Eco. Env. & Cons. 31 (4) : 2025; pp. (1778-1784)
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ISSN 0971–765X

DOI No.: **http://doi.org/10.53550/EEC.2025.v31i04.067**
Website: www.envirobiotechjournals.com

Evaluation of Hydro-chemical Characteristics of Ground Water from Tamilnadu District in and around Karur Area, South India

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(Received 26 August, 2025; Accepted 11 October, 2025)

ABSTRACT

The physico-chemical properties of the groundwater in the Karur district were chosen as the reference site for this investigation. Temperature, pH, dissolved oxygen, chloride, sulfate, nitrate, fluoride, total hardness, total alkalinity, electrical conductivity, biochemical oxygen demand (BOD), and chemical oxygen demand (COD) were all measured in triplicate in the lab using standard procedures. The management of its water quality may benefit from the findings of the physico-chemical analysis. The majority of the metrics in the water quality analysis were found to be connected with one another using Pearson's correlation matrix. It is noted that there is no substantial link between several of the metrics, suggesting that the mild contamination comes from multiple sources. Prior to consumption, the area's groundwater requires some kind of treatment, according to the analysis. Since there isn't any published data on these significant villages from the Karur district, the data collected in these villages could serve as a baseline and point of reference when evaluating additional changes brought about by nature or humans.

Key words: *Chemical Oxygen Demand, Biochemical Oxygen Demand and Physico-chemical parameters.*

Introduction

Water is essential to human existence. It is absolutely necessary for all living things to survive. Access to safe, drinkable drinking water is one of humanity's fundamental resources, particularly in rural places, as it is crucial for general health and wellness. The best freshwater source for human consumption is groundwater, which has a virtually balanced salt content. Overcrowding, unplanned urbanization, unrestrained exploration policies, and the improper disposal of filthy water all contribute to the intrusion of hazardous substances into groundwater (Pandey *et al.,* 2008). Water quality is a major concern for humanity since it has a direct impact on human well-being. In a number of Indian states, almost 90% of the population depends on groundwater for drinking and other purposes (Ramachandraiah, 2004; Tank and Singh, 2010). Groundwater contamination is mostly caused by the use of chemicals in agriculture (pesticides, herbicides, and fertilizers) and the uncontrolled dumping of urban and industrial wastes (Ullah *et al.,* 2009). It has been noted that over the past ten years, increased human activity has resulted in a significant pollution of groundwater. As a result, a number of waterborne disease cases have been observed, which poses a health risk. Hence, the present study was therefore undertaken with a view to provide much-needed information on the water quality parameters. The specific objectives of the study were to assess physical and chemical properties of groundwater in Karur district, Tamil Nadu, which was selected as the reference site.

Materials and Methods

Study Area

Karur, in the Tamil Nadu state, is a rich area for the textile and dyeing industries. The Karur block is one of the unions and blocks that have been designated for their historical significance due to their temples, rivers, and fertile agricultural regions. One of the primary water sources is the Amaravathi River, which is currently contaminated by the aforementioned industries. Karur comprises precisely 53 panchayat villages, of which about ten are the subject of our surface and ground water analysis and are shown in Table 1. Figure 1 depicts the sample collection site. In 2019, between March 1 and May 31, the pre-monsoon season; a water sample was taken for this investigation.

Table 1. Selected villages in Karur block area, Karur district

S. No	Place
1	Nanniyur
2	Thalappatti
3	Emur
4	Thaanthoni malai
5	Puliyur
6	Melappalayam
7	Vaangal
8	Manavadi
9	Aathum
10	Somur

