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ASSESSMENT OF GROUND WATER QUALITY USING WATER QUALITY INDEX

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ABSTRACT-- ***Ground water is one of the important fresh water resources available for human consumption. Early people recognized the importance of water from a quantity view point. However assessment of the quality of ground water is essential for improving its potability. In this project work we have estimated the water quality of Bapulapadu Mandal which is located 10km away from the Gannavaram airport on east coast of Krishna district of Andhra Pradesh, India. Water quality is tested for about 10 physico-chemical parameters of 90 water samples collected from various locations of 27 villages from Bapulapadu Mandal. The ground water samples are collected manually from the bore wells which were approximately equally distributed all over 27 villages of Bapulapadu Mandal. The samples were analyzed using MULTI-PARAMETER TEST KIT, which provide quick and easy water quality testing in the field. The combined effect of all there parameters was expressed in terms of WATER QUALITY INDEX. Bapulapadu Mandal map has been collected and analyzed. The data base obtained from water quality testing is used as attribute data base for preparation of thematic maps showing the spatial distribution of various water quality parameters. Thematic maps of the Water Quality Index were also developed. The water present in the villages like Ampapuram, Dantaguntala, R.A.Peta, and Arugolanu was found to be unfit for drinking. The outcome of the present research may be very much useful for proper decision making for design of the treatment facilities by the authorities.***

KEY WORDS: Ground water, Water quality, Water quality index, Water quality parameters, Multi parameter test kit.

1. INTRODUCTION

Water is an elixir of life. Life, prosperity, and civilization revolve around water in the whole world. The availability of a water supply adequate in terms of both quantity and quality is essential to human existence. Early people recognized the importance of water from a quantity view point. Civilization developed around water bodies that could support agriculture and transportation as well as provided drinking water. Recognition of the importance of the water quality developed more slowly.[1] Early humans could judge the water quality only through the physical sense of sight, taste and smell. The mean daily intake of water by man is estimated to be 3% of the body weight. Thus water for drinking purposes must not contain harmful substances that causes adverse effects, but at the same time should be aesthetically acceptable to the consumer. The water covers about three quarters of our planet and it is said to note that particularly in rural areas about 70% of the world population survive without clean water. [2,3]

Water is a chemical compound and may occur in a liquid form or in a solid form or in a gaseous form. All these three forms of water are extremely useful to man, providing luxuries and comforts, in addition to fulfilling his basic necessities of life. Every one of us knows how important and precious the water is. Whenever there is no water in our taps, we become helpless. No life can exist without water, since water is as essential for life as air is. It has been estimated that two-third of human body is constituted of water. Water is absolutely essential not only for survival of human beings, but also for animals, plants and all other living beings. Further, it is necessary that the water required for their needs must be good, and it should not contain unwanted impurities or harmful chemical compounds or bacteria in it.[4]

The precious ground water resources are now-a-days contaminated by varieties of man- made activities, which are inevitably coming up in the process of development. [5] Ground waters are contaminated mainly due to infiltration of pollutants in to the soil sub-strata. Site-specific characteristics such as soil type, depth of the aquifer, weather, season and the recharge rate of an aquifer all influence the probability and severity of a particular contamination incident.[6]

2. STUDY AREA AND DATA COLLECTION

2.1 STUDY AREA

Bapulapadu Mandal is located on the east coast of Krishna district of Andhra Pradesh, India. It is located at $16^0\,38^1\,11^{11}$ N $80^0 57^1 58^{11}$E. The average elevation of 28 meters (92.4 feet) above sea level has as total population 83,286 living in 20,790 houses with males (42,041) and females (41,245). The growth of Bapulapadu Mandal as an industrial centre started with the setting up of sugar factory, palm oil factory, spinning mills and rice mills. There is no source of drinking water for the people living in this area except ground water. Most of the people used to complain about the non-palatability of the ground water.

The ground water quality is very poor in this area and hence we have undertaken this project to assess the real ground water quality practically and to develop map showing the water quality variation in this area. The study area location is shown in the Figure.1 below.

2.2 DATA COLLECTION

Ground water samples from bore wells available in 27n village of Bapulapadu Mandal are collected in a clean water bottle. The total number of water samples collected is 90. Each sample was tested for water quality parameters.

