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WATER QUALITY ASSESSMENT BASED ON THE WATER QUALITY INDEX METHOD IN RURAL VILLAGES OF SOUTHEASTERN AREA OF KORBA DISTRICT, CHHATTISGARH, INDIA.

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Abstract: Physical and chemical pollutants of drinking water harm public health and can have immediate health implications. The present study's data was used to assess groundwater quality in rural villages in the Korba district of Chhattisgarh, India. During 2019 and 2020, water samples were obtained from 10 selected random water samples to determine the basic physicochemical parameters. Physical parameters such as pH, electrical conductivity, and turbidity, as well as chemical parameters such as total dissolved solids, total alkalinity, total hardness, and concentrations of calcium, magnesium, sodium, potassium, chloride, fluoride, sulphates, chemical oxygen demand, biochemical oxygen demand, dissolved oxygen, iron, arsenic, lead and zinc were calculated in situ. The physicochemical parameters of the water samples were determined using the APHA process. WQI implementation is needed for proper management of the present study area, and it would be a very useful tool for the public and policymakers to assess the water quality of rural areas in the Korba district's southeastern areas for long-term management.

Keywords: Pollutants, WQI, APHA, Physicochemical parameters.

I. INTRODUCTION

Groundwater pollution is mostly caused by industrialization and urbanization, and it has negative effects on the climate. Pollution occurs from point sources and practices that are relatively concentrated, such as toxic waste, leaking waste containment plants, underground storage tank spills, and the intersection of surface and groundwater. Even though industrialization leads to economic growth, most essential natural resources such as water and soil are often contaminated with pollution, affecting agricultural productivity and food security. Polluted soil and water are also secondary pollutant sources (B.V. Rao et al., 2014). The degradation of a geographic area's groundwater content is determined by a combination of individual hydrological, physical, geochemical, and biological influences (N. R. Ilavarasan et al., 2016). Because of the greater contact of groundwater with different materials in geologic strata, it contains higher concentrations of dissolved constituents than surface water. Furthermore, due to the continuous abstraction of shallow fresh groundwater, a region's water quality can deteriorate (M.J. Islam et al., 2014). This may be attributed to chemical percolation from the surface of the soil, confining aquifers or surrounding aquifers with contaminated or salty water. One of the reasons adding to the difficulty of groundwater quality assessment and monitoring is the broad variety of assessed variables associated with pollution sources (N. Srivastava et al., 2014). Water quality indexes have been created to aggregate water quality variables by converting vast amounts of data into a single number and expressing it as a single word (M. Shiji et al., 2016). The suitability of groundwater and surface water samples for human use can be determined using the Water Quality Index (WQI) (P. Ravikumar et al., 2013).

The Water Quality Index (WQI) is a ranking that represents the combined impact of a variety of water quality indicators on overall water quality. It simplifies a vast volume of data regarding water quality into a single numerical value. It is one of the most effective tools for transmitting water quality developments to lawmakers, influencing sound public policies, and successfully executing water quality management programs (T.N. Tiwari and M. Mishra, 1985, A.A. Jameel and A.Z. Hussain, 2005, B. Padmanabha and S.L. Belagali, 2005 and S. Kalavathy et al., 2011). The main aim of this research is to use WQI to connect the quality of groundwater in the Korba District's south-eastern area. This will assist in the better control of water quality and the development of policies.

II. MATERIALS AND METHODS

Study Area: Korba district is surrounded by Korea, Surguja, Surajpur, Raigarh, Bilaspur, Gaurela - Pendra - Marwahi, and Janjgir- Champa districts and is situated at latitude 22001' N to 23001' N and longitude 82008' E to 83009' E. Bilaspur is the administrative division of this district. The district is located in the state's Northern Rocks. The majority of the land on the plateau created by the Maikal ranges of the Satpura hills is high, narrow, and free. The bulk of this open land is situated near Pasan. Rural villages of Korba and Kartala Tehsils exist in the south-eastern part of Korba district under study area.

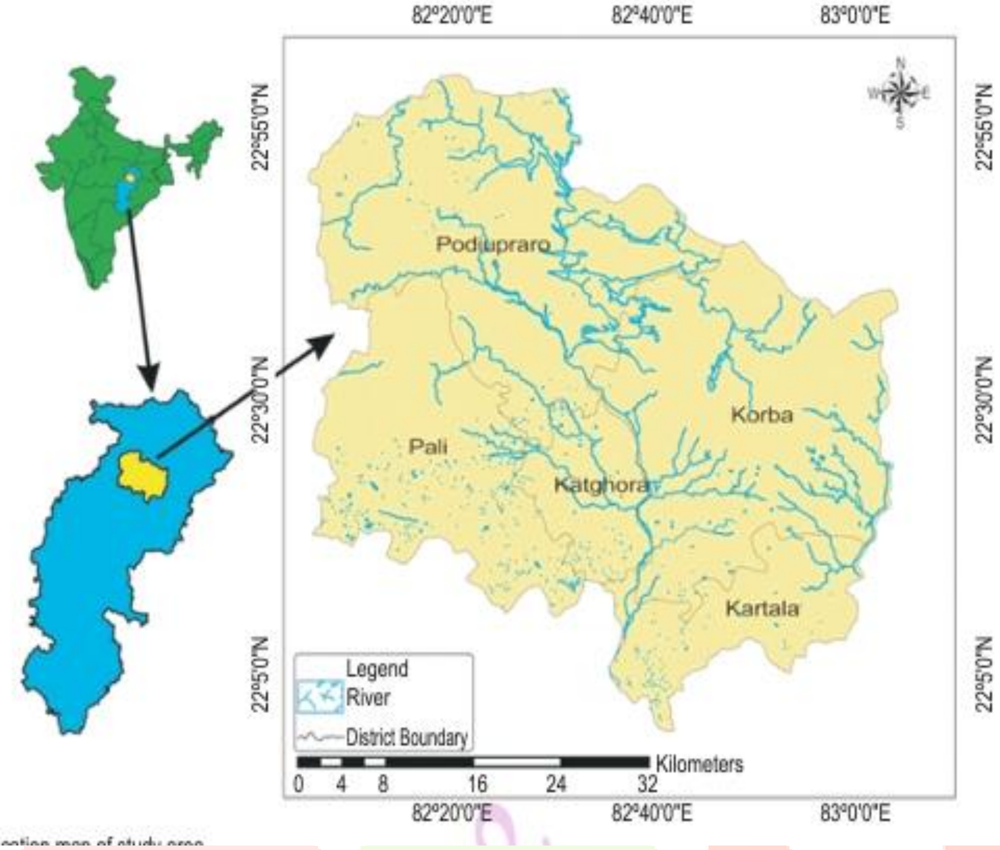

Figure 1. Map of Korba District

Sampling and Analysis: Water was sampled monthly in five stations to obtain the information needed to investigate the water quality of the Korba district's southeastern sector (Figure. 2). Accessibility and emission sources along the study region were factors in the selection of stations. The samples were stored at 4 °C in a refrigerator without acid preservation after sampling to prevent microbial degradation. Within 24 hours, all samples were analyzed. The parameters of pH, electrical conductivity (EC), and turbidity, as well as chemical parameters such as total dissolved solids (TDS), total alkalinity, total hardness, and concentrations of calcium, magnesium, sodium, potassium, chloride, fluoride, sulphates, chemical oxygen demand (COD), biochemical oxygen demand (BOD), dissolved oxygen (DO), iron, arsenic, lead and zinc. Water samples were taken to the lab and tested according to the procedures outlined in the American Public Health Association's manual (APHA 2005 and APHA 1992).

