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PREDICTION OF GROUND WATER QUALITY USING REGRESSION ANALYSIS IN KANCHIPURAM, INDIA

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ABSTRACT

Groundwater is the principal source of water for drinking, agriculture, and industry. The most significant natural resource needed to supply drinking water to the general public worldwide, especially in rural regions, is groundwater. Groundwater quality variables spatial distribution has been explored to be evaluated, and the regression technique has been studied. The outcomes of the physical and chemical studies were compared to the standard guideline levels supplied by the Bureau of Indian Standards for drinking and global health to gain an understanding of the present groundwater quality. Nearly all of the parameters tested are above the desirable levels of standard, according to the basin's overall assessment. Using geographical distribution maps of different parameters, geographic information systems, and the regression technique. According to the regional distribution map of total hardness, the majority of groundwater samples are nearly within the allowable limit.

1. INTRODUCTION

In general, human survival is dependent on the availability of a sufficient groundwater supply in terms of both quality and quantity. Water use has increased throughout time, causing scarcity in numerous areas of the world [1]. Fresh water is a precious and insufficient resource. Water contamination complicates the problem. The primary cause of India's impending freshwater disaster is ineffective water resource management and environmental degradation

[10, 13]. This necessitates the need for millions of people to have access to safe drinking water. According to the WHO, approximately 80% of water-borne infections in humans occur. Moreover, the groundwater and pollutants may move at such a slow rate that it may take a long time for the contaminants to reach the pollution source, and changes in groundwater quality may remain hidden for years [2, 4]. Once contaminated, groundwater quality cannot be restored by removing pollutants from the source. As a result, it is critical to periodically monitor groundwater quality and devise methods and means to protect it [3, 8]. The primary purpose of this project is to assess the quality of groundwater in Kanchipuram and develop themed maps utilising a Geographic Information System (GIS) and regression analysis. GIS software can be used to assess water quality, determine water availability in the research area, analyse the natural environment, prevent flooding, and manage water resources on a local or district levels.

The ground water samples were collected manually from 20 bore wells spread out across Kanchipuram (Fig 2). The samples were tested in the laboratory using standard methods. Table 1 contains a list of the samples that were obtained. PH, temperature, total alkalinity, TDS, EC, and total hardness are among the parameters that are examined during water analysis. Nitrate, Sodium, Potassium, Sulphate, Calcium, Magnesium, Chloride, Iron, Fluoride, Nitrate, and Phosphate. Toposheet and field data are the two main sources of information used in the study. A digital output comprising a spatial database was created by scanning and digitising the toposheet obtained from the SOI delineating all areas. With the aid of the map, fieldwork was completed and groundwater samples were obtained. The findings of the laboratory tests on these samples were recorded in an excel spreadsheet. The regression analysis for each sample was computed. All of the water quality metrics' spatial distribution maps were constructed utilising an integrated spatial and attribute database. The spatial distribution maps were made with the Arc Map programme.

Table 1. Location name of sampling point with various source

Sample Id	Location Name	Latitude	Longitude
S1	Damal	12.91207658	79.57883512
S2	Vadiyur	12.92755327	79.64234703
S3	Sirukaveripakkam	12.8820407	79.66354589
S4	Sitterimedu	12.88957093	79.69942856
S5	Siruvakkam	12.93039753	79.70431745
S6	Agaram	12.8577751	79.8587272
S7	A.P.Chathiram	12.97249886	79.95058246
S8	Musaravakkam	12.87633405	79.60509845
S9	Pullalur	12.98951708	79.70406095
S10	Sevilimedu	12.83633549	79.65916571

S11	Tennambakkam	12.79649796	79.73058304
S12	Sembarambakkam	12.91088834	79.68938463
S13	Nerapakkam	12.82004829	79.6527378
S14	Konerikuppam	12.88821524	79.71444732
S15	Vedal	12.77691166	79.7290371
S16	Kattavakkam	12.96910945	79.70560402
S17	Purigai	13.00356726	79.73083801
S18	Enadur	12.87691976	79.74251534
S19	Sittiyamapakkam	12.87917889	79.77409879
S20	Kuruvimalai	12.79281518	79.72242844

3. STUDY AREA

Kanchi was one of the seven revered holy cities of ancient and mediaeval India, according to Tamil literature. 11 Taluks, 13 Panchayat unions, 8 Municipalities, and 18 Town Panchayats constitute the Kancheepuram District. This district is 4433 square kilometres, and the distance along the shore is 87.2 kilometres. On the east, it borders the district of Chennai and the Bay of Bengal; on the north, Tiruvallur; on the west, the districts of Thiruvannamalai and Vellore; and on the south, the district of Villupuram. This area is flat with a few minor hills in the Mathuranthagam and Chengalpat Taluks (Fig 1).

The climate in the Kancheepuram district is typically hot and humid. Rainfall in the district is influenced by both the southeast and northeast monsoons. The majority of precipitation falls in the form of cyclonic storms, which are primarily brought on by depressions in the Bay of Bengal during the northeast monsoon season. Rainfall during the southwest monsoon is much variable, and summer showers are hardly noticeable. Across the district, the average yearly rainfall ranges from 1105 mm to 1214 mm. It is at its lowest (1105 mm) in the district's western and northwestern regions near Uttiramerur, and at its highest (1450 mm) at Kovalam (1214.2 mm). The temperature ranges between 20°C to 37°C. 76 kilometres (km) south of Chennai, in the direction of the southwest, is the town of Kancheepuram. It is located at 790 - 42' east longitude and 120 50' north latitude. The settlement is located on average 275' (83–82m) above sea level. The holy river Vegavathi, a branch of the river Pallar, flows along the northern bank of the mainland.

