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Pre and Post-monsoon Variation in Physico-chemical characteristics in Groundwater quality of Tiruchengode Taluk, Namakkal district, Tamilnadu, India

S.M.Mazhar Nazeeb Khan* and A.Ravi Kumar

Department of Chemistry, Jamal Mohamed College, Trichy-620 020, Tamilnadu, India.

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ABSTRACT

The present investigation reports the results of monitoring study focusing on groundwater quality of Tiruchengode taluk, Namakkal district during Pre and Post monsoon period of 2012. This has been determined by collecting groundwater from 23 different sampling stations and subjecting the samples to a comprehensive physico chemical analysis. For calculating the WQI, the following 10 parameters have been considered i.e. Temperature, pH, Alkalinity, Dissolved oxygen, TDS, Total Hardness, Calcium, Magnesium, Chloride, Fluoride. The WQI during Pre-monsoon season varied from 135.01 to 382.75, while for Post-monsoon, it was found between 76 and 257. Significantly lower WQI for the Post-monsoon season was observed, indicating deterioration of the groundwater overall in corresponding season. The study revealed that groundwater from only 17.39 % locations was fit for domestic use, thus reveals that the groundwater of the study area needs some degree of treatment before consumption, and regular groundwater quality monitoring should be encouraged as a strategy towards groundwater quality protection and conservation.

Introduction

India, like any other developing country of the world, is facing increasing environmental problems. The vast population and ever increasing industrial activities in India, makes its water resources more vulnerable to water quality deterioration. The groundwater resources are at higher risk as its remediation is very difficult(Prashant N. Rajankar et al, 2010). Groundwater is about 20% of the world resource of freshwater and widely used for various purposes. Only about 1% of all of freshwater is available from rivers, ponds, lakes(Sunita R. Dandwate, 2012).

According to WHO organization, about 80% of all the diseases in human being are caused by water. The major problem with groundwater is that once contaminated, it is difficult to restore its quality. Hence there is need and concern for protection and management of groundwater quality (V.V.Sasane et al., 2013). National Sanitation Foundation (NSF) information system developed water quality index calculator for assessing water quality(Brown et al., 1972).

Determination of water quality is very important for knowing the suitability of water for various purposes. Use of Water Quality Index (WQI) to determine the water quality of aqua resources is considered as one of the most effective tool for comparing water resources(Sinha and Shrivastava 1994; Pradhan et al., 2001). The WQI was developed in the 1970s by the Oregon Department of Environmental Quality for the purpose of summarizing and evaluating water quality trends and status (Dunnette 1979).

The present study was carried out with the main objective of calculating the water quality index and presents spatial and temporal variations of water quality index of Tiruchengode taluk, Namakkal district for the months of March to May 2012(Pre-monsoon) and October to December 2012(Post-monsoon) in order to assess the suitability of its water for human uses. This region has major difficulties in managing its water resources, which are in decline leads to Over exploitation of groundwater resources and improper waste management especially that during the pre-monsoon season, it has been suffering from the deterioration of groundwater quality. This alarming situation necessitates the present study to generate the water quality index map for designing suitable water management plans in Tiruchengode Taluk, Namakkal district, Tamilnadu, India.

Materials and methods

Study Area

The study area (Figure 1) is situated at a distance of 45 km south-west of Salem and at a distance of 8 km from Sankaridurg, which is the nearest railway station. It lies between North Latitudes 11°20' and 11° 30' and East Longitudes 70°50' and 78°00' with a total extent of 25.20 sq km. This area experiences a tropical climate, with an average rainfall varies from 640 mm to 880 mm. Mornings in general are more humid than the afternoons with the humidity exceeding 78% on an average. In the period from June to November the afternoon humidity exceeds 66% on an average. In the rest of the year the afternoons are drier, the summer afternoons being the driest.