3. METHODOLOGY

DETERMINATION OF WATER QUALITY INDEX: Water Quality Index (WQI) is a very useful and efficient method for assessing the quality of water. WQI is very useful tool for communicating the information on overall quality of water because the quality of water does not depend on a single parameter. There are about 11 to 12 physicochemical parameters to be tested for assessing the quality of water apart from bacteriological tests. To determine the suitability of the groundwater for drinking purposes, WQI is computed adopting the following formula.[7]

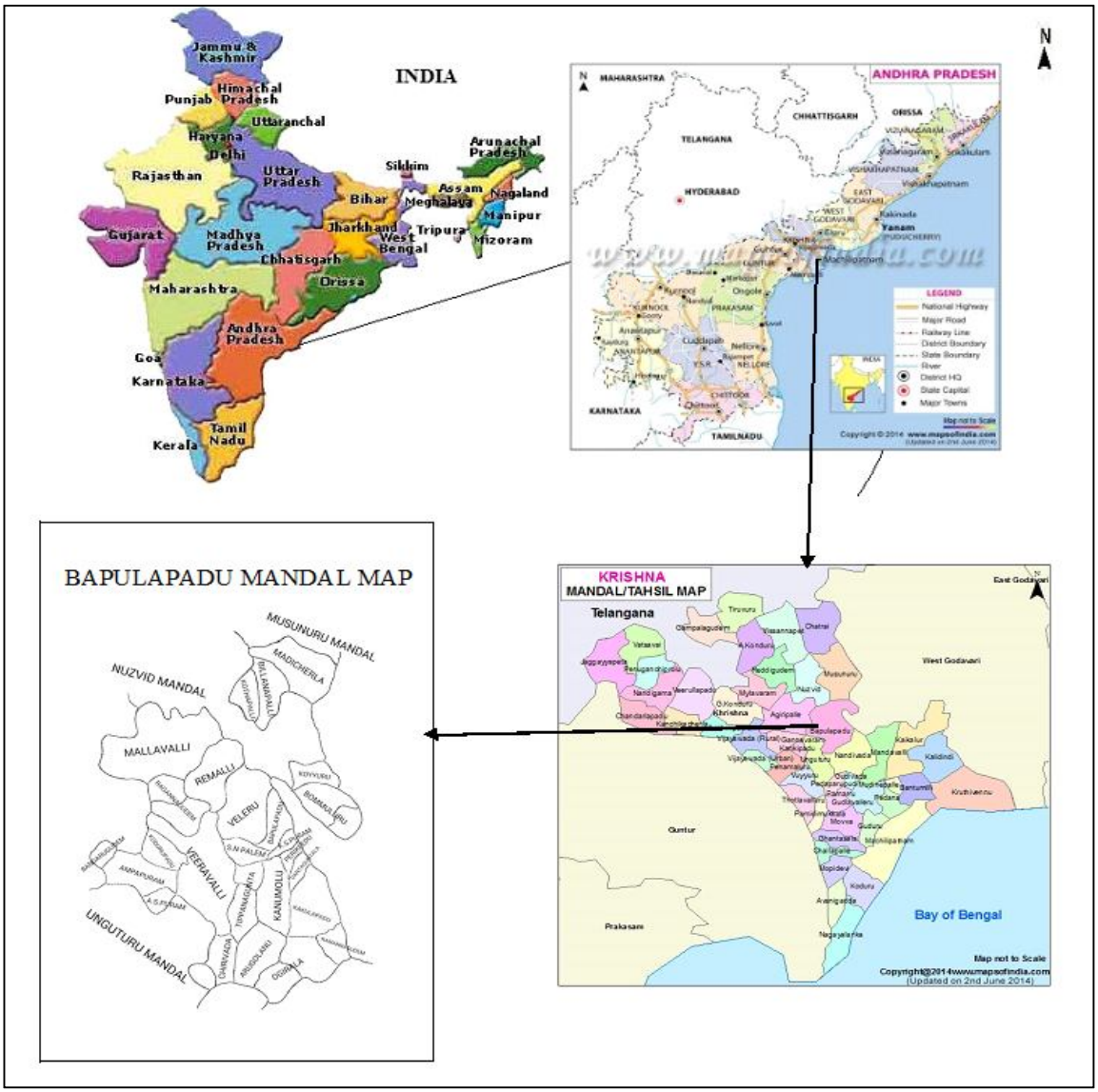

Figure.1 Location of the study area

WQI= Antilog [$\sum W^{n}{}_{n=1} \log_{10} q_n$]

here, W= Weight age factor (W) is computed using the following equation,

$W_n=K/S_n$ and K= proportionality constant is derived from,

$K=[1/(\sum^{n}{}_{n=1} 1/Si)]$

S_n and S_i are Indian Standard values of the water quality parameter.