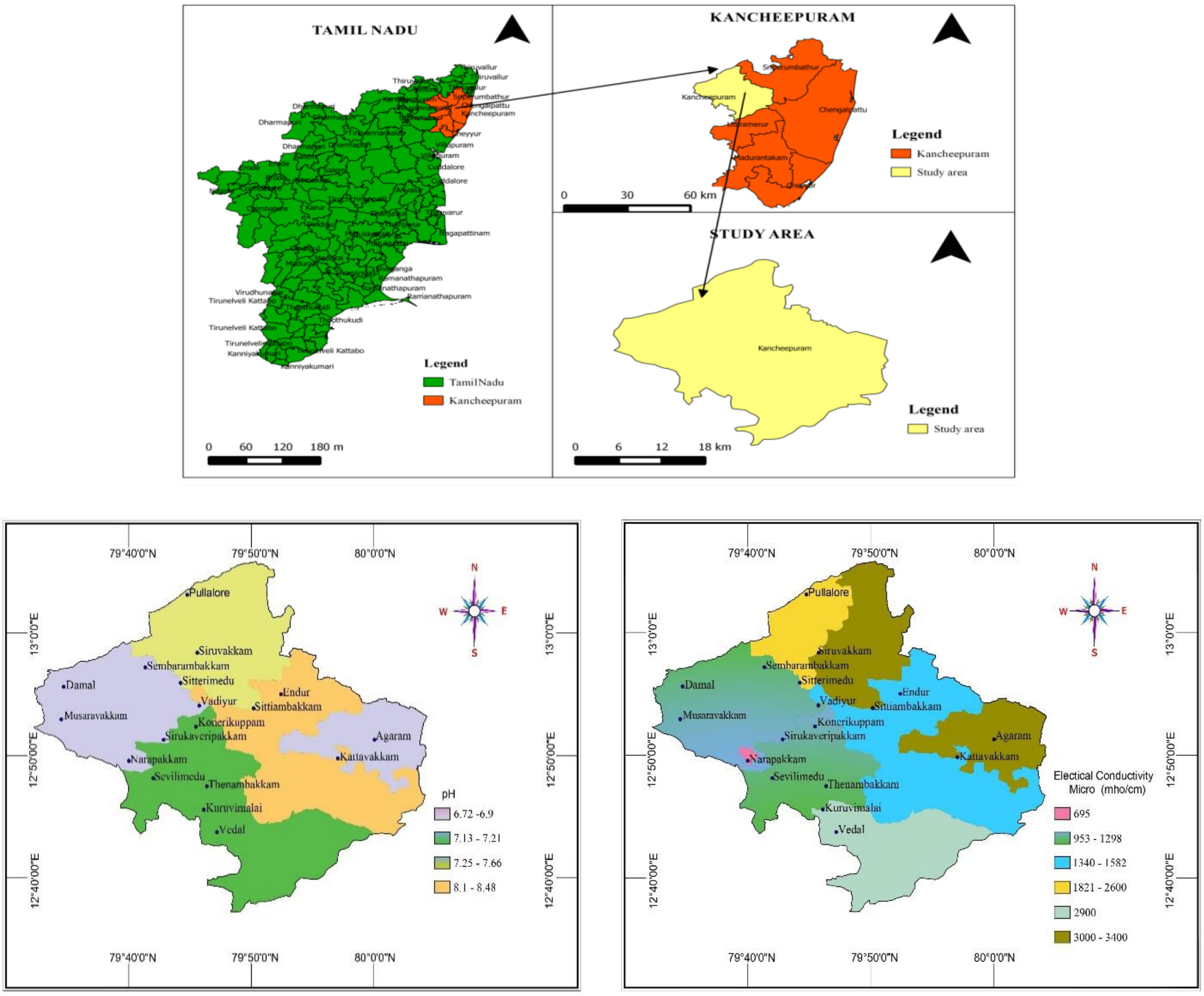


Fig 1 Study area map

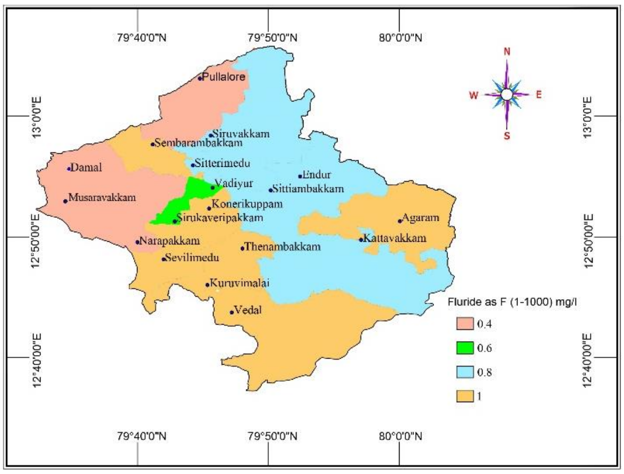
The town has good rail and road connections to the nearby cities of Arakkonam, Chengalpattu, Arcot, and Vandavasi. This town is on the broad gauge railway line between Chengalpattu and Arakkonam (construction is ongoing). In addition to this, the Local Planning Area is traversed by the Great Western Trunk Road, which runs from Chennai to Bangalore. The Planning area is traversed by the Vegavathi River from west to east, and it also divides the Planning area into two sections. The significant rivers are the Palar and Cheyyar. In general, the drainage pattern is radial and sub-dendritic. All rivers flow significantly during the monsoon season and are seasonal. The Jawadu Hills in Tiruvannamalai district are the source of the Cheyyar, a Palar tributary. It flows northeasterly through the Kancheepuram district before joining the Palar close to Pazhaiyaseevaram.

4. RESULTS AND DISCUSSION

The Bureau of Indian Standards (BIS) states that the pH range for drinking water is between 6.5 and 8.5. All types of water's pH values fall within the acceptable range. The research area's groundwater samples' PH values range from 6.72 to 8.48. Since every stage of water and waste quality management is dependent on pH, pH measurement is one of the most crucial and frequently performed tests. In addition, the maximum pH value is found at S2 and the minimum pH value is found at S10 in the sample points (Fig 2). Water's electrical conductivity, measured in micro mhos per centimetre (mhos/cm), is the capacity of water to carry electric current. Freshwaters typically have conductivity values between 200 to 600 mhos/cm. S5 had a maximum value of 3400 mhos/cm, while S13 recorded a minimum value of 695 mhos/cm (Fig 3)

Fig 2 pH Map

Fig 3 Electrical Conductivity Map



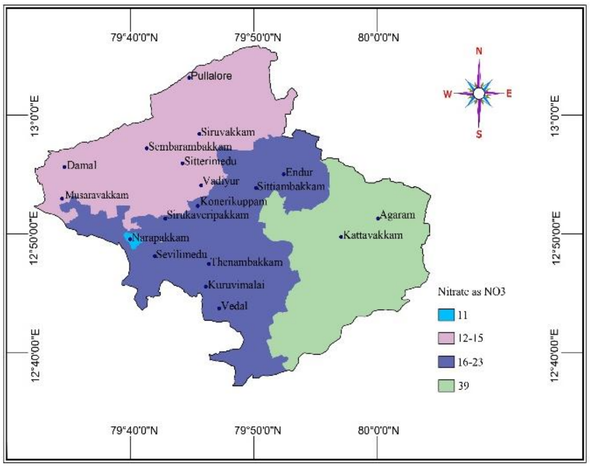


Fig 4 Alkalinity Map

Fig 5 Total harness Map

Alkalinity levels at stations were found to be between 200 and 600 mg/l. The alkalinity ranges from 216 to 536 mg/l throughout the year. The result indicates that the alkalinity in the area fluctuates relatively little, with the maximum at S5 536mg/l and the minimum at S13 216mg/l, as depicted (Fig 4).

A common method for evaluating the quality of water supply is hardness. Temporary hardness is determined by the amount of calcium and magnesium salts in water, which is largely coupled with bicarbonate and carbonate as well as sulphates, chlorides, and other ions of mineral acids (permanent hardness). Maximum hardness is attained at S16, and minimum hardness is at S13 (Fig 5).

