Drinking Water Status of Eluru Canal Area- West Godavari District, Andhra Pradesh: A Case Study

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Abstract
Although the government assures that drinking water is available in most rural areas, the quality of that water supply is a problem. Currently, a large proportion of India's rural communities are consuming water that does not meet the drinking water quality standards. Physico chemical and micro-biological parameters of selected villages and municipalities of Eluru canal area are studied for all the three seasons of a year. Of all the drinking water sources, treated surface water sources are more contaminated followed by ground water and bottled water. But overall potability of drinking water is poor and it is less than 60% irrespective of the source and treatment methods. Ultimately consumers are suffering with various health problems. This is particularly very severe in coastal villages and towns. To have safe drinking water in rural areas stringent measures are needed in technical and financial aspects.

Keywords
Canal Water, Ground Water, Eluru Canal, Bottled Water, Rural Drinking Water, Potable Water, Contamination

I. Introduction

Traditionally water supply in India was limited to the major cities within the spread of the process of urbanization. Declining health standards in the rural areas urged the post-independence government to take serious initiative to improve the rural drinking water and sanitation. Now, one of the most important aims of the government is to ensure safe water supply to the rural areas. Historically, drinking water supply in the rural areas in India has been outside the government's sphere of influence. Community managed open wells, private wells; ponds often have been the main traditional sources of rural drinking water. Government of India's effective role in rural drinking water supply sector started in 1972-73 with the launch of Accelerated Rural Water Supply Programme (ARWSP). Between the years 1972 to 1986, the aim of ARWSP was to ensure safe water supplies to rural areas. ARWSP was renamed as Rajiv Gandhi National Drinking Water Mission in 1991-92 with further stress on rural water supply coupled with community planning and management of drinking water. With the passage of time, the programme was modified in 2009-10 and renamed as National Rural Drinking Water Programme (NRDP) with the national goal to provide every rural person with adequate safe water for drinking, cooking and other domestic basic needs on sustainable basis.

The basic requirement should meet minimum water quality standards and readily and conveniently accessible at all times and in all situations. But the majority of the schemes have became non-functional and many other permanently defunct due to non-availability of funds. According to recent statistics, 44 million are affected by degraded water quality with the excess of fluoride, arsenic, iron, nitrate, heavy metals and salinity. The programme now has been modified with major emphasis on ensuring sustainability of water availability in terms of potability, adequate convenience, affordability and equity. As per the strategy plan of ministry of drinking water and sanitation, Government of India at least 55% households shall be provided with service connection within their premises by 2017 and 90% households to be provided service connection by 2021. However the state Government may decide to provide more households connections depending on the feasibility 4,5.

Water, as source of drinking water, occurs as surface water and ground water. Surface sources are like rivers, canals, streams, reservoirs and ponds. Ground water may be in the form of open dug wells and bore wells. Three aspects should be considered in appraising water resources. They are the quality, the quantity and the reliability of available water. Water scarcity, which is broadly understood as the lack of access to adequate quantities of water for human and environmental uses, is considered to be one of the most important global risks for society. Global water demands are expected to increase in the future because of increasing population, urbanization and industrialization. In addition, aspects of climate change and anticipated increases in extreme weather conditions are expected to contribute to increase in the frequency, severity and duration of drought, which can exacerbate water availability problem. The water supply and sanitation sector will face enormous challenges over the coming decades.

In India ground water is consumed directly without any treatment and disinfection. Its quality is therefore cause of concern. The national objective reducing morbidity and mortality largely depend on the reduction of diarrhea, jaundice etc. In fact no water supply and sanitation programme can be successful if water related illness is not reduced. It is a matter of concern that despite the progress made with water supply, the level of water related illness continues to be high. Approximately 10 million cases of diarrhea, more than 7.2 lakhs typhoid cases and 1.5 lakhs viral hepatitis cases occur every year in India. A majority of them are contributed by unclear water supply and poor sanitation2.