Table 1. Sample location and Sample ID

S.N.	Sample Location	Sample ID
1	Tilkeja	SE1
2	Barpali	SE2
3	Botli	SE3
4	Patrapali	SE4
5	Tapra	SE5
6	Sumedha	SE6
7	Urga	SE7
8	Baisma	SE8
9	Madanpur	SE9
10	Korkoma	SE10

Figure 2. Sampling station

Water Quality Index (WQI): The idea of using indices to reflect water quality gradation was first suggested. It gives a quality rating based on an index number that reflects the total quality of water for some use. It is known as a score that reflects the combined impact of various water quality parameters on overall water quality. The WQI was determined using the suitability of pond water for human use as a criterion (P.C. Mishra and R.K. Patel, 2001) Table.2

Table 2: WQI Worth-Based Water Quality Classification

Class	Value of WQI	Status of Water Quality
I	0 to 25	Excellent Water Quality
II	26 to 50	Good Water Quality
III	51 to 75	Poor Water Quality
IV	76 to 100	Very poor Water Quality
V	>100	Unsuitable to drink

Bureau of Indian Standards (BIS) proposed drinking water quality standards, The weighted arithmetic index method (Brown et al., 1972) was used to calculate the WQI in the steps below (P. J. Puri et al., 2015).

a. A weight was applied to each of the chemical parameters depending on their perceived impact on primary health and relative significance in the overall quality of drinking water.
b. Using Eq. 1, calculate the relative weight (Wi) of each parameter.
c. According to BIS (1998) guidance, a consistency rating scale (Qi) for each parameter was calculated by dividing its concentration in each water sample by its respective norm and then multiplying the result by 100 using Eq. 2. Finally, the WQI is estimated by first evaluating the water quality sub-index (SIi) for each chemical parameter, which is then used to calculate the WQI as per the Eqs. 3 and 4.

$$Wi = \frac{wi}{\sum_{n=1}^{n} wi} \qquad (1)$$

Where Wi denotes relative weight, wi denotes parameter weight, and n denotes the number of parameters.

$$Qi = \frac{(ci)}{(si)} * 100 \qquad (2)$$

Where Qi is the quality rating, Ci is the concentration of each chemical parameter in each water sample in mg/L, and Si is the Indian drinking water standard (BIS 1998) for each chemical parameter in mg/L excluding turbidity (NTU), conductivity (µS/cm), and pH.

$$SI = WiQi \qquad (3)$$

$$WQI = \sum_{i=1}^{n} SI\, i \qquad (4)$$

SI_i is the i^{th} parameter's sub-index; qi is the rating dependent on i^{th} parameter's concentration, and n is the number of parameters.

III. RESULTS AND DISCUSSIONS

The following research project focused on water quality assessment to determine the qualitative type and quantitative level of contamination in a water source during the study period.

Table 3. Variations in Physico-chemical Parameters on an Average Basis Throughout the study session 2019-20

Parameters	Unit	SE1	SE2	SE3	SE4	SE5	SE6	SE7	SE8	SE9	SE10
pH	-	8.3	7.2	7.6	7.9	8.1	8.3	7.8	7.4	9.1	8.2
EC	µS/cm	587	624	532	618	711	593	654	716	948	607
Turbidity	NTU	3.2	5.1	4.5	6.1	4.8	7.6	6.5	3.8	4.2	5.8
TDS	mg/L	957	721	827	694	941	878	768	682	1076	884
Total Alkalinity	mg/L	220	215	205	220	230	215	205	200	240	210
Total Hardness	mg/L	556	420	516	578	612	628	510	486	760	672
Calcium	mg/L	88.32	71.25	65.76	89.52	85.35	64.21	52.19	47.18	72.13	42.87
Magnesium	mg/L	9.25	14.65	6.67	4.26	8.35	9.52	7.82	4.20	8.52	6.15
Sodium	mg/L	39.51	27.25	46.81	36.57	38.45	46.86	39.11	41.27	33.78	35.91
Potassium	mg/L	3.02	4.21	9.42	7.51	5.20	4.31	6.52	8.91	2.89	3.31
Chloride	mg/L	195	187	190	205	194	190	192	188	200	198
Fluoride	mg/L	1.75	1.58	1.67	1.31	1.04	1.50	1.51	1.59	1.83	2.68
Sulphate	mg/L	82.42	52.37	62.28	57.35	81.16	77.23	72.41	64.82	74.63	67.55
COD	mg/L	20	14	16	22	20	15	21	20	24	20
BOD	mg/L	5.2	4.76	4.81	6.18	5.0	4.92	5.26	5.34	6.64	5.18
DO	mg/L	5.34	7.32	6.51	4.23	5.14	7.28	4.84	5.22	4.36	5.02
Iron	mg/L	0.24	0.32	0.30	0.34	0.31	0.36	0.31	0.30	0.30	0.26
Arsenic	mg/L	0.041	0.018	0.023	0.035	0.058	0.047	0.034	0.022	0.017	0.063
Lead	mg/L	0.027	0.061	0.056	0.042	0.032	0.013	0.044	0.037	0.040	0.026
Zinc	mg/L	4.26	2.61	3.54	4.25	4.18	5.21	5.02	4.27	4.12	3.57

Table 4. Water quality index calculation

Parameters	Standard Value	Unit Weight	Observed Value	Quality Rating	Weighted
pH	8.5	0.00261	7.99	66	0.172
EC	300	0.00007	659	219.66	0.016
Turbidity	10	0.0022	5.16	51.6	0.114
TDS	500	0.00004	842.8	168.56	0.007
Total Alkalinity	200	0.00011	216	108	0.012
Total Hardness	300	0.00007	573.8	191.266	0.014
Calcium	75	0.00029	64.139	85.518	0.025
Magnesium	30	0.00074	7.939	26.463	0.019
Sodium	200	0.00011	42.291	21.145	0.002
Potassium	100	0.00022	5.53	5.53	0.001
Chloride	250	0.00008	193.9	77.56	0.006
Fluoride	1.5	0.01483	1.646	129.2	1.916
Sulphate	150	0.00014	69.222	46.148	0.006
COD	20	0.00111	19.2	96	0.106
BOD	5	0.00444	5.329	106.58	0.474
DO	5	0.00444	5.526	95.515	0.424
Iron	0.3	0.07415	0.304	101.333	7.513
Arsenic	0.05	0.4449	0.0378	71.6	31.854
Lead	0.05	0.4449	0.0378	75.6	33.634
Zinc	5	0.00444	4.103	82.06	0.365

pH: Almost all aquatic organisms' biological processes are influenced by hydrogen ion concentration. The pH of the obtained water sample ranged from 7.2 to 9.1.