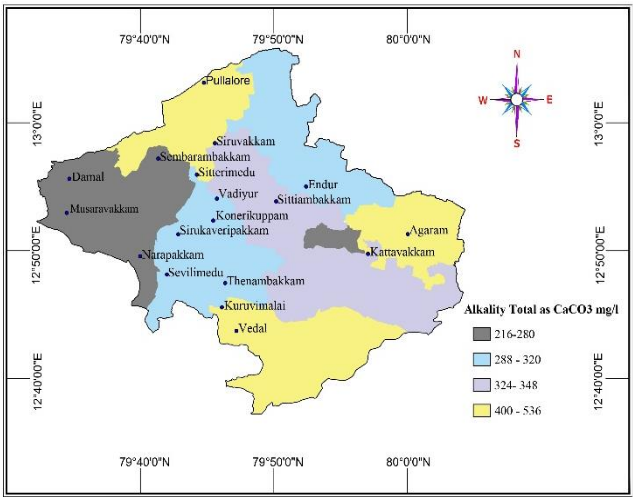


Fig 6 Fluoride Map

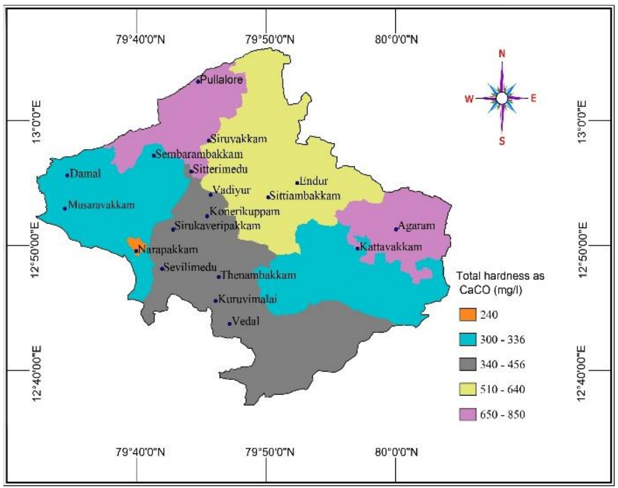


Fig 7 Nitrate Map

The fluoride concentrations in groundwater were found to be between 0.4 and 1.0 mg/l. Fluoride concentrations fluctuate depending on the type of rock the water passes through, but they typically do not go above 10 mg/l. Fluoride in excess is related to dental and skeletal fluorosis, whereas insufficient amounts are related to tooth caries. S3 has a maximum of 1 mg/l and S1 has a minimum of 0.4 mg/l (Fig 6).

The research area's nitrite concentration ranges from 11 to 39 mg/l. Nitrate levels should not exceed 45 mg/l. In surface waters, nitrates normally occur in minute amounts, but they can reach considerable concentrations in ground waters. Even at 100 mg/l concentrations, some aquatic creatures may be hazardous (15). When levels are too high, it can cause methenogobinemia in babies, with maximum levels at S6, S11, S12 and S15 are 39 mg/l and minimal levels at S13 is 11 mg/l (Fig 7).

Fig 8 Calcium Map

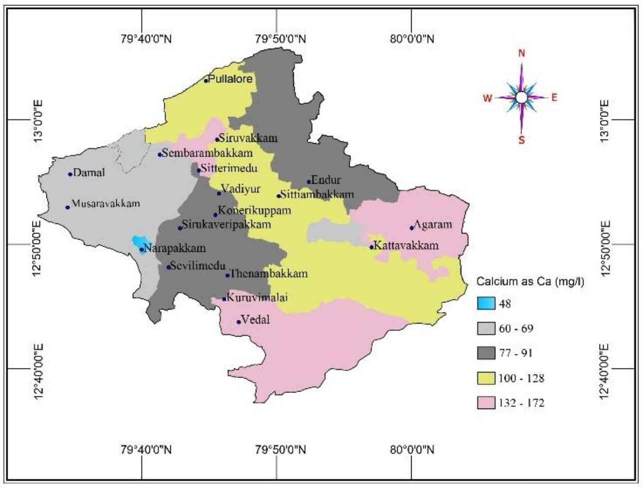
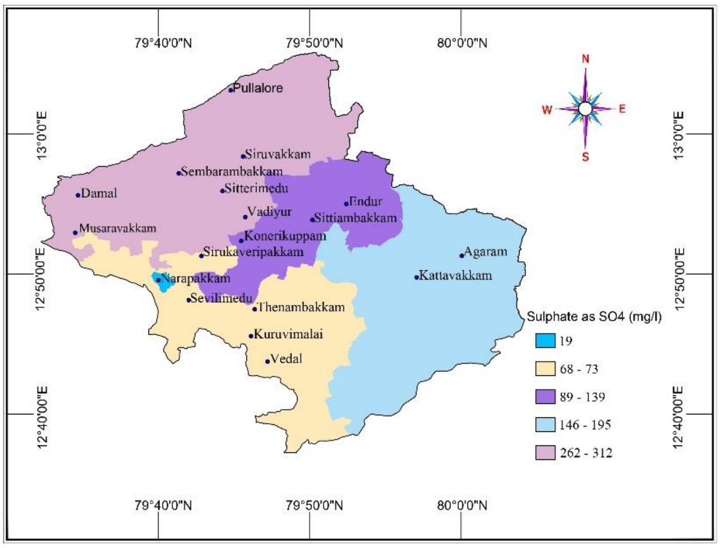


Fig 9 Chloride Map



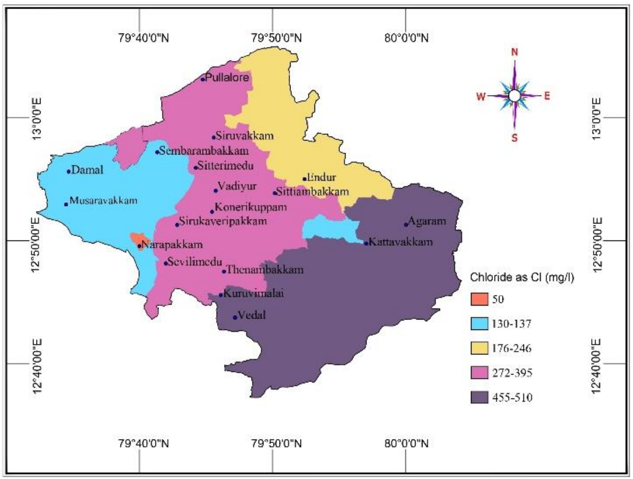


Fig 10 Sulphate Map

The study area's maximum permitted and allowable calcium concentration in drinking water ranges from 48 to 172 mg/l. Most types of rocks have a significant amount of calcium. Calcium is present in water due to incrustation in boilers and hardness. Calcium is required for human function. Rickets and tooth defects could be brought on by the low calcium level of drinking water. It is crucial for the health of the heart, blood clotting, and nervous system, peaking at S6 is 172 mg/l and lowest at S13 is 48mg/l (Fig 8).

The research area has a chloride concentration between 50 to 510 mg/l. Chlorides are allowed up to 250 mg/l. Excessive chloride concentrations can injure growing plants as well as metallic pipelines and structures. Those who are not used to high chloride levels and who drink water with an excess of chlorides may have laxative effects (7). Minimum at S13 is 19 mg/l, while maximum at S5 is 510 mg/l (Fig 9).

The main physiological effects of consuming large amounts of sulphate are catharsis, dehydration, gastrointestinal pain, and corrosion of distribution systems (14). Sulphate levels were found to range between 19 and 312 mg/l. S3 200 mg/l is the lowest value and S6, S11, S12 and S15 are 312 mg/l is the highest value (Fig 10).

