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Full Length Research Paper

Statistical Analysis of Groundwater Quality in and around of Kondapalle Industrial Region, Krishna District, Andhra Pradesh, India.

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ABSTRACT

*Water quality is a critical factor for the well-being of both humans and ecosystems. Access to safe and clean drinking water is essential for maintaining public health. This paper presents a comprehensive analysis of groundwater quality in the Kondapalle industrial region, Krishna district, Andhra Pradesh, India. The study involves the statistical analysis of various groundwater parameters in 32 different sampling stations. The data collected over a period of time provides valuable insights into the water quality and potential implications for human health and the environment. The correlation in between the parameters showed a positive association of TDS with EC (r=0.145), magnesium (r=0.141), SO_4^{--} (r=0.086), Chloride (r=0.2766**), sodium (r=0.15), and Ca^{++} (r=0.72). It indicates that high concentration of TDS with increasing these parameters (Asuero et al., 2006, Mukaka 2012). EC with Sulphate (r=0.3251**), Chloride (r=0.3193**), Turbidity (r=0.21), Magnesium (r=0.108), Nitrates (r=0.167), Turbidity with EC (r=0.211), Calcium (r=0.214), Chlorides (r= 0.069), Nitrates (r= 0.148) and Fe (r= 0.013). $SO_4^{--}$with EC (r=0.3251**), TDS (r=0.086), Cl^- (r=0.471**), Nitrates (r=0.251**), and Magnesium (r=0.330**). Cl^- with EC (r=3193**), TDS (r=0.276**), Sulphates (r=0.471**), Fe (0.28**), Potassium with Total hardness (r= 0.146), sodium (r=0.219), Fe (r=0.549**) and F (r=0.241), the total hardness has positive correlation with Ca (r=0.3566**), Na (r=0.057), Potassium (r=0.162), and Fluoride (r=1292), Alkalinity correlated with Ca^{++}(r=0.467**), total hardness (r=237**), Na (r=0.231), TDS (0.237), Mg^{++}(r=0.015), and F (r=0.17), has observed positive and slightly significant levels in very few parameters, the prediction equation also constructed. The data analysis suggests that while the majority of sampling stations have water within acceptable pH ranges, there are variations in other parameters. Elevated levels of EC, TDS, and turbidity in some stations may be indicative of pollution from industrial or agricultural sources. Based on the Correlation percentage classification most of the parameters are in inverse and poor, the groundwater in the study area is not good for the drinking and domestic, it has polluted by the pollutants so that, it needs the treatment*

Introduction

Statistical analysis plays a pivotal role in the realm of scientific research, providing researchers with the means to make sense of complex data, draw meaningful conclusions, and infer patterns and relationships within their datasets (Johnson et al., 2019). It forms an indispensable component of empirical investigations across various disciplines, including but not limited to the natural and social sciences, economics, and healthcare. Statistical methods enable researchers to uncover hidden insights, test hypotheses, and validate their findings rigorously. This introduction provides an overview of the significance and applications of statistical analysis in research, drawing upon relevant research papers to illustrate its crucial role (Jamuna 2018). Contaminated or poor-quality water can lead to various waterborne diseases and environmental degradation. The Kondapalle region situated in krishan district, Andhra Pradesh, India, faces challenges related to water quality due to industrial, agricultural, and anthropogenic activities. This paper aims to evaluate and assess the groundwater quality parameters in different sampling stations across the Kondapalle industrial region. The parameters considered in this study provide a comprehensive view of water quality and its suitability for various purposes, including drinking, agriculture, and industrial use (Jamuna 2018). Around the world, fresh groundwater systems are one of the use full sources of drinking water, the majority of the time, contaminants that are added by nearby sources come into contact with fresh water aquifers (Vetrimurugan et al., 2020). If these pollutants are pulled into the water aquifer system, they can reduce the water's potability and other uses, therefore, managing and safeguarding these resources for future use requires a quantitative understanding of the patterns of flow and mixing between fresh and polluted water as well as of the factors that affect these processes. The Statistical analysis like correlation analysis was applied to ground water sample indicated that the influence parameters on each other and the environmental factors are also affected to increase the concentration of pollutants (Jamuna 2018). Oluyemi et al., (2014), studied the purpose of such an analysis is to study of the hydro-geochemistry of an aquifer, which can clarify the concentration of dissolved particles and their variance of the analytical data (Janardhana Raju, 2007, Vetrimurugan et al., 2020).

