CCME WQI-BASED EVALUATION OF GROUND WATER QUALITY IN VILLUKURI PANCHAYAT

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Abstract

The current study's objective is to assess the quality of the ground water in Villukuri Panchayat. Kanyakumari District, Tamilnadu, concerning the Water Quality Index (CCME WQI) application from the Canadian Council of Ministers of the Environment. The fieldwork was conducted for the seven hydrochemical (pH, TDS, turbidity, Ca2+, Cl-, F- and NO3-) parameters and six Tiny amounts of Fe, Mn, Zn, Cd, and Pb. The target parameters were analyzed by standard procedure (APHA) and the trace elements were identified by Flame Atomic Absorption Spectrometry (FAAS). Using the index's findings as a basis, the quality of ground water in Villukuri Panchayat ranged between 38.61 and 76.77 It demonstrates that the level of ground water is poor to fair on account of the effects of several contaminants.

Keywords: Water Quality Index, CCME WQI, Villukuri Panchayat, Pollutants, FAAS

Introduction

All forms of life require water to survive, and it must be protected from pollution that could endanger human life. Ground water has a variety of functions, including irrigation for agriculture and home usage, and they have important resources that provide excellent benefits to society and the environment.

Natural factors like the local climate, geology, etc., as well as human-induced factors like development pojects have an impact on water quality (2013) Rahman et al. Over the past 20 years, groundwater contamination has been a big worry. A method called the To evaluate the quality of the water, the Water Quality Index (WQI) is utilised.Using physicochemical factors, which can also serve as a sign of water pollution (Tyagi, 2013).

The type of water needed to keep ecosystems healthy is highly dependent on the environment. Because other aquatic ecosystems are sensitive to even little changes in a body of water's physical and chemical composition, this can lead to a decline in ecosystem services and a loss of biological diversity. Some aquatic habitats may withstand considerable variations in water quality without any obvious consequences on the structure and functionality of the ecosystem. Because human influences on water quality often have a delayed effect, aquatic ecosystems may not always be able to identify subtle adaptations to these changes until there is a significant change in the health of the ecosystem. (Stark et al., 2000).

according to water quality factors, the WQI, or Water Quality Index offers only one numerical number It represents the overall water quality at a certain place both time of year. The water quality index's main objective is to simplify complex water quality data into knowledge that the general public can easily understand and use. (Patil et al., 2013). To avoid and manage ground water pollution and to gather accurate data on the water's quality for effective management, the WQI evaluation is crucial.

various techniques used to estimate the index of water quality, that is “The Canadian Council of Ministers of the Environment Water Quality Index (CCME-WQI), National Sanitation Foundation Water Quality Index (NSFWQI), Oregon Water Quality Index (OWQI) and Weighted Arithmetic Water Quality Index (WAWQI)” (Sharma et al., 2011). The three variations that make up the CCMEWQI—Scope, Frequency, and Amplitude combine to provide a value between 0 and 100 that describes the water quality (Khan et al., 2005).

In this research, the WQI CCME approach will be used to provide a formula for calculating the quality of ambient ground water in Villukuri Panchayat. There is also a description of how the water quality has changed at the sampling stations.

Sample locations and the area of study

The current research was carried out in the Kalkulam Taluk's Villukuri Panchayat, which is located on the south coast of Tamilnadu. Villukuri Town Panchayat comes under the administrative territory of Kalkulam Taluk, Kanyakumari District. This town Panchayat is situated on both sides of NH 47 near Chunkankadai, Nagercoil to Karavilai, Kumara Covil of Tamilnadu state. It is located 12.00 km distance from Nagercoil. The area of this town Panchayat is 9.92 Sq. Km. Study stations were located near the agricultural land, urban and rural areas. Twelve ground water sampling sites (G1- mela pallam , G2-Karupucode, G3- manakarai, G4- karinchancode, G5-parayadi, G6- thottiyodu, G7- kuzhumaikadu, G8- vellachivilai, G9- madathattuvilai, G10-paraseri, G11- thiruvidaicode, G12- villukuri) were chosen within the Villukuri Panchayat. The map of the study stations was seen in Fig. 1.

