WATER QUALITY INDEX OF DRINKING WATER SOURCES IN THE UPLAND AREA OF WEST GODAVARI DISTRICT, AP, INDIA

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Abstract: Water plays an essential role in human life**.** West Godavari District, one among the nine coastal districts of Andhra Pradesh, is located between North longitude 16°51' and 17°30' and East latitude 80°50' and 81°55' covering an area of 7795sqkm. A systematic study is proposed to assess the water quality of ground water as well as surface water resources and based on the water quality and it's dynamics in time, proper and simple treatment technologies will be suggested.

The present study deals with water quality index assessment of drinking water sources in the upland area of West Godavari District. Water Quality Index (WQI) exhibits the overall water quality based on several water quality parameters. Brown WQI Method is used to find overall WQI. The results revealed that most of the water samples are within the permissible limits, according to the WHO standards (1996). In very few places the samples are observed to contain qualities that do not comply with the WHO standards. Also the contamination is found to be due to both anthropogenic as well as from geological sources. Observed results shows that the technology to be applied for the treatment of ground water is source dependent and in most cases, effective and simple treatment solutions are sufficient without blindly implementing RO Technologies. It is recommended that constant monitoring is needed to maintain water quality.

Keywords: Water quality, Water Quality Index, standard techniques, WHO standards

Introduction: According to WHO reports that approximately 36% of urban and 65% of rural Indian were without access to safe drinking water. The quality of ground water in some parts of the country, particularly shallow ground water, is changing as a result of human activities. Ground water is less susceptible to bacterial pollution than surface water because the soil and rocks through which ground water flows screen out most of the bacteria. Bacteria, however, occasionally find their way into ground water, sometimes in dangerously high concentrations. But freedom from bacterial pollution alone does not mean that the water is fit to drink. In recent years, the growth of industry, technology, population, and water use has increased the stress upon both our land and water resources. Locally, the quality of ground water has been degraded. Municipal and industrial wastes and chemical fertilizers, herbicides, and pesticides not properly contained have entered the soil, infiltrated some aquifers, and degraded the ground-water quality. Other pollution problems include sewer leakage, faulty septic-tank operation, and landfill leachates. In some coastal areas, intensive pumping of fresh ground water has caused salt water to intrude into fresh-water aquifers.

The aim of the present study is to understand the ground water quality in Upland area of West Godavari District and to adopt more water use efficiency measures with a focus on safe drinking water. The researchers wish to involve the community and create awareness among them.

Study Area: West Godavari District, one among the nine coastal districts of Andhra Pradesh. Physiographically and geomorphologically the district can be divided into 2 major regions viz., alluvial deltaic region and upland areas. A systematic study is proposed to assess the water quality of ground water as well as surface water resources and based on the water quality and it's dynamics in time, proper and simple treatment technologies will be suggested.The paper presents the research work carried out in 15 villages of Denduluru mandal.

Water Sampling: The water samples were collected in polythene bottles which were cleaned with acid water, followed by rinsing twice with distilled water. Water was collected in the morning and the containers were immediately covered tightly and transported to the laboratory for physico-chemical and microbiological analysis.

Materials and Methods: The present study deals with water quality index assessment of drinking water sources in the upland area of West Godavari District. Water Quality Index (WQI) exhibits the overall water quality based on several water quality parameters. As a part of study, pH, Electrical Conductivity (EC), Total Dissolved Solid (TDS), Total Alkanity (TA), Total Hardness (TH), Calcium (Ca^{+2}), Magnesium (Mg^{+2}), Chloride (Cl^{-}), Nitrate (NO_3^{-}), Sulphate (SO_4^{-2}), DO, BOD using standard techniques and were used to determine WQI. Brown WQI Method is used to find overall WQI.

In this study, for the calculation of water quality index, twelve important parameters were chosen. The WQI has been calculated by using

the standards of drinking water quality recommended by the World Health Organisation(WHO), Bureau of Indian Standards(BIS) and Indian Council for Medical Research(ICMR). The weighted arithmetic index method(Brownet.al.,) has been used for the calculation of WQI of the water body. Further, quality rating or subindex (q_n) was calculated using the following expression.

$q_n = 100[V_n - V_{io}] / [S_n - V_{io}]$

(Let there be n water quality parameters and quality rating or sub index (q_n) corresponding to n^{th} parameter is a number reflecting the relative value of this parameter in the polluted water with respect to its standard permissible value.)