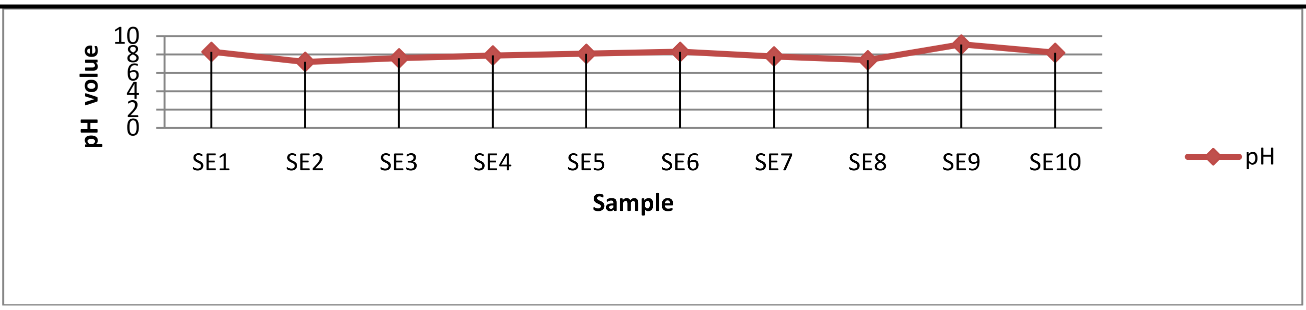

Figure 3. pH Variations

Electrical Conductivity:- Electrical conductivity [EC] measurements of groundwater provide enough information about the amount of dissolved content present in the water. EC of the obtained water sample ranged from 532 µS/cm to 948 µS/cm.

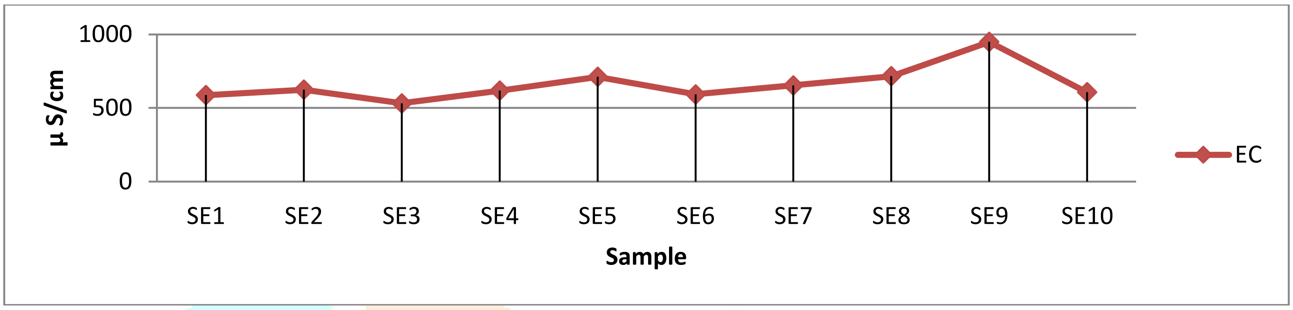

Figure 4. EC Variations

Turbidity:- Turbidity is a groundwater well stability measure as well as a drinking water quality metric. The physical property of turbidity is defined by the consistency of water. Turbidity is caused by suspended matter such as clay and silt particles, organic matter, microscopic organisms, and colloids. Turbidity is a light-scattering characteristic of water that can be measured optically. The turbidity of the samples varied from 3.2 to 7.6 NTU, The mean turbidity value is inside the acceptable range.

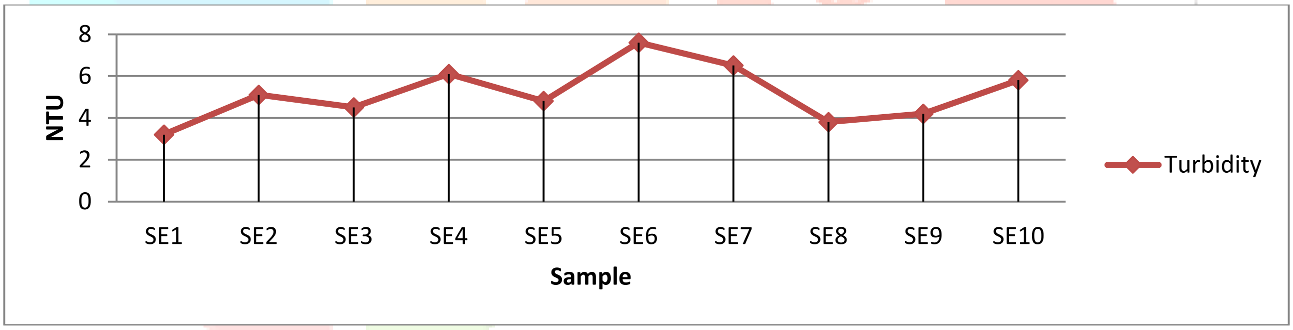

Figure 5. Turbidity Variations

TDS:- TDS of samples collected in various locations ranging from 682 mg/L to 1076 mg/L.

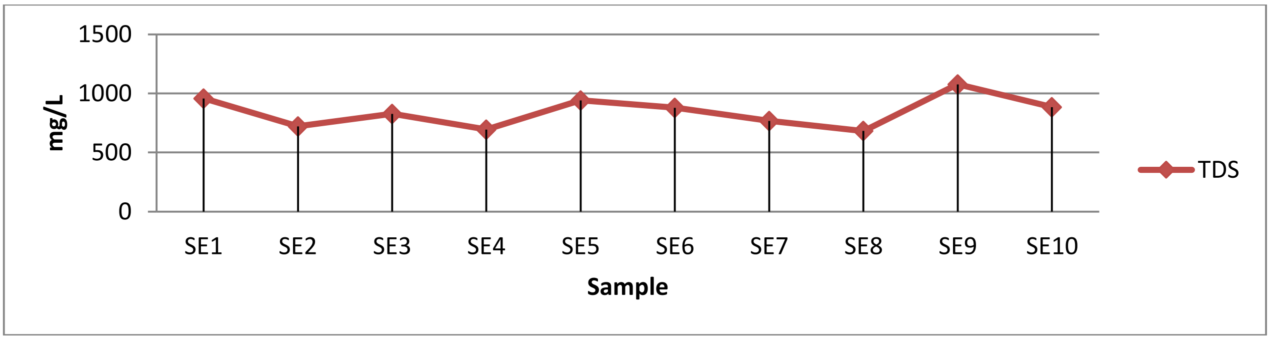

Figure 6. TDS Variations

Total Alkalinity:- Total alkalinity in the collected water sample varied from 200 mg/L to 240 mg/L.