The hot weather begins early in March, the highest temperature being felt in April and May. Weather cools down progressively from about the middle of June and December, the mean daily maximum temperature drops to 30.2°C,

Geomorphology

Namakkal district forms part of the upland plateau region of Tamil Nadu with many hill ranges, hillocks and undulating terrain with a gentle slope towards east. The prominent geomorphic units identified in the district through interpretation of Satellite imagery are 1) Structural hills, 2)Bazada zone, 3)Valley fill, 4)Pediments, 5)Shallow Pediments and 6)Deep

Tele:

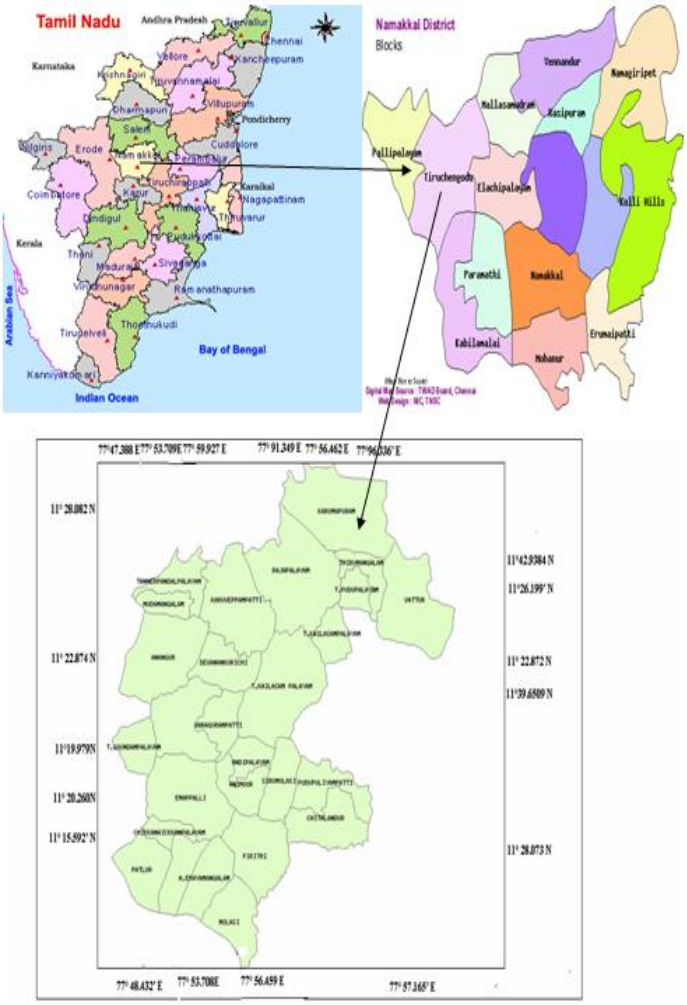
E-mail addresses: drmazharjmc@gmail.com

Pediments. The important hill ranges in the district are Kollimalaihills, Bodamalaihills, Naraikinaruhills and Pachamalaihills. The highest peak in the district is the Kollimalaihill peak with an elevation of 1293 m. above Mean Sea Level. Other important peaks are KeddaMalai(1284 m) and Melurhill in the Bodamalai hill range.

Hydrogeology

Namakkal district is underlain entirely by Archaean Crystalline formations with recent alluvial deposits occurring along the river courses and Colluvium at the foothills. The depth to water level in the district varied between 1.20 to 14.33 m bgl during premonsoon and the depth to water level varied between 0.86 to 16.60 m bgl during post monsoon. The seasonal fluctuation shows a rise in water level, which ranges from 0.03 to 3.51 m bgl. The piezometric head varied between 1.35 to 9.40 m bgl during pre-monsoon and ground level to 13.00 m bgl during post monsoon.

Figure 1 Geological Setup



Groundwater sampling and analysis

Total of 69 bore and dug-well samples were collected from the different villages of Tiruchengode taluk, Namakkal district (Fig. 1) during the year 2012 covering pre and post-monsoon seasons.

Parameters like pH and EC were measured in the field by using portable pH and EC meters respectively. The water sample containers were thoroughly washed with acid and then with distilled water in the laboratory before filling them with the sample. The precise latitude and longitude of the sampling points were determined by Global Positioning System (GPS). The location of the sampling points is shown in Figure 2.