Correlation coefficients were one of the indicators used to quantify the intensity and the relationship between two or more aspects of water quality (Mehta, 2010), (Kim et al., 2007). Pearson correlation analysis was used to describe the data to assess the suitability of the water for human consumption and domestication purposes (Okoro et al., 2012). The strong correlations between the elements generally indicate that these elements had the same input sources and similar geochemical behaviour (Moore et al., 2011). Pearson's correlation is a widely used correlation metric (r). Because "r" calculates the linear relationship between two variables, it is also known as the linear correlation coefficient (Helsel and Hirsch 2002, Sudhakar et al., 2014), The ability to statistically describe the phenomenon of groundwater contamination and to calculate the extent to which a particular locality is contaminated by a type of parameter, hydro-geologists have been using various models to determine the sources of contaminants, movement and pattern. The people are access the groundwater for the industrial, domestic and agricultural from the ground region in and around the Kondapalli industrial region, the improper treatment of water before consumption leads to several problems, hence it need to find the groundwater quality in the study area.

Objective is to find out the groundwater quality in and around the kondapalli industrial region.

Materials and methods

Study area

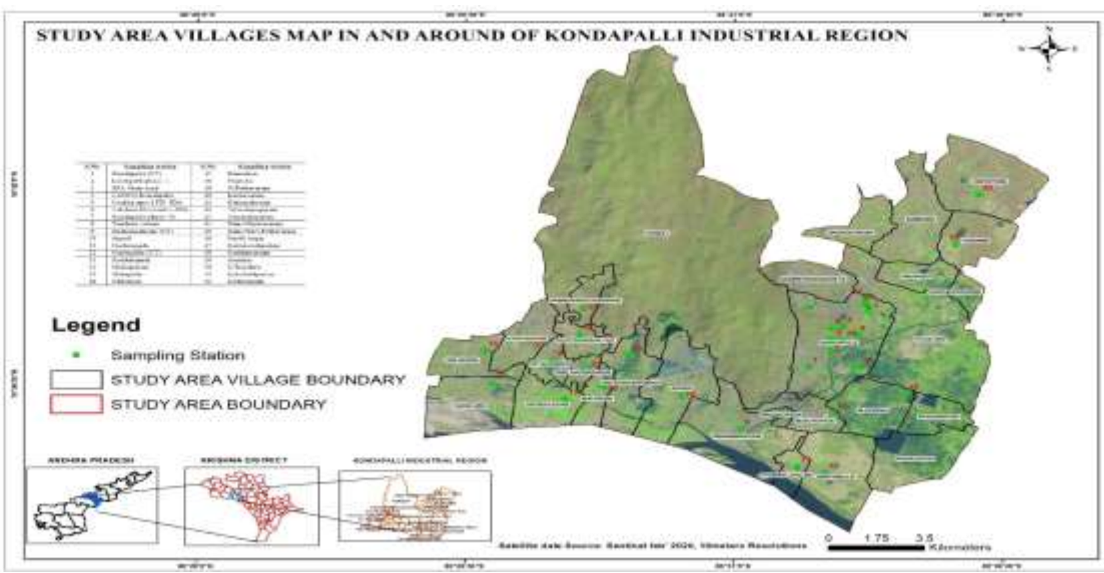

Fig. 1 Study area

The area of study According to Muthumperumal and Parthasarathy (2009), "Kondapalle is in the Eastern Ghats region, which stretches over an area of 75,000 km2 and is one of the nine floristic zones of India. Kondapalle is home to the Kondapalle Reserve Forest, one of the last remaining pristine forests in the Krishna district, spread over an area of 30,000 acres (120 km^2)", several "leopards, wild dogs, jackals, wild boar, and wolves with a varied terrain" call it home. Prolaya Vema Reddy of Kondavidu constructed the historic fort on the hill to the west of the Kondapalle hamlet between the 14^{th} and the 18^{th} centuries*"*.

The ground water samples are collected from 32 sampling station (table 1) in and around the kondapalle industrial region, and analysed the water quality parameters as per the chemical analysis procedures and compared to WHO standards, the physic parameters are pH, TDS and EC and chemical with Electrometric Conductivity meter and Turbidity by CL 52D Nephelometer (ELICO, India) (Corwin and Yemoto, 2017). The chemical parameters are also analysed in the laboratory as per the analysis procedures. The results are applied for statistical analysis. Statistical analysis allows researchers to examine correlations between variables and, in some cases, infer causal relationships. Understanding these connections is essential for making informed decisions and drawing meaningful conclusions (Vetrimurugan et al., 2020). The data underwent a normal distribution analysis and Pearson correlation using Microsoft Excel 2007. Normal distribution analysis serves as a crucial statistical method for discerning the distribution patterns of various water quality parameters within groundwater samples (Khwaja and Aggarwal 2014). Measures of correlation have the characteristics of being dimensionless and scaled to lie in the range -1 < r < 1. When there is no correlation between two variables, r = 0. One variable increase as the second also increases, ‘r’ is positive. If they vary in opposite directions, ‘r’ is negative and one variable is a measure of time or location, correlation becomes a test for temporal or spatial trend.