Quality rating (q) is calculated using the formula,

$q_{ni}= \{[(V_{actual}-V_{ideal})/(V_{standard}-V_{ideal})]*100\}$

Where, q_{ni}=Quality rating of $i^{th\ parameter}$ for a total of n water quality parameters

V_{actual}=Value of the water quality parameter obtained from laboratory analysis

V_{ideal}=Value of the water quality parameter can be obtained from the standard tables

V_{ideal} for ph=7 and for other parameters it is equivalent to zero.

$V_{standard}$ = BIS standard of the water quality parameter.

Table.1. Water Quality Parameter, Their BIS Standards, and Weightages

PARAMETER	STANDARD (S_n &S_i)	WEIGHTAGE(W_n)
PH	8.5000	0.0267418
TURBIDITY(NTU)	5.0000	0.0454611
CHLORIDE (mg/l)	250.0000	0.0009092
TOTAL HARDNESS (mg/l as caco3)	300.0000	0.0007577
TOTAL ALKALINITY(mg/l)	200.0000	0.0011365
IRON(mg/l)	0.3000	0.7576844
FLUORIDE(mg/l)	1.5000	0.1515369
NITRATE(mg/l)	45.0000	0.0050512
CALCIUM(mg/l as Ca)	75.0000	0.0030307
TOTAL DISSOLVED SOLIDS (mg/lit)	500.0000	0.000424

Based on the above WQI values, the ground water quality is rated as excellent, good, poor, very poor, and unfit for human consumption.

Table.2. Water Quality Index Categories

WATER QUALITY INDEX	DESCRIPTION
0-25	Excellent
26-50	Good
51-75	Poor
76-100	Very Poor
>100	Unfit for drinking

4. RESULTS AND DISCUSSION

As we have to analyze more than 90 samples for about 10 parameters each the laboratory procedures are found to be cumbersome and time taking which cannot be completed within the stipulated time. The multi parameter kit provides a quick, easy & in-situ measurement of water quality parameters. To calibrate or to authenticate multi parameter test kit, water samples of Bapulapadu Mandal in all villages are tested by both the kit & by laboratory procedures. The results obtained were found to be in close proximity. Hence we have resorted to this multi parameter test kit to analyze water quality parameters. The following Table.4 gives the comparison between the results obtained from multi parameter test kit & laboratory tests. Average Water Quality Parameters and WQI of each village is given in the Table.5 below.

Table.3. Sample Collection Data

S.NO	NAME OF VILLAGE	NO. OF SAMPLES COLLECTED	S.NO	NAME OF VILLAGE	NO. OF SAMPLES COLLECTED
1	KOTHAPALLI	4	15	VEERAVALLI	4
2	BILLANAPALLI	1	16	S.N.PALEM	4
3	MADICHERLA	4	17	KANUMOLU	2
4	KOYYURU	3	18	PERIKEEDU	5
5	BOMMULURU	4	19	DANTAGUNTALA	3
6	BAPULAPADU	6	20	KAKULAPADU	3
7	VELERU	4	21	R.A. PETA	2
8	REMALLI	4	22	RAMANNAGUDEM	1
9	MALLAVALLI	4	23	OGIRALA	3
10	RANGANNAGUDEM	3	24	ARUGOLANU	3
11	KODURUPADU	3	25	TIPPANAGUNTA	3
12	BANDARUGUDEM	4	26	CHIRIVADA	4
13	AMPAPURAM	3	27	K.SEETHARAMPURAM	3
14	A.SEETHARAMPURAM	3		TOTAL	90

