Eco. Env. & Cons. 30 (February Suppl. Issue) : 2024; pp. (S119-S129)
Copyright@ EM International
ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2024.v30i02s.023

Palatability Assessment of Subsurface Water in South India: An Experimental and Numerical Study

Karthick J.[1]*, Arutchelvan V.[2], Abdul Aleem M.I.[1] and Govarthanambikai K.[1]

[1]Department of Civil Engineering, PSG Institute of Technology and Applied Research, Coimbatore, India
[2]Department of Civil Engineering, Annamalai University, Annamalai Nagar, India

(Received 21 July, 2023; Accepted 14 September, 2023)

ABSTRACT

Monitoring the quality of groundwater is crucial and important for the environment, the human health and agriculture practices. This study focused on evaluating the physical and chemical characteristics of subsurface water of different selected places in Coimbatore. This study was also aimed for identifying the influence of sampling location to its characteristics. Twenty-five subsurface water samples were taken from distinct places and sources. The tests were conducted as per Indian standards. The findings indicate that temperature, available and residual chlorine, and pH are nearly identical for all groundwater samples; turbidity, electrical conductivity, total dissolved solids, sulphates and iron change significantly depending on where the source was located. To determine the appropriateness of ground water samples for drinking purposes, findings were compared with Indian (IS 10500:2012) and WHO (2006) standards. It was determined that results for all parameters are within the acceptable limit. The statistical analysis was conducted using SPSS software to know the significance of the predicted results and it has been found that the results were statistically significant.

Key words: *Coimbatore, Drinking water, Regression, Statistical analysis, Sub-surface water*

Introduction

Despite the fact that water covers three-quarters of the world, water is unquestionably nature's most precious gift after air (Sreepathy and Naveen Chandra, 2014). Water is a precious natural resource that is used for a many different things, from domestic to industrial (Andjela Brancic *et al.,* 2018, Obialo Solomon Onwukaa *et al.*, 2021 and Shengbin Wang *et al.,* 2022). About two-thirds of the world's fresh water supplies are made up of groundwater, which is a valuable resource (Roohi Rawat *et al.,* 2019; Kadri Daud, 2022). Due to fewer impurities than other water sources, groundwater is considered to be the most reliable one.Arid and semiarid areas have more delicate eco-environment systems than humid regions and struggle more to strike a balance between current development and sustainability due to the lack of surface water resources and precipitation (Shengbin Wang, 2022, Zhanwei Wang *et al.,* 2019; Andjela Brancic *et al.,* 2018; Qun *et al.,* 2021). Globally, groundwater use has grown at an alarming rate in recent decades. In huge portions of India, groundwater is increasingly being exploited, primarily for irrigation, industrial, and drinking uses due to the frequent monsoon failures, which also have an impact on surface water sources like rivers and lakes. The groundwater supplies in a aquifer are regularly recharged and discharged by rainfall and other factors, which results in fluctuations in water level. The aquifers continue to be perpetually inundated below this area of water level changes. Groundwater storage may be depleted as a result of excessive groundwater removal, which could have negative social, economic, and environmental effects (Olumuyiwa Olusola Falowo *et al.,* 2020). On the other hand, the demand for groundwater is also dramatically increased by rapid urbanization and industrialization (Srinivas *et al.,* 2014). However, the groundwater supplies are becoming contaminated with dangerous chemicals as a result of fast industrialization and population increase. Chemical or microbiological pollutants can cause a variety of health issues. The Globe Health Organization (WHO) estimates that water contamination is a direct or indirect cause of around 80% of all diseases in the world. Water's pH ranges from 6.5 to 8.5 and is colorless, odorless, and pathogen-free in its natural condition (Roohi Rawat *et al.,* 2019). This water is referred to as "potable water."

According to (Ravi Kumar *et al.,* 2020) groundwater is primarily influenced by natural and anthropogenic influences, including geological structure, precipitation composition, geochemical processes, interactions between groundwater and aquifer minerals, and human activities. Understanding the geochemical evolution of groundwater in arid and semi-arid regions could lead to sustainable development and effective management of these water resources (Seyni Ndoye *et al.,* 2018). The process of turning untreated groundwater from a subsurface source into potable water fit for drinking and other domestic applications is known as groundwater treatment. In addition, infectious organisms and hazardous materials must be removed. The type of pollutants or chemicals present will determine the treatment strategy.

The results of countless earlier research make it abundantly evident that issues with drinking water quality are caused by pollution and excessive use of the existing water resources. Rapid industrialization, uncontrollable population increase, a focus on high levels of agricultural output, financial and technological constraints, and, most importantly, law enforcement carelessness are some of the main reasons of this water resources exploitation. Similar to how droughts and floods affect water quality, there are other natural phenomena that do as well. Another reason for the decline in water quality across the nation is a lack of knowledge and awareness, as well as carelessness and irresponsibility on the part of the populace (Roohi Rawat *et al.,* 2019). It is in the situation to know that whether our drinking water and its source are safe or not. This study was primarily intended to measure the drinking water quality of 25 distinct Coimbatore locations and sources. The study's main objective is to evaluate the physical and chemical properties of water samples in accordance with WHO and Indian criteria to determine their acceptability for various applications.

Materials and Methods

Study area

Coimbatore has a 246.80 km^2 area and is situated at 11.0161°N 76.971°E. The Western Ghats Mountain range surrounds it on all sides, with the Nilgiris Biosphere Reserve and reserve forests on the northern side. The corporation's southern boundary is the Noyyal River, which flows through Coimbatore. The city has a vast tank system that is fueled by the river and rainwater and is situated inside the Noyyal Basin area. 2,860,000 people called Coimbatore's metro region home in 2021, a 2.62% growth over 2020. Over the area, the annual rainfall average ranges from roughly 550 mm to 900 mm. The eastern half of the district's Sulur area experiences the lowest rainfall (550 mm). It progressively rises in the direction of the south and reaches its peak near the Anamalai Hills.