Pearson’s “r” and P value
The most commonly used measure of “correlation is Pearson’s r. It is also called the linear correlation coefficient because ‘r’ measures the linear association between two variables”. If the data lie exactly along a straight line with “positive slope, then r = 1. Correlation-coefficient (Pearson ‘r’) has been calculated between each pair of water quality parameters by using Excel spread sheet for the experimental data”. Let X and Y are the two variables, then the correlation ‘r’ between the variable X and Y is given by:

$$\text{Correlation (r).} = \frac{\sum (X-\bar{X})\,(Y-\bar{Y})}{\sqrt{\sum (X-\bar{X})^2 \sum (Y-\bar{Y})^2}} \qquad (1)$$

Where,
“x and y are the sample means, If the values of correlation coefficient
‘r’ between two variables X and Y are fairly large, it implies that these two variables are highly correlated”.
In such cases it is feasible to try linear relation in the form: Y = Ax + B.

P value
To find out the significance of the variables in the samples of the study area need to find out the probability, formula is as follow

p= n-2/t -------(2)

t = r√n−2/√1−r2 -----------(3)

Where,
“n” = number of samples, “r” = Pearson correlation, “t” is the test statistic
Degrees of freedom (df) = n - 2 ---------(4)

Results and Discussion
The results of the groundwater quality analysis in the Kondapalle industrial region are summarized as the pH levels in most sampling stations ranged from 6.2 to 8.6, with an average of 7.6. These values indicate that the water is generally within the neutral to slightly alkaline range. The Electrical Conductivity and Total Dissolved Solids values ranged from 843 to 2910 µS/cm, with corresponding TDS values ranging from 841 to 3014 mg/L. Higher EC and TDS values were observed in several stations, indicating elevated dissolved solids content. Turbidity values varied from 1.86 to 4.9 NTU, with some stations showing higher turbidity levels, possibly due to sediment and particulate matter. TH values ranged from 159 to 542 mg/L, with Ca and Mg levels varying accordingly. These parameters are essential for assessing water's suitability for domestic and industrial use. Total Alkalinity values ranged from 76 to 150 mg/L, indicating the buffering capacity of water against pH changes. Chloride, Sulphate, Nitrate, Sodium, Potassium, Iron, and Fluoride parameters were also measured, and their values provide insights into the water's chemical composition and potential health concerns (Sudhakar and Swarnalatha 2018, Gul Daraz et al., 2014). The data on water quality that were gathered from the study area were analysed using statistical methods. The potency of relationship between two continuous variables is determined using the coefficient of correlation (Khwaja and Aggarwal 2014). This proves that whether there is a positive or negative correlation between the variables, it indicates that the rise of one variable affects the rise of another (Vetrimurugan et al., 2020). Therefore, the correlation measures the observed co-variation in variable or the parameters in water quality.

Correlation between Variables
The analytical data showed a positive association of TDS with EC (r=0.145), magnesium (r=0.141), SO_4^{--}(r=0.086), Chloride (r=0.2766**), sodium (r=0.15), and Ca^{++} (r=0.72). It indicates that high concentration of TDS with increasing these parameters (Asuero et al., 2006, Mukaka 2012). EC with Sulphate (r=0.3251**), Chloride (r=0.3193**), Turbidity (r=0.21), Magnesium (r=0.108), Nitrates (r=0.167) (Table 4). It indicates that Electrical Conductivity was increased with increasing these parameters and significant correlation in between these parameters (Khwaja and Aggarwal 2014). Turbidity with EC (r=0.211), Calcium (r=0.214), Chlorides (r= 0.069), Nitrates (r= 0.148) and Fe (r= 0.013). $SO_4^{--}$with EC (r=0.3251**), TDS (r=0.086), Cl^- (r=0.471**), Nitrates (r=0.251**), and Magnesium (r=0.330**). Cl^- with EC (r=3193**), TDS (r=0.276**), Sulphates (r=0.471**), Fe (0.28**), Potassium with Total hardness (r= 0.146), sodium (r=0.219), Fe (r=0.549**) and F (r=0.241), the total hardness has positive correlation with Ca (r=0.3566**), Na (r=0.057), Potassium (r=0.162), and Fluoride (r=1292), Alkalinity correlated with Ca^{++}(r=0.467**), total hardness (r=237**), Na (r=0.231), TDS (0.237), Mg^{++}(r=0.015), and F (r=0.17), The prevalence of water quality parameters and the observed correlations suggest that mineral weathering processes have occurred (Khanoranga and Khalid 2019), the fluoride has positive correlation with sodium (r=5491**) Nitrates (r=0.0432), and calcium (r=0.1492) (table 6), these relations indicted that influence of parameters on each other to increase their concentrations (Vetrimurugan et al., 2020). The correlation of variables in ground water samples are indicated in table 6. A moderate correlation with other variables implies a potential contribution from the infiltration of

