IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Mapping Of Drinking Water Quality From Different Resources In The Eluru Corporation Area , Andhra Pradesh

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ABSTRACT

Water is a vital natural resource for human survival as well as an efficient tool of economic development. Drinking water quality is a global issue, with contaminated unimproved water sources and inadequate sanitation practices causing human diseases, ELURU District a combined West Godavari District is carved out of old Godavari District as it is the western delta of the River Godavari. It was appropriately named as Eluru district with Headquarters at Eluru. It lies between 16º 15' 00'' and 17º 30' 00'' of the North latitude and 80º 50' 00'' and 81º 55' 00'' of East longitude which extends over an area of 8506 Sq. Kms with a coastline of around 23.00 Kms. It was surrounded on the east by River Godavari and East Godavari District, on south by Krishna District and the Bay of Bengal on the west .. Water samples were collected from different sources of water used by households in rural and urban areas. From the total 36 improved sources, 7 of them were considered for laboratory analysis. In addition, four water samples were collected from unimproved sources. Among these samples, three of them were collected from the urban and the remaining eight samples were collected from rural areas. Water samples were collected from springs, hand-dug wells and tap water. Based on the water quality of the samples investigated, the status of the existing water quality was compared with the standards of the World Health Organization (WHO, 2004, 2018). Water samples were collected from 42 locations in the ELURU municipality area during 2023. These samples were analysed using NEERI standards protocols . . The corresponding samples were analysed in the laboratory. 15 samples were analysed using verify complete water test kit. Data for 27 different locations of Andhra Pradesh is Collected from NWMP 2023 for comparison between eluru municipal corporation area and other parts of Andhra Pradesh state.

Introduction

Water is a vital natural resource for human survival as well as an efficient tool of economic development. Drinking water quality is a global issue, with contaminated unimproved water sources and inadequate sanitation practices causing human diseases (Gorchev & Ozolins, 1984; Prüss-Ustün et al., 2019). Water sources particularly unimproved sources are contaminated not only due to anthropogenic factors but also natural factors such as flooding, climate, weathering of parent material, topography, and others (Vadde et al., 2018). Diarrhea, cholera, dysentery, typhoid, and polio are some of the diseases linked to poor drinking water quality. Each year, it is estimated that 485,000 people die from diarhea as a result of contaminated drinking water (WHO, 2019). Water quality concerns are frequently the most important

component of drinking water as evaluated by physical, chemical, and bacteriological factors, as well as consumer satisfaction (WHO, 2004). Drinking water quality should meet physicochemical pollutants criteria and be entirely free of pathogens that could harm people's health. Furthermore, user perceptions of water quality are critical to the long-term viability of drinking water sources (Ochoo et al., 2017; Sherry et al., 2019). The esthetic value of water in terms of flavour, odour, and appearance is viewed differently by different households (de França Doria, 2010; Wedgworth et al., 2014; WHO/UNICEF, 2010). Consumer perceptions and esthetic characteristics should be have been developed, modified and adopted worldwide such as the Nation Sanitation Foundation Water Quality Index (NSFWQI) (Noori et al., 2019), the Canadian Council of Ministers of the Environment Water Quality Index (CCME WQI) (Hurley et al., 2012; Lumb et al., 2011; Noori et al., 2019; Tyagi et al., 2013), Oregon Water Quality Index (OWQI) (Said et al., 2004), and the Weighted Arithmetic Water Quality Index (WAWQI) (Chandra et al., 2017). Furthermore, various water pollution indexes were adopted like the Comprehensive Pollution Index (CPI) (Matta et al., 2020), the Organic Pollution Index (OPI) (Chen et al., 2016), the Trace Metal Pollution Index (TPI) (Reza & Singh, 2019), the Eutrophication Index (EI) (Van Puijenbroek et al., 2014) based on the selected water monitoring parameters. The difference between the above indexes is being the statistical integration and interpretation of parameter values.

when examining drinking water sources, even if they do not have a negative influence on human health (WHO, 2018). Despite the greatest efforts of governmental and non-governmental organizations, a considerable percentage of the water supply schemes are malfunctioning, forcing users to collect water from unimproved sources, posing health risks and reducing productivity. Furthermore, because of dissatisfaction, adequacy, income, distance, and longer waiting times households are reluctant to collect water from unimproved sources (Addisie et al., 2021). The dissatisfaction of consumers stems from variances in pH, mineral, and organic content of drinking water (Dietrich, 2006).