Table.4. Justification of Multi-parameter Test Kit

PARAMETERS	TEST RESULTS OF LAB	TEST RESULTS OF MULTIPARAMETER KIT
pH	6.9	6
TURBIDITY (NTU)	10	10
CHLORIDE (mg/l)	44.5	40
TOTAL HARDNESS (mg/l)	349.6	355.5
TOTAL ALKALINITY (mg/l)	378.3	382.5
IRON (mg/l)	0.2	0.2
FLOURIDE (mg/l)	2.5	2.8
NITRATE (mg/l)	8	10
CALCIUM (mg/l)	58	56.88
TDS(mg/l)	250	300

WATER QUALITY INDEX

The water quality index of major villages in Bapulapadu Mandal was found to be poor. The water quality index in villages like Koyyuru, Kodurupadu was found to be excellent whereas the water quality index in villages like Bommuluru, Veleru, A.Seetharampuram, Kanumolu, Kakulapadu was found to be good. The most villages had poor water quality index. The water present in the villages like Ampapuram, Dantaguntala, R.A.Peta, and Arugolanu was found to be ***unfit for drinking***. The main reasons for this as we have observed are open dumping of solid wastes, presence of , mining areas, misused ponds, use of fertilizers, etc.,

Table.5. Average Water Quality Parameters and WQI of each village

S.NO	NAME OF THE VILLAGE	pH	Turbidity(NTU)	Chloride(mg/lit)	Total hardness(mg/lit)	Total alkalinity(mg/lit)	Fluoride(mg/lit)	Calcium(mg/lit)	Nitrate(mg/lit)	Iron(mg/lit)	TDS(mg/lit)	WQI
1	KOTHAPALLI	6.625	43.75	560.88	331.25	278.5	0.375	127.5	106.25	0.3	509	68.91
2	BILLANAPALLI	7	5	762.39	475	325	0.5	90	65	0.2	613	57.09
3	MADICHERLA	7.25	2.5	490.27	356.25	287.5	0.75	127.5	48.75	0.2	422	56.34
4	KOYYURU	7.16	3.33	884	500	533.33	0.16	90	40	0.13	917	24.26
5	BOMMULURU	7.5	0	719.9	431.25	505.7	0.5	82.5	25	0.2	795	44.11
6	BAPULAPADU	7.5	5.833	860.33	479.16	509.66	0.583	108.3	37.5	0.16	891	52.54
7	VELERU	7.125	3.75	963	550	531.25	0.75	80	30	0.1	1207	33.63
8	REMALLI	7.15	3.75	887.4	575	531.25	0.5	147.5	58.75	0.23	1288	54.54
9	MALLAVALLI	7.25	8.75	1000	600	500	1.125	180	102.5	0.15	1500	53.115
10	RANGANNAGUDEM	7.16	5	1000	458.33	591.66	1.16	93.33	31.66	0.2	1500	69.95
11	KODURUPADU	7.16	5	617.01	400	425	0.33	86.66	28.33	0.13	817	17.89
12	BANDARUGUDEM	7.25	6.25	927	600	525	1	130	53.75	0.15	1302	54.09
13	AMPAPURAM	7.83	30	920.79	500	566.66	0.66	90	51.66	0.46	1304	116.55
14	A.SEETHARAMPURAM	7.166	0	943.05	550	583.33	0.66	106.7	66.66	0.2	1152	50.73
15	VEERAVALLI	7.375	6.25	860.81	506.25	562.5	1	100	72.5	0.15	1261	53.12
16	S.N.PALEM	7.75	3.75	836.25	475	537.5	0.75	100	30	0.13	1149	58.93
17	KANUMOLU	7.25	12.5	558.49	375	400	0.75	75	27.5	0.2	585	34.62
18	K.SEETHARAMPURAM	7.5	6.66	878.66	516.66	525	0.666	100	78.33	0.27	1229	66.76
19	PERIKEEDU	7.8	16	788.8	425	435	0.7	84	30	0.18	1119	54.76
20	DANTAGUNTALA	7	55	1000	600	575	0.66	173.3	38.33	0.73	1500	159.5
21	KAKULAPADU	7.16	26.66	1000	600	541.66	0.66	136.7	51.66	0.13	1500	34.06
22	R.A.PETA	8.5	5	690.5	387.5	430.5	1	90	55	0.6	735	149.7
23	RAMANNAGUDEM	7	5	1000	600	575	1	120	0	0.2	1500	52.65
24	OGIRALA	7.83	11.66	765.48	483.33	533.33	0.5	113.3	26.66	0.2	983	63.19
25	ARUGOLANU	7.16	31.66	855.78	450	600	0.66	146.7	43.33	0.63	1214	134.49
26	TIPPANAGUNTA	6.66	11.66	1000	450	483.33	0.5	110	11.66	0.23	1500	60.66
27	CHIRIVADA	7.12	10	1000	600	600	0.875	95	63.75	0.18	1500	51.68

