

## Assessment and mapping of water quality index in Prakasam district, A.P. using geographical information systems

Ch. Maruthi Devi<sup>1</sup>, Kiran Yarrkula<sup>2</sup>, Usha Madhuri T<sup>3</sup>

- 1- Assistant Professor, Civil Engineering Department, Bapatla Engineering College, Bapatla, Andhra Pradesh, India
- 2- Associate Professor, Civil Engineering Department, Bapatla Engineering College, Bapatla, Andhra Pradesh, India
- 3- Assistant Professor, Civil Engineering Department, Andhra University College of Engineering, Visakhapatnam, Andhra Pradesh, India.  
chennamsetty1970@gmail.com

### ABSTRACT

Assessment of the ground water quality has always been paramount in the field of environmental quality management. Some of the villages in Prakasam District have a special significance and needs greater attention of all concerned since it is the only major source for domestic consumption. In the present study, the ground water quality of Prakasam District has been studied. The coordinates of the district lies between 50° 30' N latitudes and 80° 03' E longitudes. The ground water samples have been collected from different places of Prakasam District were analyzed in the laboratory using standard procedures given by APHA. Prakasam District map has been collected from district collector office and sampling locations have been taken using GPS. From the analyzed data, water quality index has been calculated using weighted average method. The data base obtained from water quality index values are used as attribute data base for preparation of thematic map showing distribution of water quality index. The result of the work is presented in the form of map which is to be used for better understanding of the present water quality scenario of the study area. The variations of water quality in different places were also discussed.

**Keywords:** Ground water, water quality parameters, water quality index, spatial distribution, geographic information systems.

### 1. Introduction

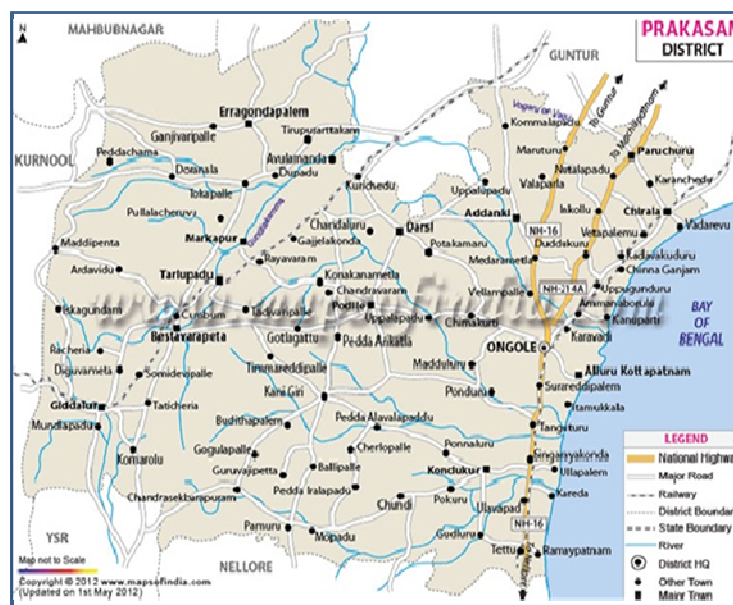
Ground water is a precious natural gift and an important renewable resource having several inherent advantages over surface water. It is a good source of fresh water available on the earth. The demand for water has increased over the years and this has led to water scarcity in many parts of the world. The situation is aggravated by the problem of water pollution or contamination. India is heading towards a fresh water crisis mainly due to improper management of water resources and environmental degradation. This leads to lack of access to safe potable water supply to millions of people. It becomes imperative to regularly monitor the quality of ground water and to device ways and means to protect it. Water Quality Index is one of the most effective tools to communicate information on overall quality status of water to the concerned user community and policy makers (Chopra .S.L. and Anwar, J.S, 1999). Thus, it becomes an important parameter for the assessment and management of ground water.

The purpose of the present study is to estimate the ground water quality in Prakasam District and thematically represent it using Geographic Information System (GIS) for understanding

of the present scenario at a glance. GIS can be used as a powerful tool for developing solutions for water resources problems for assessing water quality, determine water availability, preventing flooding, understanding the natural environment and managing water resources on a local or regional scale.