Location

ELURU District a combined West Godavari District is carved out of old Godavari District as it is the western delta of the River Godavari. It was appropriately named as Eluru district with Headquarters at Eluru. It lies between 16º 15' 00'' and 17º 30' 00'' of the North latitude and 80º 50' 00'' and 81º 55' 00'' of East longitude which extends over an area of 8506 Sq. Kms with a coastline of around 23.00 Kms. It was surrounded on the east by River Godavari and East Godavari District, on south by Krishna District and the Bay of Bengal on the west by Krishna District and on north by Khammam District of Telangana State. The District can be divided into three physiographic divisions. The southern part is represented by the delta of Krishna and Godavari rivers. The central part is an undulating terrain interspersed with low hills covering parts of Tadepalligudem and Eluru taluks, and the north is covered by Papikonda hill ranges of Eastern Ghats.

The combined West Godavari District is mainly drained by the Godavari, Yerrakalava, Tammileru and Ramileru rivers. River Godavari enters the District near the north eastern corner and after flowing a distance of 72 km, the river bifurcates into Gautami and Vasishta rivers at Vijeshwaram. The Gautami River which marks the District boundary debouches into the Bay of Bengal at Antervedi, draining about 20% of the District area. The other prominent rivers/streams in the District are Yerrakalava, Tammileru, Ramileru, and Guvvaleru. Yerrakalava which is the main tributary of Godavari River while Tammileru and Guvvaleru join Kolleru lake. Kolleru Lake, the biggest fresh water lake in the country, is situated in the south western part of the District. The total area of the lake is 16,914 Hectares out of which West Godavari area covered in 10,596 hectares. It acts as a reservoir for drainage water of surrounding delta areas during monsoon and it dries up in summer. In recent years, the aquaculture tanks encroached in all directions of the lake which has an area of 6339 ha resulting in the reduction of the original size of the lake. The drainage in the District is mainly dendritic in the northern part of the District and appears to be controlled by structure. Drainage density is more in the northern part and is sparse in the southern part. The delta area is served by the Godavari canal system and numerous other drains.

Climate and Rainfall

Tropical climate conditions with extreme hot summer and cold winter prevail in this District. April to June is the hottest period with high temperature in May. The climate of the District is moderate and characterized by tropical rainy climate with aggressive summer. The period from December to middle of February is generally the season of fine weather. The summer season is from March to May. Almost in each and every mandal , Automatic weather stations (AWS) are established by A.P. State Developmental Planning Society (APSDPS), Planning Department, Govt. of A.P. (Fig.3) at each mandal headquarter and the data from these stations is received by central server on hourly basis every day. Mandal wise and year wise rainfall data is appended in Table-1.The average annual rain fall monthly mandal wise was collected. As per the analysis northern part of the mandals i.e Polavaram and Buttayagudem mandals received good rainfall and also Narsapuram mandal received the good rainfall as the mandal is near the coast. The month wise annual rain fall receives August fallowed by July and September months. The District enjoys tropical humid type of climate with oppressive summer season and good seasonal rainfall. The summer season extends from March to May followed by southwest monsoon season, which lasts till September. October and November constitute the post monsoon or retreating monsoon season. December to February months experience cold weather conditions. This is followed by monsoon period from June to September, the post monsoon from October to December and the winter season from January to February. The monsoon usually breaks in the middle of June and brings good rains up to middle of October. The average annual rainfall of the District is 1055 mm, which ranges from nil rainfall in January to March. The mean seasonal rainfall distribution is 835 mm in southwest monsoon (June- September), 307 mm in northeast monsoon (Oct-Dec). In general, the amount of rainfall increases from west to east. The distribution of rainfall in West Godavari District is shown in the form of isohyets (Fig.4).The mean daily maximum temperature in the District is about 38°C in May and the mean daily minimum temperature is about 20°C in December/ January. Temperature in the District begins to rise from the middle of February till May. With the onset of southwest monsoon in June, the temperature decreases to about 20°C and is more or less uniform during the monsoon period. The relative humidity in the District is of the order of 80% in the mornings throughout the year, whereas in the evenings the relative humidity varies from about 70 to more than 80% (CGWB, 2013).

