ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 11, S Iss 2, 2022

Assessment of Water Quality in Paddy Fields in Pedana Mandal, Krishna District, Andhra Pradesh, India, Using Multivariate Statistical Analysis

Sarita Sajja[1], Pandu. Brahmaji Rao[2]*

[1] Department of Environmental Science, Acharya Nagarjuna University, Guntur, Andhra Pradesh, India.

[2] Associate Professor, Department of Environmental Science, Acharya Nagarjuna University, Guntur, Andhra Pradesh, India.

Email- [1] sajjasarita@gmail.com, [2] drbrahmajirao@gmail.com

ABSTRACT:

Aims: This study assessed the quality of groundwater in Pedana Mandal, Krishna district, Andhra Pradesh, India. Additionally, multivariate statistical methods were utilized to identify the potential causes of water contamination.

Materials and Methods: The chemical parameters pH, Electrical Conductivity, Chlorides, Sulphates, Nitrates, Total Hardness, Fluorides, Alkalinity, Calcium, Magnesium, Sodium, Potassium, Iron, and Fluoride were analyzed using water samples collected from 29 randomly selected sampling locations.

Results: According to hadrochemical properties, the groundwater in the research region was typically fresh, hard, and alkaline. All chemical indicators were well within the permissible limits of the Bureau of Indian Regulations/World Health Organization drinking water quality standards. Several statistically significant associations (P 0.01 and P 0.05) were identified by multivariate statistical analyses, such as principal component analysis (PCA), correlation analysis, cluster analysis (CA), ANOVA, and Pearson correlation matrix, performed on the given data. In addition, PCA analysis showed two PCs as being responsible for the data structure and accounting for 75.5 percent of the total variance in water quality. PCA revealed that the majority of the water quality fluctuations were caused by agricultural discharges.

Conclusions: These findings demonstrated that the majority of water pollution originated from home wastewater and agricultural runoff. From the current findings, it can be assumed that water contamination has happened to some degree throughout the region and is expected to continue shortly. The improvement of the local sanitation infrastructure and the implementation of frequent training and awareness programs can aid in the improvement of water quality in the area under study.

Keywords: Cluster analysis, Correlation, Multivariate statistics, Principal component Groundwater analysis.

ISSN PRINT 2319 1775 Online 2320 7876

Research paper © 2012 IJFANS. All Rights Reserved, UGC CARE Listed (Group -I) Journal Volume 11, S Iss 2, 2022

INTRODUCTION:

Water, the universal solvent and most readily accessible natural resource account for approximately 70% of the human body's mass (Talabi et al., 2020). In contrast, heavy metals are defined as "metals with concentrations five times heavier than water that occurs naturally in the terrestrial environment; they are found in rocks, plants, soils, and sediments" (Talabi et al., 2020; Orobator et al., 2020). For the preservation of a healthy ecosystem and the development of effective and sustainable water management practices, it is now essential to regularly assess the water quality of the main sources (lakes, rivers, oceans, etc.). (Yilmaz, 2007).

The lake's water quality is further impacted by the geology of the surrounding area and neighboring human activities, which limit the lake's utility (Mahananda MR et al., 2010; Mehari M et al., 2013; Sudha R et al., 2017). (Tank SK et al. water is rich in nutrients and minerals, making it essential to human life (Versari et al. 2002). According to S.C. Lahiry et al. 1966; A. Tiecher et al. (2016), M.R. Mahananda et al. (2010), and M. Mehari et al. (2013), anthropogenic activities such as construction, waste disposal, agriculture, and other related activities affect the quality of surface water by reducing its capacity for use. These activities also affect the quality of surface water by raising the likelihood of pollution (SK Tank et al. 2013).

Due to growing water demand, the availability and quality of potable water are deteriorating. The direct disposal of urbanization and industrialization trash affects surface water resources. In addition, several companies spilled untreated wastewater onto the land's surface, affecting the groundwater aquifers (Kamboj and Choudhary, 2013; Choudhary et al., 2014; Kamboj et al., 2015). However, the direct discharge of sewage and industrial effluent into water bodies such as rivers, streams, ponds, and lakes has both direct and indirect effects on water quality. When surface water resources degrade, aquatic flora and fauna are negatively affected (Kamboj and Kamboj, 2020).

Groundwater is the most abundant and valuable resource on Earth. In addition to the polar ice caps and glaciers, groundwater is one of the key sources of fresh water on our planet. However, groundwater reserves today provide nearly one-fifth of the world's water consumption. In India and other countries, the production and management of groundwater quality are thus becoming key societal concerns. To determine the quality of groundwater, it is necessary to analyze the chemical composition of the water. Ions such as Na+, K+, Ca2+, Mg2+, Cl-, So4-, HCO3-, and NO3- make up around 95% of groundwater.

