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Assessment of Water Quality Index (WQI) for Drinking Purpose of Groundwater in Lower Varahanadhi subbasin, Tamilnadu, India

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Abstract: The present study is focused to determine the suitability of ground water for drinking purposes using Water quality index (WQI) in Lower Varahanadhi subbasin,Tamilnadu, India. The groundwater samples were collected during Premonsoon and Postmonsoon season in the year 2012 and analyzed for physicochemical parameters. The following parameters have been measured for manipulative the Water Quality Index such as (TDS, pH, EC, SO_4^-, HCO^{3-}, Cl^-, NO^{3-},Ca^{2+}, Na^+, K^+ and Mg^{2+}). The WQI of study area reveals that 50 to 58 percentages of samples showed good water category followed by 23 to 35 percentage of sample showed poor water category and 5 percentage of samples fall very poor water category during Premonsoon and Postmonsoon season.

Keywords: WQI, Lower Varahanadhi Subbasin, TDS, Groundwater, Puducherry, Tamilnadu.

I. INTRODUCTION

Drinking water is monstrously essential for human life. Freshwater is a finite and a vulnerable resource, essential to sustain life, development and the environment (Kalaivani and Ramesh,2015) Water quality, otherwise known as potability can be defined as the chemical, physical and biological properties of water as it concerns safe intake. It also involves the process of evaluating their physical, chemical and biological properties in relation to the natural quality and health effects (Ememu and Nwankwoala,2018). In a research, a couple researchers reported that water quality is enormously dependent on the indigenous geology, ecosystem, as well as human activities (Dadzie, 2012).Groundwater has long been considered as one of the purest forms of water available in nature and meets the overall need of rural and semi-urban people. Groundwater is worldwide 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. Continuous increase in water demands due to increasing population and developmental activities has resulted in more use of groundwater than the surface water resource which has led to groundwater depletion(Gopal Krishan et al., 2016). The suitability of groundwater for various uses majorly depends on quality of groundwater. Hence protecting the quality of groundwater is a major concern (Packialakshmi et al.,2011).

Water quality index is one of the most efficient tools to converse information on the quality of water to the concerned people and understand the spatial and temporal variation of quality. It acts as the indicator of the quality of water (Packialakshmi et al., 2015). Water quality index is one of the most effective, simple and easily understandable tools to assess water quality for its suitability for various purposes (singh et al., 2013). WQI is a mathematical equation used to transform large number of water quality data into a single number(Giljanovic,1999). It is simple and easy to understandable for decision makers about quality and possible uses of any water body(Bordalo et al.,2001).

II. MATERIALS AND METHODS

The present study lower Varahanadi subbasin which is located in Tamilnadu and Puducherry state(Fig.1). The Lower Varahanadhi sub basin is situated between north latitude 11° 52' 30" to
12° 07' 30" and east longitude 79° 30' 00" to 79° 52' 30".The aerial extent of the study area is 539 sq. km. A total 59 groundwater samples were collected from identify sampling station during Premonsoon and Postmonsoon season and were analysed in laboratory as per standard procedures.Arc GIS 10.3 was used to prepare spatial distribution map.