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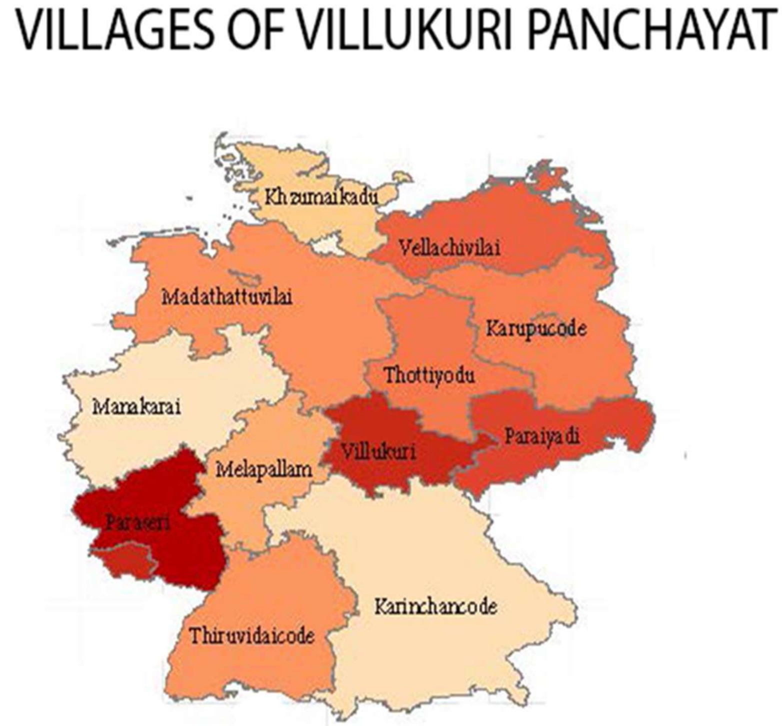

Fig.1 A map of the research region

Materials and methods

The pollution indicators (pH, TDS, turbidity, Ca2+, Cl-, F- and NO3-) were analyzed by standard procedure (APHA) and Flame Atomic Absorption Spectrometry (FAAS) allowed for the identification of the trace elements (Fe, Mn, Zn, Cd, and Pb).

Three metrics of deviation from chosen water adequacy targets (the extent, frequency, and amplitude) make up the CCME WQI model. A value ranging from 0 to 100 (with 1 denoting the worst water quality and 100 denoting the greatest) is created by combining these three variance measurements to indicate the total water quality. Haseen et al. (2005) reported that the quality of ground water was divided into five categories within this range: Fair (65-79), good (80-94), marginal (0-44), terrible (0-44), and exceptional (95-100). F1 and F2's calculations can be done quite easily; F3 requires a few extra steps. The proportion of variables that fail to achieve their goals at least once during the time period under consideration is represented by F1 (Scope). ("failed variables"), compared to the overall number of variables assessed:

F1 = (Variables that failed / total amount of variables) × 100

The frequency (Frequency) indicates the proportion of individual tests that fall short of goals. ("failed tests")

F2 = (No. of failure tests/ all tests conducted) × 100

Amplitude, F3 reflects the degree to which test levels failed fall short of the desired results. ("failed tests"). F3 has three phases to the calculation

Step: 1- Excursion calculation

The adventure is the total number of times that a person's focus changes from the aim greater than (or fewer than, if the objective is minimal) objective. when the test value cannot be greater than the goal: $ecursion = (Failed\ Test\ Value\ /\ Objective\ ) - 1$

When the test value must not fall below the objective:

$excursion = (Objective/\ Failed\ Test\ Value) - 1$

Step: 2- Calculation of Normalized Sum of Excursions

The total amount by which distinct tests are out of compliance is known as the sum of normalised excursions, or nse. This is estimated by averaging each test's deviations from its dividing the total number of tests by the objectives (including successful and unsuccessful ones).

$nse = excursion\ (n\ i)/\ Number\ of\ Tests$

Step: 3- Calculation of F3

F 3 ($Amplitude$) is calculated by an asymptotic function that scales the normalized total deviations from goals to produce a scale from 0 to 100.

$F3 = nse/(0.01\ nse + 0.01)$

The WQI is then calculated as: $CWQI = 100 - (\sqrt{(F_1{}^2 + F_2{}^2 + F_3{}^2)}\ /1.732)$

The factor of 1.732 has been introduced to scale the index from 0 to 100. The vector length can be as long as 173.2 because each index factor has a maximum value of 100, as demonstrated below: 1002 + 1002 + 1002 = 30000 = 173.2.