WATER QUALITY INDEX

In this present study, the CCME method (Canadian Council of ministers of the Environment) is used for determine the Water Quality Index (WQI) for all samples. The WQI of Sample ID S1 (Damal)is derived below steps,

F1

F1 (scope) means the parameters percentage that do not meet their corresponding parameter standards at least one time during time period under consideration.

$$F1 = \left(\frac{Number\ of\ Failed\ Parameters}{Total\ Number\ of\ Parameters}\right) \text{x}100 \quad (1)$$

$$F1 = \left(\frac{10}{19}\right) \text{x}100$$

F1=52.63157895

F2

F2 (frequency) represents the monitoring quantity percentage exceeding the guideline.

$$F2 = \left(\frac{Number\ of\ Failed\ Tests}{Total\ Number\ of\ Tests}\right) \text{x}100 \qquad (2)$$

$$F2 = \left(\frac{17}{38}\right) \text{x}100$$

$F2 =$ 44.73684211

F3

F3 (Amplitude) which is measured by which failed test results do not meet their standards, it is calculated in following steps.

Step 1

An excursion is the number of times an individual's focus is greater than (or less than, where the target is a minimum) the objective. When the test value could not surpass the objective, the excursion was calculated using Equation (3). Equation (4) was utilized since the test value could not be less than the aim.

$$excursion_i = \left(\frac{Failed\ Test\ value_i}{Objective_i}\right)-1 \qquad (3)$$

$$excursion_i = \left(\frac{Objective_i}{Failed\ Test\ value_i}\right)-1 \qquad (4)$$

Equation (5) calculates the total amount by which the separate tests are out of compliance (the normalized sum of excursions).

$$nse = \left(\frac{\sum_{i=1}^{n} excursion_i}{Total\ Number\ of\ Tests}\right) \qquad (5)$$

$$nse = \left(\frac{16.1}{38}\right)$$

$$nse = 0.4237$$

$$F3 = \left(\frac{nse}{0.01\ nse + 0.01}\right) x100$$

$$F3 = \left(\frac{0.4237}{0.01\ (0.4237) + 0.01}\right) x100$$

$$F3 = 29.7597$$

The amplitude (F3) is then computed using an asymptotic function that scales the normalized sum of the deviations from the targets to produce a value between 0 and 100.

$$CCME - WQI = 100 - \left(\frac{\sqrt{F1^2 + F2^2 + F3^2}}{1.732}\right)-1 \qquad (6)$$

$$CCME - WQI = 100 - \left(\frac{\sqrt{(52.63157895)^2 + (44.73684211)^2 + (29.7597)^2}}{1.732}\right)-1$$

$$CCME - WQI = 56.57404753$$

Table 2 water Quality Index and status of the water quality

Rank	**WQI value**
Excellent	95–100
Very Good	80–94
Good	80–88
Fair	65–79
Marginal	45–64
Poor	0–44

Table 3. WQI for the research Locations

S.No	Locations	Latitude	Longitude	WQI	Status
1	Damal	12.91207658	79.57883512	57	Marginal
2	Vadiyur	12.92755327	79.64234703	45	Marginal
3	Sirukaveripakkam	12.8820407	79.66354589	37	Poor
4	Sitterimedu	12.88957093	79.69942856	47	Marginal
5	Siruvakkam	12.93039753	79.70431745	35	Poor
6	Agaram	12.8577751	79.8587272	38	Poor
7	A.P.Chathiram	12.97249886	79.95058246	40	Poor
8	Musaravakkam	12.87633405	79.60509845	51	Marginal
9	Pullalur	12.98951708	79.70406095	44	Poor
10	Sevilimedu	12.83633549	79.65916571	48	Marginal
11	Tennambakkam	12.79649796	79.73058304	37	Poor
12	Sembarambakkam	12.91088834	79.68938463	41	Poor
13	Nerapakkam	12.82004829	79.6527378	51	Marginal
14	Konerikuppam	12.88821524	79.71444732	35	Poor
15	Vedal	12.77691166	79.7290371	29	Poor
16	Kattavakkam	12.96910945	79.70560402	31	Poor
17	Purigai	13.00356726	79.73083801	49	Marginal
18	Enadur	12.87691976	79.74251534	40	Poor
19	Sittiyamapakkam	12.87917889	79.77409879	44	Poor
20	Kuruvimalai	12.79281518	79.72242844	55	Marginal

Static Analysis

The systematic computation of correlation coefficients between water quality variables, as well as regression analysis, provide an indirect approach of monitoring water quality in real time. The correlation coefficient quantifies the degree of relationship between two variables, one of which is the dependent variable. The higher the regression coefficient value, the better the fit and the more valuable the regression variables [16]. The mutual association between two variables is referred to as correlation. A direct connection exists when an increase or decrease in the value of one parameter corresponds to an increase or decrease in the value of another parameter [17]. In this research, the obtained numerical results of the correlation analysis for pre and post monsoon, R for the nineteen water quality parameters are provided in table 4 and table 5 respectively.

Table 4. Correlation coefficients among various water quality parameters (pre-monsoon).

	pH	EC Micro	TDS (mg/l)	TA CaCO3	TH (mg/l)	Ca (mg/l)	Mg (mg/l)	NO3 (mg/l)	Cl (mg/l)	F (mg/l)	SO4 (mg/l)	Cd (mg/l)	Cr (mg/l)	Cu (mg/l)	Pb (mg/l)	Zn (mg/l)
pH	1															
EC Micro	.133	1														
TDS (mg/l)	.133	1.000**	1													
TA	.235	.937*	.937**	1												
TH (mg/l)	-.054	.896**	.896**	.792**	1											
Ca	-.060	.895*	.895**	.791**	1.000	1										
Mg (mg/l)	-.050	.898**	.898**	.799**	1.000**	.999**	1									
NO3 (mg/l)	-.314	.658**	.658**	.457*	.780**	.786**	.774**	1								
Cl (mg/l)	.113	.989**	.989**	.896**	.905**	.904**	.906**	.725**	1							
F (mg/l)	-.097	.578**	.578**	.525*	.579**	.580**	.572**	.657**	.598**	1						
SO4 (mg/l)	.050	.971**	.971**	.878**	.910**	.910**	.912**	.774**	.989**	.617**	1					
Cd	-.308	-.234	-.234	-.190	-.049	-.051	-.044	.072	-.257	.035	-.189	1				
Cr	-.081	-.344	-.344	-.396	-.197	-.196	-.197	.022	-.300	-.139	-.262	.264	1			
Cu	-.272	-.117	-.117	-.220	-.132	-.119	-.140	.249	-.086	-.033	-.060	.115	.357	1		
Pb	.036	-.173	-.173	-.156	-.177	-.178	-.181	-.297	-.205	-.003	-.280	-.163	.208	-.171	1	
Zn (mg/l)	-.086	.017	.017	.113	.008	.010	.008	-.062	.001	.088	.041	-.150	-.192	-.149	-.189	1

Strong 22 **Moderate 19** **Weak 23** **Negative 52**

Table 5. Correlation coefficients among various water quality parameters (post-monsoon).