Plate 1. Water samples

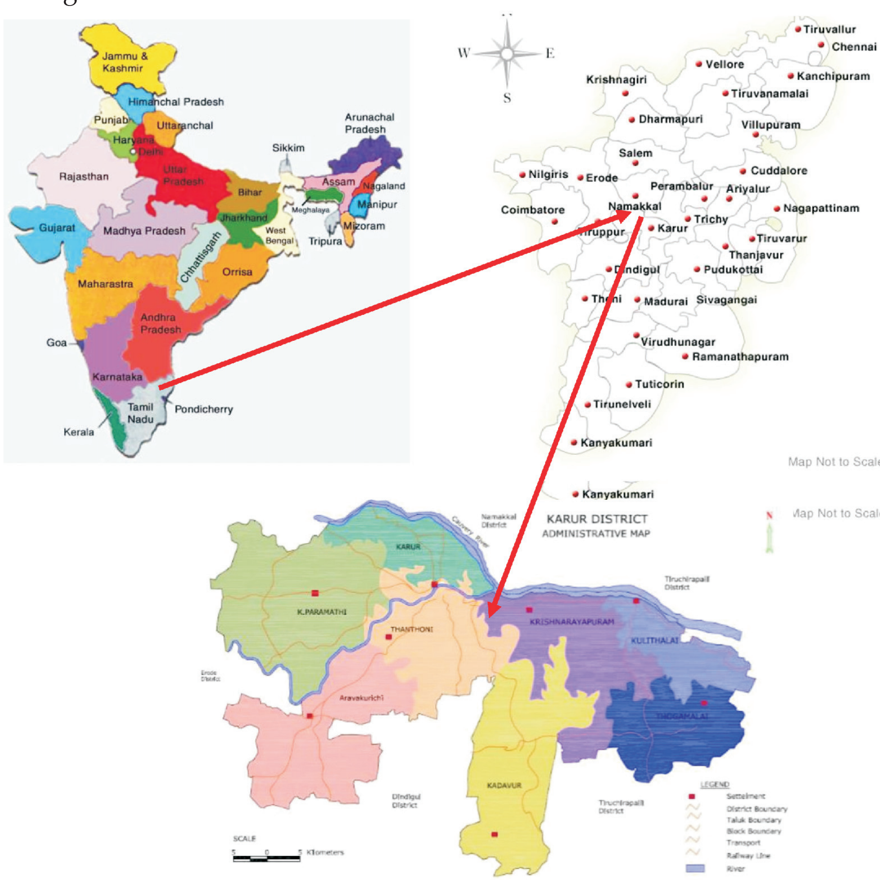

Fig. 1. Location of sample collection

Physico-chemical parameters

The National Environmental Engineering Research Institute (NEERI, 1986) and Standard Methods for the Examination of Water (APHA, 1985, 1989, 1998, Golterman *et al.*, 1969) both provided the same techniques for the examination of different physico-chemical parameters.

Colour and odour: Sensibly, the water's odor is explored, and visually, the color is inspected.

Results and Discussion

Testing the water before using it for drinking, household, agricultural, or industrial purposes is crucial. It is necessary to examine water using many physicochemical parameters. The parameters chosen for water testing are entirely dependent on the intended use of the water and the degree of purity and quality required. A variety of floating, dissolving, suspended, microbiological, and bacteriological contaminants can be found in water. Chemical tests should be conducted to determine its BOD, COD, dissolved oxygen, alkalinity, hardness, and other characteristics, while physical tests should be conducted to determine its temperature, color, odor, pH, turbidity, TDS, and other physical characteristics. The drinking water must obviously pass all of these tests and have the necessary mineral content. These requirements are only closely examined in industrialized nations. Because the levels of organic pesticide and heavy metal contaminants in water are so low, highly advanced analytical tools and skilled personnel are required. The following physical and chemical characteristics are routinely assessed to track the water's quality. Tables 1 and 2 contain information on a variety of parameters, including pH, temperature, electrical conductivity, total hardness, total alkalinity, dissolved oxygen, chemical and biological oxygen demand (BOD and COD), chloride, sulfate and more.

Temperature, Electrical conductivity and Hydrogen ion concentration (pH)

The groundwater temperature in 10 villages varied from a minimum of 28.50 °C in Nanniyur village to a maximum of 34.12°C in Aathum village. Groundwater temperature variation is displayed in Table 1. Thaanthoni Malai village's groundwater had the lowest pH of 7.20, while Thalappatti and Somur villages' groundwater had the highest pH of 8.00. Groundwater pH fluctuation is displayed in Table 1. The low temperature of the groundwater in Thaanthoni Malai village was 0.38 mmhos/l, while the maximum temperature was 1.32 mmhos/l in Thalappatti village. Groundwater temperature variation is displayed in Table 1.

The aquatic environment's biogeochemical processes are regulated by temperature, which is a significant limiting factor. Since shallow water reacts