In scientific inquiry, both the purity of ground and surface water and the causes of water contamination are completely unknown. It is necessary to analyze the state's water quality to guarantee that inhabitants have access to clean, potable water because the region is a key agricultural powerhouse. Pedana Mandal ground and surface water samples were gathered for a detailed physical and chemical examination. multivariate statistical methods were used to

ISSN PRINT 2319 1775 Online 2320 7876

Research paper **© 2012 IJFANS. All Rights Reserved, UGC CARE Listed (Group -I) Journal Volume 11, S Iss 2, 2022**

evaluate the physicochemical features of the water in and around the Pedana Mandal. The amounts of heavy metals in soil samples were also evaluated. For two years (2019-2020) and each of the three seasons, 29 samples were taken at various points along the ground and surface water resources.

The samples were evaluated using standard procedures. The majority of the values were within the World Health Organization and Bureau of Indian Standards-established permissible range (BIS). Indicators of water quality and multivariate statistical analysis assisted in identifying an expanding and broad array of human activities as the root cause of a failing water supply. The report recommended ongoing monitoring of pollutants and local laws to decrease both diffuse and point sources of pollution.

MATERIALS AND METHODS:

Study area:

Pedana (Latitude: 16°16'12.00"N; Longitude: 81°10'12.00"E) is a town, Mandal, and municipality in Andhra Pradesh's Krishna district. It has an average elevation of 0.5 meters above sea level and is surrounded by. It is administered by the Machilipatnam revenue division, and its headquarters can be found in Pedana. It is bordered by the Mandals of Gudlavalleru, Mudinepalle, Bantumilli, Gudur, and Machilipatnam. As of the 2011 census, there is one town and thirty-one villages in the Mandal.

ISSN PRINT 2319 1775 Online 2320 7876

Research paper © 2012 IJFANS. All Rights Reserved, UGC CARE Listed (Group -I) Journal Volume 11, S Iss 2, 2022