## 2. Study area

Prakasam District occupies an area of 17626 km<sup>2</sup> and average rainfall is 616mm. It is the largest in area among the coastal districts. This district lies between 14<sup>0</sup> 50' 27.725" to 16<sup>0</sup> 17' 21.168" north latitude and 78<sup>0</sup> 31' 1.298" to 80 30' 22.62" east longitude. The average elevation is 10m (30ft). It has a population of above 3054940 as per 2001 census. The total geographical area is 17626 sq.km. It is bounded on the north by Guntur and Mahaboobnagar Districts. On the south by Cuddapah and Nellore Districts, on the east by Bay of Bengal and on the west by Kurnool Districts. The district headquarters is located at Ongole. Many areas in this district depends on ground water for drinking and other purposes. The base map representing the boundaries of 56 mandals are collected from collector office, Ongole. The collected map has been digitized by Arc Map 9.2 software. Map of the study area are shown in the following figure 1.



**Figure 1:** Location map of the study area

## 3. Materials and methods

### 3.1 Sample collection

The ground water samples are collected manually from the bore wells which are approximately equally distributed all over 55 villages of Prakasam District. The samples are analyzed using standard procedures in the laboratory (APHA, 1985). The list of samples collected was given in table 1. The parameters which are analyzed during water analysis are pH, Chlorides, Fluorides, Calcium, Magnesium (Mg), Nitrates, Total Dissolved Solids (TDS), Total Hardness (TH), Calcium hardness and Magnesium hardness.

**Table 1:** Statistics of samples collected

Sl. No	Village	Number of Samples Collected	Sl. No	Village	Number of Samples Collected
1	Giddaluru-s	3	29	Gudluru	4
2	Komarolu	8	30	Kandukuru	8
3	Bestavaripeta	3	31	Ramayapatnam	8
4	Racherla	6	32	new ch.kamula	4
5	Veligendla	6	33	Tanguturu	8
6	C.S.puram	8	34	Kothapatnam	8
7	Pamuru	8	35	Chilakapadu	6
8	Hanumantunipadu	8	36	Cheemakurthy	8
9	Kumbum-d	3	37	Talluru	8
10	Tadivaripalli	3	38	Mundlamuru	6
11	Gotlagattu	3	39	Addanki	6
12	Kanigiri	8	40	Balikulavapadu	6
13	Pd alavalapadu	3	41	S.Manguluru	6
14	Lingasamudram	6	42	Marturu	6
15	Chundi	6	43	Jarugumalli	8
16	Ponnaluru	6	44	Inkollu	8
17	Jarugumalli	8	45	Karamchedu	8
18	Marripudi	8	46	Vetapalem	8
19	Kondepi	6	47	Chinaganjam	8
20	Podili	8	48	Naguluppalapadu	8
21	Darsi	8	49	Maddipadu	8
22	Kuruchedu	4	50	Chirala	8
23	Donakonda	4	51	Parchuru	8
24	Markapuram-d	6	52	Yanamadala	4
25	Pullalacheruvu	6	53	Tripuranthakam	4
26	Yerragondapalem-d	6	54	Arthaveedu-d	4
27	Dornala-d	6	55	Ongole [west]	8
28	Peddaraveedu	6		TOTAL	340

### 3.2 Determination of water quality index

Water Quality Index (WQI) is a very useful and efficient method for assessing the quality of water. Water Quality Index is very useful tool for communicating the information on overall quality of water. To determine the suitability of the groundwater for drinking purpose, WQI is computed by adopting the following formula. Table 2 provides the information about water quality parameter, their BIS standards and weight ages and table 3 provides the information of water quality index categories .

Water Quality Index:

$$WQI = \sum q_i w_i \quad (1)$$

Where:

$$q_i(\text{waterqualityrating}) = 100 \left[ \frac{v_a - v_i}{v_s - v_i} \right] \quad (2)$$

$V_a$  = actual value present in the water sample.  
 $V_v$  = ideal value (0 for all parameters except PH and DO)  
 $W_i$  (unit weight) =  $k/S_n$

$$k \text{ (constant)} = \frac{1}{((1/V_{S1}) + (1/V_{S2}) + \dots + (1/V_{Sn}))}$$

(3)

$S_n$  = standard value

**Table 2:** Water quality parameter, their BIS standards and weightages

Parameter	Standard (Sn and Si)	Weightage (Wi)
pH	8.5	0.1363529
Calcium(mg/l)	75	0.0154533
Chlorides(mg/l)	250	0.0046360
Flourides(mg/l)	1.5	0.7726666
Total Hardness (mg/l)	300	0.0038633
Mg (mg/l)	30	0.0386333
Nitrates (mg/l)	45	0.0257555
TDS (mg/l)	500	0.00231800