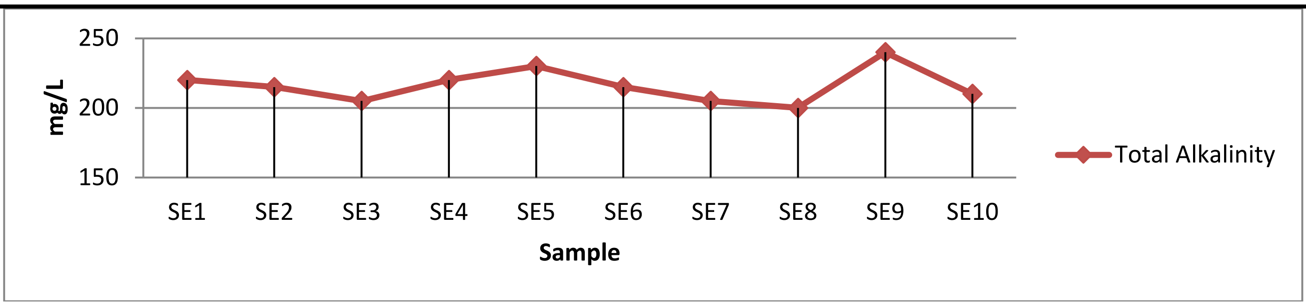

Figure 7. Total Alkalinity Variations

Total Hardness:- Positive ions dissolved in water, such as Ca^{++}, Mg^{++}, Sr^{++}, Fe^{++}, and Mn^{++}, trigger stiffness. In addition to these cations, water contains several anions (primarily SO_4^{2-}, Cl^-, NO_3^-, and SiO_3^-). Calcium and bicarbonate are commonly found in waters. Complete hardness in the collected water sample varied from 420 mg/L to 760 mg/L.

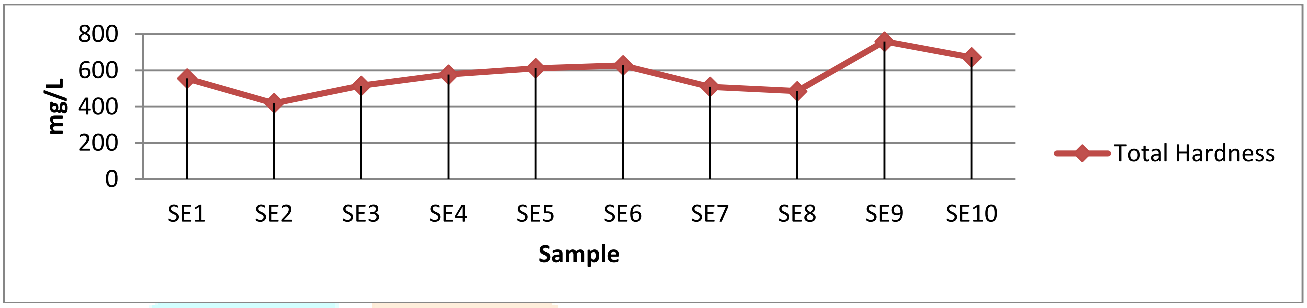

Figure 8. Total Hardness Variations

Major Ion Chemistry (calcium, magnesium, sodium and potassium): The dominant average cation trend in sample water was $Ca^{2+} > Na^+ > Mg^{2+} > K^+$, with calcium being the dominant cation. Calcium levels in the analyzed water sample ranged from 42.87 mg/L to 89.52 mg/L. Magnesium in the analyzed water sample ranged from 4.20 mg/L to 14.65 mg/L. Sodium in the collected water sample varied from 27.25 mg/L to 46.86 mg/L. Potassium of the obtained water sample ranged from 2.89 mg/L to 9.42 mg/L. Calcium and magnesium content was found to be below the BIS permissible limits based on the results of this analysis. As agricultural fields are irrigated with water containing a high concentration of sodium, the sodium ions replace the Ca and Mg ions, resulting in a negative land structure. Calcium minerals containing carbonate and sulphate are a type of Ca ion. Different calcium concentrations in water can occur in this regard. Ca and Mg concentrations in drinking, industrial and irrigation water are limited.