wastewater associated with agricultural activities and the return flow from irrigation (Vhonani et al., 2019). The similar results were observed by Helsel and Hirsch (2002), Sundar and Saseetharan (2008), Khan et al., (2010), Khwaja and Aggarwal (2014).

In addition to the absolute amounts of these elements, higher water Mg and Ca levels are frequently linked to higher levels of other dissolved solids, which may not be good for health (Raju et al.., 2014). The negative correlation with almost all parameters in the study area has been observed in the correlation matrix, the pH has showed negative correlation with EC, turbidity, Total hardness, SO_4^-, NO_3. The electrical conductivity showed the negative correlation with TH, Ca, Alkalinity, Sodium, Potassium, Fluoride and Fe.

The parameter TDS has showed the negative correlation with turbidity, TH, Ca^{++}, Nitrates, Potassium and fluoride. Turbidity parameter showed negative correlation with TH, Mg, TA, SO_4, Na, K and F. Sulphates has negative correlation with Turbidity, total hardness, Ca^{++}, Alkalinity, sodium, K^{++}, Fe^{++} and F (table 4) the similar results were obaserved by Khwaja and Aggarwal (2014), Jamuna (2018), and Vetrimurugan et al., (2020). A positive correlation was observed (Asuero et al., 2006, Mukaka 2012, Vetrimurugan et al., 2020) in between Cl and Sulphates (47%), EC (32%), TDS (28%). Potassium and fluoride (24%), Total Hardness and Calcium (36%), sulphates and Electrical conductivity (33%), TDS and Sodium (16%), Nitrates and Magnesium (13%), Sodium and Total alkalinity (23%), Iron and Chloride (28%), Potassium (55%), potassium and Sodium (22%), indicated (Table 7). The negative correlation has been observed in between TDS with Ca, TH, TA, NO_3, K and F most of the parameters have positive correlation in ground water samples to maintain the high concentration of TDS in all the samples, turbidity has the negative correlation with TH, Mg, TA, SO_4, Na, and K, and the sulphate has negative relation with Na, K, Fe and F. the parameter magnesium has negative relation with Cl, Na, K, Fe and F. The similar study has been done by Basavaraja et al., (2014).

Classification of water quality based on the Correlation percentage

The groundwater quality parameters data has been classified into four categories based on the correlation matrix percentage and the physic chemical water parameters concentrations such as Inverse (-I % to -100%), Poor water quality (0 % to 33 %), Fair water quality (34 % to 66 %) and Good water quality (67 % to 100%), (Table 3 and 4), the parameters correlations with the other variable relation not only positive and negative but also the inverse, poor, fair and good are calculated and indicated in table 5. pH has inverse relation with EC, Tr, TH, SO_4, NO_3. Poor relation with TDS, Ca, Mg, TA, Cl, Na, Fe, F, and only one parameter has fair relation K. EC has Inverse with TH, Ca, TA, Na, K, Fe, F, Poor relation with TDS, Tr, Mg, Cl, SO_4, NO_3, K, TH and the no one has fair relation of parameters. TDS relation is Inverse with pH, Tr, TH, Ca, TA, NO_3, K, F, Poor relation with the parameters like Mg, Cl, SO_4, Na, Fe and no one parameter is in fair relation. Indicates high pollutant concentration in ground water samples, TDS has inverse relation pH, Tr, TH, Ca, TA, NO_3, K, F, Poor relation with Mg, Cl, SO_4, Na, Fe. The Turbidity has inverse relation with pH, TDS, TH, Mg, TA, SO_4, Na, K, F, poor relation with EC, Ca, Cl, NO_3, Fe. The Total hardness pH, EC, TDS, Tr, Mg, Cl, SO_4, NO_3, Fe and poor relation TA, Na, K, F and one parameters has fair relation that is Ca (Table 3). The parameters like EC, TDS, Mg, Cl, SO_4, NO_3, K are in inverse category, parameters like pH, Tr, Na, Fe, F are in poor category and TA, TH, are in poor category with Ca. these categories indicated that water quality in the study area. (Table 3)