Table 1. Physical characters of water sample during pre-monsoon period at 2019

S. No	Place	Clarity	Nature of sample	Colour	Odour	Taste	pH	Temperature (°C)	Electrical conductivity (mmhos/l)
1	**Nanniyur**	Transparent	Liquid	Colourless	No Characteristic	No Characteristic	7.30	28.50	0.45
2	**Thalappatti**	Transparent	Liquid	Colourless	No Characteristic	No Characteristic	8.00	30.12	1.32
3	**Emur**	Transparent	Liquid	Colourless	No Characteristic	No Characteristic	7.50	32.14	0.48
4	**Thaanthoni malai**	Transparent	Liquid	Colourless	No Characteristic	No Characteristic	7.20	28.75	0.38
5	**Puliyur**	Transparent	Liquid	Colourless	No Characteristic	No Characteristic	7.50	33.25	0.49
6	**Melappalayam**	Transparent	Liquid	Colourless	No Characteristic	No Characteristic	7.90	31.45	0.54
7	**Vaangal**	Transparent	Liquid	Colourless	No Characteristic	No Characteristic	7.50	30.67	0.47
8	**Manavadi**	Transparent	Liquid	Colourless	No Characteristic	No Characteristic	7.40	29.54	0.45
9	**Aathum**	Transparent	Liquid	Colourless	No Characteristic	No Characteristic	7.60	34.12	0.47
10	**Somur**	Transparent	Liquid	Colourless	No Characteristic	No Characteristic	8.00	30.22	1.27
***WHO (2011) Std.**		Transparent	Liquid	Colourless	No Characteristic	No Characteristic	6.5-8.5	25.6	0.52

rapidly to changes in atmospheric temperature, samples taken from shallow zones indicate a direct relationship between air temperature and water temperature, which typically corresponds with air temperature (Rajkumar *et al.,* 2011). Temperature affects how organisms behave and how soluble gases and salts are in water (Vincy *et al.,* 2012).

The pH of water is a significant environmental component, and variations in pH are associated with species composition, chemical changes, and biological activity. It is typically regarded as an indicator of the environment's appropriateness (Rani *et al.,* 2012). Due to its high concentration of chemicals, salts, and dissolved particles, industrial wastewater may have the greatest electrical conductivity value (Mishra and Saksena, 1993). A greater number of dissolved inorganic compounds in an ionized state is indicated by a higher EC (Murhekar, 2011). The EC value in domestic wastewater was likewise moderate to high. Since the monsoon water is distilled and contains ions and compounds in trace amounts, the electrical conductance (EC) was determined to be below the detection limit of the water.

Total suspended solids, Total dissolved solids and Total solids

Total solids (TS) in the groundwater of ten villages varied from a minimum of 140.72 mg/l in Thaanthoni Malai village to a maximum of 910.46 mg/l in Somur village. The total dissolved solids (TDS) of the groundwater in ten villages varied from a minimum of 374.73 mg/l in Thaanthoni Malai village to a maximum of 889.05 mg/l in Somur village. Ten villages' groundwater had total suspended solids (TSS) ranging from a minimum of 6.09 mg/l in Manavadi village to a maximum of 51.41 mg/l in Somur village. Groundwater's variations in TS, TDS, and TSS are displayed in Table 2.

An aquatic ecosystem's water quality standards are determined by the dissolved oxygen value, which is impressive. The dissolved oxygen serves as an indicator of the trophic status of the water body and regulates the metabolic activity of organisms, hence controlling the metabolisms of the entire biological community (Saksena and Kaushik, 1994). Low organism metabolic rates and freshwater mixing from rivers may also be to blame. Sahu *et al.* made similar observations (2000). According to Saksena and Kaushik (1994), dissolved oxygen regulates the metabolic activity of organisms, which in turn controls the metabolisms of the entire biological community. It also serves as an indicator of the trophic condition of the water body.

Alkalinity, Dissolved oxygen, Total Hardness, Chloride and Sodium

The total hardness of the groundwater in ten villages varied from a minimum of 220.30 mg/l in Manavadi village to a maximum of 380.78 mg/l in Somur village. Table 2 displays the variance in groundwater's total hardness. The dissolved oxygen (DO) content of the groundwater in 10 villages varied from a minimum of 4.20 mg/l in Manavadi village to a maximum of 9.10 mg/l in Emur village. Groundwater's dissolved oxygen (DO) varies, as shown in Table 2. The alkalinity of the groundwater in ten villages varied, with the lowest being in Manavadi village (15.20 mg/l) and the highest being in Somur village (198.45 mg/l). Table 2 displays the groundwater's fluctuating alkalinity. In ten villages, the groundwater's chloride content varied from a minimum of 174.18 mg/l in Thaanthoni Malai vil-