Figure 2 Location map showing sampling points in the study area

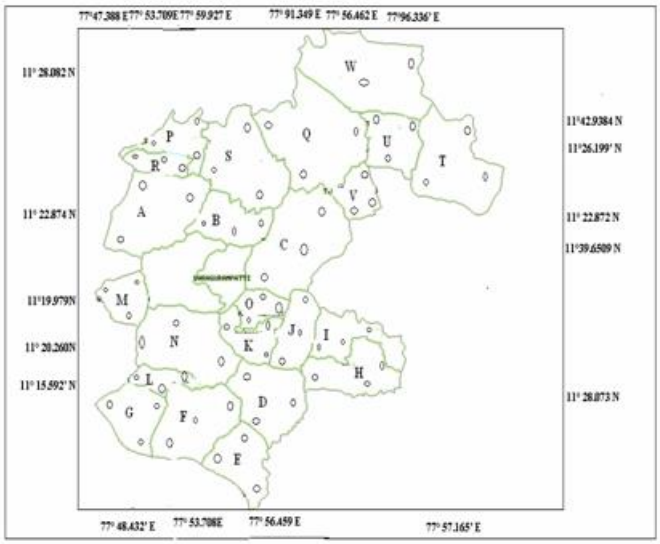


Table 1: Latitude and Longitude of study areas

S No	Station Name	Latitude	Longitude
1	Anangur	11°23.638'N	77°48.994'E
2	Devanankurichi	11°24.383'N	77°51.669'E
3	Srinivasampalayam	11°22.547' N	77°52.659'E
4	Pirithi	11°16.575'N	77°51.845'E
5	Molasi	11°15.725'N	77°50.741'E
6	Eryamangalam	11°16.197'N	77°50.533'E
7	Patlur	11°16.880'N	77°47.161'E
8	Chitalandur	11°19.237'N	77°55.009'E
9	Pudupuliyampatti	11°20.770'N	77°53.954'E
10	Sirumolasi	11°20.245'N	77°52.610'E
11	Animoor	11°22.304'N	77°53.100'E
12	Chickanaikanpalayam	11°16.001'N	77°48.502'E
13	T Goundampalayam	11°19.753'N	77°50.021'E
14	Emapalli	11°20.260'N	77°59.927'E
15	Andipalayam	11°21.671'N	77°48.230'E
16	Thaneerpandalpalayam	11°25.564'N	77°51.013'E
17	Valrasapalayam	11°25.153'N	77°49.478'E
18	Modamangalam	11°25.025' N	77°49.478'E
19	Karuvepampatti	11°24.146'N	77°52.939'E
20	Vattur	11°26.251'N	77°57.278'E
21	T Kailasampalayam	11°24.789'N	77°54.037'E
22	Thirumangalam	11°26.027'N	77°55.948'E
23	Karumapuram	11°25.316'N	77°56.270'E

Water Quality Index

Water quality index (WQI) is defined as a technique of rating that provides the composite influence of individual water quality parameter of the overall quality of water (Brown et al., 1972).

Weightage

For computing water quality index three steps are followed as given in table3.

In the first step, each of the 8 parameters has been assigned a weight (wi) according to its relative importance in the overall quality of water for drinking purposes. The maximum weight of 4 has been assigned to the parameter pH, TDS and DO due to its major importance in water quality assessment. EC, which is given weight of 1.

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

$$Wi=wi/\sum wi \quad ----(1)$$

Where (Wi) is the relative weight, (wi) is the weight of each parameter. Calculated relative weight (wi) values of each parameters are also given in (table 3).