**Table 3:** Water quality index categories

Water Quality Index (WQI)	Description
0-24	EXCELLENT
25-49	GOOD
50-74	POOR
75-100	VERY POOR
>100	UNFIT FOR DRINKING

### 3.3 Creation of data base

The study is carried out with the help of two major components; Cadastral maps and field data. The cadastral maps collected from collector office, Ongole, demarcating all villages are scanned and digitized to generate a digital output forming a spatial database. Field work was conducted and ground water samples were collected from various villages of Prakasam District with the help of the map. These samples were tested using standard procedures in the laboratory and the results were tabulated in an excel worksheet. The Water Quality Index for each village was calculated. The water quality data thus obtained forms the attribute database for the present study. The database table consisting of average values of the parameters determined and the calculated values of water quality index are given in the Table 4.

**Table 4:** Averages of various parameters of all villages along with WQI

S.No.	Village	pH	Ca (mg/l)	Cl (mg/l)	Fl (mg/l)	TH (mg/l)	Mg (mg/l)	Ni (mg/l)	TDS (mg/l)	WQI
1	Giddaluru-s	8.46	56	380	0.67	580	107	52	1304	55.3
2	komarolu	8.56	40	400	0.71	359	63	38	1304	56.1
3	Bestavaripeta	8.61	32	180	1.25	298	53	7	816	81.6

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4	Racherla	8.48	88	150	0.81	380	39	29	648.3	60.2
5	Veligendla	8.66	88	70	1.1	339	29	10	588.8	75.1
6	C.S.puram	8.51	24	210	0.26	443	93	19	785.9	31.2
7	Pamuru	8.92	40	360	3.71	318	53	7	1881	212
8	Hanumantunipadu	8.93	16	120	2.75	180	34	8	914.6	161
9	Kumbum-d	8.43	24	140	0.27	122	15	1	465.3	29.7
10	Tadivaripalli	8.64	40	90	1.21	339	58	2	615	79.3
11	Gotlagattu	8.42	56	260	0.64	502	88	77	1241	53.7
12	Kanigiri	8.4	48	250	2.62	499	92	53	1005	154
13	Pd alavalapadu	8.71	48	690	0.35	482	88	23	2493	39.8
14	Lingasamudram	9.66	72	80	0.95	382	49	1	620.8	76
15	Chundi	8.2	40	290	1.07	540	107	72	1466	74.2
16	Ponnaluru	8.2	32	80	1.14	199	29	2	505	72.9
17	Jarugumalli	8.4	24	210	0.13	299	58	64	1262	30.6
18	Marripudi	8.71	16	130	0.9	242	49	5	656	153
19	Kondepi	8.58	32	80	0.94	240	39	8	581.5	64.6
20	Podili	9.04	120	830	0.22	802	122	62	2968	41.3
21	Darsi	8.51	40	100	1	281	44	1	434.6	66.9
22	Kuruchedu	8	240	1440	0.3	1859	306	350	4774	60.7
23	Donakonda	8.59	40	830	2.05	199	24	3	471.7	121
24	Markapuram-d	8.92	24	210	2.78	122	15	4	1052	162
25	Pullalacheruvu	8.36	24	200	0.25	138	19	3	268.2	29.9
26	Yerragondapalem-d	8.48	24	140	0.02	179	29	2	411.5	15.9
27	Dornala-d	8.27	56	830	0.53	621	117	37	2526	45.5
28	Peddaraveedu	8.51	56	90	0.44	202	15	3	521.4	38.4
29	Gudluru	8.49	32	220	0.47	479	97	10	698.9	41.3
30	Kandukuru	8.78	40	200	4.8	219	29	2	1071	266
31	Ramayapatnam	8.34	24	210	0.01	122	15	27	741.1	20.4
32	New ch.kamula	8.72	72	300	1.17	258	19	30	1105	80.7
33	Tanguturu	8.65	80	30	0.75	200	25	1.83	353.3	35.9
34	Kothapatnam	8.28	128	1170	0.45	1139	199	3	3964	45.6
35	Chilakapadu	8.69	40	130	1.23	199	24	36	770.6	82.8
36	Cheemakurthy	8.27	40	90	0.83	318	53	30	462.1	58
37	Talluru	8.83	40	130	0.7	260	39	10	507.5	54.9
38	Mundlamuru	8.48	56	70	0.45	379	58	18	526.7	40.4
39	Addanki	8.88	32	60	2.7	158	19	6	579.2	158
40	Baligurava	8.76	56	220	2.08	502	88	54	1341	130
41	S.Manguluru	8.63	48	160	0.4	322	49	37	1425	40
42	Marturu	8.9	56	80	2.44	300	39	18	565.1	94.9
43	Jarugumalli	8.4	24	210	0.13	299	58	64	1262	24.2
44	Inkollu	8.01	40	200	0.7	200	40	20	500	24.4