Sample collection and analysis

Surface water and precipitation from the atmosphere are the principal sources of ground water recharge in the study area. Evapotranspiration, radial discharge and artificial exploitation are additional ways that ground water is released. According to the gradient of the terrain, the flow direction of ground water is from north to south (Qun Miao *et al.,* 2021). Drinking water samples from 25 distinct sources of ground water were gathered for this study starting in November 2022 in various Coimbatore, Tamilnadu, India. Theplaces were Postal colony, Avinashi, Perur, Muthu Chettipalayam, Therkkuppalayam, Jothi Puram, and Narasimhanicpalayam. They are: Puranadapalayam, Molapalayam, Kaikolapalayam, Selvapuram, Periyanakananpalayam, Rasakalipalayam, Neelambur, and Rasakalipalayam. Plastic bottles were used to collect samples, which were then transferred to a lab for analysis of their quality assessment properties (Table 1). The site name, as well as its location and source, are shown in the Table 2. Fig. 1 shows where the suggested study region is geographically.For this investigation, the physical and chemical characteristics including pH, temperature, odour, color, turbidity, electrical conductivity, total dissolved solids, available chlorine, residual chlorine, sulphates, iron, fluorides, total hardness, lead, chromium, and cadmium were taken into consideration. The tests were conducted according to Indian standards and WHO standards.

Results and Discussion

Physical Properties (Table 3)

Colour

The presence in surface water of colored organic particles, primarily humic ones caused by the decomposition of plants, is what gives drinking water its color. By being oxidized by bacteria into ferric and manganese oxides, respectively, iron and manganese also give water a red and blue color, respectively. The sample is visually examined to determine the color. In this investigation, there were no colored samples. This demonstrates the absence of colloidal materials and decomposed plant matter.

Odour

Physical investigation was used to determine the samples' odour. Our water samples did not have any offensive or disagreeable odors. This demonstrates that the water being provided is clean and devoid of contaminants and soluble gases.

Temperature

The reactions between water and solid or gaseous mediums are significantly influenced by temperature. The temperature and partial pressure will have

Table 1. Quality Assessment

S. No.	Test Parameter	Units	BIS (Allowable Limit)	ISI 1983	WHO (Allowable Limit)	Methods of Testing	Significant Effect on human Health / Others
1.	Turbidity	NTU	5	5	5	TurbidimetryMethod	Bacterial Diseases
2.	EC	scm^{-1}	-	-	1500	Electrode Method	Higher the conductivity, High number of impurities (dissolved substances, chemicals and minerals)
3.	TDS	mg/l	1500	1500	1500	Drying Method	Unwanted taste, Gastrointestinal irritation, Corrosion.
4.	pH	-	6.5 – 8.5	6.5-9.2	6.5 – 8.5	ElectrodeMethod	Mucous membrane, Bitter Taste and Corrosion all are impacted.
5.	RC	mg/l	-	-	250	Volumetric Method (Titration)	Congenital abnormalities, Bladder and rectal cancer,
6.	AC	mg/l	1000	1000	600	Volumetric Method (Titration)	Asthma symptoms, food allergies, Unpleasant smell and taste.
7.	SO_4	mg/l	400	400	250	Photometric Method	Reduced lung function, Aggravated asthmatic symptoms, diarrhea and dehydration.
8.	Iron	mg/l	-	-	1	Photometric Method	Skin Irritation, Bacterial Diseases, Damages in pipeline, Stain on appliances, Unpleasant taste in food and beverages.
9.	F	mg/l	-	-	-	Photometric Method	Bone disease, Dental Issues
10.	Hardness	mg/l	200-600	-	200-500	Volumetric Method (Titration)	Poor soap lathering, declining clothing quality and the development of scale
11.	Heavy Metals (Ld, Cr, Cd)	mg/l	-	-	-	Adsorption Spectro Photometer (Titration)	Anemia, Cancer, Liver, Kidney and Intestinal damage.

Source: ISI (1983). WHO (1984)

an impact on the solubility of gases (Olumuyiwa I. Ojo *et al.*, 2012; Roohi Rawat *et al.*, 2019). The chemical and biological functions of aquatic creatures in water depend on temperature. Due to the city's seasonal temperature changes in November, this is directly tied to the meteorological conditions in effect at the time of study. Groundwater in the research area has a temperature of 25 ^{0}C to 27 ^{0}C, with an average temperature of 26.70 ^{0}C. As you go deeper, the temperature of the groundwater typically rises. The average temperature in the research area was 26.70 ^{0}C at shallow depth and 270 ^{0}C at further depth, which represents a 0.30 ^{0}C difference.

Turbidity

The World Health Organization (WHO) asserts, turbidity is a measure of the water sample's ability to scatter and absorb light since plankton, silt, clay, colloidal particles, suspended debris and other microbes are present. The Nepheleo Turbidity Meter can measure turbidity. When colloidal particles give turbidity to water, it impacts other water quality measures like color. Additionally, it encourages bacteria growth, which harms the water's microbiological quality. The chemical quality of drinking water is also impacted by the formation of complexes between the humic matter that produces turbidity and heavy metals (WHO 1984, Olumuyiwa I. Ojo *et al.*,