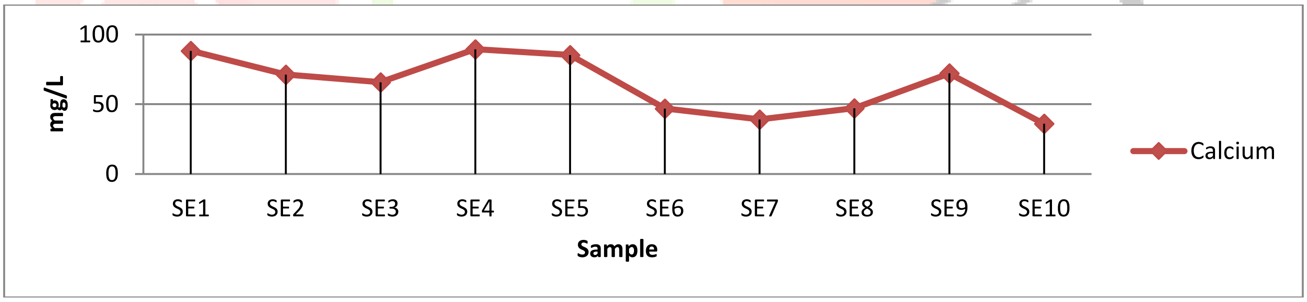

Figure 9. Calcium Variations

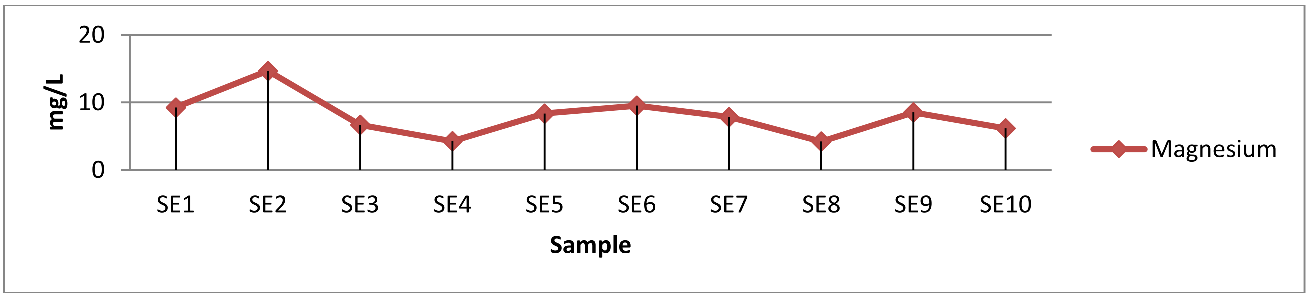

Figure 10. Magnesium Variations

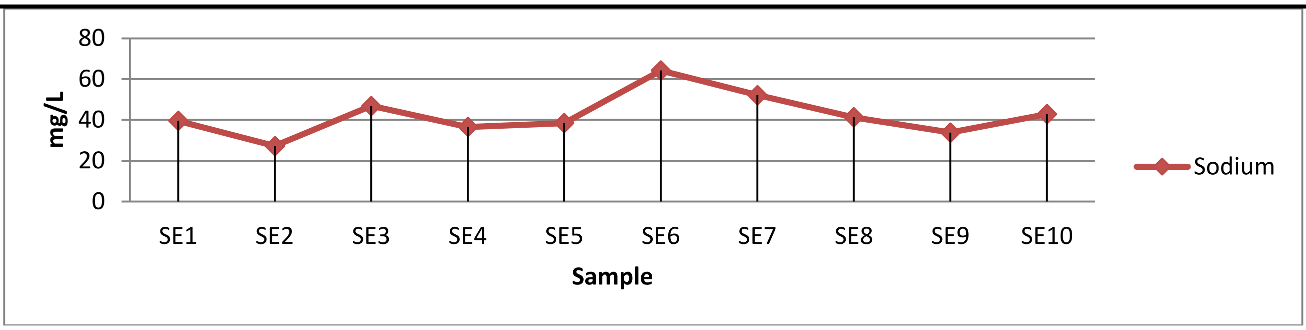

Figure 11. Sodium Variations

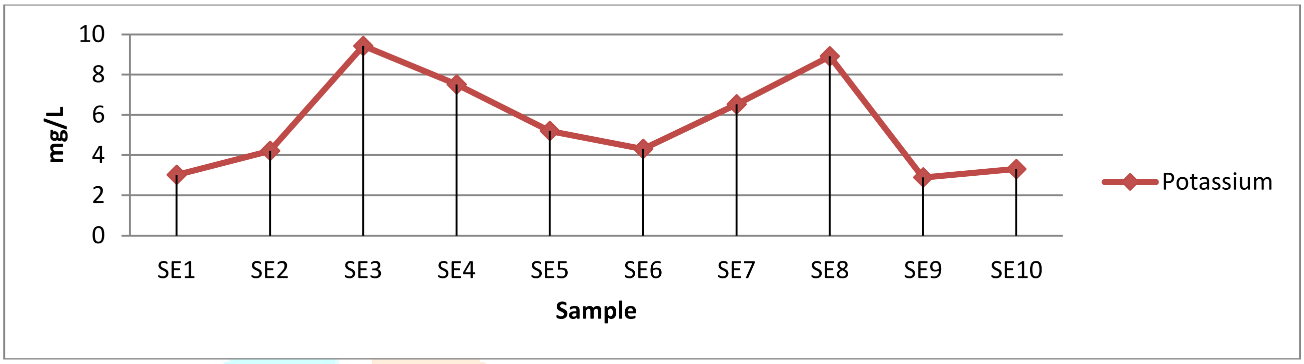

Figure 12. Potassium Variations

Chloride: The presence of a high chloride concentration is believed to be a symptom of contamination caused by high levels of organic waste from animals. Chloride levels in the collected water sample ranged from 188 mg/L to 205 mg/L.

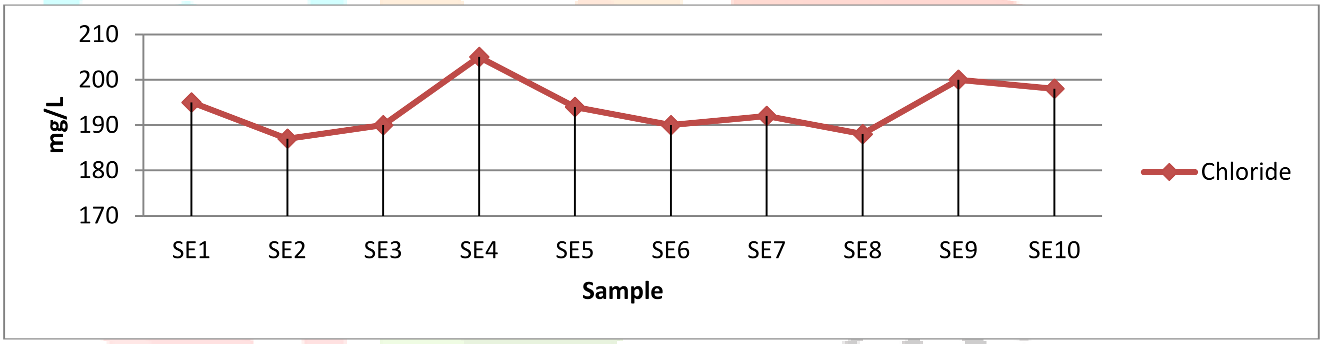

Figure 13. Chloride Variations

Fluoride: Fluoride is a trace element found in water at concentrations ranging from 0.1 to 1.5 mg/L. It should be applied to water in excess (0.7 to 1.2 mg/L) to avoid tooth decay in humans. Depending on the complicated water conditions, levels at or above 3 mg/L has been reported to cause fish species declines. Fluoride levels in the collected water sample ranged from 1.04 mg/L to 2.68 mg/L.