Q_n = Quality rating for the n^{th} Water quality parameter

V_n = Estimated value of the n^{th} parameter at a given sampling station.

S_n = Standard permissible value of the n^{th} parameter.

V_{io} = Ideal value of n^{th} parameter in pure water. (i.e.,0 for all other parameters except the parameter pH and Dissolved oxygen(7.0and 14.6 mg/L respectively)

Unit weight was calculated by a value inversely proportional to there commended standard value S_n of the corresponding parameter.

$W_n = K/S_n$

W_n = unit weight for the n^{th} parameters.

S_n = Standard value for n^{th} parameters

K = Constant for proportionality.

The overall Water Quality Index was calculated by aggregating the quality rating with the unit weight linearly.

$WQI = \sum q_n W_n / \sum W_n$

Table1.Water Quality Index (WQI) and status of water quality

Water quality Index Level	Water quality status
<50	Excellent water quality
50-100	Good water quality
100-200	Poor water quality
200-300	Very Poor water quality
>300	Unsuitable for drinking

Table 2. Drinking Water standards and recommending Agencies and unit weights. (All values except pH and Electrical Conductivity are in mg/Litre)

Sr. No.	Parameters	Standards	Recommended agency	Unit Weight
1.	pH	6.5-8.5	ICMR/BIS	0.2190
2.	Electrical Conductivity	300	ICMR	0.371
3.	Total Dissolved Solids	500	ICMR/BIS	0.0037
4.	Total alkalinity	120	ICMR	0.0155
5.	Total hardness	300	ICMR/BIS	0.0062
6.	Total suspended solids	500	WHO	0.0037
7.	Calcium	75	ICMR/BIS	0.025
8.	Magnesium	30	ICMR/BIS	0.061
9.	Chlorides	250	ICMR	0.0074
10.	Nitrate	45	ICMR/BIS	0.0412
11.	Sulphate	150	ICMR/BIS	0.01236
12.	Dissolved oxygen	5.00	ICMR/BIS	0.3723
13.	Biological oxygen demand	5.00	ICMR	0.3723

Table 3
Physicochemical characterestics and WQI Status of Denduluru mandal source water bodies
All values except pH and EC are in mg/ litre

S. No	Name of the village	pH	E.C mS	T.D.S	Alkalinity	TH	Ca^{2+}	Mg^{2+}	Cl^-	NO_3—	SO_4^{2-}	DO	B.O.D	WQI	Rating
1.	Challachinatalapudi	6.76	970	620	282	172	98	74	81	0.081	22.77	8	7.2	160.3	Poor
2.	Challapalle	7.44	2780	1780	483	240	154	86	502	0.056	27.31	10	7.6	320.4	Unsuitable
3.	Denduluru	8.21	440	280	148	68	28	40	60	0.1	6.36	9	6	121.7	Poor
4.	Galayagudem	7.58	1660	1060	542	148	80	68	156	0.093	28.70	8.4	6.2	221.1	Very Poor
5.	Gopannapalem	7.72	2080	1330	412	226	124	102	292	0.081	24.44	8	5	263.0	Very Poor
6.	Kothapalle	7.60	2210	1410	447	260	140	120	318	0.043	26.3	8	6.2	272.6	Very Poor
7.	Malakacherla	7.38	1360	870	412	200	120	80	122	0.093	19	9	6.4	198.4	Poor
8.	Medinaraopalem	7.55	1060	680	217	166	94	72	135	0.075	31.98	8	6	168.2	Poor
9.	Naguladevunipadu	7.29	1640	1050	447	260	190	70	192	0.087	25.9	9	5	224.8	Very Poor
10.	Ramaraogudem	7.43	1060	680	217	190	108	82	102	0.285	32.18	9.2	7.4	186.5	Poor
11.	Saanigudem	7.54	3040	1950	373	300	184	116	542	0.081	44.48	7.8	5.4	300	Very Poor
12.	Somavarappadu	7.28	2170	1390	423	296	160	136	352	0.031	24.43	8.6	6	271.3	Very Poor
13.	Sriramavaram	6.69	920	590	308	140	80	60	95	0.04	10.34	9	6.4	162.8	Poor
14.	Uppugudem	7.07	2360	1510	391	246	196	50	447	0.056	27.21	9	7.8	272.5	Very Poor
15.	Vegavaram	7.30	1940	1241	534	294	180	114	223	0.043	24.6	9	6	253.5	Very Poor