Statistical Analysis

The correlation between the 12 water-related variables was examined using Pearson's correlation coefficient. Microsoft Excel 2010 was used to conduct the statistical analysis.

Results and Discussion

Seasonal variations in pollution indicators of ground water

For ground water, it is helpful to be aware of a few general baseline water quality criteria. Regular monitoring programmes are necessary for optimal management and for obtaining information affects the water quality of fresh water resources (Singh et al., 2005). Fig. 2 depicts the variations of pollution indicating variables during the study period.

According to the results of pollution indicators (hydrochemical parameters) the value of TDS exceeded their standard limit (500 ppm) at a maximum number of ground water samples in Villukuri Panchayat except for G2 (mela pallam), G3 (karupucode) and G5 (karinchancode). According to Singh et al. (2020), TDS stands for the ground water's salinity. Similarly, the concentration of cadmium (Cd) and lead (Pb) was high in all the ground water samples which indicates the contaminants present in Villukuri Panchayat.

Water Quality Evaluation

The CCME WQI approach, as indicated in Table 4, was used to determine the level of ground water within Villukuri Panchayat. The annual WQI values at the twelve distinct locations were discovered using the CCME approach (Fig. 2). Every value fell inside the scale's acceptable bounds. The sample G9 value with the lowest value (madathattuvilai) showed the worst condition, demonstrating the impact of nearby residential wastes' effluent discharged into the groundwater.

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Statistical Analysis

The correlation between the sampling stations was identified by using Pearson's correlation method and depicted in Tables 5 and 6. The correlation matrices were used to find relationships between two or more variables (sampling stations). They were significant levels at 0.05. It is deemed significant and strongly correlated if the probability of significance (P>0.05) exists.

There is a significant association between all of the sampling stations in the current investigation and both the season which showed a strong positive correlation with one another at 0.01 significant levels implying they may have the same origin of pollution.

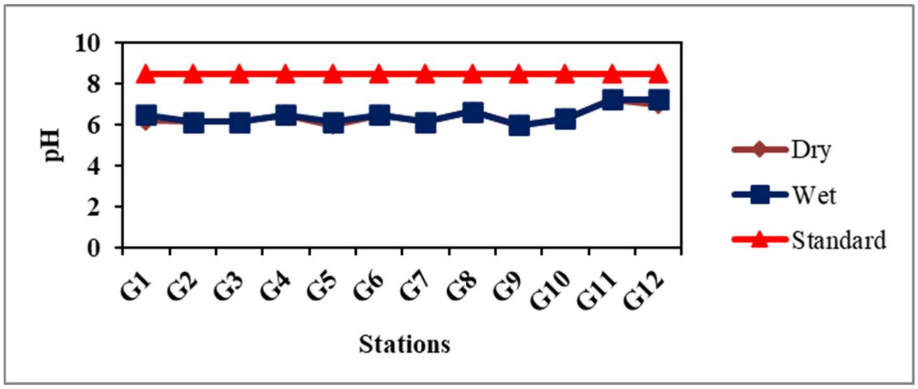
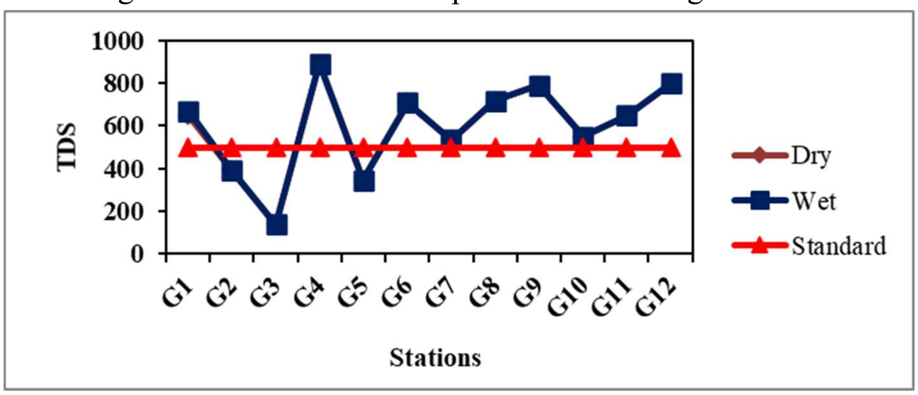
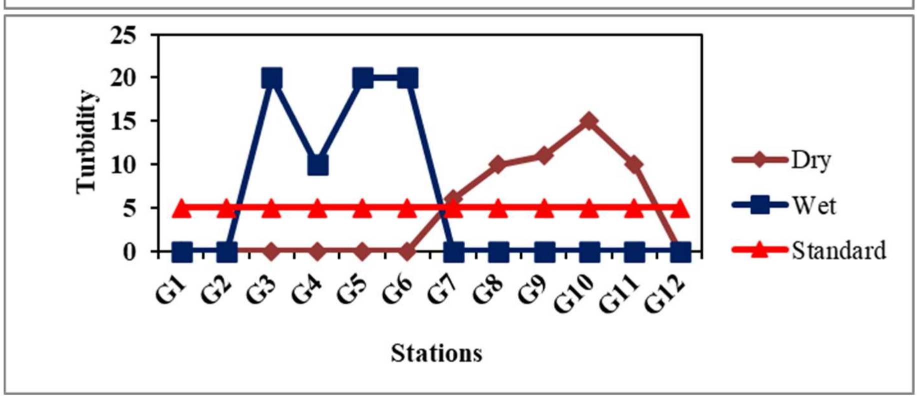