Correlation and prediction equations

The prediction equation of total dissolved solids with Ca 1900 + 0.4326 TDS, Mg 1591.09 + 3.9225 TDS, Cl 1707.841 + 1.1441 TDS, EC 1353.42 + 0.3024 TDS, TH 1793.73 + 0.667 TDS, NO_3 2040.101 + -1.0145 TDS (Table 6). The correlation and prediction equation of Total Hardness with TDS- 218.589 + 0.0401 TH, Ca 198.402 + 0.469 TH, Mg 99.76 + 1.940 TH, EC 223.77 + 0.035 TH, Cl 16.004 TH, NO_3 323.009 + -0,525 TH (Table 4 & 5).

Table: 1 Sampling stations list

Samples	Sampling station	Samples	Sampling station
S1	Kondapalle (CT)	S17	Damuluru
S2	Kondapalle-phase–I,	S18	Elaprolu
S3	IDA-Main road	S19	N.Pothavaram
S4	LANCO-Kondapalle	S20	Kachavaram
S5	Godreg agro LTD- IDA	S21	Kethanakonda
S6	Lakshmi Electrodes -IDA	S22	Trilochanapuram
S7	Kondapalle phase -II	S23	Tummalapalem
S8	teachers colony	S24	Zami Machavaram
S9	Ibrahimpatnam (CT)	S25	Zami Navi Pothavaram
S10	Jupudi	S26	Santhi nagar
S11	Gudurupadu	S27	Kattukondupalem
S12	Guntupalle (CT)	S28	Gaddamanugu
S13	Kotikalapudi	S29	Autukur
S14	Malkapuram	S30	G Konduru
S15	Mulapadu	S31	Kattubadipalem
S16	Chilukuru	S32	gudurupadu

Table: 2. Broad classifications of correlation in percentage

Correlation percentage	Quality of water
67 % to 100 %	Good water quality
34 % to 66 %	Fair water quality
0 % to 33 %	Poor water quality
-1 % to -100 %	Inverse water quality

Table: 3. Classification of water quality based on the Correlation

Parameters	Inverse	Poor	Fair	Good
pH	EC, Tr, TH, SO_4, NO_3	TDS, Ca, Mg, TA, Cl, Na, Fe, F	K	---
EC	TH, Ca, TA, Na, K, Fe, F	TDS, Tr, Mg, Cl, SO_4, NO_3, K, TH	---	---
TDS	pH, Tr, TH, Ca, TA, NO_3, K, F	Mg, Cl, SO_4, Na, Fe	---	---
Tr	pH, TDS, TH, Mg, TA, SO_4, Na, K, F	EC, Ca, Cl, NO_3, Fe	---	---
TH	pH, EC, TDS, Tr, Mg, Cl, SO_4, NO_3, Fe	TA, Na, K, F	Ca	---
Ca	EC, TDS, Mg, Cl, SO_4, NO_3, K,	pH, Tr, Na, Fe, F	TA,TH	---
Mg	Tr, TH, Ca, Cl, Na, K, Fe, F	pH, EC, TDS, TA, SO_4, NO_3	---	---
TA	EC, TDS, Tr, Cl, SO_4, NO_3	pH, TH, Mg, Na, K, Fe, F	Ca	---
Cl,	TH, Ca, Mg, TA, NO_3, Na, F	pH, EC, TDS, Tr,K, Fe	SO_4	----
SO4	pH, Tr, TH, Ca, TA, Na, K, Fe, F	EC, TDS, Mg,NO_3	Cl	---
NO3	pH, TDS,TH, Ca, TA, Cl,Na, K, Fe	EC,Tr,Mg, SO_4, F	---	---
Na	EC,Tr, Mg, Cl, SO_4, NO_3, Fe	pH, TDS,TH, Ca, Na, TA, K, F	---	---
K	EC, TDS, Tr, Ca, Mg, SO_4, NO_3,	pH, TH, TA, Cl, Na	Fe, F	---
Fe	EC, TH, Mg, SO_4, NO_3, Na, F	pH, TDS, Tr, Ca, TA, Cl	K	---
F	EC, TDS, Tr, Mg, Cl, SO_4, Fe	pH, TH, Ca, NO_3, TA, Na, K	---	---