The study area of Eluru is found in the Southern india, eastern ghats Zone of Andhra pradesh state . 16º 15’ 00’’ and 17º 30’ 00’’ of the North latitude and 80º 50’ 00’’ and 81º 55’ 00’’ of East longitude which extends over an area of 8506 Sq. Kms with a coastline of around 23.00 Kms.. The main rainy season lasts from june through October. April to may are the wettest months. The annual precipitation ranges from 900 to 1,100 mm and the annual average temperature is 23°C (Addisie et al., 2021). Data collection and analysis Household survey. A cross-sectional research design was employed to collect the data for

understanding households' perceptions on water source quality. Household heads were considered for interviews and information was collected from women who took the greater responsibility of water collection. A pre-testing survey was done to identify and correct any potentially problematic questions. As a result, questions that the respondents didn't understand were adjusted to make them clearer. Finally, the survey questionnaires were divided into three sections. The first section focuses on the respondents' perceptions of the primary water quality indicators (Test, Odor, and Color). The second section contains questions on the perceived safety of drinking water, and the third section has questions about the primary causes of drinking water quality deterioration. The sample size was determined assuming 10% of the total households from the urban and rural areas. The total number of households using the water sources were selected from 3 urban and 13 rural water points.

Water sampling. Water samples were collected from different sources of water used by households in rural and urban areas. From the total 16 improved sources, 7 of them were considered for laboratory analysis. In addition, four water samples were collected from unimproved sources. Among these samples, three of them were collected from the urban and the remaining eight samples were collected from rural areas. Subsequently, samples from unimproved water sources were included due to its significance that households equally use these sources. Water samples were collected from springs, hand-dug wells and tap water. Based on the water quality of the samples investigated, the status of the existing water quality was compared with the standards of the World Health Organization (WHO, 2004, 2018). A questionnaire was prepared to focus on consumers' water quality perceptions on color, taste, and odor. The analytical results from laboratory analysis compared with the WHO standards. The physicochemical parameters included electrical conductivity (EC), pH, Total Dissolved Solids (TDS), Turbidity (TUR), Nitrate (NO_3^-), Nitrite (NO_2^-), Iron (Fe), Manganese (Mn), and residual Chlorine (Cl). The physicochemical water quality parameters were identified for the determination of the water quality index (WQI).

Materials and methods

pH

$pH = -\log_{10}[H^+] = \log_{10}1/[H^+]$ OR $[H^+] = 10^{-pH}$

This method has advantage because all states of acidity and alkalinity of solutions with respect to hydrogen and hyroxide ions can be expressed by a series of positive numbers between 0 to 14 [H+]

•Chemical reactions depend on pH •Water Supply and Waste Water Treatment •Water Softening ,Precipitation., Coagulation, Disinfection, Corrosion Control,Alkalinity and CO_2Measurement and fluoride activity

•Electrometric method -Using pH meter and electrodes •e.m.f. produced in glass electrode system varies linearly with pH •pH meter is calibrated potentiometrically with electrode system using standard buffers having assigned values so that $pH = -\log_{10}[H^+]$ •

pH Hydrogen Ion Exponent 6.5 -8.5

Chloride

Methodology : An Argentometric Method •Principle Chloride is determined in a natural or slightly alkaline solution by titration with standard silver nitrate, using potassium chromateas an indicator. Silver chloride is quantitatively precipitated before red silver chromate is formed. Chloride mg/L = (A-B) x N x 35.45 x 1000 ml sample Where A = ml $AgNO_3$ required for sample B= ml $AgNO_3$ required for blank N= Normality of $AgNO_3$ used

Fluoride

Significance Dual significance in water High concentration of F-causes dental Fluorosis Concentration < 0.8 mg/L results in dental Carries

Essential to maintain F-concentration between 0.8 mg/L to 1.0 mg/L in drinking water

Methods Colorimetric SPADNS Method Principle: Under acidic conditions fluorides (HF) react with zirconium SPADNS solution and the lake (colour of SPADNS reagent) gets bleached due to formation of ZrF_6 . Since bleaching is a function of fluoride ions, it is directly proportional to the concentration of fluoride. It obeys Beers law in a reverse manner.