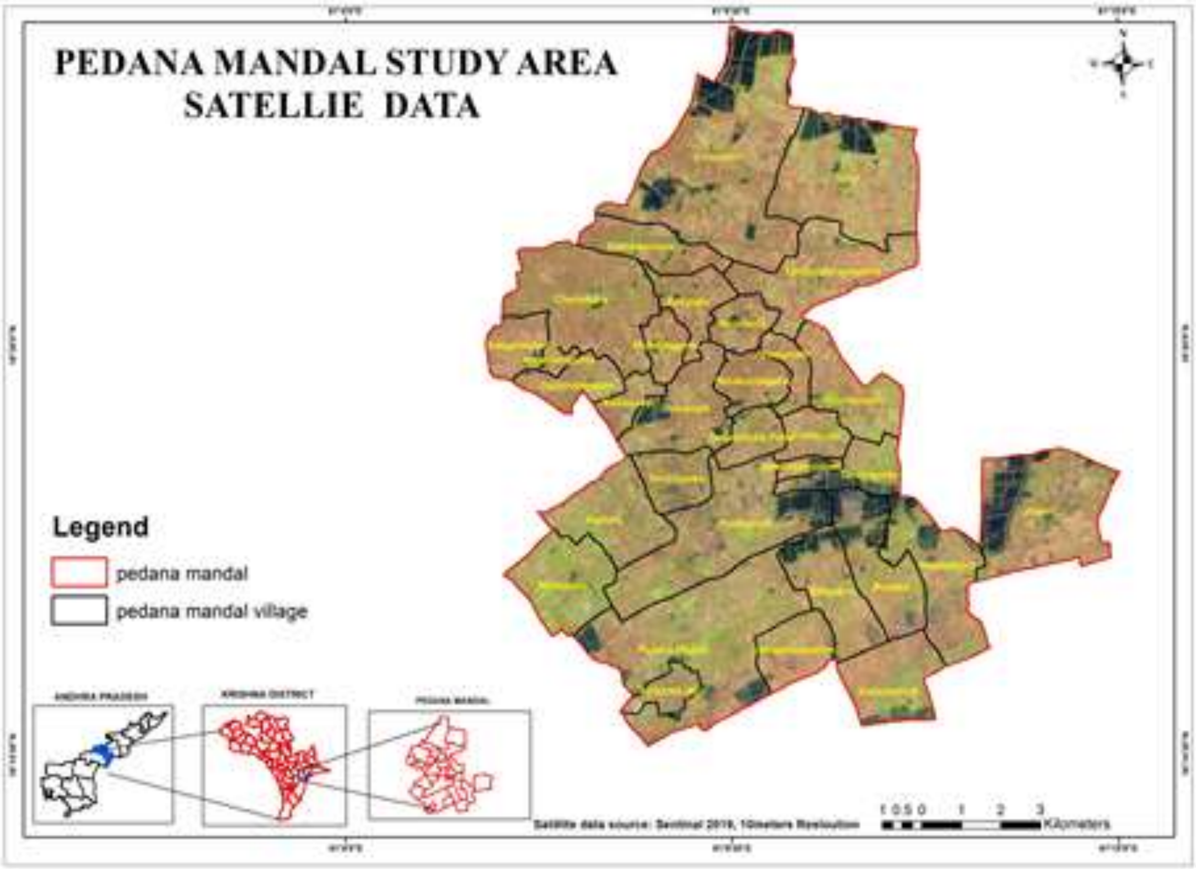

Figure 1: Satellite image of the study area in Krishna district, Andhra Pradesh

Table 1: Sampling stations in the study area

S.No	Sampling stations	Sample Number	S.No	Sampling stations	Sample Number
1	Balliparru	S1	16	Kummarigunta	S 16
2	Chennuru	S 2	17	Lankalakalavagunta	S 17
3	Chevendra	S 3	18	Madaka	S 18
4	Chodavaram	S 4	19	Mutcherla	S 19
5	Devarapalle	S 5	20	Mutchiligunta	S 20
6	Dirisavalli	S 6	21	Nadupuru	S 21
7	Guruvindagunta	S 7	22	Nandamuru	S 22
8	Jinjeru	S 8	23	Nandigama	S 23
9	Kakarlamudi	S 9	24	Nelakondapalle	S 24

ISSN PRINT 2319 1775 Online 2320 7876
Research paper **© 2012 IJFANS. All Rights Reserved, UGC CARE Listed (Group -I) Journal Volume 11, S Iss 2, 2022**

10	Kamalapuram	S 10	25	Penumalli	S 25
11	Kavipuram	S 11	26	Pullapadu	S 26
12	Kongamcherla	S 12	27	Sirivathalapalle	S 27
13	Konkepudi	S 13	28	Singarayapalem	S 28
14	Koppalle	S 14	29	Urivi	S 29
15	Kuduru	S 15			

After rinsing with the sample, water samples from the designated places are collected in a one-liter pre-cleaned plastic bottle. The sampling bottles are filled with water, sealed, and transported to a laboratory for chemical analysis. Utilizing a water analysis kit, several parameters are examined at the time of sampling.

In the laboratory of the Department of Environmental Sciences at Acharya Nagarjuna University, the samples were analyzed according to the following standard protocol. A sufficient number of groundwater samples are collected from the study area, and their quality is assessed by analyzing their physicochemical properties (APHA, 2014). The Selected Water Quality Parameters are pH, Electrical Conductivity, Chlorides, Sulfates, Nitrates, Total Hardness, Fluorides, Alkalinity, Calcium, and Magnesium. 29 groundwater samples are collected at appropriate locations around the study area.

In an aerial distribution pattern, sampling locations are dispersed across the reservoirs' upstream, downstream, and other two sides. Table 3.1 summarises the equipment and methods used to derive the water quality characteristics of the collected samples.

RESULTS AND DISCUSSION:

WATER QUALITY ANALYSIS

The focus of the study was the water quality in the study area, and water samples were collected from 29 locations in 29 different sampling regions. In 2019 and 2020, periodic physical and chemical analyses were conducted during the rainy, winter, and summer seasons, and the results are presented in Table 2.

Table 2: Average values physico chemical analysis of water samples.

	2019				2020			
	min	**max**	**Mean**	**Std**	**min**	**max**	**Mean**	**Std**
pH	6.68	8.96	7.85	0.035	7.12	8.96	7.89	0.037
EC	320	8142	3423	76.00	420	7830	3470	7.74

ISSN PRINT 2319 1775 Online 2320 7876

 UGC CARE Listed (Group -I) Journal Volume 11, S Iss 2, 2022

TDS	202	5615	2219	38.51	241	4928	2145	12.96
TA	112	1120	487	20.53	88	1182	454	11.51
TH	102	2168	810	9.49	117	2168	823	41.18
Ca	24	437	170	5.18	33	612	173	11.38
Cl^-	24	1842	728	15.42	36	2196	793	12.75
SO_4^{2-}	12	698	206	4.37	19	674	218	6.27
NO_{3-}	12	96	34	1.16	11.34	78	39	0.85
Mg	13.74	341	103	10.3	19	249	102	5.12
K	29	192	89	2.14	41	191	93	3.32
Na	41	214	105	4.65	56	210	114	2.46
Fe	0.01	1.63	0.38	0.07	0.01	1.63	0.54	0.03
F^-	0.02	1.6	0.51	0.18	0.02	1.68	0.63	0.08

The pH levels range from 6.68 to 8.96 in 2019, and 7.12 to 8.96 in 2020, and the average values for the three seasons are 7.85 0.035, and 7.89 0.037. showing that maximum values for S26- Pullapadu (8.66), S12-Kongamcherla (8.67), S20 Mutchiligubta (8.96), S17-Lankalakalvagunta (8.67), and S9 Kakarlamudi (8.64) exceed the standards limit during the summer season, while all other sampling stations have below the standard level in 2020, by the WHO and BIS standards (6.5 to 8.5).