TDS (mg/l	TA CaCO3	TH (mg/l	Ca (mg/l	Mg (mg/l	NH3 (mg/l	NO2⁻ (mg/l	NO3 (mg/l	Cl (mg/l	F (mg/l)	SO4 (mg/l	PO4 (mg/l	Cd (mg/l	Cr (mg/l)	Cu (mg/l)	Pb (mg/l	Zn (mg/l
1																
.842*	**1**															
.745*	.916**	**1**														
.668*	.804**	.829*	**1**													
.603*	.760**	.873*	.451*	1												
.286	.299	.170	.096	.182	1											
.226	.041	-.024	-.107	.056	.130	1										
.166	.010	-.004	.029	-.036	-.221	.155	**1**									
.970*	.733**	.624*	.567*	.498*	.254	.239	.137	**1**								
.421	.382	.389	.363	.309	.031	.180	.409	.323	**1**							
.982*	.792**	.673*	.607*	.542*	.309	.307	.218	.947*	.453*	**1**						
.343	.183	.065	.346	-.200	.031	.634**	.239	.354	.150	.379	**1**					
-.145	.057	-.075	-.128	-.004	-.312	-.365	-.095	-.141	.006	-.157	-.363	**1**				
-.439	-.408	-.436	-.343	-.395	-.282	-.199	-.095	-.473*	-.151	-.410	-.230	.261	**1**			
-.184	-.160	-.138	-.131	-.103		.042	-.052	-.280	.009	-.102	-.047	0.111	.415	1		
-.138	-.281	-.161	-.133	-.137	-.168	-.116	.251	-.133	.186	-.166	-.077	-.186	.188	-.161	**1**	
.132	.344	.406	.585**	.135	.024	-.459*	-.218	.110	-.229	.068	-.078	-.139	-.349	-.169	-.159	1

	pH	EC Micro
pH	1	
EC Micro	.267	1
TDS (mg/l)	.271	.999**
TA CaCO3	.253	.839**
TH (mg/l)	.160	.744**
Ca (mg/l)	.204	.669**
Mg (mg/l)	.076	.602**
NH3 (mg/l)	-.204	.289
$NO2^-$ (mg/l)	.484*	.231
NO3 (mg/l)	.417	.157
Cl (mg/l)	.261	.970**
F (mg/l)	.301	.433
SO4 (mg/l)	.312	.982**
PO4 (mg/l)	.545*	.345
Cd (mg/l)	-.093	-.144
Cr (mg/l)	-.062	-.437
Cu (mg/l)	-.246	-.181
Pb (mg/l)	.008	-.133
Zn (mg/l)	-.042	.126

Strong 12 Moderate 17 Weak 75 Negative 67

When the correlation between the parameters is in the range of +0.8 to 1.0 and -0.8 to 1.0, it is considered strong; when it is in the range of +0.5 to 0.8 and -0.5 to -0.8, it is considered moderate; and when it is in the range of +0.0 to 0.5 and -0.0 to -0.5, it is considered weak [18]. Table 4&4 shows that the concept of bearing a single analysed parameter has a link with other parameters. In table 4 the positive correlation observed between TA CaCo3 and EC Micro (0.937) , TA CaCo3and TDS(0.937), TH and EC Micro (0.896), TH and TDS(0.896), Ca and EC Micro (0.895), Ca and TDS (0.895), Mg and Ca (0.999), Cl and EC (0.989), Cl and TDS (0.989), Cl and TH (0.905), Cl and Ca (0.904), Cl and Mg (0.906), Cl and TA CaCO3(0.896), SO4 and EC Micro (0.971), SO4 and TDS (0.971), SO4 and TA CaCo3 (0.878), SO4 and TH (0.910), SO4 and Ca (0.910), SO4 and Mg (0.912), SO4 and Cl (0.989).

Likewise, the positive correlation observes in table 5 between TDS and EC Micro (0.999), TA CaCo3 and EC Micro (0.839), TA CaCo3and TDS (0.842), TH and TA CaCo3(0.916), Ca and TA CaCo3(0.804), Ca and TH (0.829), Mg and TH (0.873), Cl and EC (0.970), Cl and TDS (0.970), SO4 and EC Micro (0.982), SO4 and TDS (0.982), SO4 and Cl (0.947).

Apart from this, in the linear Regression analysis, some of the parameters are highly positive correlate with other parameters such as EC-Cl(R=0.937), EC-TH (R=0.896), EC-TA CaCo3(R=0.836), EC- Ca (R=0.895), EC-Mg (R=0.898), EC-Cl (R=0.989), EC-SO4 (R=0.971), TDS- TA CaCo3 (R=0.937), TDS-TH (R=0.896), TDS-Ca (R=0.895) TDS-Mg (R=0.898), TDS-Cl (R=0.971), TDS-SO4(R=0.896), TA CaCo3 -Cl (R=0.896), TA CaCo3 -SO4(R=0.878), TH-Cl(R=0.905),TH-So4(R=0.910),Ca - Mg(R=0.999),Ca -Cl(R=0.904),Ca-So4(R=0.910),Mg-Cl(0.906),Cl-Cd(0.989).The remaining parameters pairs were positively correlated in pre-monsoon (Table 6).

While, Table 7 explained the correlation between the parameter pairs in postmonsoon.EC-TDS (R=0.999), EC-TA CaCo3 (R=0.839), EC-SO4 (R=0.982), EC-Cl (R=0.970), TDS-SO4 (R=0.982), TDS-Cl (R=0.970), TDS- TA CaCo3 (R=0.842), TA CaCo3-TH (R=0.916), TA CaCo3-Ca (R=0.804), TH-Ca (R=0.829), TH-Mg (R=0.873) were the parameter pairs significantly correlated. The remaining parameter pairs were sufficiently correlate between them. The findings explore that the regression relation have same correlation coefficients, EC-Cl(R=0.937), TDS- TA CaCo3 (0.937), TDS-TH (0.896), TDS-SO4(0.896), TA CaCo3- TH (0.916), TH-So4(0.910), and Ca-So4(0.910) (table 6), EC-Cl (0.970) and TDS-Cl (0.970) (table 7).

Finally, to conclude that, the relationship of heavy metals among the remaining parameters Cd (mg/l), Cr (mg/l), Cu (mg/l), Pb (mg/l), Zn (mg/l) weak and negatively correlated (table 4&4) and also had a weak linear correlation(R<0.5) coefficient value (table 6 &6)

Table 6 Linear Correlation coefficient R and regression equation for the pairs of the parameter (Pre- monsoon)