Table 2. Chemical characters of water sample during pre-monsoon period at 2019

S. No	Place	TS (mg/L)	TDS (mg/L)	TSS (mg/L)	CO_3 (mg/L)	HCO_3 (mg/L)	Total alkalinity (mg/L)	Total Hardness (mg/L)	Dissolved oxygen (mg/L)	BOD (mg/L)	COD (mg/L)	Na (mg/L)	Cl (mg/L)
1	Nanniyur	420.18	390.92	29.26	2.17	15.15	120.74	265.74	4.8	6.23	8.52	98.35	182.86
2	Thalappatti	901.38	845.13	56.25	1.65	274.08	180.65	350.45	8.2	11.32	13.65	265.07	386.41
3	Emur	670.59	642.85	27.74	2.18	147.19	140.65	280.8	9.1	10.25	11.32	165.74	242.39
4	Thaanthoni malai	410.72	374.73	35.99	3.15	248.04	110.4	235.42	4.2	7.4	8.3	57.05	174.18
5	Puliyur	651.38	618.07	33.31	1.76	119.73	146.23	279.21	5.4	9.53	10.2	149.83	219.74
6	Melappalayam	865.63	812.74	52.89	2.86	325.52	170.24	325.74	7.02	10.78	11.45	250.46	365.5
7	Vaangal	620.48	596.04	24.44	2.18	85.01	152.04	255.74	6.32	8.6	9.23	157.18	237.05
8	Manavadi	425.04	418.95	6.09	2.94	65.43	15.2	220.3	4.2	5.27	6.75	140.72	195.07
9	Aathum	738.32	714.32	24	1.55	272.35	158.23	265.3	6.85	8.45	9.76	152.18	241.01
10	Somur	940.46	889.05	51.41	4.74	335.04	198.45	380.78	8.62	12.3	11.2	274.74	379.42
*WHO (2011) Std.			500	500	-	1500	150	300	6	10	10	200	250

TDS=Total dissolved solids, TSS=Total solid substances lage to a maximum of 386.41 mg/l in Thalappatti village. The groundwater's fluctuating chloride levels are displayed in Table 2. Thaanthoni Malai village groundwater had the lowest sodium content at 57.05 mg/l, while Somur village groundwater had the highest at 274.74 mg/l. Groundwater's sodium fluctuation is displayed in Table 2.

Hardness is a water quality metric that describes the impact of dissolved minerals, primarily calcium and magnesium, on the water's suitability for drinking, industrial, and household use. It is caused by the presence of calcium and magnesium nitrates, bicarbonates, sulfates, and chloride. The current findings concur with those of Mohan Raj *et al.* (2013). High hardness ratings are most likely caused by the frequent addition of significant amounts of detergents to lakes that drain into estuaries by the surrounding residential areas.

Water's alkalinity is its ability to neutralize acids. According to Singh *et al.* (2010), alkalinity is a measurement of the water's weak acidity and the cations that balance it out. According to Ouyang *et al.* (2006), total alkalinity is the sum of the concentrations of bases in water, typically carbonates and bicarbonates. The amount of the material that raises the pH of the water determines the total alkalinity. Strongly alkaline industrial wastewater and sewage are present in the estuary when alkalinity levels are high (Safari *et al.,* 2012). As the alkalinity value rises, the decomposition of plants, living organisms, and organic waste in the estuary may also be a contributing factor to the rise in carbonate and bicarbonate levels (Wang *et al.,* 2006). Our findings are consistent with those of the previous publication (Mohan Raj *et al.,* 2013).

Chemical oxygen demand and Biological oxygen demand

The biological oxygen demand of the groundwater in ten villages varied from a minimum of 5.27 mg/l in Manavadi village to a maximum of 12.30 mg/l in Somur village. The fluctuation in groundwater's biological oxygen demand is displayed in Table 2. The chemical oxygen demand of the groundwater in ten villages varied from a minimum of 6.75 mg/l in Manavadi village to a maximum of 13.65 mg/l in Thalappatti village. The fluctuation in groundwater's chemical oxygen demand is displayed in Table 2.

Aquatic ecosystem contamination is measured by the Chemical Oxygen Demand (COD). It calculates the organic matter's carbonaceous component. The amount of oxygen needed by the living things that use, eventually destroy, or stabilize organic water is known as the biological oxygen demand, or BOD. It is a crucial determinant of a water body's level of pollution. Because of the high organic load and the excessive proliferation of total microorganisms, BOD was high in both domestic and industrial wastewater in the studies that were conducted (Kandhasamy and Santhaguru, 1994). The depositing of feces by the nearby metropolitan area and human settlements may be the primary cause of the organic materials escaping into the river. As distilled water with no organic load, the control sample had a BOD value below the detection limit. The continuous input of sewage from metropolitan areas may be the cause of the highest COD rates observed in domestic wastewater (Mishra *et al.*, 1990).

