quality in Veppanthattai block of Perambalur district, Tamilnadu-implements of the water quality index method

A. Mohamed Ibraheem, *S. M. Mazhar Nazeeb Khan and A. Ravikumar

Department of Chemistry, Jamal Mohamed College (Autonomous), Tiruchirappalli, Tamilnadu, India

ABSTRACT

Seasonal study on the groundwater quality was carried out among the Veppanthattai block of Perambalur district in the year 2013 and the study covers three seasons namely post monsoon, pre monsoon and monsoon. Forty five Groundwater samples were collected from various locations in Veppanthattai block and were analyzed for their physico-chemical characteristics by using the standard analytical procedure of APHA (2005). The sample were analysed for the following parameters namely pH, Total Alkalinity, Electrical Conductivity, Total Dissolved Solids, Total Hardness, Calcium, Magnesium, Chloride, Sulphate, Nitrate, Phosphate, Dissolved Oxygen, Chemical Oxygen Demand and Iron. The result concludes that total alkalinity, total hardness, magnesium and chemical oxygen demand are above the permissible limit in the three seasons therefore it is suggested that the groundwater may be used after pre treatment.

Key words: Seasonal study, groundwater, Veppanthattai, permissible limit

INTRODUCTION

Water is the elixir of life and living organisms can't survive for short duration without water. It is a widespread solvent and as a solvent it provides the ionic balance and nutrients, which maintain all forms of life [1]. Particularly Groundwater plays a pivotal role in human life and development. There are several states in India where more than 90% populations are dependent on groundwater for drinking and other purposes [2, 3]. Groundwater is generally considered to be much cleaner than surface water. Nevertheless, several factors such as discharge of industrial, agricultural and household water, land use practices, geological formation, rainfall patterns, and infiltration rate affect the groundwater quality [4].

Thus groundwater possess little amount of soluble salts. The kind and quality of these salts depend upon the sources for recharge of the groundwater and the strata through which it flows. An excess of soluble salts can be injurious for many crops. Hence, an understanding of the chemistry of groundwater is essential to properly evaluate groundwater quality for drinking and agricultural purposes [5].

Water Quality Index

Water quality index is a mathematical equation that rates the strength of water body with a single number; it includes data from various water quality parameters. This number is justifying the water quality in category from excellent to unfit for drinking. The water quality Index calculation was carried out, through adaptation of Horton's method [6] and application of modification proposed by Tiwari and Mishra. The overall water quality index for all the samples was calculated by weighted arithmetic index method [7] and is given by the following equation.

Water quality Index (WQI) = $\frac{\sum Q_i W_i}{\sum W_i}$

$$W_i = k/s_n$$

$$Q_i = V_n - V_i / V_s - V_i$$

where,

W_i = Unit weight of the i^{th} parameter

k = Constant of proportionality

Q_i = Quality rating of the i^{th} parameter

V_n = Estimated value of the i^{th} parameter

V_i = Ideal value of the i^{th} parameter in pure water

V_s = Standard permissible value of the i^{th} parameter.

Table 1. WQI values and its status

| Serial No | WQI Value | Status |
|-----------|-----------|--------------------|
| 1 | 00-24 | EXCELLENT |
| 2 | 25-49 | GOOD |
| 3 | 50-74 | POOR |
| 4 | 75-100 | VERY POOR |
| 5 | >100 | UNFIT FOR DRINKING |

Study area

Geographically Perambalur lies with latitude of 11°14' N and longitude of 78°56' E. The district is bounded by Cuddalore district in the north, Tiruchirappalli district in the south, Thanjavur in the east and Namakkal district in the west. The district lies in the Southern plateau and hill zone of Agro-climate regional planning with characteristics of semi-arid climate. The soil is predominantly red loamy and black soil. The normal rainfall of the district is 908 mm which is less than 946.9 mm, the normal rainfall of the State.

Veppanthattai is one of the permanent block of Perambalur district it locates 13.7 Km west side of Perambalur in the way of Attur main road. The latitude and longitude is 11.34, 78.82 respectively. Veppanthattai block has 29 Panchayat Villages according to the 2011 census and population of 1,48,700.

EXPERIMENTAL SECTION

45 samples were collected from representative bore wells, during post monsoon (Jan - Feb) pre monsoon (Jun - Aug) and monsoon (Oct - Nov) seasons in 2013. 2 L polythene bottles were used for sample collections which were previously cleaned with distilled water. The analysis was systematically carried out by adopting volumetric and instrumental techniques. The standard Procedures were followed for the analysis [8,9,10].