Table: 4. Correlation and prediction using total hardness

Relationship.	Correlation-coefficient	Regression-coefficient	Prediction-equation
TH vs TDS	0.164	0.04017	TDS 218.589 + 0.0401 TH
TH vs Ca	0.4245	0.4694	Ca 198.402 + 0.469 TH
TH vs Mg	0.5645	1.9405	Mg 99.7653 + 1.9405 TH
TH vs EC	0.204	0.0353	EC 223.776 + 0.0353 TH
TH vs Cl	0.5002	1.1141	Cl 16.0043 + 1.1141 TH
TH vs NO_3	-0.0731	-0.5259	NO_3 323.0098 + -0.525 TH

Table: 5. Correlation and prediction using Nitrates

Relation	Correlation coefficient	Regression coefficient	Prediction equation
NO_3 vs TH	-0.0731	-0.01017	TH 49.3456 + -0.01017 NO_3
NO_3 vs Ca	-0.1082	-0.0166	Ca 49.8622 + -0.0166 NO_3
NO_3 vs Mg	0.2265	0.1082	Mg 35.2088 + 0.1082 NO_3
NO_3 vs Cl	-0.109	-0.0337	Cl 54.8659 + -0.0337 NO_3
NO_3 vs TDS	-0.035	-0.0011	TDS 48.6606 + -0.0011 NO_3
NO_3 vs EC	0.075	0.00182	EC 42.4584 + 0.00182 NO_3

Table: 6 Correlation of Groundwater Physiochemical Parameters.

r=+1 positive,o- linear, r=-1 negative
*Correlation is significant at the 0.01 level (1-tailed).

	pH	**EC**	**TDS**	**Tr**	**TH**	**Ca**	**Mg**	**TA**	**Cl**	**SO4**	**NO3**	**Na**	**K**	**Fe**	**F**
pH	1														
EC	-0.2563	1													
TDS	0.2911**	0.1456	1												
Tr	-0.1319	0.2119	-0.234	1											
TH	-0.1072	-0.2918	-0.0718	-0.0512	1										
Ca	0.1891	-0.2638	-0.3468	0.2144	0.3566**	1									
Mg	0.2978**	0.1083	0.1415	-0.106	-0.389	-0.157	1								
TA	0.1417	-0.1804	-0.0204	-0.1274	0.2374**	0.4677**	0.0158	1							
Cl	0.1272	0.3193**	0.2766**	0.0699	-0.251	-0.414	-0.033	-0.443	1						
SO4	-0.1139	0.3251**	0.0816	-0.0936	-0.53	-0.498	0.3301**	-0.296	0.471**	1					
NO3	-0.4571	0.1674	-0.151	0.1487	-0.049	-0.137	0.1309	-0.157	-0.1	0.2519**	1				
Na	0.1115	-0.1657	0.1593	-0.4461	0.057	0.1626	-0.174	0.2319	-0.409	-0.144	-0.1302	1			
K	0.3685	-0.1077	-0.042	-0.3029	0.1462	-0.03	-0.14	0.0731	0.0925	-0.172	-0.2137	0.2193	1		
Fe	0.1983	-0.0454	0.1299	0.01342	-0.129	0.0196	-0.171	0.0322	0.2842**	-0.05	-0.0088	-0.0318	0.5491**	1	
F	0.0731	-0.3016	-0.1391	-0.1731	0.1292	0.1492	-0.142	0.1792	-0.3	-0.147	0.04321	0.2655**	0.2413	-0.032	1

***Correlation is significant at the 0.05 level (1-tailed).*
****Correlation is significant at the 0.001 level (1-tailed)*

Table: 7. Correlation for physico-chemical parameters in percentage (Venkateswarlu Gogana 2016).