Groundwater samples taken from the research area reveal EC values ranging between 320 and 8142 mg/l in 2019 and 420 and 7830 mg/l in 2020. S11 (7830 mg/l) was the groundwater sample with the highest EC levels. The majority of stations exceed the acceptable threshold in 2020, and the majority of samples exceed the standard level. Following WHO and BIS guidelines, the maximum allowed TDS concentration for aquatic life is 2,000 mg/l, indicating that higher TDS concentrations may be harmful (Tawati et al., 2018). The range of total dissolved solids in groundwater samples is 202 mg/l to 5615 mg/l in 2019, 325 mg/l to 5584 mg/l in winter, and 241 mg/l to 4928 mg/l in 2020, with average values of 2219 38.51 mg/l and 2145 12.96 mg/l, respectively. S20 had the highest TDS values among the groundwater samples (5,615 mg/l). In the study area, the majority of the samples exceeded the allowed limits (500-2,000 mg/l).

CaCo3 has an acceptable alkalinity level of 600 mg/L, as suggested by the Indian Standards. In 2019, the alkalinity levels in groundwater samples ranged from 112 mg/l to 1120 mg/l, with an average and standard deviation of 487 20.53 mg/l, and 454 11.51 mg/l, respectively. In 2020, the range will be 88 to 1182 mg/l, with an average and standard deviation of 454 11.51 mg/l. These minimum and maximum levels were discovered in S19-Mutcherla and S1-

ISSN PRINT 2319 1775 Online 2320 7876

Research paper **© 2012 IJFANS. All Rights Reserved, UGC CARE Listed (Group -I) Journal Volume 11, S Iss 2, 2022**

Ballarpurru, respectively. The total hardness of groundwater samples in the research region ranged from 102 mg/l to 2168 mg/l in 2019 and from 117 mg/l to 2168 mg/l in 2020. The mean and standard deviation values are 810 9.49 mg/l and 823 41.18 mg/l, respectively. The maximum levels found in S22 (2168 mg/l) exceeded the regulatory limit, but are below the acceptable range during the wet season.

Calcium concentrations in groundwater sampling stations vary from 24 to 437 mg/l in 2019 and 33 to 641 mg/l in 2020, with a mean and standard deviation of 170 5.18 mg/l and 173 11.37 mg/l, respectively. S1 (437 mg/l) had the highest concentrations, followed by S2 (400 mg/l) and S22 (356 mg/l). The majority of samples exceeded the standard limit for Calcium (75 mg/l), but not the allowable amount of 200 mg/l, except for the S1 sampling site. The greater value is mostly attributable to the quantity of lime and, as a result, the greater solubility of calcium ions.

The chlorides value ranges from 24 to 1842 mg/l in 2019 and 36 to 2196 mg/l in 2020, with average and standard deviation values of 711.52 690.75 mg/l, 722.03 664.53 mg/l, and 752.41 664.56 mg/l for the three seasons. The groundwater samples with the highest amounts of Chloride were S9 (2196 mg/l) and S9, S12, and S14 (1834 mg/l). The Sulphate concentration in groundwater in the study area ranges from 12 to 698 mg/l in 2019, 22 to 647 mg/l in winter, and 19 to 674 mg/l in 2020. The average values are 206 4.3 and 218 6.27, respectively, and the high levels found in sampling station S1 (698 mg/l) exceeded the standards' allowable limits.

The concentration of nitrates in sample stations ranged from 12 to 96 mg/l in 2019 and from 11 to 78 mg/l in 2020, with the average values for the three seasons being 34 1.16 and 39 0.58, respectively. The majority of stations are substantially below the permissible limit of 45 mg/l. A concentration of nitrates greater than 45 mg/l causes the neonatal illness hemoglobinemia. Magnesium in the sampling stations ranges from 13.74 to 230.7 mg/l during the rainy season, 19 to 247 mg/l during the winter, and 27 to 341 mg/l during the summer season, with the average values for the three seasons being 90.70 62.32, 102 65.29, and 118.28 81.79, respectively, in 2019. The groundwater samples with the highest levels of Mg in the study area are S22 (230.7 The majority of groundwater samples in the research area exceeded the standard's allowable levels. The Mg concentrations indicate the strong influence of human factors.

In 2019, the minimum and maximum potassium concentrations are 36 to 162 mg/l during the rainy season, 29 to 182 mg/l during the winter, and 39 to 192 mg/l during the summer season, as shown in Tables 4.20 to 4.22 and 4.26. Throughout the three seasons, the average values of the groundwater samples were 79.03 35.06, 89.38 39.93, and 100.93 39.79, respectively. By WHO regulations, all sample locations exceed acceptable limits.