Fig. 2 Seasonal variation of pollution indicating variables





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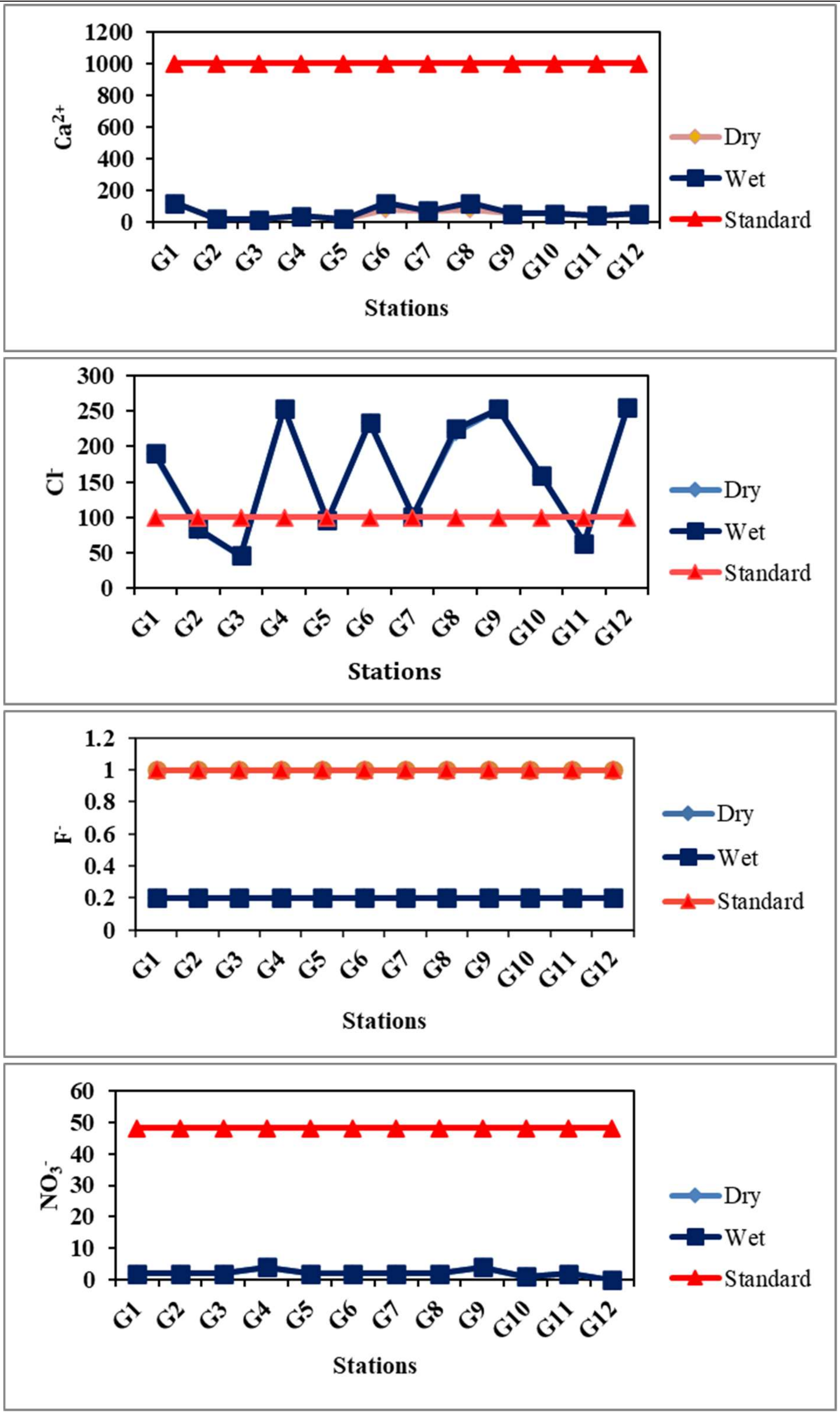