Parameters pair	**R value**	**Coefficient Regression**		**Regression Equation**
		a	**b**	
pH-EC	0.133	8.747E-5	7.207	pH =8.747E-5 EC+7.207
pH-TDS	0.133	0.000	7.207	pH =0.000TDS+7.207
pH-TA CaCo3	0.235	0.001	6.884	pH =0.001 TA CaCo3+6.884
pH-TH	0.054	0.000	7.454	pH =0.000TH+ 7.454
pH-Ca	0.060	-0.001	7.462	pH =-0.001Ca+7.462
pH-Mg	0.050	-0.001	7.448	pH =-0.001Mg+7.448
pH-NH_3	0.204	-0.030	7.108	pH =-0.030 NH3+7.108
pH-Cl	0.261	0.001	6.917	pH =0.001Cl+6.917
pH-SO_4	0.312	0.001	6.911	pH =0.001So4+6.911
pH-Cd	0.308	-7.305	7.517	pH =-7.305Cd+7.517
pH-Cr	0.081	-0.589	7.457	pH =-0.589Cr+7.457
pH-Cu	0.272	-0.126	7.499	pH =-0.126Cu+7.499
pH-Pb	0.036	0.648	7.343	pH =0.648Pb+7.343
pH-Zn	0.086	-0.012	7.425	pH =-0.012Zn+7.425
EC-TDS	1.000	1.429	-0.399	EC =1.429TDS+-0.399
EC- Cl	0.937	8.596	-1066.909	EC =8.596EC-1066.909
EC-TH	0.896	4.062	-93.998	EC =4.062TH-93.998
EC-TA CaCo3	0.836	7.284	-652.094	EC =7.284TA CaCO3-652.094
EC-Ca	0.895	20.186	-83.287	EC =20.186Ca-83.287
EC-Mg	0.898	-101.442	34.046	EC =-101.442Mg+34.046
EC-Cl	0.989	5.276	337.433	EC =5.276Cl+337.433
EC-F	0.578	2178.115	236.951	EC =2178.115F+236.951
EC-SO4	0.971	7.856	541.190	EC =7.856So4+541.190
EC-Cd	0.234	-844.406	2079.018	EC =-844.406Cd+2079.018

EC-Cr	0.344	-3818.015	2452.44	EC =-3818.015Cr+2452.44
EC-Cu	0.117	-82.281	1995.385	EC =-82.281Cu+1995.385
EC-Pb	0.173	-4693.719	2139.633	EC =-4693.719 Pb+2139.633
EC-Zn	3.841	3.841	1898.29	EC =3.841Zn+1898.29
TDS- TA CaCo3	0.937	6.016	-746.415	TDS =6.016TDS-746.415
TDS-TH	0.896	2.843	-65.522	TDS =2.843TH-65.522
TDS-Ca	0.895	14.128	-58.025	TDS =14.128Ca-58.025
TDS-Mg	0.898	23.829	-70.731	TDS =23.829 Mg-70.731
TDS-Cl	0.989	3.692	236.456	TDS =3.692Cl+236.456
TDS-F	0.578	1524.579	166.024	TDS =1524.579 F +166.024
TDS-SO4	0.971	5.499	379.052	TDS =5.499+379.052So4
TDS-Cd	0.234	-5909.006	1455.353	TDS =-5909.006Cd+1455.353
TDS –Cr	0.344	-2672.109	1716.717	TDS =-2672.109Cr+1716.717
TDS –Cu	0.117	-57.559	1396.822	TDS =-57.559Cu+1396.822
TDS –Pb	0.173	-3284.288	1497.760	TDS =-3284.288Pb+1497.760
TDS –Zn	0.17	2.685	1328.896	TDS =2.685Zn+1328.896
TA CaCo3- TH	0.792	153.173	0.392	TA $CaCo_3$ =153.173TH+0.392
TA CaCo3-Ca	0.791	1.946	154.217	TA $CaCo_3$ =1.946 Ca+154.217
TA CaCo3-Mg	0.799	3.303	151.286	TA $CaCo_3$ =3.303Mg+151.286
TA CaCo3 –Cl	0.896	0.522	190.924	TA $CaCo_3$ =0.522Cl+190.924
TA CaCo3 –F	0.525	215.610	180.780	TA $CaCo_3$ =215.610F+180.780
TA CaCo3 -SO4	0.878	0.775	211.377	TA $CaCo_3$ =0.775So4+211.377
TA CaCo3- Cd	0.190	-745.918	361.368	TA $CaCo_3$ =-745.918Cd+361.368
TA CaCo3 –Cr	0.396	-480.201	414.508	TA $CaCo_3$ =-480.201Cr+414.508
TA CaCo3 –Cu	0.220	-16.946	363.541	TA $CaCo_3$ =-16.946Cu+363.541
TA CaCo3 –Pb	0.156	-463.359	369.064	TA $CaCo_3$ =-463.359Pb+369.064
TA CaCo3 –Zn	0.113	2.717	335..614	TA $CaCo_3$ =2.717Zn+335.614
TH-Ca	1.000	4.976	1.981	TH =4.976Ca+1.981
TH-Mg	1.000	8.359	-0.433	TH =8.359Mg-0.433
TH-NH3	0.170	8.809	422.085	TH =8.809NH3+422.085
TH-Cl	0.905	1.066	175.924	TH =1.066Cl+175.924
TH-F	0.579	480.976	124.049	TH =480.976F+124.049
TH-So4	0.910	1.625	210.346	TH =1.625So4+210.346
TH-Cd	0.049	502.090	-393.775	TH =502.090Cd+-393.775

TH-Cr	0.197	-483.055	562.511	TH =-483.055Cr+562.511
TH-Cu	0.132	-20.486	514.639	TH =-20.486Cu+514.639
TH-Pb	0.177	-1059.568	545.312	TH =-1059.568Pb+545.312
TH-Zn	0.008	0.365	492.896	TH =0.365Zn+492.896
Ca – Mg	0.999	-0.393	1.678	Ca =-0.393Mg+1.678
Ca –Cl	0.904	.214	35.047	Ca =0.214Cl+35.047
Ca-F	0.580	96.863	24.366	Ca =96.863F+24.366
Ca-So4	0.910	0.326	41.919	Ca 0.326So4+41.919
Ca-Cd	0.051	-81.207	100.536	Ca=-81.207Cd+100.536
Ca-Cr	0.196	-96.760	112.593	Ca =-96.760Cr+112.593
Ca-Cu	0.119	-3.706	102.611	Ca =--3.706 Cu+102.611
Ca-Pb	0.178	-214.880	109.275	Ca =--214.880Pb+109.275
Ca-Zn	0.10	0.094	98.565	Ca =-0.094Zn+98.565
Mg-Cl	0.906	0.128	21.060	Mg =-0.128Cl+21.060
Mg-F	0.572	56.896	15.390	Mg =-56.896 F+15.390
Mg-So4	0.542	0.094	35.669	Mg =-0.094Mg+35.669
Mg-Cd	0.044	-41.542	60.011	Mg =--41.542So4+60.011
Mg-Cr	0.197	-57.903	67.364	Mg =--57.903Cr+67.364
Mg-Cu	0.140	-2.160	61.779	Mg =--2.160Cu+61.779
Mg-Pb	0.181	-129.654	65.429	Mg =--129.654Pb+65.429
Mg-Zn	0.008	0.046	59.011	Mg =-0.046Zn+59.011
Cl-F	0.598	422.517	-26.488	Ca =-422.517F-26.488
Cl-Cd	0.989	1.5	36.778	Cl=1.5Cd+36.778
Cl-Cr	0.300	-624.737	386.938	Cl=-624.737Cr+386.938
Cl-Cu	0.086	-11.346	310.058	Cl=-11.346Cu+310.058
Cl-Pb	0.205	-1042.936	348.963	Cl=-1042.936Pb+348.963
Cl-Zn	0.001	0.044	298.669	Cl=0.044Zn+298.669
F- So4	0.617	0.001	0.539	F =0.001So4+0.539
F- Cd	0.035	0.335	0.763	F =0.335Cd+0.763
F-Cr	0.139	-0.411	0.828	F =-0.411Cr+0.828
F-Cu	0.033	-0.006	0.776	F =-0.006Cu+0.776
F-Pb	0.003	-0.021	0.771	F =-0.021Pb+0.771
F-Zn	0.088	0.005	0.749	F =0.005Zn+0.749
So4-Cd	0.189	-841.507	191.185	So4 =-841.507Cd+191.185