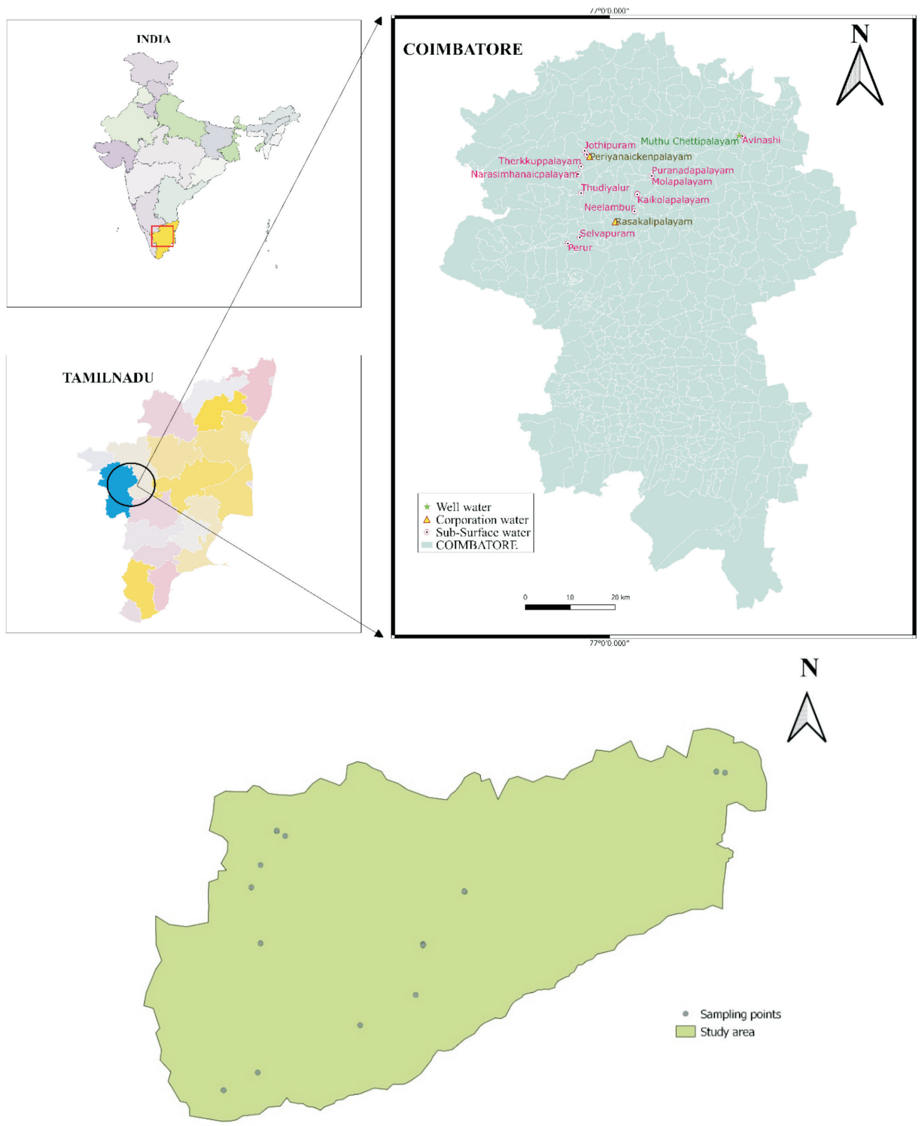

Fig. 1. Geographical location of study area

2012). Gastric problems and waterborne illnesses are brought on by highly turbid water (Roohi Rawat *et al.,* 2019). In this study, the turbidity of each sample was in a permissible range (Fig. 2).

Electrical Conductivity (EC)

The presence of dissolved salts and other inorganic compounds is what gives water its electrical conductivity. As salinity rises, conductivity rises as well. EC measured in situ utilizing portable field meters right away after sample collection and without filtration. The measured EC value in the suggested study region ranges from 0.10 to 4.20 µS/cm (Fig. 3). All values fall within the range that is acceptable. The findings of (Ravi Kumar *et al.,* 2020, Falak Naeem *et al.,* 2021) support this outcome.