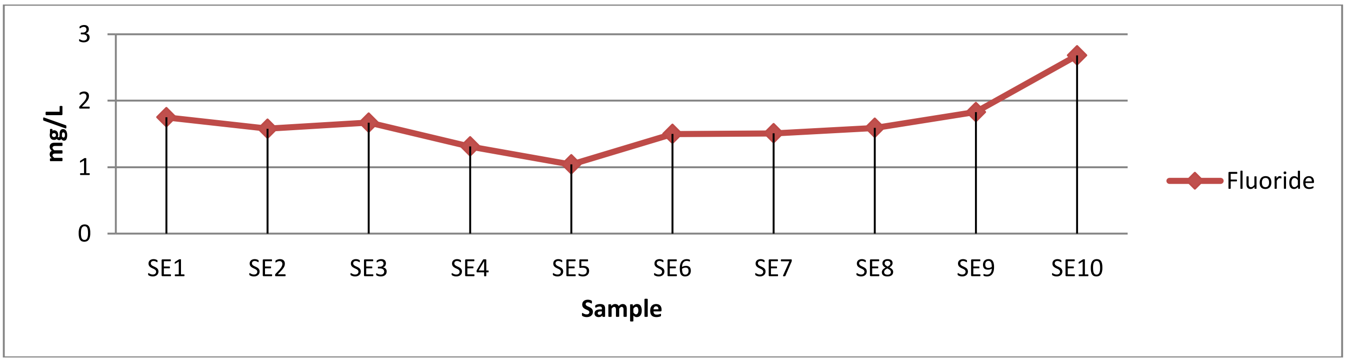

Figure 14. Fluoride Variations

Sulphate: When found in small amounts, sulphate ions have little effect on the taste of water. The concentration of sulphate ions varied between 52.37 mg/L and 82.42 mg/L. All values were below the permissible limit, according to the result.

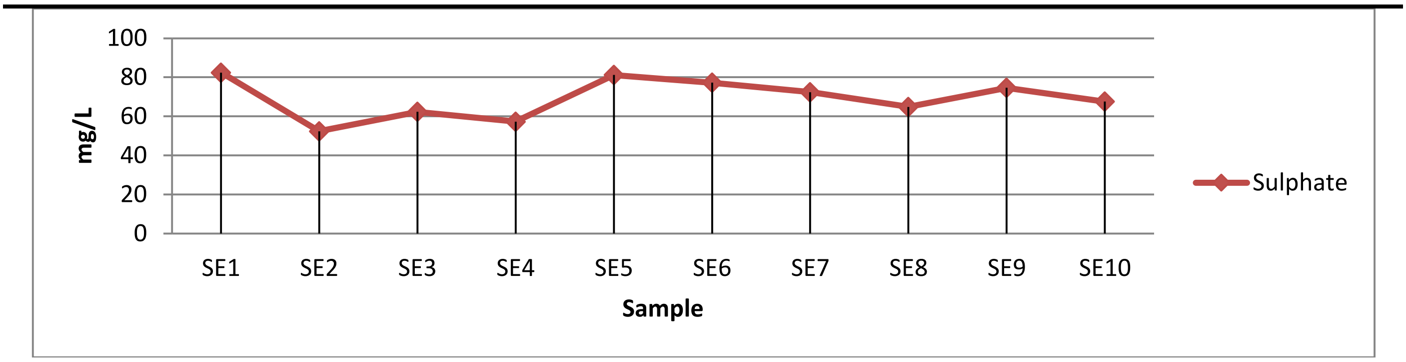

Figure 15. Sulphate Variations

COD: Chemical oxygen demand in the collected water sample ranged from 14 mg/L to 24 mg/L. With the aid of a strong chemical oxidant, the chemical oxygen demand (COD) dictates the amount of oxygen needed for chemical oxidation of most organic matter and oxidizable inorganic substances. The COD test, when used in combination with the BOD, can help detect poisonous conditions and the presence of biologically resistant organic substances.

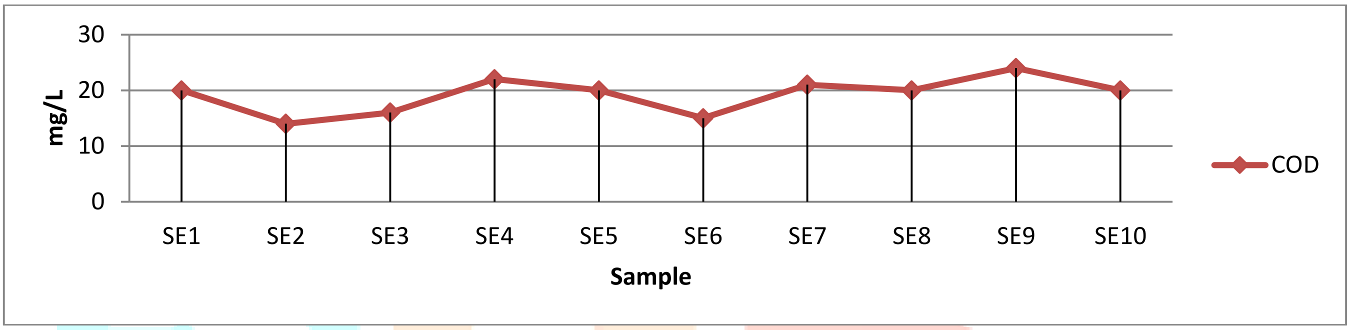

Figure 16. COD Variations

BOD: BOD and COD are essential indicators of pollution caused by organic wastes. The amount of oxygen needed by bacteria to stabilize decomposable organic matter under aerobic conditions is known as biochemical oxygen demand (BOD). The degradation of surface and groundwater caused by the discharge of residential and industrial effluents must be assessed. Biochemical oxygen demand in the collected water sample ranged from 4.76 mg/L to 6.64 mg/L.

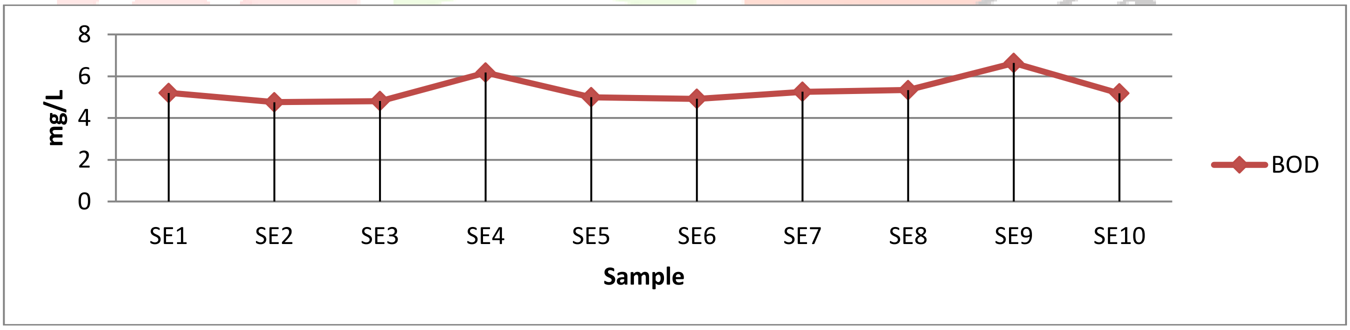

Figure 17. BOD Variations

DO: For most aquatic organisms and self-purification systems, oxygen is the most essential gas. It is an essential parameter that is needed for the metabolism of all aquatic species that breathe aerobically. Dissolved oxygen levels in the collected water sample ranged from 4.23 mg/L to 7.32 mg/L.