Table 2: Relative weight of chemical parameters during Pre-monsoon Season

S. No	Chemical parameters	Indian standatds	Weightage (wi)	Relative Weightage (Wi)	Quality Rating (qi)	Sub index (Si)
1	pH	6.5-8.5	4	0.173	108	18.36
2	EC	<300	1	0.043	167.26	6.69
3	TDS	500-2000	4	0.173	326.60	55.52
4	TH	300-600	3	0.130	186.67	24.26
5	TA	200-60	3	0.130	263.00	34.19
6	Ca	75-200	2	0.086	201.00	16.10
7	DO	>5	4	0.173	84.00	14.28
8	Mg	30-100	2	0.086	340.00	27.20
			∑ wi=23	∑Wi=0.994	∑qi=1676.53	∑Si=196.60

Table 3: Relative weight of chemical parameters during Post-monsoon Season

S No	Chemical Parameters	Indian Standards	Weightage(wi)	Relative Weight(Wi)	Quality Rating(qi)	Sub Index(Si)
1	pH	6.5-8.5	4	0.173	101.33	17.22
2	EC	<300	1	0.043	145.2	5.8
3	TDS	500-2000	4	0.173	271.2	46.1
4	TH	300-600	3	0.13	154.66	20.1
5	TA	200-600	3	0.13	234.5	30.48
6	Ca	75-200	2	0.086	165.33	13.22
7	DO	>5	4	0.173	73.4	12.47
8	Mg	30-100	2	0.086	293.9	23.51
			∑ wi=23	∑Wi=0.994	∑qi=1439.52	∑Si=168.90

Table 4: Water quality classification based on WQI value

WQI Value	Water Quality
<50	Excellent
50-100	Good Water
100-200	Poor Water
200-300	Very Poor Water
>300	Water Unsuitable for Drinking

Table 5 Physicochemical parameters analysis in Tiruchengode Taluk during Pre- and Post- monsoon season

PARAMETER	SEASON	MEAN	SD	MIN	MAX	MEDIAN
pH	Pre-monsoon	8.11	0.84	7	9.9	7.9
	Post-monsoon	7.3	0.42	6.9	8.4	7.2
EC	Pre-monsoon	2509	1573	919	6192	1844
	Post-monsoon	2178	1408	872	5702	1620
TDS	Pre-monsoon	1633	707.4	728	3183	1428
	Post-monsoon	1356	666.4	612	2792	1071
TH	Pre-monsoon	560.34	156.7	300	833	536
	Post-monsoon	464.4	117.7	260	701	472
TA	Pre-monsoon	526.1	172.7	40	750	545
	Post-monsoon	469.8	149	87	686	490
Ca	Pre-monsoon	151.7	72.2	65	312	144
	Post-monsoon	124	68.1	48	290	106
DO	Pre-monsoon	4.25	1.97	1	8.5	4.8
	Post-monsoon	3.67	1.81	1	7.6	3.9
Mg	Pre-monsoon	102	132.4	18	455	53
	Post-monsoon	88.17	120.7	20	406	40

Table 6: WQI Classification for Pre- and Post- monsoon Seasons

STATION	WQI (Pre- monsoon	Classification	WQI (Post- monsoon)	Classification
A	312.71	Unsuitable	240	Very Poor
B	305.34	Unsuitable	257	Very Poor
C	382.75	Unsuitable	248	Very Poor
D	225.97	Very Poor	126	Poor
E	140.85	Poor	76	Good
F	159.99	Poor	102	Poor
G	155.51	Poor	98	Good
H	178.03	Poor	121	Poor
I	199.62	Poor	138.2	Poor
J	210.68	Very Poor	187.6	Poor
K	221.7	Very Poor	164.2	Poor
L	179.28	Poor	121	Poor
M	203.87	Very Poor	172.2	Poor
N	206.32	Very Poor	143.6	Poor
O	197	Poor	123.1	Poor
P	159.44	Poor	104.12	Poor
Q	218.48	Very Poor	154.2	Poor
R	173.6	Poor	105.12	Poor
S	171.34	Poor	98.4	Good
T	226.71	Very Poor	155.1	Poor
U	135.01	Poor	76.2	Good
V	241.16	Very Poor	171.6	Poor
W	254.5	Very Poor	187.16	Poor

In the third step, a quality rating scale (qi) for each parameter is assigned by dividing its concentration in each water sample by its respective standard according to the guidelines laid down in the BIS and the result is multiplied by 100:

qi = (Ci / Si) * 100 --------(2)

Where **qi** is the quality rating, **Ci** is the concentration of each chemical parameter in each water sample in mg/*l*, and **Si** is the BIS (Bureau of Indian standards) water standard for each chemical parameter in mg/*l* according to the guidelines of the BIS10500:1991.