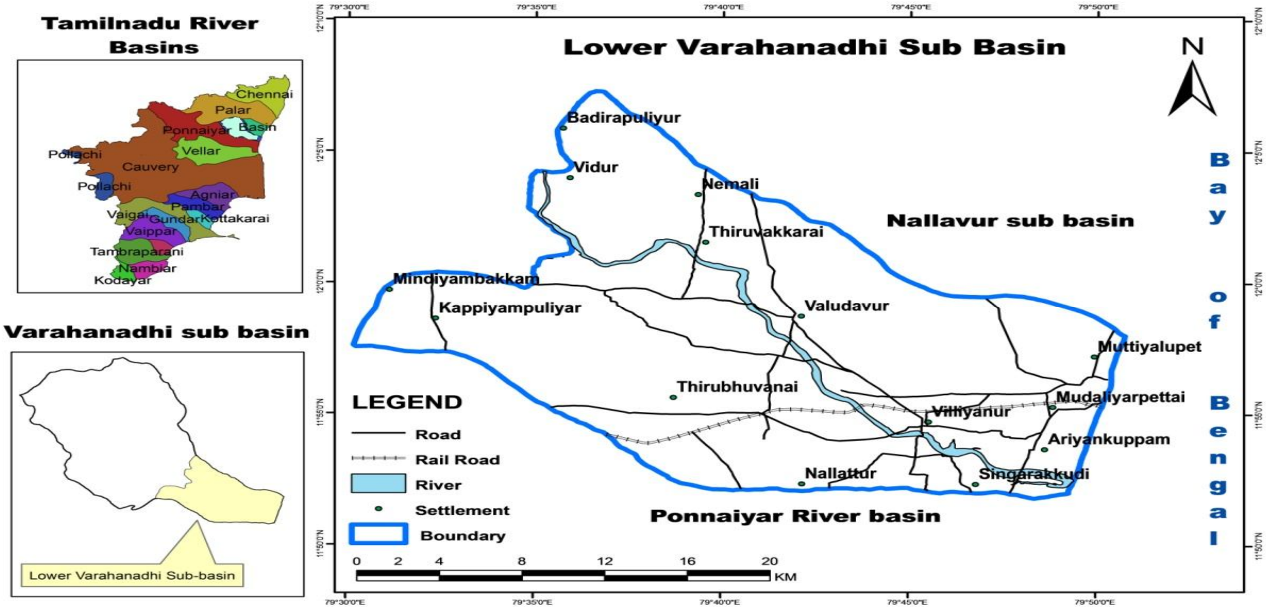

Fig:1 Study area

III. CALCULATION OF WQI

WQI is an important parameter for demarcating groundwater quality and its suitability for drinking purposes (Subba Rao, 1997;Magesh et al., 2013).WQI is defined as a technique of rating that provides the composite influence of individual water quality parameters on the overall quality of water (Mitra B.K.ASABE Member,1998) for human consumption. The standards for drinking purposes as recommended by WHO(2011) have been considered for the calculation of WQI.

For computing WQI three steps are followed. In the first step, each of the 11 parameters (TDS, pH, EC, SO_4, HCO_3^-, Cl^-, NO^3, Ca^{2+}, Na^+, K^+ and $Mg^{2+)}$ has been assigned a weight(wi) as shown in Table: 1 according to its relative importance in the overall quality of water for drinking purposes. The assigned weight ranges from 1 to 5.The maximum weight of 5 has been assigned for nitrate and TDS, 4 for EC, pH, SO4, 3 for Cl, HCO3, 2 for Ca, Na, K and 1 for Magnesium (Krishnakumaret al.,2015;Vasanthavigar et al.,2010).

In the second step, the relative weight (Wi) is computed from the following equation:

$Wi = wi / \sum^{n} i=1\ wi$

Where,Wi is the relative weight,

wi is the weight of each parameter and n is the number of parameters.

Table:1. Relative weight of chemical parameters (values in mg/l)

Chemical parameters	WHO standards (2011)	Weight(wi)	Relative weight $WI = \frac{wi}{\sum^{n}_{i=1} wi}$
pH	6.5-8.5	4	0.114
Electrical conductivity	500	4	0.114
Total dissolved solids	500	5	0.143
Bicarbonate	500	3	0.086
Chloride	250	3	0.086
Sulphate	250	4	0.114
Nitrate	45	5	0.143
Calcium	75	2	0.057
Magnesium	50	1	0.029
Sodium	200	2	0.057
Potassium	200	2	0.057
		$\sum wi = 35$	$\sum wi = 1.00$

Calculated relative weight(Wi)values of each parameter are given in (Table: 1).In the third step, a quality rating scale (qi) for each parameter is assigned by dividing its concentration in each water sample by its relative standard according to the guidelines laid down in the WHO (2011) and the result is multiplied by 100.

$q_i = (C_i/S_i) \times 100$ Where,qi is the quality rating. is the concentration of each chemical parameter in each water sample in mg/l and Si is the Indian drinking water standard for each chemical parameter in mg/l according to the guidelines of the WHO (2011).