Ion Selective Electrode Method Principle: The fluoride sensitive electrode is of the solid state type ,consisting of a lanthanum fluoride crystal; in use it forms a cell in combination with a reference electrode, normally the calomel electrode. The crystal contacts the sample solution at one face and an internal

reference solution at the other. A potential is established by the presence of fluoride ions across the crystal which is measured by a device called ion meter or by any modern pH meter having an expanded millivolt scale. Calculate mg F-/ L present in the sample using standard curve

Sulphate

Significance •Occurs in natural water •High concentration of Sulphatelaxative effect (enhances when sulphate consumed with magnesium) •Problem of scaling in industrial water supplies •Problem of odour and corrosion in wastewater treatment due to its reduction to H2S

Sulphate

Method Spectorphotometric Method Principle: Sulfate ions are precipitated as BaSO4in acidic media (HCl) with Barium Chloride. The absorption of light by this precipated suspensionis measured by spectrophotometer at 420 nm or scattering of light by Nephelometer

Calculate

mg / L SO4 =mg SO 4 x 1000 ml sample

'DRINKING WATER QUALITY

The quality of drinking water is of great significance in relation to public health and .well being of people. Therefore, the drinking waters should meet the high standards recommended by WHO and BIS

Colour (Hazen Scale) Less than 10 to 50

Taste & Odour Unobjectionable

Max.AIIowable Concentration pH 7.0-8.5 <6.5 to 9.2>·

Total dissolved solids (mg/l) 500-1500

Total harness mg/l (CaC03) 200-300 (ill Chloride as Cl (mg/l) 200-250 1000

Sulphate as SO4, 150-200- 400

Fluorides as F (mg/l) 0.6-1.2- 1.5

Nitrates as N03 (mgll) 45 -100

Calcium as Ca (mg/l) 75- 200

Magnesium as Mg (mg/l) If there are <30 150 250 ing/I of

sulphate, Mg content can be increased to a maximum of 125 mg/l with reduction of sulphates at the rate of 1 unit per every 2.5 units of sulphate Iron as Fe (mg/l) 0.1-0.3 1.0 Manganese as Mn (mg/l) 0.05-0.1 0.5 Copper as Cl) (mg/l) 0.05to 1.5

Zinc as Zn (mg/l) 5.0 to15.0

Phenolic compounds as phenol (mg/l) 0.001to 0.002 Anionic detergents as MBAS (mg/l) 0.2 1.0 0 Mineral Oil (mg/l) . 0.01

Water quality data from different locations

Water quality data is collected from different locations in Eluru municipal corporation area Andhra Pradesh.

Date	P^h	TDS	HARDNESS	H2S	IRON	Zn	Chlorine	nacl	fluoride
21-04-2023	8	68	250	0	0	5	0.5	1200	4
05-06-2023	8	680	325	0	0	5	0.5	1800	10
20-07-2023	7.5	285	200	0.5	0	10	1	1100	10
18-09-2023	7.5	310	250	0	0	5	1	1750	4
07-10-2023	7	260	250	0	0	5	2	1000	4
12-11-2023	6.5	245	200	0	0	5	2	800	0
19-12-2023	6.5	55	200	0	0	0	4	500	0