Methods adopted for physicochemical parameters analysis are as follows

Hydrogen ion concentration (pH) was determined by using pH meter (Systronics digital model 335). Electrical Conductivity (EC) was estimated conductivity meter. Total Dissolved Solids (TDS) was calculated by using conversion factor multiplied by EC value (Conversion factor 0.55 to 0.75). Total Alkalinity (TA) was estimated by titration with HCl acid. Calcium (Ca^{2+}) was estimated by Titration with EDTA. Magnesium (Mg^{2+}) estimation was done by subtracting the Calcium from Total Hardness value. Phosphate, Nitrates and iron are determined by using colorimeter. Sulphate and Dissolved Oxygen (DO) are estimated by precipitation method. Chloride was estimated by titration with AgNO_3 Solution and chemical oxygen demand (COD) was estimated by titration with potassium dichromate solution. Concentrations of all the parameters are expressed in milligrams per litre (mg/L) except pH and EC in $\mu\text{S}/\text{cm}$.

RESULTS AND DISCUSSION

The physico chemical parameter values of post monsoon, pre monsoon and monsoon seasons are represented in table 2, table 3 and table 4 respectively. The pH value is ranges from 6.6 to 7.8 in post monsoon, 7.0 to 8.5 in pre monsoon and 7.3 to 8.5 in monsoon season. Most of the samples are alkaline in nature except only one station in post monsoon as acidic in nature. PH values of all the samples are within the permissible limit at all the three seasons.

Table 2. Physico chemical parameters of groundwater sample in post monsoon

| | PH | EC | TDS | TA | TH | Ca | Mg | Fe | Cl | SO ₄ | NO ₃ | DO | COD | PO ₄ |
|---------|-----|---------|---------|------|------|--------|--------|------|-------|-----------------|-----------------|-------|-----|-----------------|
| Average | 7.4 | 1710.04 | 1190.19 | 459 | 450 | 76.89 | 90.99 | 0.16 | 270.1 | 26.44 | 0.47 | 2.78 | 51 | 0.8 |
| Median | 7.4 | 1648.84 | 1147.59 | 425 | 418 | 73.65 | 77.54 | 0.14 | 220.1 | 27.44 | 0.42 | 2.65 | 48 | 0.6 |
| Min | 6.6 | 579.59 | 403.40 | 50 | 14 | 4.81 | 2.24 | 0.00 | 63.9 | 1.93 | 0.09 | 0.20 | 16 | 0.1 |
| Max | 7.8 | 3397.60 | 2364.73 | 1075 | 1364 | 159.52 | 314.23 | 0.85 | 745.5 | 62.09 | 1.26 | 10.61 | 100 | 2.4 |

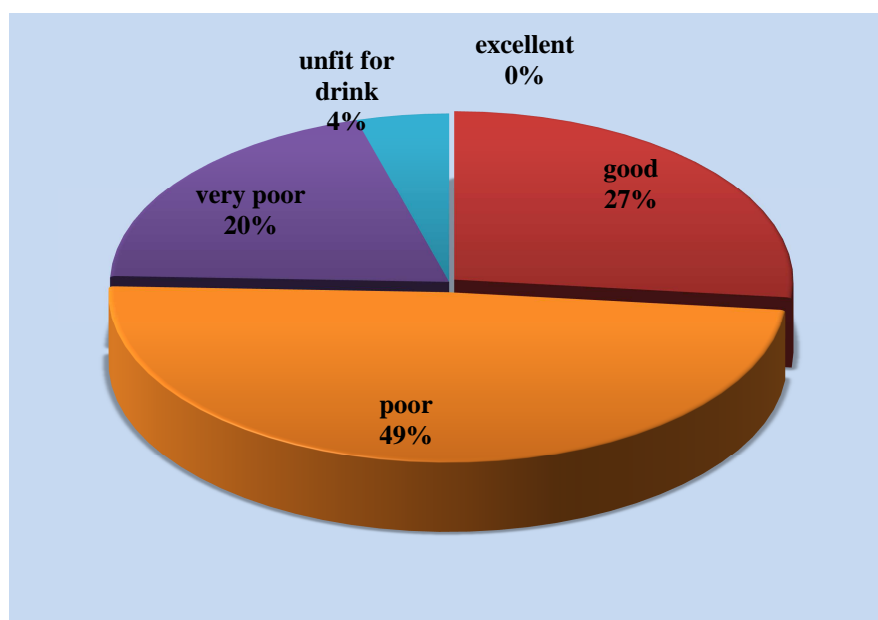
Table 3. Physico chemical parameters of groundwater sample in pre monsoon