For computing the **WQI**, the **SIi** is first determined for each chemical parameter, which is then used to determine the **WQI** as per the following equation

SIi = Wi * qi----------(3)

WQI = ∑SIi ---------- (4)

SIi is the Sub Index of i^{th} parameter, qi is the rating based on concentration of i^{th} parameter. The computed WQI values are classified into five types "excellent water", "good water", "poor water" "very poor water" and "water unsuitable for drinking" as shown in table no 4.

Results and Discussion

Table 5 presents the Physico-chemical parameters of groundwater of Tiruchengode block, Namakkal district. The groundwater was free from Colour, Odour, Taste and was slightly saline.

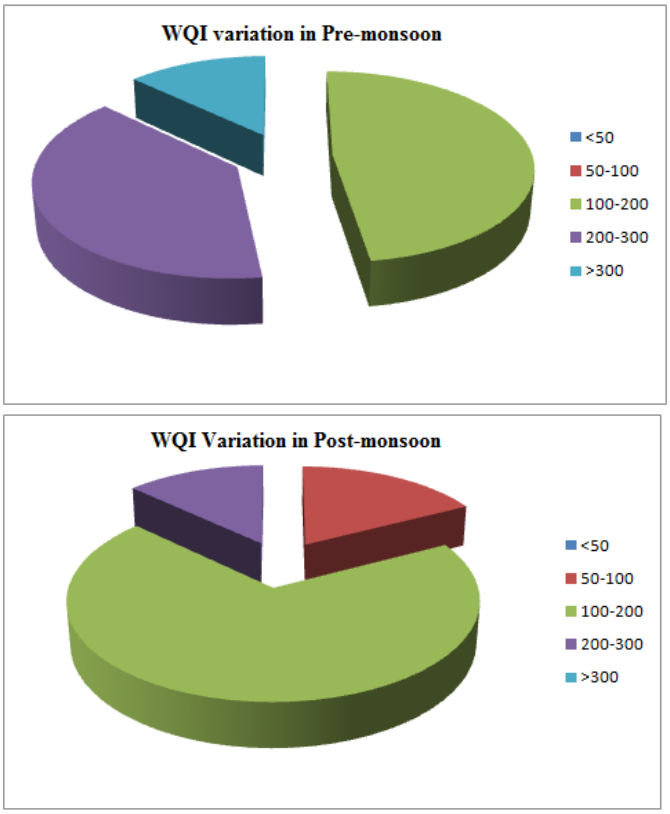


Figure 3 Classification of WQI of Tiruchengode Taluk during different seasons

Water Quality Index

The determination of WQI helps in deciding the suitability of various groundwater sources for designated usage. The WQI values of all the samples collected during this study are presented in Table 6. In general, during pre-monsoon season the WQI varied from 135.01 to 382.75, while during post-monsoon, it was between 76 and 257. It was found a significantly lower WQI during the post-monsoon season indicating a substandard quality of the groundwater during that season.

Conclusion

The WQI for 23 stations ranges from 135.01 to 382.75 during pre-monsoon and during post-monsoon it was found between 76 and 257. The high value of WQI at these stations has been found to be mainly from the higher values of Alkalinity, TDS, Hardness, Calcium and Magnesium in the groundwater. About 82% of water samples are very poor in quality. Overall Pre- monsoon from obtained results for study area groundwater resources are not potable. The groundwater quality may got improved in rainy season due to inflow of freshwater. The water quality indices are among the most effective ways to communicate the information on water quality trends to the general public or to the policy makers and water quality management.

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