So4-Cr	0.262	-359.794	225.481	So4 =-359.794Cr+225.481
So4-Cu	0.060	-5.205	179.892	So4=-5.205Cu+179.892
So4-Pb	0.280	219.911	-939.870	So4 =219.911Pb-939.870
So4-Zn	0.041	1.107	170.193	So4 =1.107Zn+170.193
Cd-Cr	0.264	0.081	0.008	Cd =0.081Cr+0.008
Cd-Cu	0.115	0.002	0.017	Cd =0.002Cu+0.017
Cd-Pb	0.163	-0.122	0.025	Cd =-0.122Pb+0.025
Cd-Zn	0.150	-0.001	0.023	Cd =-0.001Zn+0.023
Cr-Cu	0.357	0.023	0.119	Cr =0.023Cu+0.119
Cr-Pb	0.208	0.508	0.117	Cr =0.508Pb+0.117
Cr-Zn	0.192	-0.004	0.157	Cr =-0.004Zn+0.157
Cu-Pb	0.171	-6.603	1.305	Cu =-6.603Pb+1.305
Cu-Zn	0.149	-0.046	1.179	Cu =-0.046Zn+1.179
Pb-Zn	0.189	-0.002	0.054	Pb =-0.002Zn+0.054

Table 7 Linear Correlation coefficient R and regression equation for the pairs of the parameter (Post- monsoon)

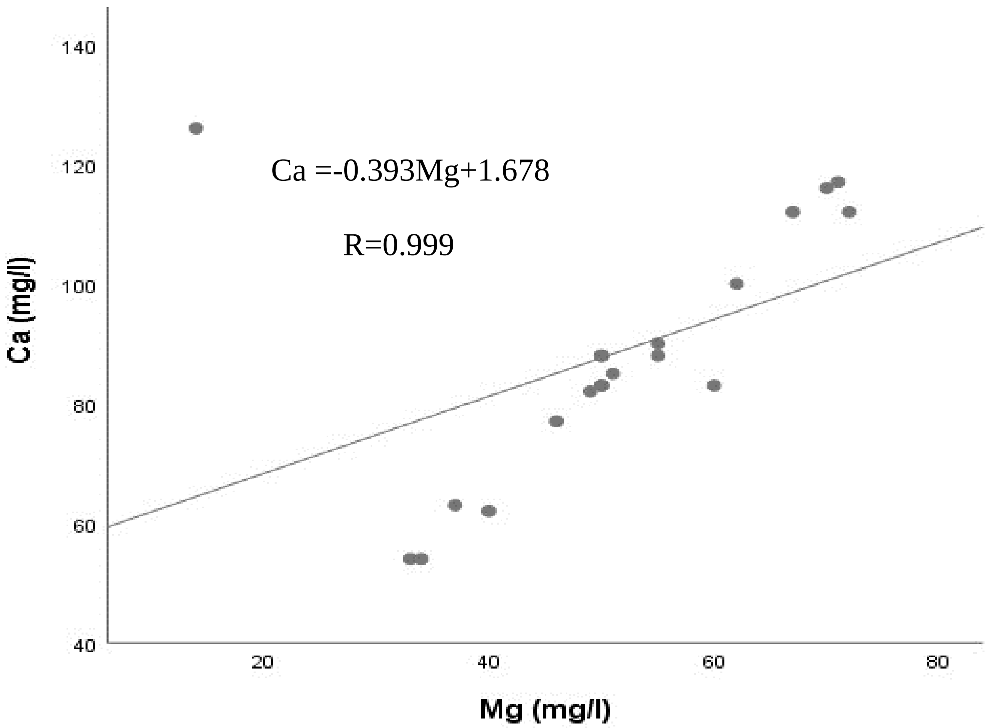
Parameters pair	R value	Coefficient Regression		Regression Equation
		a	b	
PH-EC	0.267	0.000	6.885	PH =0.000EC+6.885
PH-TDS	0.271	0.000	6.884	PH =0.000TDS+6.884
PH-TA CaCo3	0.253	0.001	6.785	PH =0.001TA CaCo3+6.785
PH-TH	0.160	0.000	6.877	PH =0.000TH+ 6.877
PH-Ca	0.204	0.003	6.839	PH =0.003Ca+6.839
PH-Mg	0.076	0.001	7.001	PH =0.076 Mg+7.001
PH-NH_3	0.204	-0.030	7.108	PH =-0.030NH_3+7.108
PH-Cl	0.261	0.001	6.917	PH =0.001Cl+6.917
PH-SO_4	0.312	0.001	6.911	PH =0.001SO_4+6.911
PH-Cd	0.093	-1.174	7.094	PH =0.093Cd+7.094
PH-Cr	0.062	-0.266	7.104	PH =-0.266Cr+7.104
PH-Cu	0.246	-0.060	7.131	PH =-0.060Cu+7.131
PH-Pb	0.066	0.008	7.070	PH =0.008Pb+7.070
PH-Zn	0.042	-0.003	7.085	PH =-0.003Zn+7.085

EC-TDS	0.999	1.416	14.099	EC =1.416TDS+14.099
EC- C	0.839	7.284	-652.094	EC =7.284 TA CaCo3-652.094
EC-TH	0.744	5.432	-529.396	EC =0.744 TH-529.396
EC-TA CaCo3	0.839	7.284	-652.094	EC =7.284 TA CaCo3-652.094
EC-Ca	0.669	22.5	-163.907	EC =22.5Ca-163.907
EC-Mg	0.602	28.972	347.652	EC =28.972Mg+347.652
EC-Cl	0.970	5.399	315.761	EC =5.399Cl+315.761
EC-F	0.433	1400.293	895.257	EC =1400.293F+895.257
EC-SO4	0.982	8.232	500.340	EC =8.232So4+500.340
EC-Cd	0.144	-4679.892	1904.133	EC =-4679.892Cd+1904.133
EC-Cr	0.437	-4852.342	2386.204	EC =-4852.342Cr+2386.204
EC-Cu	0.181	-114.856	1929.062	EC =-114.856Cu+1929.062
EC-Pb	0.133	-2993.639	1958.804	EC =-2993.639Pb+1958.804
EC-Zn	0.126	24.005	1722.505	EC =24.005Zn+1722.505
TDS- TA CaCo3	0.842	5.163	-476.443	TDS =-5.163TA CaCo3-476.443
TDS-TH	0.745	3.837	-383.728	TDS =-3.837TH+-383.728
TDS-Ca	0.668	15.872	-123.733	TDS =-15.872Ca-123.733
TDS-Mg	0.603	20.485	234.770	TDS =-20.485Mg+234.770
TDS-Cl	0.970	3.811	214.013	TDS =-3.811Cl+214.013
TDS-F	0.421	962.297	640.284	TDS =-962.297F+640.284
TDS-SO4	0.982	5.811	344.265	TDS =-5.811SO4+344.265
TDS-Cd	0.145	-3339.536	1335.829	TDS =--3339.536Cd+1335.829
TDS –Cr	0.439	-3439.135	1677.091	TDS =--3439.135+1677.091
TDS –Cu	0.184	-82.447	1354.084	TDS =--82.447Cu+1354.084
TDS –Pb	0.138	-2184.729	1377.146	TDS =--2184.729Pb+1377.146
TDS –Zn	0.132	17.705	1203.898	TDS =-17.705Zn+1203.898
TA CaCo3- TH	0.916	0.770	6.301	TA CaCo3=0.770 TA CaCO3+6.301
TA CaCo3-Ca	0.804	3.115	64.736	TA CaCo3=3.115Ca+64.736
TA CaCo3-Mg	0.706	4.211	125.375	TA CaCo3=4.211TH +125.375
TA CaCo3 –Cl	0.733	0.47	208.426	TA CaCo3=0.47Cl+208.426
TA CaCo3 –F	0.382	142.387	245.324	TA CaCo3=142.387F+245.324
TA CaCo3 -SO4	0.792	0.764	216.824	TA CaCo3=0.764SO4+216.824
TA CaCo3- Cd	0.057	212.164	335.461	TA CaCo3=212.164 Cd+335.461
TA CaCo3 –Cr	0.408	-522.228	400.296	TA CaCo3=-522.228 Cr +400.296