| | PH | EC | TDS | TA | TH | Ca | Mg | Fe | Cl | SO ₄ | NO ₃ | DO | COD | PO ₄ |
|---------|-----|---------|---------|-----|------|--------|--------|------|--------|-----------------|-----------------|------|-----|-----------------|
| Average | 7.8 | 1669.47 | 1161.95 | 467 | 526 | 88.71 | 106.78 | 0.32 | 245.1 | 32.95 | 0.08 | 3.99 | 48 | 0.6 |
| Median | 7.8 | 1606.81 | 1118.34 | 460 | 510 | 79.36 | 101.07 | 0.31 | 227.2 | 26.96 | 0.06 | 3.88 | 48 | 0.4 |
| Min | 7.0 | 644.54 | 448.60 | 225 | 154 | 28.06 | 29.75 | 0.00 | 56.8 | 2.34 | 0.00 | 2.04 | 28 | 0.1 |
| Max | 8.5 | 2986.66 | 2078.72 | 850 | 1340 | 374.35 | 235.62 | 0.99 | 1065.0 | 84.24 | 0.25 | 5.10 | 82 | 2.5 |

Table 4. Physico chemical parameters of groundwater sample in monsoon

| | PH | EC | TDS | TA | TH | Ca | Mg | Fe | Cl | SO ₄ | NO ₃ | DO | COD | PO ₄ |
|---------|-----|---------|---------|-----|------|--------|--------|------|-------|-----------------|-----------------|------|-----|-----------------|
| Average | 7.8 | 1815.44 | 1263.55 | 461 | 565 | 79.18 | 118.52 | 0.21 | 235.4 | 24.82 | 0.04 | 3.32 | 63 | 0.4 |
| Median | 7.7 | 1691.56 | 1177.32 | 449 | 536 | 77.72 | 110.72 | 0.15 | 219.3 | 22.20 | 0.04 | 3.38 | 62 | 0.3 |
| Min | 7.3 | 761.00 | 529.65 | 233 | 221 | 28.86 | 45.90 | 0.00 | 75.9 | 5.68 | 0.00 | 1.74 | 25 | 0.1 |
| Max | 8.5 | 4104.44 | 2856.69 | 775 | 1147 | 230.56 | 257.38 | 0.70 | 761.0 | 51.62 | 0.12 | 4.27 | 122 | 1.4 |

Concentrations of all the parameters are expressed in milligrams per litre (mg/L) except pH and EC in $\mu\text{S/cm}$.

**Figure 1. Water Quality Index for Post monsoon**

The electrical conductivity range in post monsoon, pre monsoon and monsoon is 579.59 to 3397.6 $\mu\text{S/cm}$, 644.5 to 2986.7 $\mu\text{S/cm}$ and 761.0 to 4104.4 $\mu\text{S/cm}$ respectively. There is no prescribed standard suggested by WHO. The EC value is completely depends on the TDS value if TDS is increases the EC value will increase. But the high EC value indicates the more salts in the groundwater.

The total dissolved solids are the sum of total cations and anions. It includes the total ionic species such as sodium, potassium, calcium, magnesium, chloride, bicarbonate, nitrate, sulphate and other trace elements [11]. The TDS range in post monsoon, pre monsoon and monsoon is 403.4 to 2364.7 mg/L, 448.6 to 278.7 mg/L and 529.7 to 2856.7 mg/L respectively. Most of the samples are above the permissible limit. It may be due to the agricultural runoff. Water with high dissolved solids generally has inferior palatability and may induce an unfavourable physiological reaction in the person who drinks it. Highly mineralized water is also unsuitable for many industrial applications [12,13].

Total alkalinity value is above the permissible limit in 98% of stations in post monsoon and all the stations in pre monsoon and monsoon season. The alkalinity range in post monsoon, pre monsoon and monsoon is 50 to 1075 mg/L, 225 to 850 mg/L and 233 to 775 mg/L respectively. Most of the samples are above the permissible limit. The

high value is due to the hydroxide, carbonates and bicarbonate ions probably released from limestone sedimentary rocks, carbonate rich soils, cleaning agents contributes to the alkalinity [14].