Table 4 Sampling location with their latitude and longitude

S. No.	Name of the village	GPS details			Source Details		Geology
		Latitude	Longitude	Elevation (mtrs)	B.D(ft)	W.T(ft)	
01.	Challchintalapudi	N $16^0$50'424"	E $81^0$12'739"	54	500	200	Red loamy
02.	Challapalli	N $16^0$45'984"	E $81^0$06'060"	46	400	180	Red soil
03.	Denduluru	N $16^0$45'639"	E $81^0$09'861"	29	250	80	Alluvial soil
04.	Galayagudem	N $16^0$46'450"	E $81^0$08'576"	80	600	350	Red Soil
05.	Gopannapalem	N $16^0$46'180"	E $81^0$06'930"	56	450	300	Red Soil
06.	Kothapalli	N $16^0$46'243"	E $81^0$06'279"	46	450	280	Red Soil
07.	Malakacharla	N $16^0$49'556"	E $81^0$12'081"	43	400	200	Red Soil
08.	Medinaraopalem	N $16^0$50'087"	E $81^0$11'197"	51	500	300	Red Soil
09.	Naguladevunipadu	N $16^0$47'567"	E $81^0$08'002"	73	550	350	Red Soil
10.	Ramaraogudem	N $16^0$49'673"	E $81^0$11'811"	48	480	200	Red soil
11.	Sanigudem	N $16^0$45'635"	E $81^0$09'878 "	78	550	350	Red soil
12.	Somavarapadu	N $16^0$44'984"	E $81^0$06'948"	29	300	150 ft.	Black Cotton Soil
13.	Sriramavaram	N $16^0$48'844"	E $81^0$11'687"	42	400	250	Red Soil
14.	Thimmannagudem	N $16^0$49'887"	E $81^0$13'430"	48	450	300	Red Soil
15.	Vegavaram	N $16^0$45'999"	E $81^0$06'827"	51	480	350	Red Soil

Results and discussion: The values of various physicochemical parameters for calculation of Water quality index are presented in Table3. Sampling location with their latitude and longitude are presented in Table 4.

Among all the physicochemical parameters selected for the Water Quality Index calculations, pH is an important parameter which determines the suitability of water for various purposes. In the present study pH ranged between 6.69 & 8.2. It was observed that concentration of parameters were not within the permissible limits. Narasinga rao(1993) and Sinha(1995) have also made similar observations in their studies on different water bodies. pH is the scale of intensity of acidity and alkalinity of water and measures the concentration of hydrogen ions. Most of the biological and biochemical reactions are pH dependant.

Electrical conductivity is a measure of water capacity to convey electricity. The present study reveals that most of the water samples tested exceeds the permissible range. EC value was found to be 3040 in Sanigudem which is found to be very high compared to permissible range. EC has close relationship with Total Dissolved Solids (TDS).

TDS in the study was as high as 1950 mg/ litre in the sampling station Sanigudem. If TDS is more water cannot be used for drinking. TDS affects palatability of food cooked and also causes gastrointestinal irritation. Srinivas etal., 2013 also observed high values of TDS.

Total alkalinity was observed high in Galayagudem. The large amount of alkalinity gives a bitter taste to water. Total hardness of water is characterized by contents of calcium and Magnesium salts.

Munawar(1970) is of the opinion that higher concentrations of chlorides indicate higher degree of organic pollution. In the present study the concentration of chloride fluctuated between 81mg/litre and 542mg/litre. Nitrate ion concentration is very important in public water supplies because it causes methemoglobinemia in children. Nitrate and sulphate ion concentrations are found to be very low.

The concentration of dissolved oxygen regulates the distribution of flora and fauna. The present investigation indicated that the concentration of dissolved oxygen fluctuated between 7.8mg/litre and 10 mg/litre. Biochemical oxygen demand is a parameter to assess the organic load in a water body. Many researchers have recorded higher BOD values in polluted water. The BOD concentration ranged between 5 mg/litre to 7.8mg/1itre i.e., within the permissible limits.

Conclusions and Recommendations: From the foregoing observations of the physicochemical parameters, it can be concluded that the water body shows the characters of eutrophication. High bio-chemical oxygen demand indicate the eutrophic status of the water body. A relatively higher concentration of chlorides and sulphates also indicate the unsuitability of water for domestic use. Hence, application of Water quality index technique for the over all assessment of the water quality of a water body is a useful tool.

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