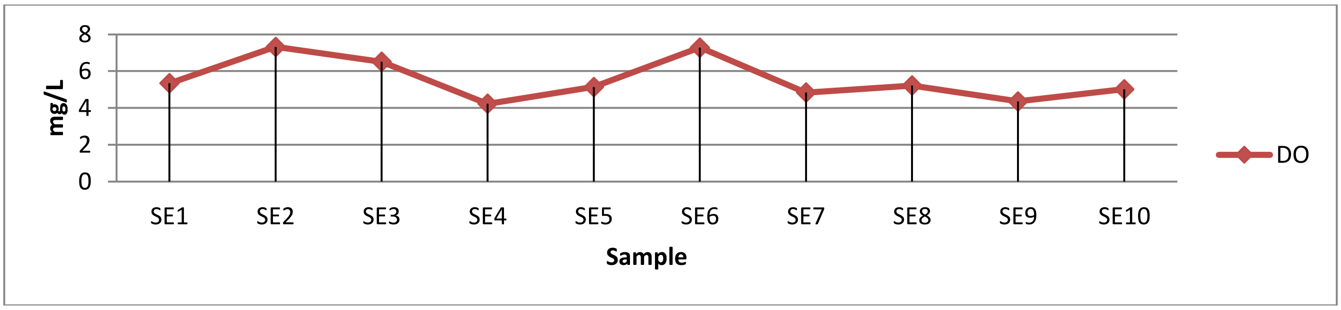

Figure 18. DO Variations

Iron: The concentration of Fe in water samples obtained from various sampling sites was found to be extremely high, owing to the inflow of surface runoff from hill torrents and agricultural wastes (agricultural and rocks). Adsorbed metals on the sediment surface that can be readily remobilized into Water are referred to as exchangeable Fe. Chemical oxygen demand in the collected water sample ranged from 0.24 mg/L to 0.36 mg/L

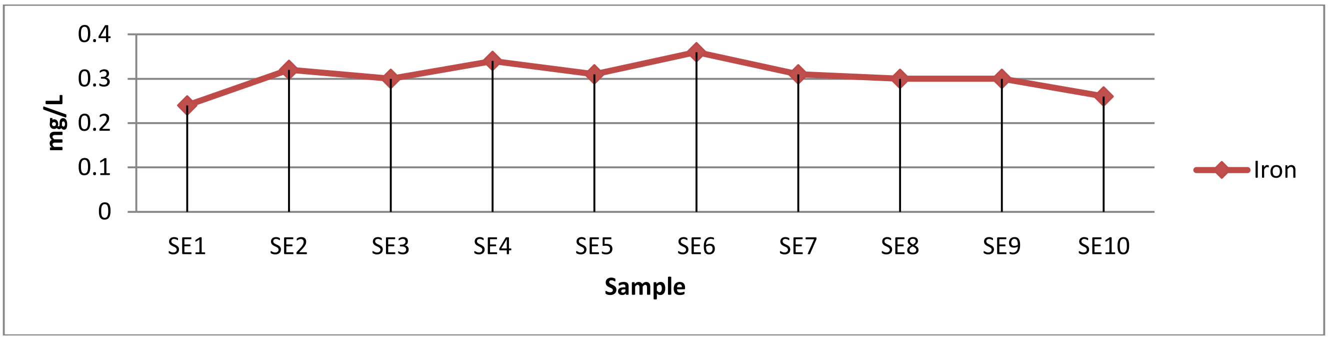

Figure 19. Iron Variations

Arsenic: Natural processes such as the degradation of As-containing rocks, as well as anthropogenic practices such as mine water percolation, may be significant causes of As contamination. Because of its high toxicity and widespread prevalence in drinking water and drainage, arsenic (As) is a health issue. Arsenic in the collected water sample ranged from 0.017 mg/L to 0.063 mg/L.

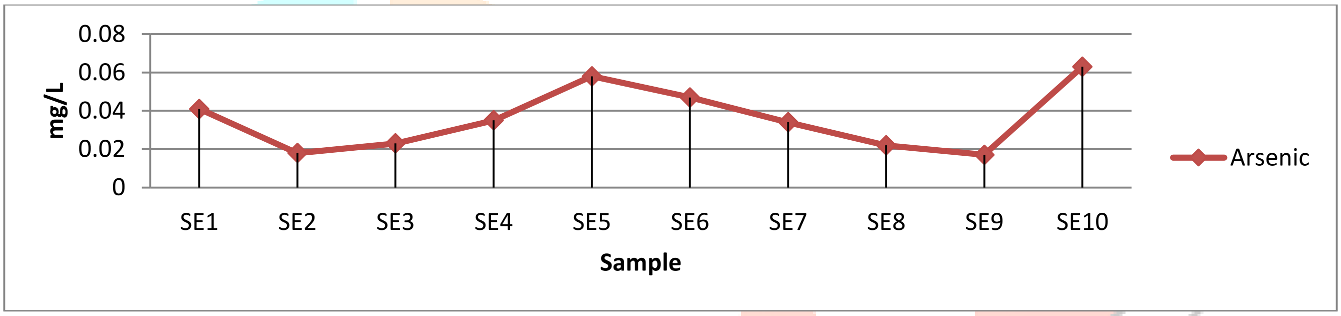

Figure 20. Arsenic Variations

Lead: Lead (Pb) can be found in household drinking water, Because of the deterioration of pipes, joints, and plumbing elements in a water delivery system. The concentration of sulphate ions varied between 0.013 mg/L and 0.061 mg/L.

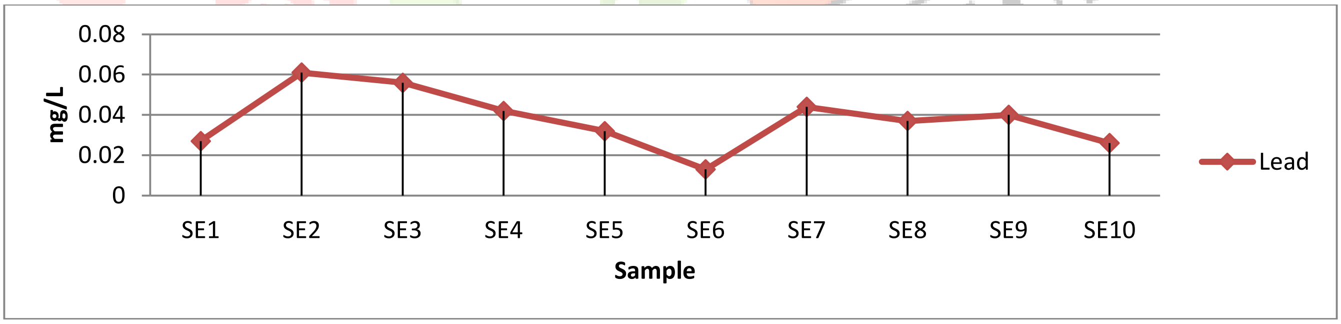

Figure 21. Lead Variations

Zinc: The majority of zinc in the soil is bound to it and will not dissolve in water. However, depending on the form of soil, some zinc can enter groundwater, and hazardous waste sites have contaminated groundwater. Animals that consume zinc-rich soil or drink zinc-rich water will absorb zinc. Zinc is a trace mineral nutrient that is needed in trace quantities by all animals. When you eat zinc-fortified food or drink zinc-fortified water, zinc enters the body through the digestive tract. Zinc concentration of samples collected in various locations ranging from 2.61 mg/L to 5.21 mg/L.