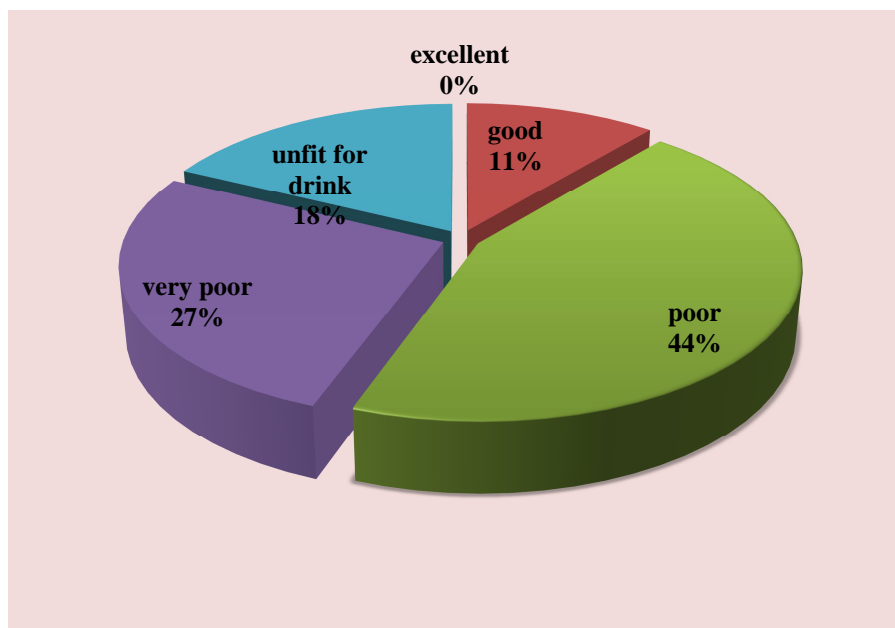


Figure 2. Water Quality Index for Pre monsoon

Total hardness Water hardness is caused primarily by the presence of cations such as calcium and magnesium and anions such as carbonates and bicarbonates, chloride and sulphate in water [15]. The value ranges is 14 to 1364 mg/L in post monsoon, 154 to 1340 mg/L in pre monsoon and 221 to 1147 mg/L in monsoon season. Most of the samples are above the permissible limit in all the three seasons. Principal cations imparting hardness are calcium and magnesium. So the high value is due to the dissolved Ca and Mg from sedimentary rocks and soil leakage and overflow. Hardness is called temporary if it is caused by bicarbonate and carbonate salts of cations, since it can be removal easily by boiling the water. Permanent hardness is caused mainly by sulphates and chlorides of the metals [16].