For computing the WQI, the SI is first determined for each chemical parameter, which is then used to determine the WQI as per the following equation $SI_i = W_i \times q_i$ $WQI = \sum SI_i$

Where, SIi, is the sub index of i^{th} parameter and n is the number of parameters. The WQI range and type of water can be classified as shown in the Table.2

Table :2. Water Quality Index and their status of the groundwater

Range	Type of water	Percentage of the samples	
		PRM	POM
< 50	Excellent water	8.47	13.56
50- 100	Good water	50.84	57.62
100-200	Poor water	35.59	23.72
200-300	Very poor water	5.08	5.08
>300	Water unsuitable for drinking purposes	0	0

The water quality classification based on WQI values shows that during PRM, 8.4 % of the samples fall in excellent water category, 50.8% of the samples fall in good water category and 35.5 % of the samples fall in poor water category. During POM, 13.5 % of samples fall in excellent water category, 57.6 % samples of good quality and 23.7% of samples fall inpoor category. Overall, the WQI study reveals that 50 to 58 percentages of samples showed good water category followed by 23 to 35 percentage of sample showed poor water category and 5 percentage of samples fall very poor water category(Table:3). This may be due to effective leaching and dissolution process of rock salt and gypsum-bearing rock formations(Krishnakumar et al 2015).The spatial distribution map shows(fig 2 & 3) poor category of groundwater was observed in small patches of upper region of northern part.