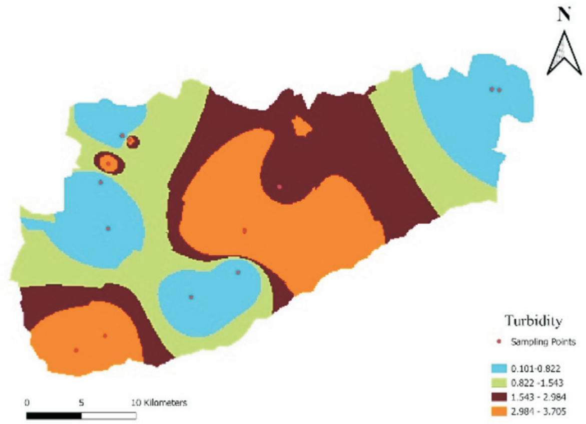

Fig. 2. Spatial Distribution Turbidity

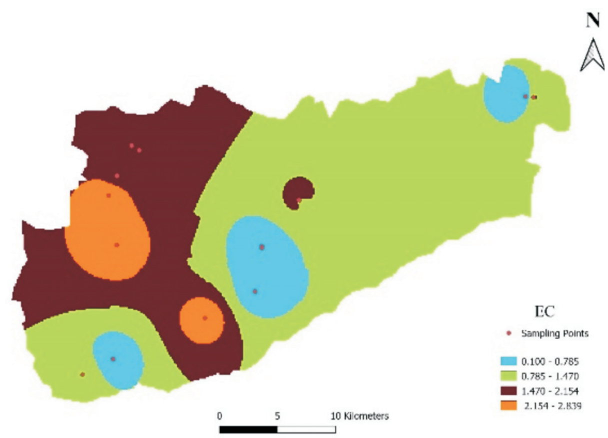

Fig. 3. Spatial Distribution of EC

Table 2. Sources and Geographical Location of Water Samples

S. No.	Samples	Locations			Source
		Site Name	Latitude	Longitude	
1.	WS1	Puranadapalayam	11.11282 N	77.08569 E	Sub Surface Water
2.	WS2	Molapalayam	11.11258 N	77.08601 E	Sub Surface Water
3.	WS3	Puranadapalayam	11.11282 N	77.08569 E	Sub Surface Water
4.	WS4	Kaikolapalayam	11.0754549 N	77.0564683 E	Sub Surface Water
5.	WS5	Kaikolapalayam	11.076454 N	77.0564682 E	Sub Surface Water
6.	WS6	Kaikolapalayam	11.0754549 N	77.0564683 E	Sub Surface Water
7.	WS7	Selvapuram	10.987653 N	76.939454 E	Sub Surface Water
8.	WS8	Periyanaickenpalayam	11.155554 N	76.953923 E	Sub Surface Water
9.	WS9	Periyanaickenpalayam	11.1555131 N	76.9539640 E	Sub Surface Water
10.	WS10	Periyanaickenpalayam	11.1521582 N	76.9598950 E	Corporation Water
11.	WS11	Periyanaickenpalayam	11.1560150 N	76.9538960 E	Sub Surface Water
12.	WS12	Rasakalipalayam	11.0200772 N	77.0117790 E	Corporation Water
13.	WS13	Neelambur	110409.4 N	77.051006 E	Sub Surface Water
14.	WS14	Neelambur	110409.4 N	77.051006 E	Sub Surface Water
15.	WS15	Postal Colony	10.9755 N	76.9153 E	Sub Surface Water
16.	WS16	Avinashi	11.194 N	77.270 E	Sub Surface Water
17.	WS17	Avinashi	11.194 N	77.270 E	Sub Surface Water
18.	WS18	Avinashi	11.194 N	77.270 E	Sub Surface Water
19.	WS19	Perur	10.9755 N	76.9153 E	Sub Surface Water
20.	WS20	Muthu Chettipalayam	11.194724 N	77.263887 E	Sub Surface Water
21.	WS21	Therkkuppalayam	11.132022N	76.942360 E	Sub Surface Water
22.	WS22	Muthu Chettipalayam	11.194724 N	77.263887 E	Well Water
23.	WS23	Jothipuram	11.0955.5 N	76.5656.5 E	Sub Surface Water
24.	WS24	Narasimhanaicpalayam	11.116511 N	76.935784 E	Sub Surface Water
25.	WS25	Thudiyalur	11.077612 N	76.942067 E	Sub Surface Water

Total Dissolved Solids (TDS)

The TDS concentration in groundwater determines whether it can be used for irrigation, drinking, or industrial uses. The weight of the material on evaporation to dryness up to a temperature of 180°C gives the concentration of dissolved compounds in water (Ravikumar *et al*., 2020). Water that has an excessive amount of dissolved solids is considered to be contaminated. Large-scale agricultural activities and other geological factors can also result in high levels of TDS (Kasthuri *et al.,* 2012; Rohi Rawat *et al.,* 2019). Untreated sewage and wastewater from residential and commercial sectors are dumped into pits, ponds, and lagoons where they eventually seep down to the water table, causing high levels of TDS due to water pollution (Roohi Rawat *et al.,* 2019; Olumuyiwa I. Ojo *et al.,* 2012). Volatile and nonvolatile solids are both a part of TDS. The study found that the samples' TDS values ranged from 0 mg/l to 1.95 mg/l. TDS levels in high-quality water ought to be lower than 600 (Fig. 4). This result showed that

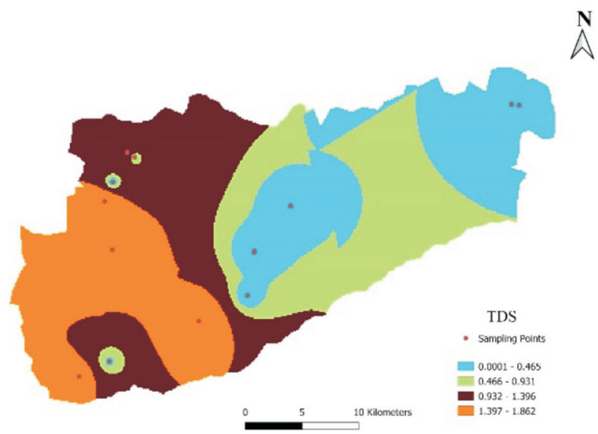

Fig. 4. Spatial Distribution of TDS

the water quality is quite high because the TDS value is very low.

Chemical Characteristics

Hydrogen Ion Concentration (pH)

In order to control how the body's metabolic processes, operate, pH is a crucial groundwater parameter. Additionally, pH has a big impact on how corrosive, odor, and taste when a substance of a drugs neutral and ionized forms in solution, it is particularly important (Olumuyiwa I. Ojo *et al.,* 2012). Additionally, the water starts to turn acidic. Between 6 and 8.5 is the typical pH range for groundwater systems. The pH ranged from 6.32 to 8.39 in the groundwater samples included in this investigation, with a mean pH of 7.68(Fig. 5). This demonstrates that the research area's groundwater quality is within the acceptable range (Ravikumar *et al.,* 2020 and Nawale *et al.,* 2016). Sample WS11 has the highest pH. (Periyanayakenpalayam Latitude 11.1560150 N Longitude 76.9538960 E). This has a mild alkaline pH. Water bodies that are productive have an alkaline pH. On the other hand, a high pH can result in incrustation, silt deposits, and issues with chlorination, whilst a low pH can produce tuberculation and corrosiveness. The higher pH values found during sample analysis suggest that the physiochemical condition modification had a greater impact on carbon dioxide, carbonate, and bicarbonate equilibrium (Roohi Rawat *et al.,* 2019). However, in this investigation, all of the samples fell within acceptable bounds. Electrical conductivity and total alkalinity

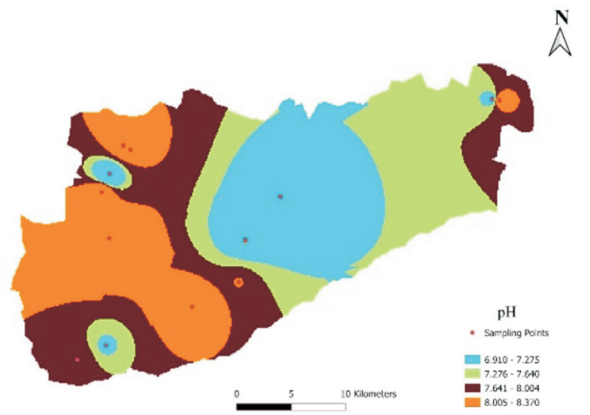

Fig. 5. pH Spatial Distribution

also have a positive association with this pH (Gupta *et al.*, 2009 and Olumuyiwa I. Ojo *et al.,* 2012). The chemical characteristics are presented in Table 4.