In 2019, the minimum and maximum sodium values range from 41 to 214 mg/l, whereas in 2020, they range from 56 to 210 mg/l. In 2019, the average readings in samples of

ISSN PRINT 2319 1775 Online 2320 7876

Research paper **© 2012 IJFANS. All Rights Reserved, UGC CARE Listed (Group -I) Journal Volume 11, S Iss 2, 2022**

groundwater were 105 4.65 and 114 2.46, respectively. Other than the following examples S3 (41 mg/l) S1 (42 mg/l) S22 (49 mg/l) S21 (58 mg/l) S5 (59 mg/l) S3 (41 mg/l) S22 (49 mg/l) S21 (58 mg/l) S5 (59 mg/l) S3 (41 mg/l) S1 (42 mg/l) S22. In 2019 and 2020, the iron levels range from 0.01 and 1.63 mg/l. During the study period, the average values in water samples were 0.38 0.07, and 0.54 0.03, respectively. The samples that surpassed the standard limit S4 (1.34 mg/l) > S14 (1.31 mg/l) > S17 (1.2 mg/l) in S14 (1.63 mg/l) > S4 (1.5 mg/l) in three seasons when compared to the standard limit (1.0 mg/l) of WHO and BIS. Fluoride concentrations were between 0.02 and 1.60 mg/l in 2019 and 0.02 and 1.68 mg/l in 2020. In 2019, the mean values for the water samples were 0.51 0.18, 0.63 0.08, respectively. S26 (1.5 mg/l), S13 (1.6 mg/l) > S26 (1.53 mg/l) > S6, S12, S18 (1.5 mg/l) contained the highest concentrations of fluoride. Except for the above stations, all sampling stations' fluoride levels were under WHO's standard limit (1.5 mg/l) except the above stations.

Multivariate Statistical analysis of Physico-chemical parameters in Groundwater

Physicochemical parameters of surface and groundwater samples were analyzed using principal component analysis, correlation matrix, cluster analysis, and analysis of variance (ANOVA) to gather substantial statistical data, and their correlations were investigated.

The purpose of this study is to examine the physicochemical water quality parameters in the paddy fields of Pedana Mandal, Krishna district. In the research area of Andhra Pradesh, groundwater samples will be collected from various monitoring sites and analyzed frequently from 2019 to February 2020.

The input data set consisted of a 2914 matrix, where rows represented water samples studied (29 sampling locations) and columns indicated the specific analyzed 14 parameters (variables): pH, EC, main ions (HCO3-, Ca2+, Mg2+, Na+, K+, Cl, NO3-, SO24).

Principal Component Analysis (PCA):

ISSN PRINT 2319 1775 Online 2320 7876

Research paper © 2012 IJFANS. All Rights Reserved, UGC CARE Listed (Group -I) Journal Volume 11, S Iss 2, 2022

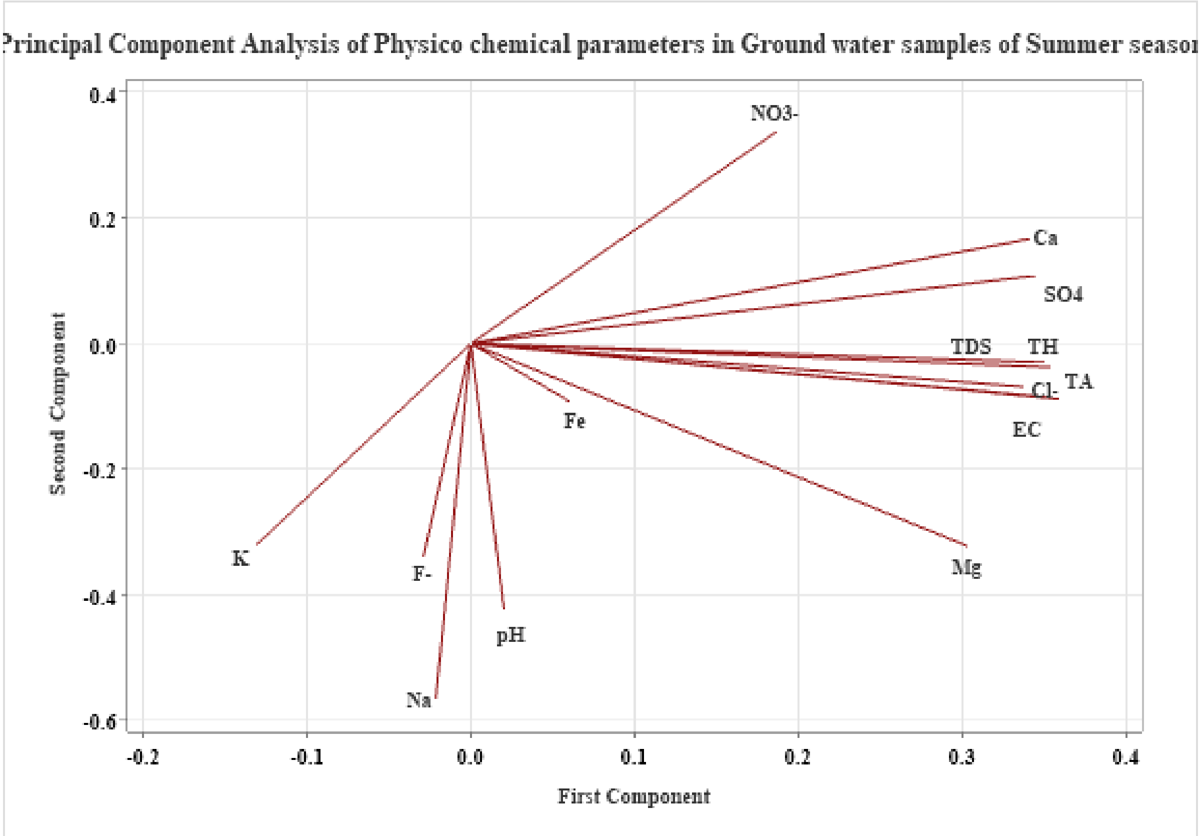

Figure 2: Principal component analysis of Physicochemical parameters in Groundwater samples.