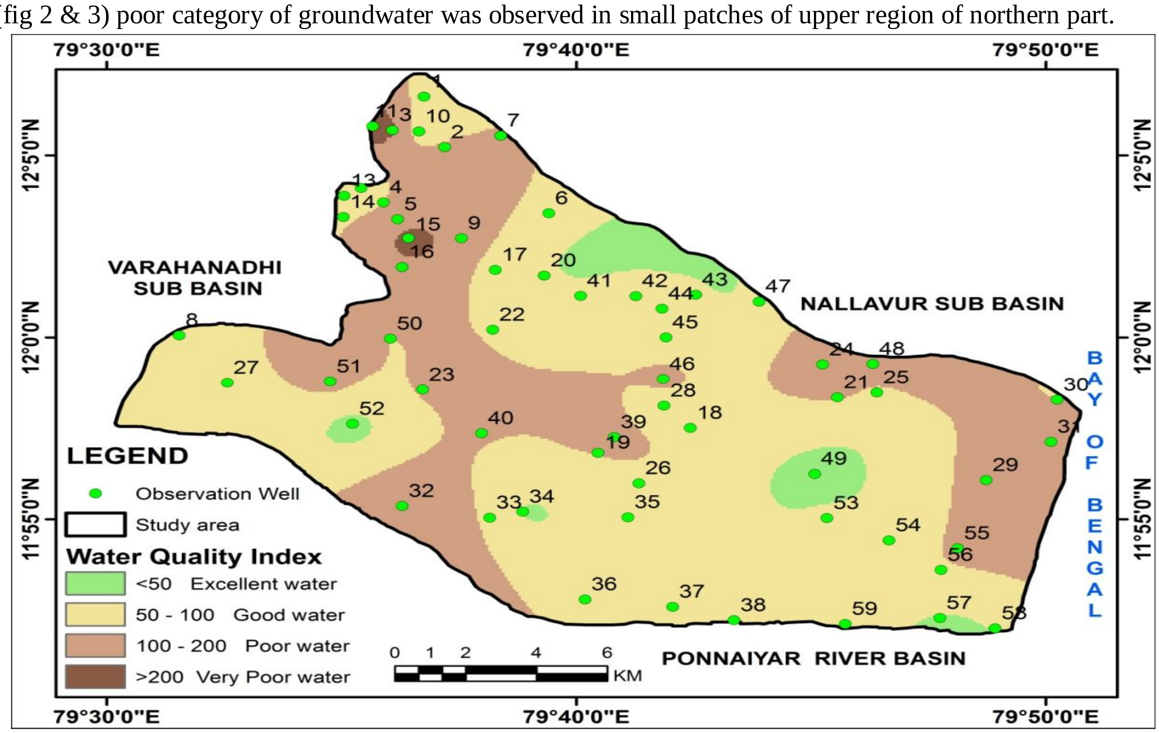

Fig: 2 Spatial distribution map of WQI during PRM

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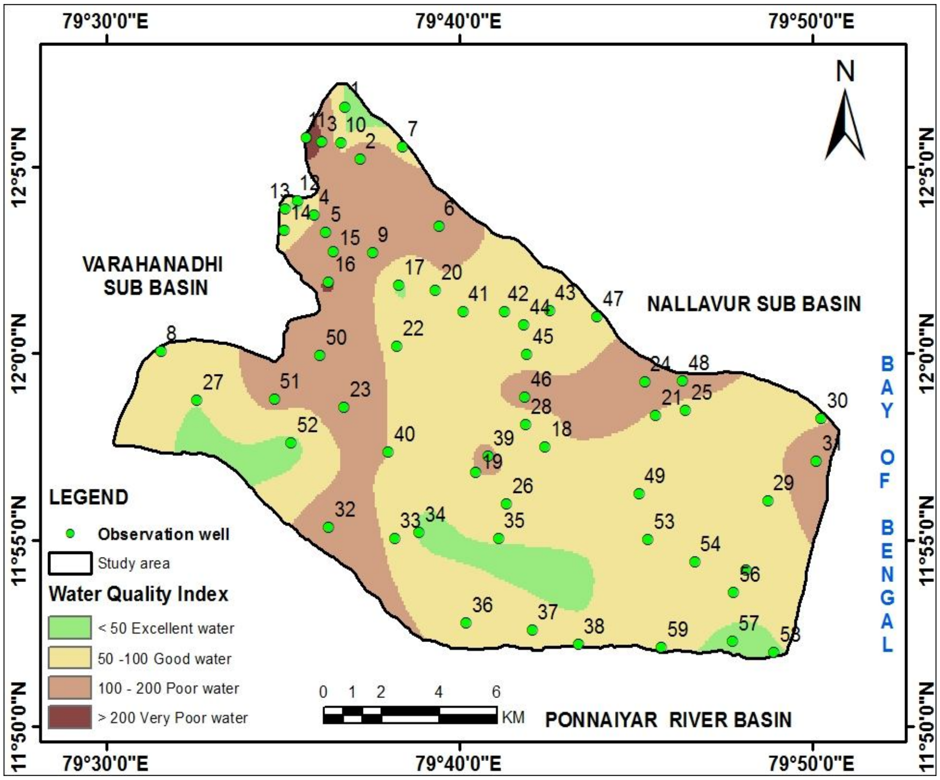

Fig:3 Spatial distribution map of WQI during POM

TABLE:3 WQI Category with sample number for POM and PRM season

Range	Type of water	No.of samples in POM	Sample numbers in POM	No.of samples in PRM	Sample numbers in PRM	% of the sample in PRM	% of the sample in POM
< 50	Excellent water	8	1,10,12,17,34,52,57, 58	5	10,34,49,52,57	8.47	13.56
50- 100	Good water	34	4,7,8,13,14,18-22, 25-30,33, 35-38, 40-45,47,49,53-56,59	30	1,6,8,12-14,17,18,20,22 , 25-28,33,35-38,41-45, 47,53,54,56,58 ,59	50.84	57.62
100-200	Poor water	14	2,5,6,9,15,23,24,31, 32, 39,46,48,50,51	21	2,4,5,7,9,16,19 ,21,23,24, 29-32, 39, 40, 46, 48,50,51,55	35.58	23.72
200-300	Very poor water	3	3,11,16	3	3,11,15	5.1	5.1
>300	Water unsuitable for drinking purposes	Nil	-	Nil	-	0	0

IV. CONCLUSION

Water Quality Index of lower varahanadhi subbasin was calculated from various physicochemical parameters in order to evaluate the suitability of water for drinking purposes. The WQI maps shows that the safest zone is in the Middle and Southern part of the study area, where majority of the samples are fall in good category for drinking purposes. In general, the groundwater quality decreases North-West part of the study area. The WQI values of poor category shows there is need for regular monitoring of water quality in order to identify major changes in physicochemical parameters. To improve the quality of groundwater, by improving artificial recharge wells and rainwater harvesting structures.