Available and Residual chlorine

Chloride levels in water are a sign of wastewater and sewage percolation contaminating the groundwater. In order to ensure microbiological safety, a balance must be struck between the amount of residual chlorine and the flavor it imparts to drinking water (Olumuyiwa I. Ojo *et al.,* 2012). Chloride is not present in natural water at all (Rani *et al.,* 2013). Animal and human feces include significant amounts of nitrogen and chloride molecules. In addition to giving the water a harsh flavor, high chloride content in drinking water might lead to cardiovascular problems (Roohi Rawat *et al.*, 2019). In this analysis, none of the samples contained any available and residual chlorine (Fig. 6&7).

Sulphates

Groundwater in the study area has sulphate concentrations that vary from 0.10 to 10 mg/l, with a mean of 1.74 mg/l. The findings are in desirable limit (Fig. 8). Sulfate typically enters groundwater from precipitation from the atmosphere. In the presence of other gases in the atmosphere, rainwater reacts with sulphur dioxide gases to generate sulphate ions, and hydrogen sulfide gas dissolved in water also produces sulfate. Similar to this, igneous and

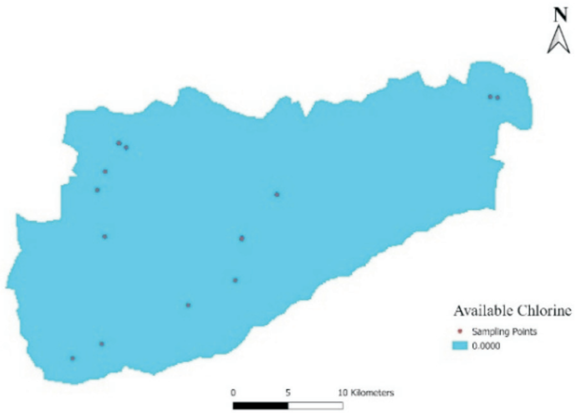

Fig. 6. Available Chlorine Spatial Distribution

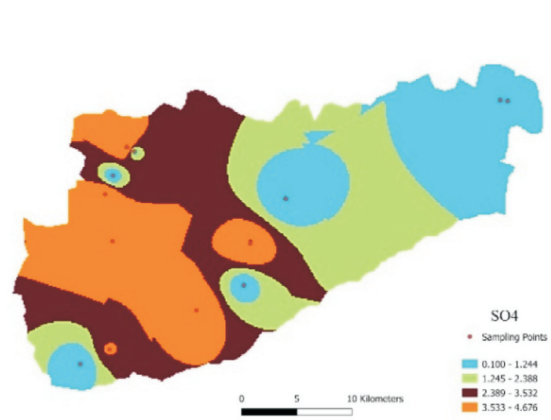

Fig. 7. Residual Spatial Distribution

Table 3. Physical Characteristics

S. No	Samples	Physical Properties					
		Colour	Odour	Temperature (°C)	Turbidity	EC	TDS
1.	WS1	Colourless	Nil	27.00	3.77	2.20	1.000
2.	WS2	Colourless	Nil	26.00	1.37	0.10	0.003
3.	WS3	Colourless	Nil	26.00	1.20	3.00	0.000
4.	WS4	Colourless	Nil	26.00	4.67	4.20	0.01
5.	WS5	Colourless	Nil	27.00	2.43	0.10	0.002
6.	WS6	Colourless	Nil	27.00	3.80	0.30	0.000
7.	WS7	Colourless	Nil	26.50	1.70	0.10	0.083
8.	WS8	Colourless	Nil	27.00	1.70	2.40	0.000
9.	WS9	Colourless	Nil	26.50	0.23	0.10	0.000
10.	WS10	Colourless	Nil	27.00	1.80	1.90	0.000
11.	WS11	Colourless	Nil	27.00	0.00	2.35	1.950
12.	WS12	Colourless	Nil	27.00	0.53	2.80	1.840
13.	WS13	Colourless	Nil	27.00	0.60	0.20	0.060
14.	WS14	Colourless	Nil	27.00	0.10	0.30	0.000
15.	WS15	Colourless	Nil	27.00	1.70	1.40	1.172
16.	WS16	Colourless	Nil	27.00	0.70	1.60	0.003
17.	WS17	Colourless	Nil	27.00	3.10	1.80	0.043
18.	WS18	Colourless	Nil	27.00	1.80	0.20	0.002
19.	WS19	Colourless	Nil	27.00	0.00	0.10	0.033
20.	WS20	Colourless	Nil	27.00	0.80	0.10	0.003
21.	WS21	Colourless	Nil	27.00	1.80	1.80	0.001
22.	WS22	Colourless	Nil	25.00	1.80	1.84	0.000
23.	WS23	Colourless	Nil	26.00	1.81	1.90	0.000
24.	WS24	Colourless	Nil	26.50	0.56	2.82	1.860
25.	WS25	Colourless	Nil	27.00	0.61	2.84	1.870

sedimentary rocks may include sulfide- or sulphate-bearing minerals that, when weathered in contact with aerated water, can result in sulfate ions in solution (Nawalae *et al.,* 2016; Sakthivel *et al.,* 2021). According to the planned study region, there are fewer industrial operations in the area that emit Sulphur dioxide into the atmosphere, which means that the impact of sulfate from atmospheric precipitation to groundwater may not be considerable. However, some sulphate can be found in groundwater as a result of runoff that is produced after rainfall and collects pollutants from soil and domestic wastewater (Nitish Sharma *et al.,* 2020).