The normalized data were then applied to principal component analysis (PCA) to assess the configurational pattern of the soil sample and identify the influencing elements. Approximately 75.5% of the overall variance in the Physico-chemical quality data set was attributable to three principal components with Eigen values greater than 5. On the first principal component, which accounted for 51.8% of the variance, there were positive correlations between pH, Fe, Mg, EC, Cl, TA, TH, So4, Ca, and No3. It was determined that the elements Na, F, and K were strongly associated with the second principal component, which accounted for 23.7% of the total variance (Figure 4.95).

Principal component analysis was used to decompose water quality changes in the study area into their constituent pieces (PCA). By analyzing the relationship between water quality variables, any PC may be classified as a pollutant. The eigenvalue coefficient gives a quantitative way of evaluating PC, which provides insight into the significance of numerous elements contributing to water quality differences. Higher eigenvalues indicate a greater contribution from the source of water quality variability when identifying essential components.

ISSN PRINT 2319 1775 Online 2320 7876

 UGC CARE Listed (Group -I) Journal Volume 11, S Iss 2, 2022

Correlation Matrix:

Groundwater samples were collected during the summer, and a Pearson correlation matrix was used to analyze the relationships between the physiochemical parameters. Pearson correlation coefficients between EC and other elements may be shown in Table 4.45, and they strongly suggest that these elements originated from human activity: There was a significant correlation between TDS and TA (r = 0.945, p 0.001), TH and 950 (r = 0.001), Ca and 0.853 (r = 0.001), Cl and 0.923 (r = 0.001), and So4 and 0.873 (r = 0.873).

Table 3: Pearson correlation matrix among the Physico-chemical parameters in Groundwater samples.

	pH	EC	TDS	TA	TH	Ca	Cl-	SO42-	NO3-	Mg	K	Na	Fe
EC	0.080												
TDS	0.057	**0.945**											
TA	0.044	**0.881**	**0.825**										
TH	-0.006	**0.950**	**0.897**	**0.817**									
Ca	-0.025	**0.853**	**0.804**	**0.823**	**0.874**								
Cl-	0.143	**0.927**	**0.910**	**0.837**	**0.923**	**0.835**							
$SO4^{2}$-	0.002	**0.873**	**0.845**	**0.822**	**0.854**	**0.873**	**0.866**						
NO3-	-0.052	0.369	0.404	0.483	0.314	**0.524**	0.416	**0.586**					
Mg	0.239	**0.832**	**0.793**	**0.743**	**0.815**	**0.659**	**0.809**	**0.635**	0.143				
K	0.181	-0.187	-0.253	-0.239	-0.374	-0.419	-0.285	-0.337	-0.165	-0.133			
Na	0.360	-0.017	-0.061	0.063	-0.091	-0.234	-0.001	-0.100	-0.163	0.246	0.325		
Fe	-0.181	0.061	0.135	0.177	0.138	0.042	0.139	0.146	0.098	0.174	-0.224	0.222	
F-	-0.021	-0.017	-0.121	0.029	0.085	-0.211	0.011	-0.206	-0.444	0.123	-0.018	0.071	0.183

Cluster analysis:

To group similar parameter concentrations, cluster analysis (CA) was applied to the Physico-chemical parameters in summer groundwater samples. Cluster analysis (CA) yielded a dendrogram in which all 14 Physico-chemical parameters analyzed were clustered into two statistically significant groups. Cluster 1 consists of the macroelements pH, Na, K, Fe, and F, which were widely accessible in groundwater. Cluster 2's EC, TDS, TH, TA, Ca, So4, Mg, and No3 can be derived from anthropogenic or local soil and wastewater at the sampling locations.