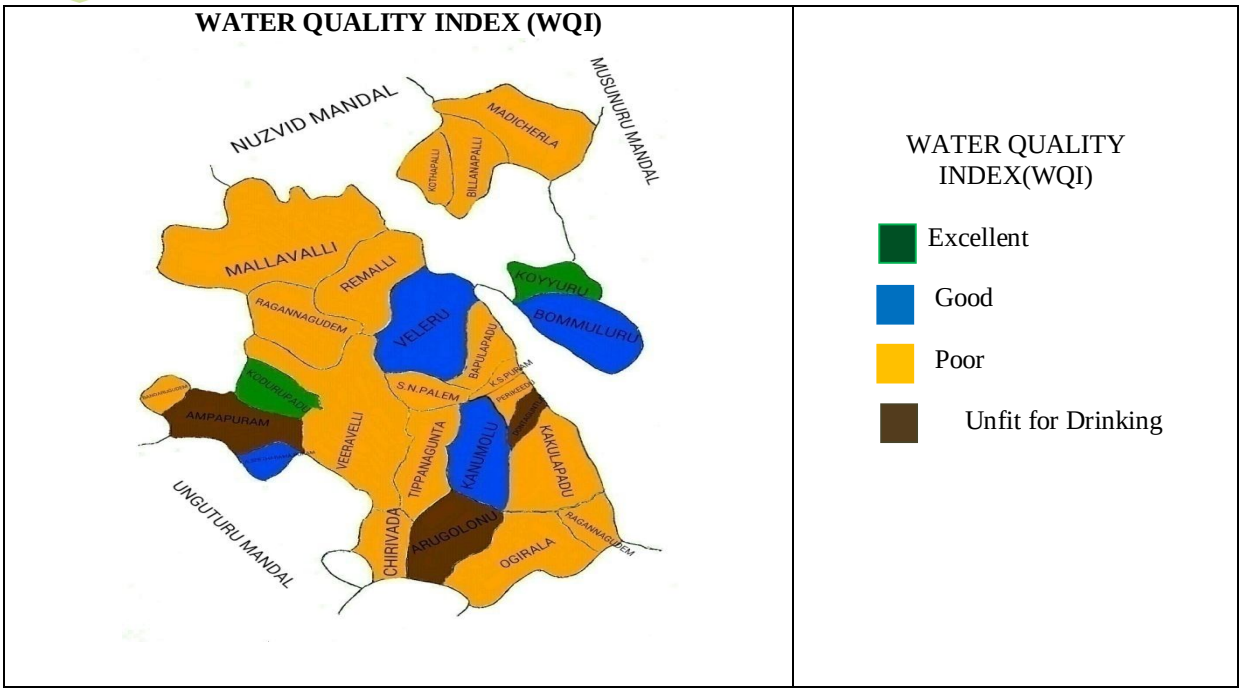

Figure.2. Spatial Distribution of Water Quality Index

5. CONCLUSIONS

It is necessary that the drinking water should be pure. However the absolute pure water is not found in nature. Even the rain water which absolutely pure at the instant it is formed becomes impure because as it passes through atmosphere it dissolves. certain gases, traces of minerals, dust, bacteria, and various other substances, It is therefore essential to ascertain the quality of water available from the various sources to whether the water is potable or not. So to know the portability conditions various parameters like Ph, Chloride, Turbidity, Total Hardness, Total Alkalinity, Iron, and fluoride, Nitrate, Calcium and Total dissolved solids were analysed for the study area and tabulated. Water quality index was calculated and spatial distribution of WQI was developed. The final output has given in the pictorial representation of ground water quality suitable or unsuitable for drinking purposes in the area under study. Out of 27 villages only two villages contain ground water in 'excellent' category and four villages in 'good' category. In three villages the ground water is unfit for drinking and in remaining villages it is in poor condition as per WQI. The analysis reveals that the groundwater of the area needs some degree of treatment before consumption.

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