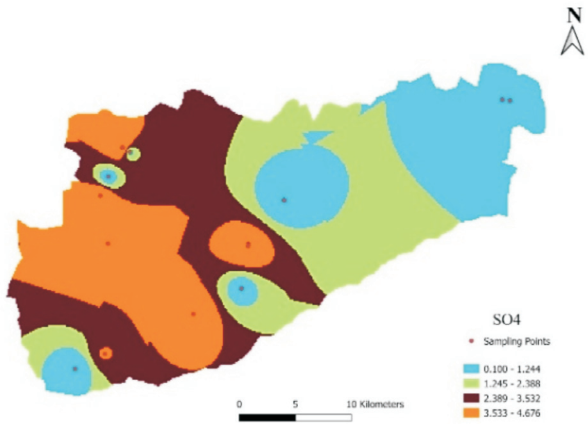

Fig. 8. Sulphates Spatial Distribution

Iron

The acceptable limit of iron concentration, according to (IS 10500: 2012), is 0.3 mg/l. Many of the samples used in this study were within the acceptable range. Some samples slightly exceed the allowed limit, which is shown in Table 4. The collected water samples had an average iron content of 0.85 mg/l. For WS 16, a maximum value of 3.20 mg/l was noted (Fig. 9). By weight, iron makes up the majority of the crust. It can be found in water in both its ferric and ferrous forms, especially under well-aerated circumstances. Rock and mineral dissolution, acid mine drainage, land fill leachates, sewage and iron-related industries all contribute to high iron levels in groundwater, lakes and reservoirs, particularly where reducing conditions are common (Olumuyiwa I. Ojo *et al.,* 2012).

Table 4. Chemical Characteristics

S. No.	Samples	Chemical Properties									
		pH	RC	AC	SO_4	Iron	F	Total Hardness	Heavy Metals		
									Lead	Cadmium	Chromium
1.	WS1	7.61	0	0	3.30	1.60	0.136	3.70	0.00	0.70	0.00
2.	WS2	7.23	0	0	0.10	0.15	0.159	2.90	0.00	0.60	0.00
3.	WS3	7.64	0	0	0.10	0.40	0.136	12.30	0.00	0.90	0.00
4.	WS4	7.83	0	0	0.30	0.10	0.290	3.60	0.00	0.60	0.00
5.	WS5	6.97	0	0	0.30	0.20	0.132	3.40	0.00	0.60	0.00
6.	WS6	8.04	0	0	5.00	0.30	0.159	3.80	0.00	0.60	0.00
7.	WS7	7.62	0	0	2.00	0.10	0.155	3.10	0.00	0.55	0.00
8.	WS8	7.86	0	0	2.00	0.10	0.105	17.10	0.00	0.60	0.00
9.	WS9	7.89	0	0	2.00	0	0.086	1.10	0.00	0.50	0.00
10.	WS10	8.05	0	0	0.30	0.30	0.079	11.80	0.00	0.60	0.00
11.	WS11	8.39	0	0	3.90	0.10	0.087	12.10	0.00	0.95	0.00
12.	WS12	8.23	0	0	3.00	1.73	0.081	18.50	0.00	0.60	0.00
13.	WS13	7.75	0	0	10.00	0.20	0.165	2.80	0.00	0.50	0.00
14.	WS14	7.93	0	0	0.20	0.20	0.090	11.80	0.00	0.60	0.00
15.	WS15	7.92	0	0	0.10	0.10	0.074	10.70	0.00	0.50	0.00
16.	WS16	8.18	0	0	0.10	3.20	0.092	24.50	0.00	0.60	0.00
17.	WS17	6.61	0	0	0.10	1.60	0.085	11.20	0.00	0.60	0.00
18.	WS18	6.93	0	0	0.10	1.10	0.153	2.60	0.00	0.50	0.00
19.	WS19	6.32	0	0	0.30	1.90	0.069	2.50	0.00	0.55	0.00
20.	WS20	7.45	0	0	0.10	2.60	0.075	2.70	0.00	0.60	0.00
21.	WS21	6.91	0	0	0.10	1.30	0.141	12.40	0.00	0.60	0.00
22.	WS22	7.91	0	0	2.01	0.20	0.088	3.70	0.00	0.50	0.00
23.	WS23	8.06	0	0	2.00	0.30	0.078	2.80	0.00	0.55	0.00
24.	WS24	8.32	0	0	3.01	1.76	0.083	3.60	0.00	0.50	0.00
25.	WS25	8.37	0	0	3.00	1.77	0.087	2.90	0.00	0.60	0.00

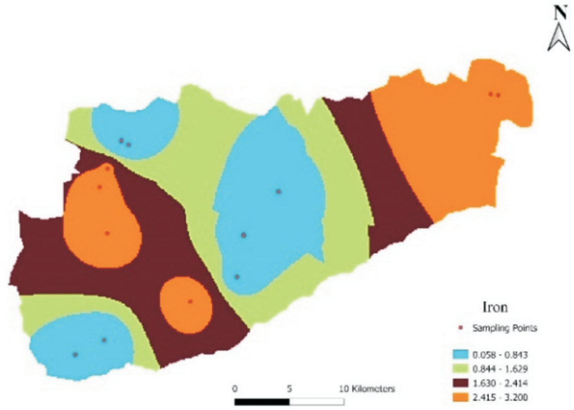

Fig. 9. Iron Spatial Distribution

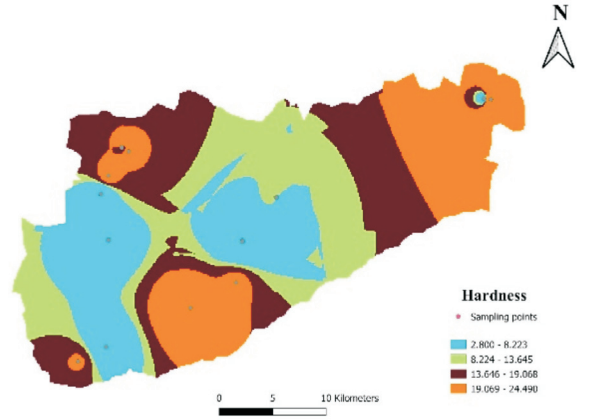

Fig. 11. Total Hardness Spatial Distribution

Fluorides

The average groundwater fluoride concentration in the research area is 0.120 mg/l, with a range of 0.069 to 0.290 mg/l. All of the samples had extremely low fluoride values, it was discovered (Fig. 10). The fluoride in groundwater may be caused by the dissolution of fluoride bearing minerals that are local to the area, although it cannot be totally ruled out that anthropogenic sources, such as the use of phosphate fertilizers for agriculture, could contribute to the fluoride (Nawale *et al.,* 2016). However, our study's results make it abundantly evident that neither contamination nor the usage of phosphate fertilizers exists in the area that will be the subject of the study.