45	Karamchedu	7.9	40	230	0.8	190	45	30	700	25.2
46	Vetapalem	8.8	16	70	0.02	139	24	3	25.9	18.1
47	Chinaganjam	8.56	40	100	0.1	240	34	3	481.3	21
48	Naguluppalapadu	8.28	72	690	0.01	620	107	96	2547	85.1
49	Maddipadu	8.69	48	1380	0.2	540	102	19	5937	62
50	Chirala	8.01	40	200	0.7	200	40	20	500	17.7
51	Parchuru	7.9	40	230	0.8	190	45	30	700	121
52	Yanamadala	8.94	48	610	1.05	301	44	2	2467	76
53	Tripuranthakam	8.79	48	90	0.67	280	39	2	580.5	52.7
54	Arthaveedu-d	8.49	64	540	0.55	559	97	3	1633	46.6
55	Ongole	9.05	48	830	0.23	441	78	54	2954	16.8

### **3.4 Generation of map**

The Spatial and attribute database generated were integrated for the generation of the spatial distribution map of Water Quality Index. The water quality data ( attribute ) is linked to the sampling location ( spatial). i.e.) Prakasam District maps showing spatial distribution were prepared using Arc Map 9.3 software.

## **4. Results and discussion**

### **4.1 Ground water quality variation**

The variations of WQI of the ground water in the different villages of Prakasam District were presented in Figure 2 The quality of ground water varies from place to place. Even at the same location, from season to seasons the quality of ground water varies. It also depends upon both the surface and subsurface characteristics. Presence of landfills, open dump, usage of fertilizers, disposal of industrial wastes etc. changes the quality of ground water.

### **4.2 Chlorides**

The Chlorides concentration less than 250mg/lit was found to be for the villages like Racherla, C.S.Puram, Veligondla, Pamuru, kumbum, tadovaripalli, kanigiri etc. The villages having concentration 250-600 mg/lit are Giddaluru, Bestavaripeta, Hanumanthinipadu, Lingasamdram Darsi, Kothapatnam, Arthavedi Inkollu. A very high concentration more than 600 mg/lit was found to be for the stations namely pedalavalapadu, kuruchedu, Nagullapalapadu, Maddipadu, Yanamadala and ongole.

### **4.3 Calcium**

The villages having high concentration of calcium in the range 75-200 mg/lit are Racherla, veligondla podili, tanguturu and kothapatnam.

### **4.4 Flourides**

Flouride is the most commonly occurring form of fluorine. It is the natural contaminant of water. The concentration of flouride is below 1 mg/lit in most of the cases.

The fluoride value is within desirable limits in areas of Giddaluru-s, Bestavaripeta, Pamuru, Veligandla, Tadivaripalli, Gudluru, and Kandukuru etc. but in some villages like Hanumanthunipadu, Kumbum-d, Pullalacheruvu, Markapuram-d, Marturu, S.Mangaluru, the fluoride concentration is more than 1.5 mg /lit. This may lead to diseases like dental and skeletal fluorosis.

#### **4.5 Hardness**

Highest concentration of Total hardness is found in the villages Donakonda and Cheemakurthy. In some of the villages like Darsi, Gudluru, Chirala. The concentrations of total hardness was found to be lying between 600-1000 mg/l softening is required to make water potable for drinking.

#### **4.6 Magnesium**

The concentration of magnesium was found to be within the permissible limits in the villages Tadivaripalli, Pullalacheruvu, Kandukuru, Pedaraveedu, Yerragondlapalem, Jarugumalli etc.,.

The magnesium concentration was in between 30-100 in the villages Maddipadu, naguluppalapadu, Chinaganjam, Inkollu, Ballikurava, etc.,. The villages Gudluru, Donakonda, Darsi, Cheemakurthy, Chirala, Parchuru have very high concentrations of magnesium.