	pH	**EC**	**TDS**	**Tr**	**TH**	**Ca**	**Mg**	**TA**	**Cl**	**SO4**	**NO3**	**Na**	**K**	**Fe**	**F**
pH	100%														
EC	-26%	100%													
TDS	29%	15%	100%												
Tr	-13%	21%	-23%	100%											
TH	-11%	-29%	-7%	-5%	100%										
Ca	19%	-26%	-35%	21%	36%	100%									
Mg	30%	11%	14%	-11%	-39%	-16%	100%								
TA	14%	-18%	-2%	-13%	24%	47%	2%	100%							
Cl	13%	32%	28%	7%	-25%	-41%	-3%	-44%	100%						
SO4	-11%	33%	8%	-9%	-53%	-50%	33%	-30%	47%	100%					
NO3	-46%	17%	-15%	15%	-5%	-14%	13%	-16%	-10%	25%	100%				
Na	11%	-17%	16%	-45%	6%	16%	-17%	23%	-41%	-14%	-13%	100%			
K	37%	-11%	-4%	-30%	15%	-3%	-14%	7%	9%	-17%	-21%	22%	100%		
Fe	20%	-5%	13%	1%	-13%	2%	-17%	3%	28%	-5%	-1%	-3%	55%	100%	
F	7%	-30%	-14%	-17%	13%	15%	-14%	18%	-30%	-15%	4%	27%	24%	-3%	100%

Table: 8. Correlation and prediction using total dissolved solids

Relationship.	Correlation-coefficient	Regression-coefficients	Prediction-equation
TDS Vs Ca	0.096	0.4326	Ca 1900 + 0.4326 TDS
TDS vs Mg	0.279	3.9225	Mg 1591.094 + 3.9225 TDS
TDS vs Cl	0.126	1.1441	Cl 1702.841 + 1.1441 TDS
TDS vs EC	0.427	0.3024	EC 1353.42 + 0.3024 TDS
TDS vs TH	0.164	0.667	TH 1793.73 + 0.667 TDS
TDS vs NO_3	-0.039	-1.0145	NO_3 2040.101 + -1.01452 TDS

Conclusion

This paper provides a detailed assessment of groundwater quality in and around of Kondapalle industrial region of India. The data collected from 32 sampling stations reveals variations in several key water quality parameters. These findings can serve as a basis for further investigations and remediation efforts to ensure access to safe and clean drinking water for the local population and the preservation of the region's ecosystem. The data analysis suggests that while the majority of sampling stations have water within acceptable pH ranges, there are variations in other parameters. Elevated levels of EC, TDS, and turbidity in some stations may be indicative of pollution from industrial or agricultural sources. Additionally, the presence of certain ions like chloride, sulphate, nitrate, and fluoride at higher concentrations may raise concerns regarding the water's potability and suitability for irrigation. Based on the Correlation percentage classification most of the parameters are in inverse and poor, the groundwater in the study area is not good for the drinking and domestic, it has polluted by the pollutants so that, it needs the treatment.