Total Hardness

For domestic use of water, total water hardness is a crucial factor. Water's hardness is caused by the presence of alkaline earths like calcium and magnesium, and bicarbonate versions of these materials and the presence of poisonous heavy metals (Ravikumar *et al.,* 2020). This is merely the water's resistance to the formation of lather with soap. Therefore, a lot of soap is needed to make lather in hard water (Olumuyiwa I. Ojo *et al.,* 2012). Additionally leading to heart-related issues and kidney stone formation (Jameel *et al.,* 1998; Roohi Rawat *et al.,* 2019). Due to its strong solubilizing capacity, with concentrations up to several thousand mg/l, groundwater is frequently harder than surface water, especially when it comes to rocks with gypsum, calcite, and dolomite (Olumuyiwa I. Ojo *et al.,* 2012). Examining the samples reveals that the total hardness ranged between 1.1 mg/l and 24.50 mg/l despite the fact that drinking water hardness should be below 60 mg/l.(Fig. 8). According to the groundwater study for overall hardness, each sample is classified as having very little hardness (Table 4). This is symbolically justified that there is no harmful metals and earth in the tested water samples (Fig. 11). This finding is also justified by Srinivas *et al.,* (2014).

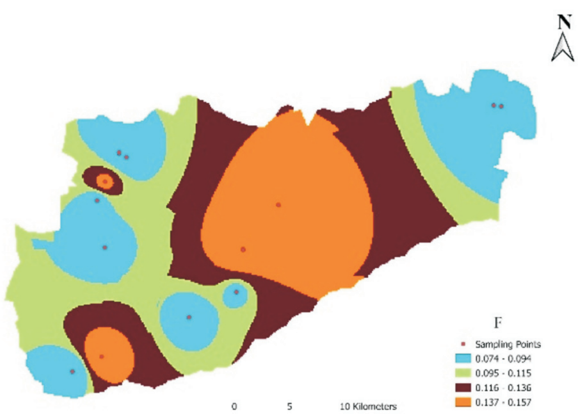

Fig. 10. Fluorides Spatial Distribution

Table 5. Notations and Abbreviation

S.No.	Notation	Abbreviations
1.	TDS	Total Dissolved Solids
2.	pH	Hydrogen ion concentration
3.	RC	Residual Chlorine
4.	AC	Available Chlorine
5.	SO_4	Sulphate
6.	F	Fluoride
7.	EC	Electrical Conductivity
8.	IS	Indian Standards
9.	Ld	Lead
10.	Cr	Chromium
11.	Cd	Cadmium

Table 6. Statistical Analysis Results

S. No.	Test Parameters	Statistic Analytical Parameters					
		Minimum	Maximum	Mean	Mode	Standard Deviation	Median
1.	Turbidity	0	4.67	1.54	1.8	1.24	1.70
2.	EC	0.10	4.20	1.46	0.10	1.46	1.80
3.	TDS	0	1.95	0.40	0	0.40	0.003
4.	pH	6.32	8.39	7.68	-	7.68	7.86
5.	RC	0	0	0	0	0	0
6.	AC	0	0	0	0	0	0
7.	SO_4	0.10	10.00	1.74	0.1	1.74	0.30
8.	Iron	0	3.20	0.85	0.1	0.85	0.30
9.	F	0.069	0.29	0.12	0.14	0.12	0.09
10.	Hardness	1.1	24.5	7.50	3.7	6.26	3.7

Lead

The earth's crust naturally contains lead, which has an average content of 16 mg/kg. Since a large proportion of lead is removed via convectional water treatment processes, lead levels in drinking water are generally low (Olumuyiwa I. Ojo *et al.,* 2012). The weekly lead intake cap for people 3 mg (0.05 mg/kg body weight) from food, air, and water is (WHO, 1984). The study's water sample collection did not contain any lead.

Chromium

The collected water samples did not contain any chromium.

Cadmium

An average cadmium concentration of 0.60 mg/l was noted in this study.

One Sample T-Test Results

The abbreviations and notations used in this study was reported in Table 5. One Sample T-Test was conducted using SPSS 26 software. The statistical relationship exist between the Physical and chemical properties of water samples were ascertained through mean, standard deviation, standard mean error (Table 6 and 7). When the p-value was less than 0.05, statistical significance was regarded to have been achieved. Statistical significance was assessed at the 5% level. The number of samples taken for this was 25. These results clearly validate the correlation between the test parameters. In all the cases the statistical significance of 0.000 was observed. This is clearly proven the reliability of the proposed model.

Table 7. One Sample Statistics

Parameter	N	Mean	Std. Deviation	Std. Error Mean
Turbidity	25	1.5432	1.24470	0.24894
EC	25	1.4580	1.21453	0.24291
TDS	25	0.3974	0.72410	0.14482
pH	25	7.6808	0.56086	0.11217
RC	25	0.0000	0.00000[a]	0.00000
AC	25	0.0000	0.00000[a]	0.00000
So4	25	1.7368	2.26631	0.45326
Iron	25	0.8524	0.92085	0.18417
F	25	0.1154	0.04891	0.00978

a. t cannot be computed because the standard deviation is 0.

Conclusion

This study analyzes the physical and chemical properties of 25 groundwater samples taken from various selected places of Coimbatore, Tamil Nadu, and India. The analysis is founded on the primary Physical-chemical properties. The results of the qualitative assessment of groundwater led to the following findings. The water samples had no color and smell. The gathered water samples had an average temperature of 26.7°C. The total dissolved solids, electrical conductivity, and turbidity were all quite low. As a result, all of the samples' physical parameters were within the acceptable range according to Indian and WHO guidelines. The chemical properties of the groundwater samples that were gathered showed that they were free of heavy metals like lead, chromium, and cadmium. The water samples that were taken from the aforementioned sources are also clean that is no contamination. Even while there were significant variations in the physical and chemical features, those were well within the parameters set by Indian and WHO guidelines. Therefore, the water samples that were taken can be used for drinking and other household tasks. Through SPSS analysis, the validity of the experimental results was evaluated. The findings were statistically significant, according to the findings.