#### **4.7 pH**

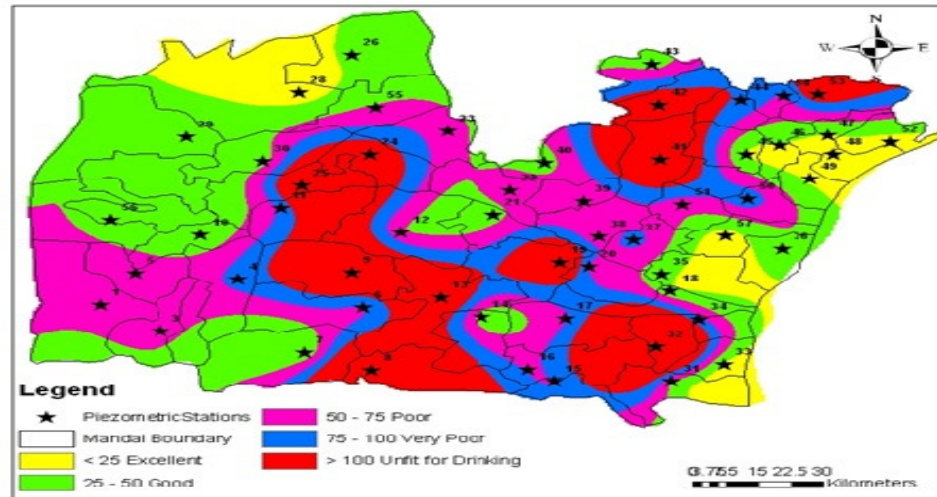
Most of the villages are having pH more than 8.5 which may cause incrustation in water supply systems. No village in prakasam district is less than 6.5 which may not cause tuberculation of water in the pipes. Some of the villages like parchuru, karamchedu, chundi etc. are within the range of 6.5-8.5.

#### **4.8 Nitrates**

The high concentrations of nitrates having range more than 100 is found in Donakonda, which arises due to over application of fertiliser improper manure management practices and operation of land, open dump sites of solid wastes. The villages having nitrates concentration less than 45 mg/l are gudluru, veligandla, inollu, peddaraveedu, kumbum, pamuru etc.,. And the range in between 45-100 mg/l are Giddaluru, Kanigiri, Darsi, Ponnaluru, Chirala, Karamchedu, Marturu etc.

#### **4.9 Water quality index**

The water quality index was found to be excellent in the villages pedaraveedu, Karamchedu, Maddipadu, Yanamadala where as the WQI was found to be good in the villages Tadivaripalli, yerragondlapalem-d, Gudluru, Chilakapadu, Cheemakurthy etc. WQI was poor in the villages Giddaluru-s, Bestavaripeta, Veligandla, Talluru, Mundlamuru, etc.,. And it is unfit for drinking in the villages Hanumanthunipadu, P.D.alavalapadu, Pullalacheruvu, New ch.kamula, Marthuru etc. The main reason observed for the water to be unfit is due to open dumping of solid wastes, presence of mining areas, misused ponds, use of fertilizers etc.



**Figure 2:** Spatial distribution of water quality index

## 5. Conclusions

The present work reveals whether the water is suitable or unsuitable for drinking purposes in the area. The major conclusions drawn from the study were given below.

1. It is observed, Kanigiri, Murrupudi, Donakonda, Markapuram, Kandukur, Addanki, Balikurva, Parchuru had water quality which is unfit for drinking. Necessary measures are to be taken to supply safe drinking water to the people living in the villages.
2. The water quality is excellent in the villages having the range less than 25mg/l are Yerragondapalem, Ramayapatnam, Jarugumalli, Inkollu, Karamchedu, Vetapalem, Chinaganjam, Chirala and Ongole.
3. Total hardness was found to be very high in Kuruchedu and Kothapatnam villages.
4. Very high chloride concentration more than 600mg/l was found to be in PC palli, Podili, Kuruchedu, Dornala, Donakonda, Kothapatnam, Naguluppalapadu, Maddipadu, Yeddapanudi and Ongole.

The final output has been given in the thematic representation of ground water quality. The analysis suggests that the groundwater of the area needs some degree of treatment before consumption. The study helps us to understand the quality of the water as well as to develop suitable management practices to protect the ground water resources.

### 5.1 Suggested further studies

Bacteriological examination of water if conducted would reveal the potability conditions of the water as per BIS standards. Ground water quality can be correlated with the land cover and land use practices in the study area.

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