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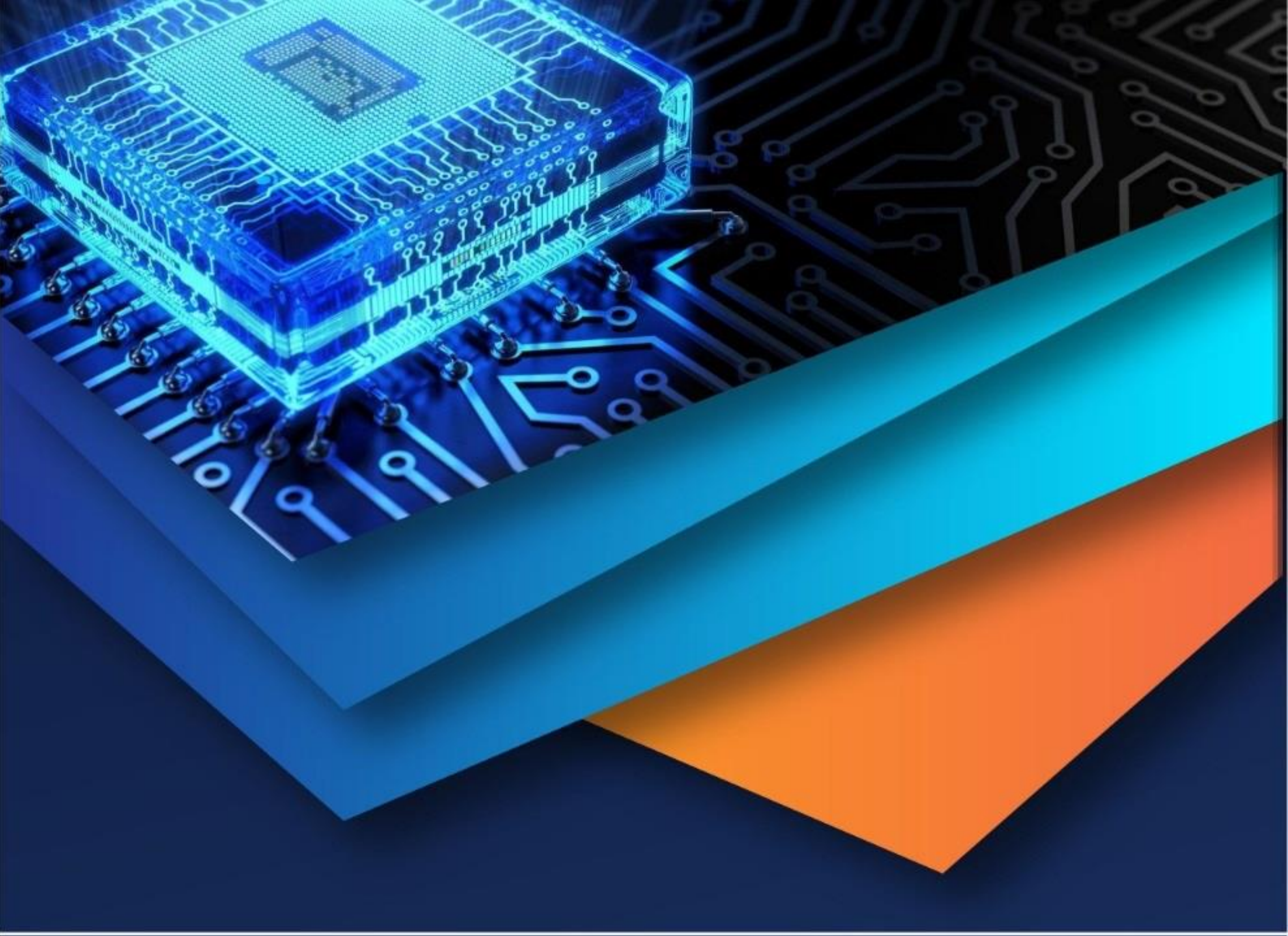

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