Reference

1. Johnson, K. A.; Busdieker-Jesse, N.; McClain, W. E.; Lancaster, P. A., (2019),. Feeding strategies and shade type for growing cattle grazing endophyte-infected tall fescue. Livest. Sci., Vol- 230: 103829
2. M. Jamuna (2018), Statistical Analysis of Ground Water Quality Parameters in Erode District, Taminadu, India, International Journal of Recent Technology and Engineering. Vol-7(4S), pp-84-89.
3. Vetrimurugan Elumalai, Vhonani G. Nethononda, V. Manivannan, N. Rajmohan, Peiyue Li, L. Elango (2020), Groundwater quality assessment and application of multivariate statistical analysis in Luvuvhu catchment, Limpopo, South Africa, Journal of African Earth Sciences, Vol-171:103967, pp- 1-14.
4. Oluyemi. A.A., Obi. C.N., Okon. A.E., Tokunbo.O., Ukata. S.U & Edet.U.H. (2014), Seasonal variation in the physico-chemical characteristics of surface water in Etche River, Niger Delta Area of Nigeria. Journal of environmental sciences, toxicology and food technology. Vol 8(7), pp- 01-07.
5. N. Janardhana Raju (2007), Hydrogeochemical parameters for assessment of groundwater quality in the upper Gunjanaeru River basin, Cuddapah District, Andhra Pradesh, South India, Environmental Earth Sciences, Vol- 52(6): pp-1067-1074.
6. Mehta, K.V., (2010), Physico-chemical characteristics and statistical study of groundwater of some places of Vadgam taluka in Banaskantha district of Gujarat state (India), Jr. of Chemical Pharmal Research,Vol-2(4), pp-663-670.
7. Kim, J-G, KO, K-S., Kim, T.H., Lel, G.H., Song.Y., Chon, C-M.,andLee,JS., (2007), Effect of mining and geology on the chemistry of stream water and sediment in a small watershed, Geosciences Journal, Vol-11, pp-175-183.
8. Okoro Hussein K, Adeniyi Adeyinka, Omollo E. Jondiko, Bhekumusa J. Ximba and Sumbu J Kakalanga, (2012): Assessment of heavy metals contamination in groundwater: A case study of central industrial district in Ilorin, Kwara State, Nigeria; International Journal of Physical Sciences, Vol-7(28), pp-5078 -5088.
9. Moore.F, Esmaeili.K, and Keshavarzi. B., (2011), Assessment of heavy metals contamination in stream water and sediments affected by the sun gun porphyry copper deposit, East Azerbaijan Provice, Northwest Iran. Water Quality, Exposure and Health, Vol-24, pp-268-274
10. Helsel D. R. and Hirsch R. M. (2002) Statistical methods in water resources", U.S. Department of the interiorgale, chapter 3, pp-218.
11. Sudhakar G, Swarnalatha, G, V.Venkataratnamma, (2014), Water quality index for groundwater of Bapatla mandal, Coastal Andhra Pradesh, India. International Journal of Environmental Sciences, Vol-5(1), pp-23-33.
12. C. Muthumperumal, N. Parthasarathy (2009), Angiosperms, climbing plants in tropical forests of southern Eastern Ghats, Tamil Nadu India, Check List, Vol-5(1), pp-92-111.
13. Corwin D. L and K. Yemoto. (2017), Salinity: Electrical conductivity and total dissolved solids. Methods of soil analysis 2.
14. Khwaja M. Anwar and Aggarwal Vanita (2014), Analysis of Groundwater Quality using Statistical Techniques: A Case Study of Aligarh City (India), International Journal of Technical Research and Applications, Vol- 2(5), PP. 100-106.
15. Asuero A. G., A. Sayago, and A. G. Gonz´alez (2006), the Correlation Coefficient: An Overview, Critical Reviews in Analytical Chemistry, Vol-36, pp-41–59.
16. Mukaka M.M (2012), A guide to appropriate use of Correlation coefficient in medical research, Malawi Medical Journal., Vol-24(3), pp-69–71.
17. Khanoranga, Khalid, S, (2019), An assessment of groundwater quality for irrigation and drinking purposes around brick kilns in three districts of Balochistan province, Pakistan, through water quality index and multivariate statistical approaches. Journal of Geochem. Explor. Vol-197, pp-14–26.

18. Vhonani, G.N., Vetrimurugan, E., Rajmohan, N., (2019), Irrigation return flow induced mineral weathering and ion exchange reactions in the aquifer, Luvuvhu catchment, South Africa. Journal of Afr. Earth Sci. Vol-149, pp-517–528.
19. Sundar M. Lenin and Saseetharan M.K. (2008), Groundwater Quality in Coimbatore, Tamil Nadu along Noyyal River, Journal of Environmental Science and Engineering, Vol-50(3), pp-187-190.
20. Khan M. M. Ali, Umar Rashid and Habibah Lateh, (2010), Study of trace elements in groundwater of WesternUttar Pradesh, India, Scientific Research and Essays, Vol-5(20), pp-3175-3182. =
21. Sudhakar. G and G.Swarnalatha, (2018), Study on Groundwater Analysis for Drinking in Mangalagiri Mandal, Andhra Pradesh, International Journal of Research and Analytical Reviews, Vol-5(4), pp-818-826.
22. D.Basavaraja, J.Narayana, B.R.Kiran and E.T.Puttaiah (2014), Fish diversity and abundance in relation to water quality of Anjanapura reservoir, Karnataka, India, Int.J.Curr.Microbiol.App.Sci. Vol-3(3), pp-747-757.
23. Venkateswarlu Gogana (2016), Geo spatial studies on environmental impact assessment of ground water quality of the part of Hyderabad Metropolitan city, Telangana state, India, chapter 5-thesis, awarded from Andhra University, Department of geo-engineering and resource development technology, Andhra Pradesh, http://hdl.handle.net/10603/379450.
24. Gul Daraz Khan, Farid Akbar,Taimur Khan, Waheed Ullah, Naseebullah and Bismillah (2014), Assessment of Salinity and Alkalinity of Groundwater and It Relation to the Geochemical Propersties of Soil in a Specific Site of Lasbela Region, Chemistry and Materials Research, Vol-6(4), pp-93-96.
25. P.A.R. K. Raju, M.S.R. Reddy, P. Raghuram, G.Suri Babu, T.Rambabu and J. Jeevan Kumar (2014), Alkalinity and Hardness Variation in Ground Waters of East Godavari District due to Aquaculture, International Journal of Fisheries and Aquatic Studies, Vol-1(6), pp-121-127.