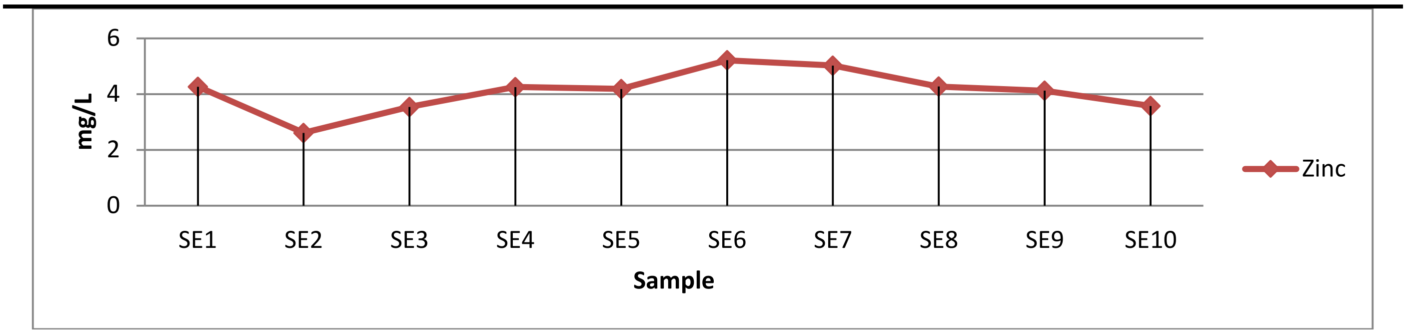

Figure 22. Zinc Variations

WQI: Owing to climate change, rapid urbanization, crop runoff, and industrialization, water pollution has become a major problem for developing countries (G. Matta et al., 2020). A water quality index is a way to compile vast volumes of water quality data into easy-to-understand terminology with accurate reporting to management and the public (D.S. Rao et al., 2018). The water quality in the Korba district's southeastern area ranges from poor to very poor. The water quality index in the sampled water was 76.689.

IV. CONCLUSIONS

Based on the findings of the existing research, during 2019–2020, the groundwater quality of rural villages in the Korba district's southeastern area was vulnerable to pollution. As opposed to Indian standards, the higher level of hardness rendered the water unfit for human use. By translating the dataset into commensurate unit data and numeric index values, the WQI and are shown to be beneficial approaches to characterize the spatial and temporal heterogeneity in groundwater quality. The water quality in the rural villages in south-eastern area of the Korba district varies from poor to very poor. The sampled water had a water quality index of 76.689. These studies provide details about how to treat groundwater management and emissions regulation.

V. ACKNOWLEDGEMENT

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REFERENCES

[1] APHA. 2005. Standard Methods for the Examination of Water and Waste Water 21th edition, American Public Health Association, Washington DC.

[2] APHA. 1992. Standard methods for analysis of water andwastewater.18th Ed. American Public Health Association, Inc.,Washington D C.

[3] Ilavarasan N. R., Ilangovan and Prasanna P.R. 2016. Water quality assessment on Ooty Lake in Nilgiris district. J. Environ. Biol., 37, 1463-1472.

[4] Islam M.J., Hakim M.A., Hanafi M.M., Juraimi A.S., Aktar S, Siddiqa A, Shajedur Rahman A..K..M., Islam M.A. and Halim M.A. 2014. Hydrogeochemical quality and suitability studies of groundwater in northern Bangladesh. J. Environ. Biol., 35, 765-779.

[5] Jameel A.A., and. Hussain A.Z. 2005. Water Quality Index of Uyyakondan Channel of River Cauvery at Tiruchirappalli. IJEP, 25, 941-942.

[6] Kalavathy S., Sharma T. R. and Sureshkumar P. 2011. Water quality Index River Cauvery in Tiruchirappalli district, Tamilnadu, Arch. Environ. Sci., 5, 55-61.

[7] Matta G., Nayak A., . Kumar A. and . Kumar P. 2020. Water quality assessment using NSFWQI, OIP and multivariate techniques of Ganga River system, Uttarakhand, India. Applied Water Science, 10, 206.

[8] Mishra P.C. and Patel R.K.. 2001. Quality of Drinking water in Rourkela, out side the steel town ship J. Env. Poll, 8(2), 165-169.

[9] Padmanabha B. and Belagali S.L. 2005. Comparative study on the water quality index of four lakes in the Mysore city. IJEP, 25, 873-876.

[10] Puri P. J., Yenkie M.K.N., Rana D.B. and Meshram S.U. 2015. Application of water quality index (WQI) for the assessment of surface water quality (Ambazari Lake). European Journal of Experimental Biology, 5(2), 37-52

[11] Rao B. V., Machiraju P.V.S and Satyavani Ch. V. V. 2014. Physicochemical and Biochemical Characterization of Ground waters near point Sources for Assessing their Quality for user End Application. J. Applicable Chemistry, 3 (1), 290-301

[12] Rao D.S., Jyothi M., Swarnalatha G. and Rao P.B. 2018. Statistical study of groundwater quality in Pedacherlo Palle mandal villages, Prakasam district, Andhra Pradesh. 6(2), 1240-1246.

[13] Ravikumar P., Mehmood M.A. and Somashekhar R.K.. 2013. Water quality index to determine the surface water quality of Sankeytank and Mallathahallilake, Banglore urban district, Karnataka, India. Appl. Water Sci., 3, 247-261.

[14] Shiji M., Sabitha A.R., Prabhakar K. and Harikumar P.S. 2016. Water quality assessment of Kavvayi Lake of northern Kerala, India using CCME water quality index and biological water quality criteria. J. Environ. Biol., 37, 1265-1272.

[15] Srivastava N., Harit G.H. and. Srivastava R. 2009. A study of physico-chemical characteristics of lakes around Jaipur. India. J. Environ. Biol., 30, 889-894.

[16] Tiwari T.N. and Mishra M. 1985. A preliminary assinment of water quality index of major Indian rivers. IJEP, 5, 276-279.