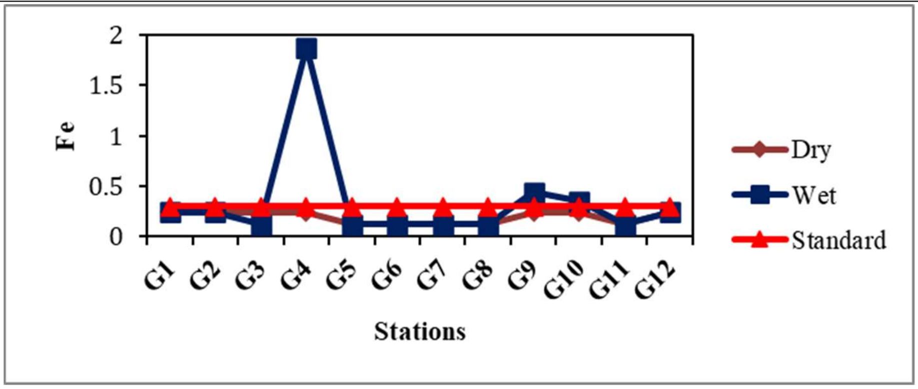
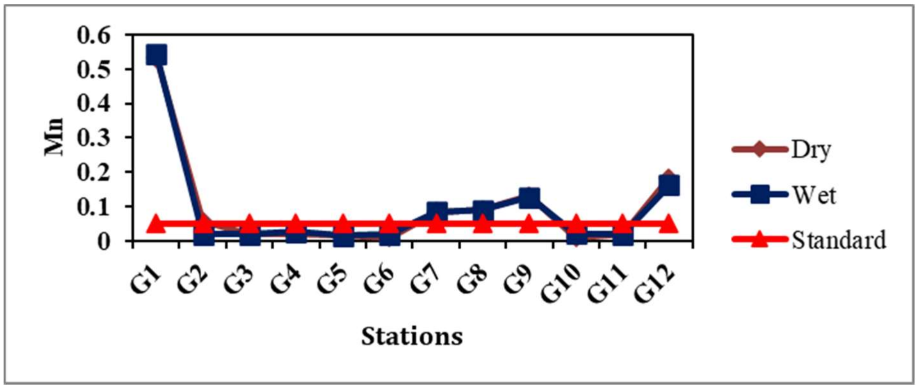
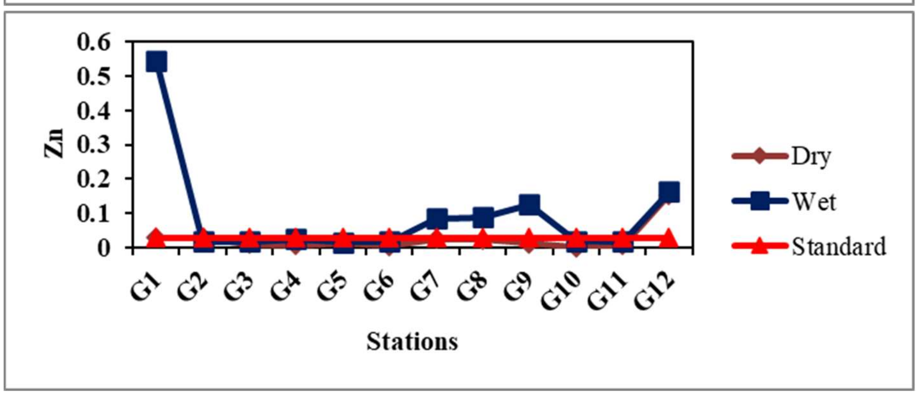
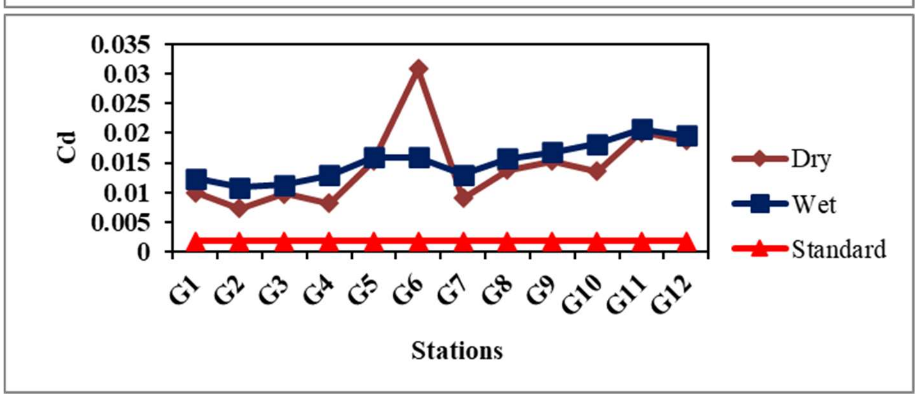