To evaluate the condition of the groundwater in

Table 3. Correlation coefficient (r) values between the Physico-chemical parameters (n = 10)

Parameters	pH	Tem.	EC	TS	TDS	TSS	CO_3	HCO_3	Total alkalinity	TH	DO	BOD	COD	Na	Cl
pH	1														
Tem.	0.229	1													
EC	0.821	-0.136	1												
TS	0.960	0.423	0.738	1											
TDS	0.957	0.452	0.724	0.998	1										
TSS	0.735	-0.050	0.694	0.741	0.702	1									
CO_3	0.226	-0.436	0.325	0.145	0.134	0.241	1								
HCO_3	0.702	0.230	0.540	0.749	0.733	0.730	0.365	1							
Total alkalinity	0.685	0.347	0.559	0.813	0.795	0.798	0.031	0.621	1						
TH	0.912	0.084	0.863	0.899	0.881	0.865	0.347	0.668	0.798	1					
DO	0.744	0.380	0.615	0.832	0.837	0.533	0.080	0.524	0.721	0.755	1				
BOD	0.840	0.349	0.700	0.925	0.913	0.813	0.213	0.713	0.866	0.895	0.856	1			
COD	0.808	0.312	0.700	0.866	0.851	0.813	-0.120	0.601	0.815	0.836	0.834	0.902	1		
Na	0.983	0.206	0.794	0.931	0.931	0.669	0.254	0.606	0.615	0.890	0.759	0.822	0.777	1	
Cl	0.984	0.118	0.824	0.939	0.928	0.811	0.279	0.734	0.700	0.928	0.742	0.858	0.830	0.968	1

Agra City, Krishna Kumar Yadav *et al.* (2012) conducted an investigation. Some of the physicochemical parameters that were found to be higher than the natural background level of groundwater included pH (7.2-7.7), EC (1580-5200 mmhos), TDS (1020-4950 mg/l), Turbidity (1.1-31.4 NTU), Total Alkalinity (330-525 mg/l), Total Hardness (240-1425 mg/l), Chloride (295-1140 mg/l), Calcium (72-436 mg/l), Magnesium (14.6-151.2 mg/l), Sodium (126.5-1254.9 mg/l), and Potassium (1.9-60.6 mg/l). This shows that 12 test locations in Agra city between February and May 2011 had water samples that were chosen to show groundwater contamination. The findings indicated that the research area's groundwater generally could not be regarded as high quality.

Correlation matrix

The physico-chemical parameters were statistically analyzed in order to identify the similarities and differences among the groundwater samples. The values of the correlation coefficients (r) between the several water quality metrics were determined and are shown in Table 3 as a matrix.Pearson's correlation analysis calculates how closely two variables are related to one another at any given time. The likelihood that x and y will be related is indicated by correlation coefficient values that are closer to +1 or -1. By attempting to determine the nature of the linear relationship between the variables, this analysis offers a prediction mechanism (Mulla *et al.*, 2007; Kumar *et al.*, 2005; P. Lilly Florence *et al.*, 2012). The values of the relationship values range from -1 to +1, where -1 denotes an absolute inverse link between the bivariates, 0 denotes no linear relationship, and +1 denotes an absolute perfect positive linear relationship. The correlation's direction can be inferred from the sign that appears before its value. The association and relationship between various physical and chemical characteristics were understood by computing Pearson correlation coefficients. In order to compare physico-chemical properties, a quick and straightforward method based on statistical correlation has been developed in recent years. Numerous studies on statistical analysis for surface water quality evaluation have been conducted (Joshi *et al.*, 2009). Significant positive correlations between pH, EC, TS, TDS, TSS, and HCO_3 were discovered during the experiment. There was a negative association between COD and CO_3, meaning that where COD increases, CO_3 will likewise decrease. Total alkalinity, TH, DO, BOD, COD, Na, and Cl were measured.

Correlation coefficient is a measure of relationship between two variables, it ranges 0 to +1 or 0 to -1. Size of correlation coefficient 0.9 to 1.0 (or) -0.9 to -1.0 in this range very strong correlation, 0.7 to 0.9 (or) -0.7 to -0.9 in this range strong correlation, 0.5 to 0.7 (or) -0.5 to -0.7 in this range moderate correlation, 0.3 to 0.5 (or) -0.3 to -0.5 in this range low correlation while 0.0 to 0.3 (or) 0.0 -0.3 in this range very low correlation and 0.0 is no correlation in this range was used as present aim of study.

Conclusion

The management of its water quality may benefit from the findings of the physico-chemical analysis. Most of the water quality parameters are connected with one another, according to the correlation study on the parameters (Person's Correlation matrix). It is found that some parameters do not significantly correlate with one another, suggesting that the moderate contamination comes from distinct sources. According to the investigation, the area's groundwater requires some sort of treatment before it can be consumed.Due to the lack of published data on these significant villages from the Karur area, the data collected in these villages could serve as a baseline and point of reference when evaluating additional changes brought about by either nature or human activity.

Conflict of Interest- None

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