S.No	Source of the Sample	pH	EC	TDS	TH (mg/l)	Cl-	Na	K
1	Ro water	6.5	100	68	24	31.24	22	01
2	Bore water	7.15	1500	1020	420	215.84	139	11
3	Ro water	6.50	300	204	56	69.58	34	01
4	Bore water	7.10	1900	1292	510	394.76	182	08
5	Ro water	6.52	100	85	46	48.28	52	05
6	Bore water	6.97	1800	820	556	565.16	193	34
7	RO Water	6.71	85	128	30.0	18.46	18	04
8	Bore Water	7.22	1550	795	319.5	464	137	24
9	RO Water	6.50	70	47.6	50.0	31.24	07	04
10	Bore Water	6.70	770	523.6	42.0	149.1	35	05
11	Ro water	6.9	50.0	90.0	38.0	45.44	01	Nil
12	Bore Water	7.0	2000	1360.0	1080.0	1086.3	14	04
13	Ro water	5.98	40	58.0	38.0	29.98	Nil	Nil
14	Bore Water	7.05	1090	741.2	640.0	548.12	08	03
15	Ro water	5.38	30.0	20.4	42.0	26.98	Nil	Nil
16	Bore Water	7.0	710.0	482.8	260.0	134.9	03	01
17	Ro water	5.75	120	81.6	50.0	44.02	02	Nil
18	Bore Water	7.02	1160	788.8	502.0	427.42	12	02
19	Ro water	5.95	100	68	40.0	55.38	03	Nil
20	Bore Water	7.05	1000	680	690	781	34	Nil
21	Ro water	6.24	130	88.4	44.0	46.86	02	Nil
22	Bore Water	7.60	180	122.4	110.0	53.96	02	Nil
23	Ro water	6.38	70.0	47.6	34	29.0	02	Nil
24	Bore Water	7.07	980.0	666.4	320.0	304.5	18	01
25	Ro water	6.31	140	95.2	20.0	49.7	18	Nil
26	Muncipal Water	6.93	1100	748	280.0	428.84	86	04
27	Ro water	6.15	100	68	4.0	29.82	08	Nil
28	Bore Water	7.30	1580	1074.4	340.0	353.58	76.0	03
29	Ro water	6.42	210	142.8	50.0	41.8	07	Nil
30	Bore Water	7.49	1820	1237.6	290.0	264.12	30.0	01
31	Ro water	6.40	90.0	61.2	26.0	17.04	24	Nil

32	Bore Water	7.43	1280	870.4	386	252.76	198	01
33	Ro water	6.55	540	367.2	38.0	116.44	195	06
34	Bore Water	7.01	1000	680.0	440.0	475.7	682	08
35	Ro water	6.54	140	95.2	52	21.3	02	Nil
36	Bore Water	7.50	1330	904.4	258	15.73	32.3	01
37	Ro water	7.01	90	61.2	282	164.72	16	01
38	Bore Water	5.94	110	74.8	36	22.72	02	01
39	Ro water	6.0	180	122.4	38	26.98	03	01
40	Bore Water	7.7	1760	1196	396	276.9	27	02
41	Ro water	7.9	1080	734.4	250	163.3	14	01
42	Bore Water	6.15	70	47.6	12	15.6	02	Nil