Fe
2
1.5
1
0.5
0
G1 G2 G3 G4 G5 G6 G7 G8 G9 G10 G11 G12
Stations
Dry
Wet
Standard


Mn
0.6
0.5
0.4
0.3
0.2
0.1
0
G1 G2 G3 G4 G5 G6 G7 G8 G9 G10 G11 G12
Stations
Dry
Wet
Standard


Zn
0.6
0.5
0.4
0.3
0.2
0.1
0
G1 G2 G3 G4 G5 G6 G7 G8 G9 G10 G11 G12
Stations
Dry
Wet
Standard


Cd
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
G1 G2 G3 G4 G5 G6 G7 G8 G9 G10 G11 G12
Stations
Dry
Wet
Standard

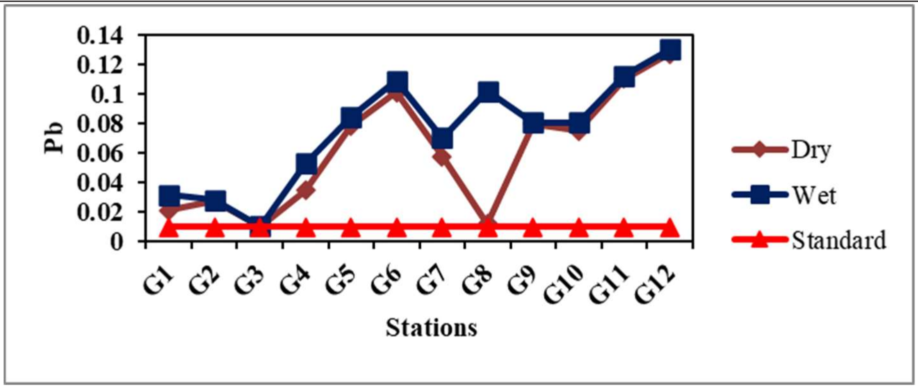


Fig. 2 Seasonal variation of pollution indicating variables

Table. 1 CCME Standards for Physico-chemical parameters

Parameter	CCME standards
pH	8.5
TDS	500
Turbidity	5
Ca^{2+}	1000
Cl^-	100
F^-	1
NO_3^-	48.2
Fe	0.3
Mn	0.05
Zn	0.03
Cd	0.0018
Pb	0.01