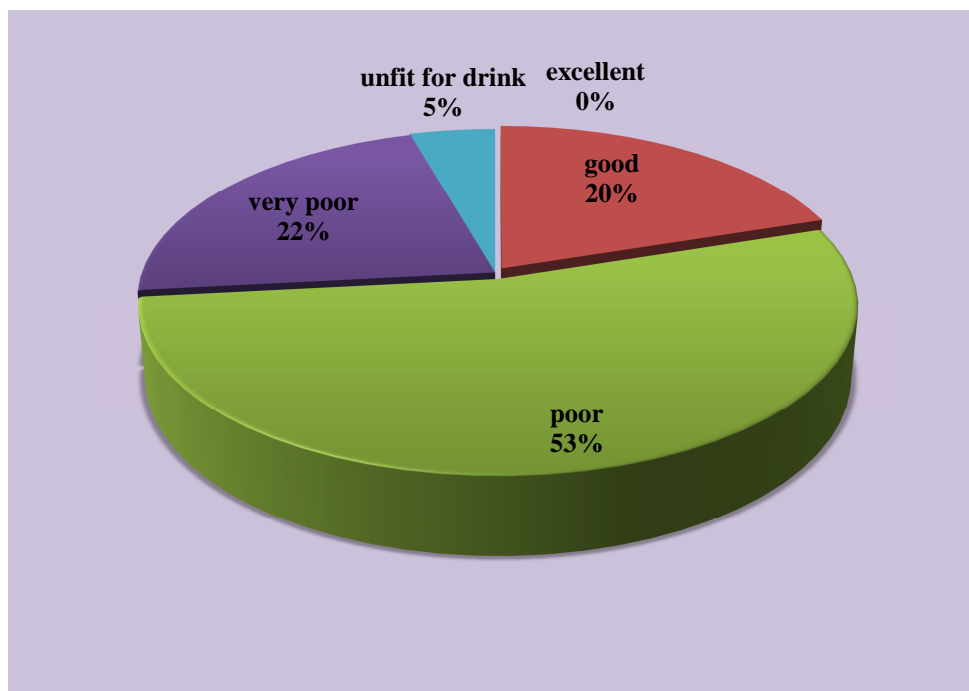


Figure 3. Water Quality Index for Monsoon

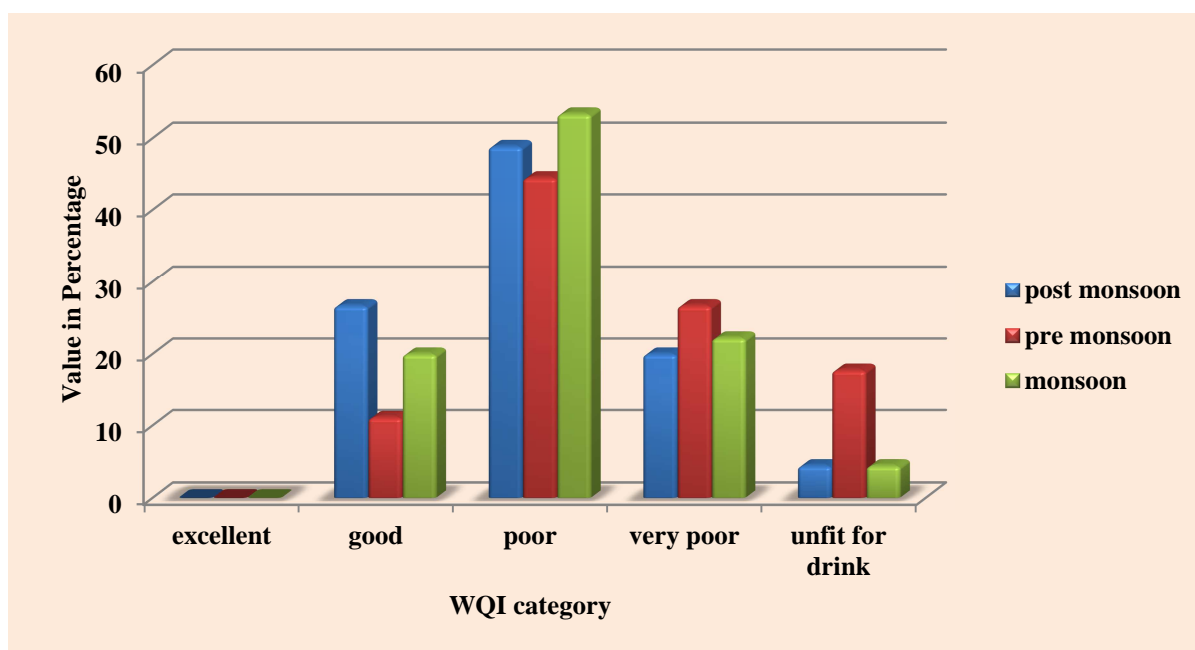


Figure 4. Comparison of Water Quality index for three seasons

Calcium range in post monsoon, pre monsoon and monsoon is 4.81 to 159.52 mg/L, 28.06 to 374.35 mg/L and 28.86 to 230.56 mg/L respectively. Most of the samples are within the permissible limit. High value is due to limestone. Magnesium range in post monsoon, pre monsoon and monsoon is 2.24 to 314.23 mg/L, 29.75 to 235.62 mg/L and 45.90 to 257.38 mg/L respectively. Most of the samples are above the permissible limit in three seasons. The high concentration of magnesium may be due the dissolution of magnesium calcite, gypsum and dolomite [17].

The chloride range in post monsoon, pre monsoon and monsoon is 63.9 to 745.5 mg/L, 56.8 to 1065 mg/L and 75.9 to 761 mg/L respectively. Most of the samples are above the permissible limit in three seasons. The high value is may be due to the discharge of domestic sewage and agricultural waste into ground. And Soil porosity and permeability also has a key role in building up the chloride concentration [18]. The values of COD in the groundwater samples are found to be in the range of 16 to 100 mg/L, 28 to 82 mg/L and 25 to 122 mg/L at post monsoon, pre monsoon and monsoon respectively. All the samples in the three seasons are above the permissible limit. The high value is indicates the groundwater is polluted is may be due to the sewage disposal to the groundwater.

Water Quality Index, Value in post monsoon season is 27% good, 49% poor, 20% very poor and 4% unfit for drinking. Value in pre monsoon season is 11% good, 44% poor, 27% very poor and 18% unfit for drinking. Value in monsoon season is 20% good, 53% poor, 22% very poor and 5% unfit for drinking. 0% is excellent in all the three seasons. Here WQI value of all stations falls in poor and very poor quality range as shown in the figure 1, 2 and 3. This is due to all the major parameters in all the three seasons were in above the desirable limit given by WHO standards. Figure 4 is indicates the comparative of Water Quality Index value in all the three seasons.

CONCLUSION

The water quality parameter like total alkalinity, total hardness, calcium, magnesium, total dissolved solid and chloride are found to be High value in most of the sample at all the three seasons. Water Quality Index value also indicate that the groundwater is not suitable for drinking and domestic purpose. So it is advice to special care for protect the groundwater from the pollution by sewage, agricultural disposal and some human activities.

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