TA CaCo3 –Cu	0.160	-11.651	350.419	TA CaCo3=-11.651Cu+350.419
TA CaCo3 –Pb	0.281	-729.002	373.235	TA CaCo3=-729.002Pb+373.235
TA CaCo3 –Zn	0.344	7.531	308.885	TA CaCo3=7.531Zn+308.885
TH-Ca	0.829	3.82	95.681	TH =3.82Ca+95.681
TH-Mg	0.873	5.752	140.196	TH =5.752Mg+140.196
TH-NH3	0.17	8.809	422.085	TH =8.809TH +422.085
TH-Cl	0.624	0.476	299.88	TH =0.476 Cl +299.88
TH-F	0.389	172.432	318.595	TH =172.432F+318.595
TH-So4	0.673	0.773	308.572	TH =0.773 So4+308.572
TH-Cd	0.075	-332.975	438.425	TH =-332.975Cd+438.425
TH-Cr	0.436	509.944	-663.903	TH =509.944Cr+-663.903
TH-Cu	0.138	-11.961	443.815	TH =-11.961Cu+443.815
TH-Pb	0.161	-497.112	455.541	TH =-497.112Pb+455.541
TH-Zn	0.406	10.572	389.704	TH =10.572Zn+389.704
Ca-Mg	0.451	0.644	55.414	Ca =0.644Mg+55.414
Ca-Cl	0.567	0.094	62.008	Ca =0.094Cl+62.008
Ca-F	0.363	34.932	65.095	Ca =34.932Ca+65.095
Ca-So4	0.607	0.151	63.905	Ca =0.151So4+63.905
Ca-Cd	0.128	-123.436	90.384	Ca =-123.436 Cd+90.384
Ca-Cr	0.343	-113.281	101.381	Ca =-113.281Cr+101.381
Ca-Cu	0.131	-2.464	90.052	Ca =-2.464Cu+90.052
Ca-Pb	0.133	-88.778	92.283	Ca =-88.778Pb+92.283
Ca-Zn	0.585	3.305	74.801	Ca =3.305Zn+74.801
Mg-Cl	0.498	0.058	34.741	Mg =0.058Cl+34.741
Mg-F	0.309	20.766	37.095	Mg =20.766 F+37.095
Mg-So4	0.542	0.094	35.669	Mg =0.094 So4+35.669
Mg-Cd	0.004	-2.679	50.848	Mg =-2.679Cd+50.848
Mg-Cr	0.395	-91.193	61.451	Mg =-91.193Cr+61.451
Mg-Cu	0.103	-1.356	52.094	Mg =-1.356Cu+52.094
Mg-Pb	0.137	-63.867	53.773	Mg =-63.867Pb+53.773
Mg-Zn	0.135	0.533	48.649	Mg =0.533Zn+48.649
Cl-F	0.323	187.613	154.676	Cl =187.613F+154.676
Cl-Cd	0.141	-822.784	293.388	Cl =-822.784Cd+293.388
Cl-Cr	0.473	-943.665	388.720	Cl =-943.665Cr+388.720

Cl-Cu	0.280	-31.922	308.964	Cl =-31.922 Cl+308.964
Cl-Pb	0.133	-537.925	303.540	Cl =-537.925Pb+303.540
Cl-Zn	0.110	263.319	3.759	Cl =263.319Cl+3.759
F- So4	0.453	0.001	0.472	F =0.001So4+0.472
F- Cd	0.006	0.55	0.659	F =0.55Cd+0.659
F-Cr	0.151	-0.519	0.721	F =-0.519Cr+0.721
F-Cu	0.09	0.002	0.658	F =0.002Cu+0.658
F-Pb	0.186	1.292	0.600	F =1.292Pb+0.600
F-Zn	0.229	-0.013	0.714	F =-0.013Zn+0.714
So4-Cd	0.157	-611.070	171.307	So4=611.070+171.307
So4-Cr	0.410	-544.164	223.808	So4=-544.164Cr+223.808
So4-Cu	0.102	-7.682	167.581	So4=-7.682So4+167.581
So4-Pb	0.166	-445.496	180.988	So4=-445.496Pb+180.988
So4-Zn	0.068	1.551	153.985	So4=1.551So4+153.985
Cd-Cr	0.261	0.89	0.008	Cd =0.89Cr+0.008
Cd-Cu	0.111	0.002	0.016	Cd =0.002Pb+0.016
Cd-Pb	0.186	-0.126	0.024	Cd =-0.126Cd+0.024
Cd-Zn	0.139	-0.001	0.021	Cd =-0.001Zn+0.021
Cr-Cu	0.415	0.024	0.094	Cr =0.024Cu+0.094
Cr-Pb	0.188	0.380	0.099	Cr =0.380Pb+0.099
Cr-Zn	0.349	-0.006	0.141	Cr =-0.006Zn+0.141
Cu-Pb	0.161	-5.724	1.221	Cu =-5.724Pb+1.221
Cu-Zn	0.169	-0.051	1.159	Cu= -0.051Zn+1.159
Pb-Zn	0.159	-0.001	0.052	Cu =-0.001Zn+0.052

The highly positive correlate parameter pair (Ca-Mg) in linear regression analysis shown in Figure 11.



CONCLUSION

In this research investigation, the ground water quality in the twenty locations Kanchipuram District has evaluated by the CCME WQI technique according to a dataset of Physiochemical properties for pre-monsoon and post monsoon. In addition, the relationship among the physiochemical parameters were determined by the Karl Pearson's Correlation analysis method at the same time relationship between the physiochemical parameters were found by the linear regression analysis. Apart from this, the regression equations were determined for the pairs of physiochemical parameters. In the correlation regression study, vast majority parameters were correlated with each other at the same time, some of the parameters were greatly correlated to each other. According to static analysis results, this research concluded that the heavy metals have a weak and negative correlation relationship with the other physiochemical parameters.

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