References

Andjela Brancic, Anastasija Dordjevic and Dejan Neskovic, 2018. Characteristics of groundwater surface water interaction in areas with scarce input data – case study of bnaja river catchment (Western Serbia). *Proceedings*. 17(2): 625-632.

Falak Naeem and Lubna Ghazal, 2021. Assessment of physiochemical characteristics of groundwater quality in districts of Punjab: A geoinformatics perspective. *Pakistan Geographical Review*. 76 (1): 191-202.

Gupta, T.P., Sunita and Saharan, J.P. 2009. Physico-chemical analysis of ground water of selected rea of Kaithal city (Haryana) India. *Researcher*. 1(2): 1-5.

IS 10500: 2012. Drinking Water – Specification. Bureau of Indian Standards. New Delhi.

Jameel, A. 1998. Physico-chemical studies in Vyyakondam channel water of river Cauvery. *Pollution Research*. 17(2): 111-114.

Kadri Daud, Henny Pramoedyo, Aminudin Afandhi and Ishardita Tama, 2022. Hydrogeochemical character and groundwater potential in ternate basin, North Maluku, Indonesia. *Journal of Southwest Jiaotong University*. 57(3): 492-503.

Kasthuri, R., Lalitha, S., Kalaivani, D., Banumathi., K and Nitha. 2012. Essay of groundwater quality at Kothattai of Tiruchirappalli. *Indian Journal of Environmental Protection*. 25(3): 245-248.

Nawale, V.P., Yenkie, M.K.N and Malpe, D.B. 2016. Physico-chemical characteristics of groundwater in Wardha sub basin, Maharashtra, India. *International Journal of Innovative Research in Science, Engineering and Technology.* 5(6): 9370-9379.

Nitish Sharma, Upma Vaid and Sanjay Kumar Sharma. 2020. Assessment of groundwater quality for drinking and irrigation purpose using hydro chemical studies in Dera Bassi town and its surrounding agricultural area of Dera Bassi Tehsil of Punjab, India. *SN Applied Sciences*. 3(1): 245-258.

Obialo Solomon Onwuka, Ezugwu Chimankpam Kenneth and Okpe Kennedy Chikezie, 2021. Groundwater source evaluation and quality checks, for drinking and irrigation uses in Eha-Amufu and environs, Eastern Nigeria. *Environmental Forensics*. 4(1/2),411-420.

Olumuyiwa Ojo, I., Fred Otieno, A.O. and George Ochieng, M. 2012. Groundwater: characteristics, qualities, pollutions and treatments: An overview. *International Journal of Water Resources and Environmental Engineering*. 4(6): 162-170.

Olumuyiwa Olusola Falowo, Olayemi Olajumoke Ojo and Abayomi Solomon Daramola, 2020 Groundwater resource assessment by hydraulic properties determination for sustainable planning and development in central part of Ondo state, Nigeria. *Environmental and Earth Sciences Research Journal*. 7(1): 1-8.

Qun Miao, Xuefei Li, Youqin Xu, Chao Liu, Ruikang XIe and Zhihan Lv, 2021. Chemical characteristics of groundwater and source identification in a coastal city. *Plos One*. 16(8): 1-17.

Rani, D.F.G., Geetha, S. and Ebanazar, J. 2013. The drinking water quality characteristics of five rural places in and around Thittakudi, Tamilnadu, India. *Pollution Research*. 22(1): 111-115.

Ravikumar, Y., Rama Mohan, K. and Krishna Rao, K.S.V. 2020. Appraisal of groundwater quality and hydrogeochemical process in Handri river basin of Kurnool District, Andhra Pradesh, India. *Indian Journal of Advances in Chemical Science*. 8(3): 85-93.

Roohi Rawat and Siddiqui, A.R. 2019. Assessment of physio-chemical characteristics of drinking water quality in Allahabad metropolitan city, India. *The Oriental Anthropologist*. 19(1): 121-135.

Sakthivel, G. and Manjula, R. 2021. A study on groundwater quality and its characteristics in Tuticorin costal region using geo-statistical approaches, Tamilnadu, India. *Indian Journal of Geo Marine Sciences*. 50(4): 329-338.

Seyni Ndoye, Claude Fontaine, Cheikh Becaye Gaye and Moumtaz Razack. 2018. Groundwater quality and suitability for different uses in the saloum area of Senegal. *Water*. 10(12): 1837-1857.

Shengbin Wang, Zhan Xie, Fenglin Wang, Yuqing Zhang, Wanping Wang, Kui Liu, Zexue QI, Fengyun Zhao, Guoqiang Zhang and Yong Xiao, 2022. Geochemical characteristics and quality appraisal of groundwater from huatugou of the qaidam basin on the Tibetan plateau. *Frontiers in Earth Science*. 10(1): 1-13.

Srinivas, Y., Hudson Oliver, D., Stanley Raj, A. and Chandrasekar, N. 2014. Quality assessment and hydro geotechnical chemical characteristics of groundwater in Agastheeswaram Taluk, Kanyakumari district, Tamilnadu, India. *Chin. J. Geochem*. 33(1): 221-235.

Sripathy, L. and Naveen Chandra, 2014. Study on the physico-chemicalcharacteristics of groundwater. *International Journal of Scientific & Engineering Research.* 75(4): 218-232.

WHO, 1984. Guidelines for drinking water quality. Vol 1. Geneva: WHO.

Zhanwei Wang, Lin Wang, Aihua Ma, Kunfeng Liang, Zun Song and Lianwei Feng, 2019. Performance evaluation of ground water source heat pump system with a fresh air pre-conditioner using ground water. *Energy Conversion and Management*. 188(1): 250-261.