Table. 2 Concentration of pollution indicators in ground water during dry season

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Parameters	Stations												Mean± SD
	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11	G12	
pH	6.2	6.15	6.15	6.5	6	6.5	6.15	6.65	6	6.3	7.25	7	6.40±0.40
TDS (ppm)	650	390	140	892	345	710	535	720	790	550	650	800	597.67±217.47
Turbidity (NTU)	0	0	0	0	0	0	6	10	11	15	10	0	4.33±5.69
Ca^{2+} (ppm)	123	20	17	40	20	80	75	82	53	53	42	53	54.83±31.16
Cl^- (ppm)	189	82	46	254	96	234	102	220	253	160	64	256	163.00±81.05
F^- (ppm)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.20±0.00
NO_3^- (ppm)	2	2	2	4	2	2	2	2	4	1	2	0	2.08±1.08
Fe (ppm)	0.24	0.24	0.24	0.24	0.12	0.12	0.12	0.12	0.24	0.24	0.12	0.24	0.19±0.06
Mn (ppm)	0.534	0.055	0.0193	0.02	0.0156	0.01	0.083	0.0889	0.13	0.0099	0.0193	0.183	0.0973±0.15
Zn (ppm)	0.03	0.0303	0.01	0.007	0.013	0.006	0.0255	0.0244	0.013	0.002	0.0063	0.1545	0.0268±0.04
Cd (ppm)	0.01	0.0073	0.0098	0.0081	0.0153	0.0308	0.009	0.0138	0.0153	0.0135	0.0201	0.0187	0.0143±0.01
Pb (ppm)	0.0213	0.0275	0.0098	0.0346	0.0785	0.1009	0.0575	0.012	0.08	0.0749	0.1103	0.127	0.0612±0.04

Table. 3 Concentration of pollution indicators in ground water during wet season

Parameters	Stations												Mean±SD
	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11	G12	
pH	6.5	6.15	6.15	6.5	6.15	6.5	6.15	6.65	6	6.3	7.25	7.25	6.46±0.42
TDS (ppm)	670	390	140	892	345	710	535	720	790	550	650	800	599.33±217.99
Turbidity (NTU)	0	0	20	10	20	20	0	0	0	0	0	0	5.83±9.00
Ca^{2+} (ppm)	120	20	17	40	20	120	72	120	53	53	42	53	60.83±39.15

Cl^- (ppm)	190	84	46	254	96	234	102	225	253	160	64	256	163.67±81.23
F^- (ppm)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.20±0.00
NO_3^- (ppm)	2	2	2	4	2	2	2	2	4	1	2	0	2.08±1.08
Fe (ppm)	0.24	0.24	0.12	1.88	0.12	0.12	0.12	0.12	0.44	0.35	0.12	0.24	0.34±0.50
Mn (ppm)	0.5437	0.0189	0.0192	0.0255	0.0156	0.0182	0.0847	0.0893	0.126	0.0196	0.0186	0.163	0.0952±0.15
Zn (ppm)	0.0299	0.0029	0.005	0.0089	0.0077	0.006	0.0314	0.0243	0.0712	0.0554	0.0079	0.1817	0.0360±0.05
Cd (ppm)	0.0124	0.0108	0.0113	0.0129	0.0159	0.0159	0.013	0.0157	0.0168	0.0182	0.0207	0.0196	0.0153±0.00
Pb (ppm)	0.0316	0.0281	0.0105	0.0527	0.0844	0.109	0.0703	0.1019	0.0808	0.0808	0.1125	0.1301	0.0744±0.04

Table. 4 CCME WQI for Villukuri Panchayat

	Variables Tested	**Variables Failed**	**Total Number of Tests**	**Failed Test**	**F1**	**F2**	**F3**	**CCME WQI**
G1	12	5	24	10	41.67	41.67	59.81	51.523
G2	12	2	24	4	16.67	16.67	32.614	76.767
G3	12	3	24	4	25	16.67	12.77	73.484
G4	12	6	24	10	50	41.67	53.227	51.456
G5	12	3	24	5	25	20.83	57.61	61.796
G6	12	5	24	9	41.67	37.5	67.33	49.418
G7	12	7	24	12	58.33	50	48.1	47.481
G8	12	5	24	10	41.67	41.67	54.44	53.68
G9	12	8	24	13	66.67	54.17	62.67	38.61
G10	12	7	24	11	58.33	45.83	58.33	45.51
G11	12	4	24	7	33.33	29.167	63.935	55.09
G12	12	6	24	12	50	50	35.153	54.41
Average								54.94