ISSN PRINT 2319 1775 Online 2320 7876

 UGC CARE Listed (Group -I) Journal Volume 11, S Iss 2, 2022

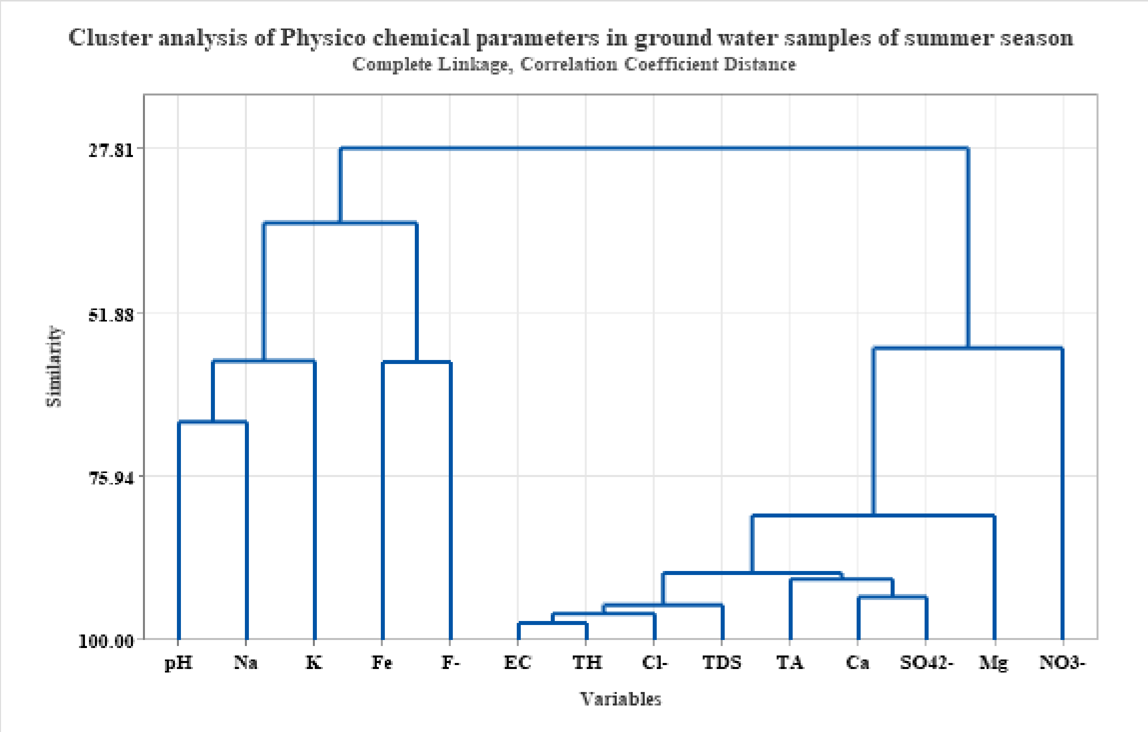

Figure 3: Cluster analysis of the Physico-chemical parameters in Groundwater samples.

Analysis of Variance (ANOVA) test:

Significant spatial and temporal differences (p 0.05) were evaluated using a one-way ANOVA. Using Pearson's coefficient and a significance level of p 0.05, the relationships between the considered variables were evaluated. All Physico-Chemical Parameters of Ground Water Samples from the Summer Season Exhibited Significant Spatial Variations During the Study Period.

Table 4: One-way ANOVA analysis of Physico-chemical parameters in Ground water samples of the summer season.

Source	DF	Seq SS	Contribution	Adj SS	Adj MS	F-Value	P-Value
Factor	13	412352581	62.26%	412352581	31719429	49.74	0.000
Error	392	249968252	37.74%	249968252	637674		
Total	405	662320833	100.00%				

Identified are the parameters that influence water quality evaluations. Based on the pattern of these PCs, we can conclude that commercial and industrial locations, as well as domestic wastewater, pesticides, and fertilizers used in agriculture, were the leading contributors to runoff pollution, implying that these variables had a greater impact than natural ones. The

ISSN PRINT 2319 1775 Online 2320 7876

Research paper **© 2012 IJFANS. All Rights Reserved, UGC CARE Listed (Group -I) Journal Volume 11, S Iss 2, 2022**

sources were related to local occurrences, as determined by PCA, CA, Correlation analysis, and ANOVA analyses. There were further reports of identical discoveries discovered.

CONCLUSIONS:

The findings reveal that the groundwater of Pedana Mandal in the Krishna district of Andhra Pradesh is severely degraded and polluted, with elevated levels of electrical conductivity and macronutrients such as calcium, magnesium, salt, and potassium. In some areas, there were also high concentrations of iron, fluoride nitrate, and sulfates. Most of the water quality parameters exceed the legal limits, which suggests that anthropogenic activities, such as the extensive use of chemical fertilizers and pesticides on rice fields, may be contributing to the degradation of water quality. PCA provided 75.50% of the total variance, as determined by multivariate statistical analyses including PCA, cluster analysis, correlation analysis, and ANOVA. The most significant finding was that TDS and hardness, which influence EC, are the two most influential factors in groundwater quality regulation. This initial component has a significant TDS loading, indicating that the hydrogeochemical process largely enriches and salinizes the water by adding sodium, nitrogen dioxide, and sulfur dioxide. By comparing the first component loadings, it can be determined that the elements that contribute to the electrical conductivity of water vary, hence indicating the quality variation of ground fluids. Using cluster analysis, fourteen parameters were clustered into two to three groups and shown. The PCA's major components' fundamental pieces were grouped. This is mostly attributable to the diverse lithology and rock-water interaction. ANOVA analysis revealed that the same parameters with strong correlation values were statistically significant. This study also demonstrates the usefulness of multivariate statistical analyses in hydrogeochemical studies of the study area, which reveal that the majority of water variance is caused by anthropogenic and organic sources.