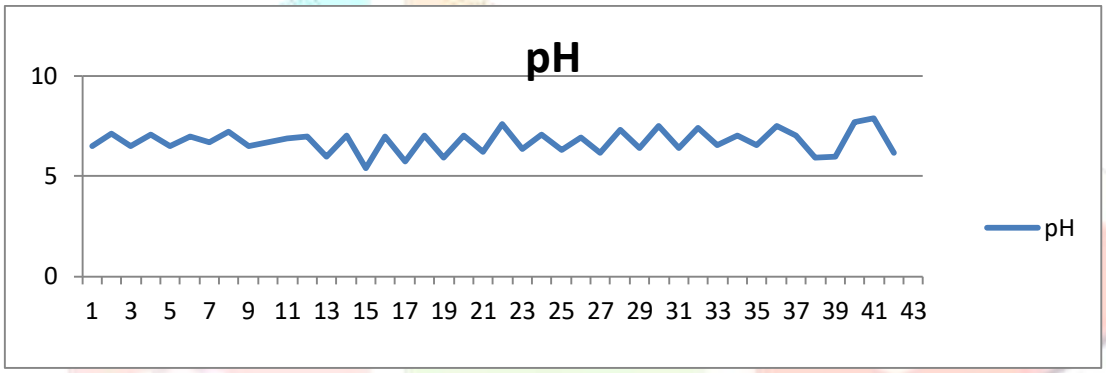

Fig showing water P[H] values for different resources

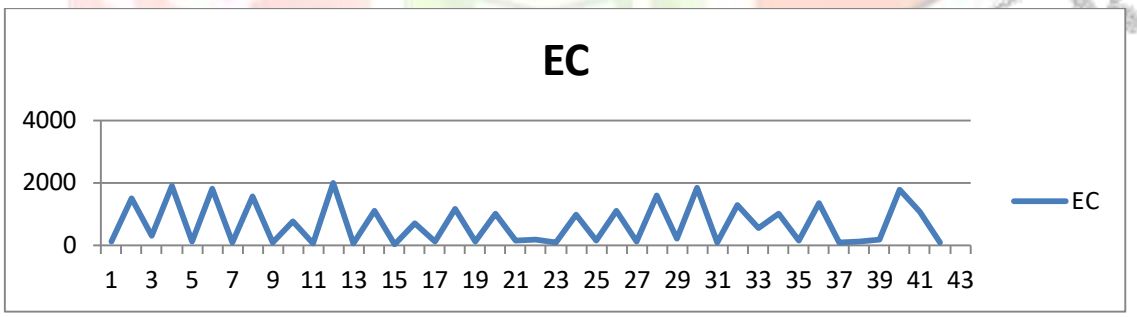

Fig showing electrical conductance variation in different water resources

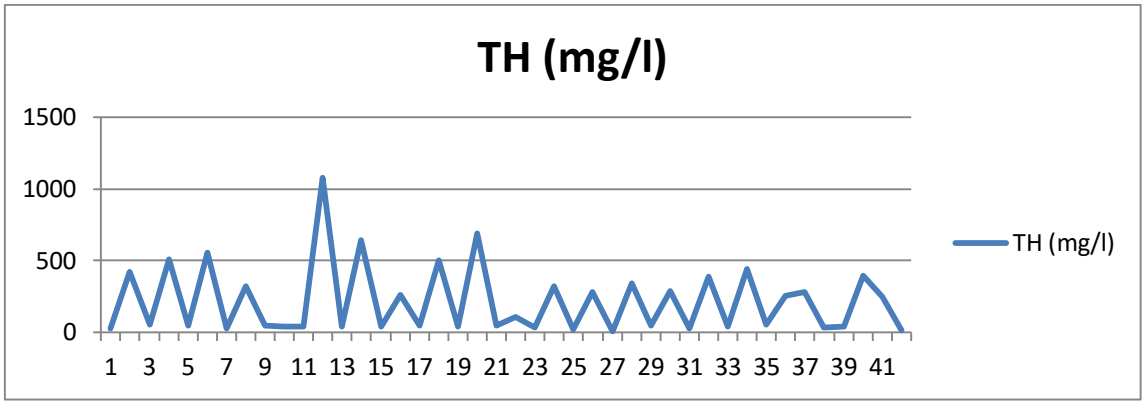

Fig gives the variation of total hardness in the water

Observations and conclusion

Water samples were collected from 42 locations in the ELURU municipality area during 2023. These samples were analysed using NEERI standards protocols . chemicals were purchased with the financial assistance from sir c r r educational institutions seed money. The corresponding samples were analysed in the laboratory. 15 samples were analysed using verify complete water test kit. Data for 27 different locations of Andhra Pradesh is Collected from NWMP 2023 for comparison between eluru municipal corporation area and other parts of Andhra Pradesh state.

It is observed that p^H value lies between 5.35 to 6.5 in the packaged

drinking water samples, whereas its value varies between 6.5 to 8 in bore well water, as it was observed as greater than 7 in samples detected through water test kit. Total dissolved solids (TDS) in the collected packaged drinking water sources is observed in between 60 to 750, TDS value is varying between 400 to 1300 in the normal water resources like bore well, open well etc, the same was reflected in the water quality test kit between 55 to 680. Total hardness value is found as 24 to 220 in packaged and RO plants water, TH value varies between 200 to 1080 in the normal resources water.

Out of the 27 samples data from different locations of Andhra Pradesh lot 0f variations were observed like conductance between 400 to 2000 and even more in some areas like industrial zones. Total dissolved solids have great fluctuations from 200 to 2500 and above. Out of these observations we can coclud that the 50 samples collected in and around the Eluru municipal corporation area , majority of the samples comes under safe and potable for drinking purpose

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