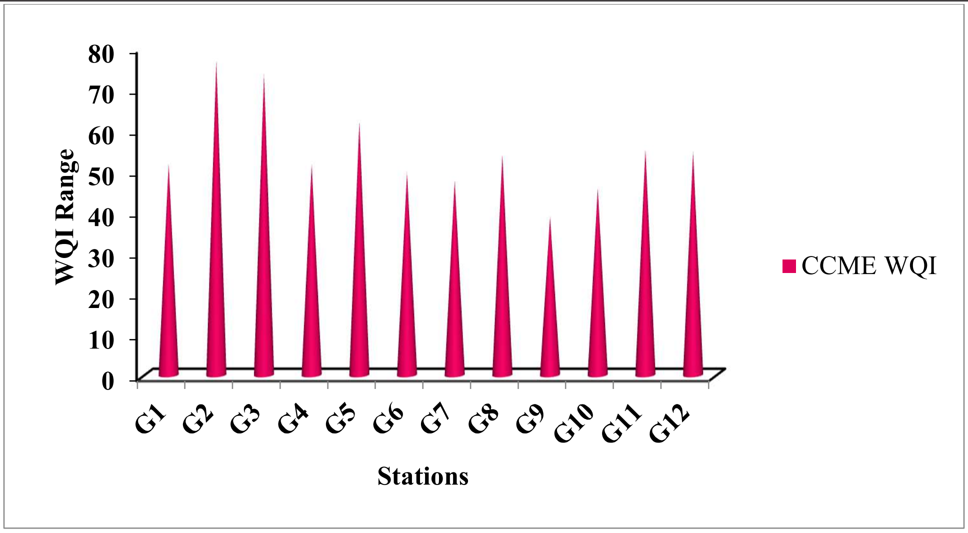

Fig. 3 CCME WQI of ground water samples

Table. 5 Correlation between sampling stations during dry season

G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11	G12
1											
0.988	1										
0.996	0.992	1									
0.990	0.997	0.996	1								
0.991	0.998	0.997	1.000	1							
0.996	0.992	0.999	0.997	0.997	1						
0.994	0.996	0.990	0.990	0.992	0.990	1					
0.997	0.994	0.999	0.998	0.998	1.000	0.993	1				
0.992	0.994	0.998	0.999	0.999	0.999	0.988	0.999	1			
0.995	0.996	0.998	0.998	0.999	0.999	0.994	1.000	0.999	1		
0.976	0.993	0.973	0.982	0.984	0.973	0.993	0.978	0.976	0.982	1	
0.992	0.994	0.998	0.999	0.999	0.999	0.988	0.999	1.000	0.999	0.975	1

Table. 6 Correlation between sampling stations during wet season

G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11	G12
1											
0.990	1										
0.987	0.985	1									
0.991	0.998	0.990	1								
0.990	0.997	0.995	0.999	1							
0.999	0.988	0.992	0.992	0.992	1						
0.995	0.996	0.982	0.991	0.991	0.990	1					
0.999	0.990	0.988	0.992	0.991	1.000	0.993	1				
0.993	0.995	0.990	0.999	0.997	0.995	0.989	0.995	1			
0.997	0.996	0.990	0.999	0.997	0.997	0.994	0.997	0.999	1		
0.978	0.993	0.968	0.982	0.983	0.971	0.994	0.974	0.976	0.982	1	
0.993	0.995	0.990	0.999	0.997	0.995	0.989	0.995	1.000	0.999	0.976	1

4. Conclusion

Using indicator of CCME water quality, seasonal fluctuations in terms of the ground water in a Villukuri Panchayat of the Kanyakumari district were assessed. According to the study, state of water quality of the various samples of groundwater was fair (65-79) in the G1-mela pallam. G2-Karupucode stations than that of poor (0-44) at G9- madathattuvilai station in both seasons although the average seasonal water quality status of Villukuri Panchayat ground water sample was the marginal state. This study confirms the necessity of monitoring ground water for optimal management and the need for strong action.

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