REFERENCES:

1. Choudhary, M., Pal, C. and Kamboj, N. (2014). Potable water is a serious Environmental issue: A special study on Umiam area, of RI-Bhoi District, Meghalaya, India. International Research Journal of Environmental Sciences, 3: 37-42.
2. Kamboj, N. and Choudhary, M. (2013). Impact of solid waste disposal on ground water quality near Gazipur dumping site, Delhi, India. Journal of Applied and Natural Science, 5(2): 306-312.
3. Kamboj, N., Chaubey, A.K., Kumar, S. and Parasher, C.K. (2015). Quality Assessment of Municipal supplied water for drinking purpose, district Haridwar, Uttarakhand, India. Journal of Global Biosciences, 4(5): 2375-2379
4. Kamboj, N., Kamboj, V., Bharti, M. and Sharma, S. (2016). Productive assessment of Pisum sativum l. by using organic fertilizers. Environment Conservation Journal, 17(3): 79-83.

ISSN PRINT 2319 1775 Online 2320 7876

 UGC CARE Listed (Group -I) Journal Volume 11, S Iss 2, 2022

5. Kamboj, V. and Kamboj, N. (2020). Spatial and temporal variation of zooplankton assemblage in the mining-impacted stretch of Ganga River, Uttarakhand, India. Environmental Science and Pollution Research, 27(21): 27135-27146.
6. Kamboj, V., Kamboj, N. and Bisht, A. (2020). An overview of water quality indices as promising tools for assessing the quality of water resources. In: Advances in Environmental Pollution Management: Wastewater Impacts and Treatment Technologies, Volume 1, Eds. Kumar, V., Kamboj, N., Payum, T., Singh, J. and Kumar, P., pp. 188-214, https://doi.org/10.26832/aesa-2020-aepm-013
7. Kamboj, V., Kamboj, N. and Sharma, A.K. (2020). A review on general characteristics, classification and degradation of river systems. In: Environmental Degradation: Causes and Remediation Strategies, Volume 1, Eds. Kumar, V., Singh, J. and Kumar, P., pp. 47-62, https://doi.org/10.26832/aesa-2020-edcrs-04
8. M. Mehari, B. Mulu, Distribution of trace metals in two commercially important fish species (Tilapia Zilli and Oreochromis Niloticus) Sediment and Water from Lake Gudbahri, Eastern Tigray of Northen Ethiopia, Int. J. Sci. Res. Publ. 3 (2013) 2250–3153.
9. Mahananda MR, Mohanty BP, Behera NR. Physico-chemical analysis of surface and ground water of bargarh district, Orissa, India, Int. J. Res. Rev. Appl. Sci. 2010;2(3):284–295.
10. Orobator PO, Akiri-Obaroakpo TM, Orowa R (2020) Water quality evaluation from selected aquaculture ponds in Benin City, Nigeria. J Res Wildl Environ 12(1):24–33
11. S.C. Lahiry, Impact on the environment due to industrial development in 924, Chhattisgarh region of Madhya Pradesh, Finance India 10 (1) (1966) 133–136.
12. Sudhira H.S, T. V. Ramachandra, and K. S. Jagadish, (2004), "Urban sprawl: metrics, dynamics and modelling using GIS," International Journal of Applied Earth Observation and Geo information, vol. 5, no. 1, pp. 29–39.
13. Talabi AT, Odunaike KO, Akinyemi LP, Bashiru BO (2020) Investigation for heavy metals in river waters in the federal capital territory North Central of Nigeria. Int J Energy Water Res (In Press). https:// doi. org/ 10. 1007/ s42108- 020- 00063-8.
14. Tank S.K and Chippa R.C. Analysis of water quality of Halena Block in Bharatpur Area, Int. J. Sci. Res. Publ. 2013;3(3).
15. Tawati F, Risjani Y, Djati MS, Yanuwiadi B, Leksono AS (2018), The analysis of the physical and chemical properties of the water quality in the rainy season in the sumber maron river- Kepanjen, Malang- Indonesia. Resources and Environment Vol-8: pp-1-5.
16. Tiecher, T. L., Ceretta, C. A., Tiecher, T., Ferreira, P. A. A., Nicoloso, F. T., Soriani, H. H., Rossato, L.V., Mimmo, T., Cesco, S., Lourenzi, C. R., Giachini, A. J. and Brunetto, G. (2016). Effects of zinc addition to a copper-contaminated vineyard soil on sorption of Zn by soil and plant physiological responses. Ecotoxicology and Environmental Safety, 129, 109-119.

ISSN PRINT 2319 1775 Online 2320 7876

 UGC CARE Listed (Group -I) Journal Volume 11, S Iss 2, 2022

17. Versari A, Parpinello GP, Galassi S. Chemometric survey of Italian bottled mineral waters by means of their labelled physico-chemical and chemical composition, J. Food Compos. Anal. 2002;15:51–64.
18. Yilmaz I (2007) Fuzzy evaluation of water quality classification. Ecol Ind 7(3):710–718.