Developing countries are more vulnerable to drinking water than developed countries. The annual per capita water availability in India was 1816m3 in 2001, which decreased to 1545m3 in 2011. The country is facing water stress and the demand for water is continuously increasing. India's drinking water crisis has become severe over the past decade. Increasing demands on available water resources for intensive agriculture practices and industrial use, together with deteriorating water quality, constrain drinking water availability. Moreover there are growing concerns about the sustainable use of ground water and surface water with respect to emerging issues of inequality of water distribution and access3.

While accessing drinking water continues to be a problem, assuming that it is safe is a challenge by itself. Water quality problems are caused by pollution and over exploitation. The rapid pace of industrialization and greater emphasis on agricultural growth combined with financial and technological constraints and non-enforcement of laws have led to generation of large quantities of waste and pollution. Water quality is affected by both point and non-point sources of pollution. These include sewage discharge, discharge from industries, run-off from agricultural fields and urban run-off. Water quality is also degraded, due to

lack of awareness and education among users. The need for user involvement in maintaining water quality and looking at other aspects like hygiene, environment, sanitation, storage and disposal are critical elements to maintain the quality of water resource.
Bacterial contamination of water continues to be a wide spread problem across the country and is a major cause of illness and death with 37.7million affected by water borne diseases annually. The major pathogenic organisms responsible for water borne diseases are bacteria (E.Coli, Shigella, V.Cholera), viruses (Hepatitis A, Polio Virus, Rota Virus) and parasites (E. Histolytica, Giardias, Hookworm). Contaminants include excess of iron, nitrates and brackishness especially in coastal areas. Increase in brackishness in coastal areas has been the result of ground water extraction through deep tube wells for drinking and irrigation purposes, leading to salinity ingress where sea water seeps in. The occurrence of inland salinity is due to over exploitation of ground water and less recharge of aquifers1.

II. Methodology

Water samples of various sources were collected from selected 17 villages and 3 municipalities of Eluru canal area. The samples collected were raw water samples of canals, summer storage tanks, ground water from open dug wells, bore wells, hand pumps and also from NGO/NTR source waters. Similarly treated water samples of surface water (from panchayat and municipal treated) and ground water including water samples directly supplied to consumer points with or without treatment; Private supplied drinking water by various branded and unbranded companies; NGO organizations and drinking water supplied under NTR Srujala Sravanthi Scheme. All these samples were collected for all the three seasons of a year 2015-16 and analyzed (However canal water samples were not collected during summer season as the canals were closed).The physico chemical and biological parameters analyzed are PH, Turbidity, TDS, EC, TH, TA, NH3, NO2, NO3, Cl-, DO, BOD, COD, Na, K, Residual Chlorine, MPN, TFC, E.Coli by following standard protocol6.

III. Results and Discussion

Following is the total number of samples collected and analyzed during the three seasons of the year (Oct 2015- Sept 16).

1. Total No. of samples collected (for all the three seasons) = 161
2. No. of villages and Municipalities selected = 17+3 =20
3. Total No. of surface water samples(canal) = 33
4. Total No. of summer storage pond samples = 42
5. Total No. of Ground water samples (Before treatment) = 6
6. No. of surface water (After treatment) = 43
7. No. of Ground water (After treatment) = 19
8. No. of NTR/NGO/Private suppliers samples = 15

A total of 161 samples were collected from all the sources and analyzed for various physic chemical and biological parameters. However only the averages of physico chemical parameters of all the seasons are presented in Table Nos-1, 2 &3.

Table 1: Averages of the Physico Chemical Analysis of Water Samples in Winter Season

PARAMETER	CANAL	S.W PRE TREATMENT	S.W POST TREATMENT	G.W PRE TREATMENT	G.W POST TREATMENT	G.W Direct Drinking/ OHT	NTR/ NGO
Turbidity (NTU)	3.07	4.35	2.68	1	0.8	0.32	0.51
pH	8.59	8.8	7.9	7.77	7.65	7.22	8.25
CO_3 (ppm)	0.00	2.94	0	4	0	0	0
HCO_3 (ppm)	97.7	101.1	108.9	380	265.83	182	51.4
Total Alk. (ppm)	97.7	102.8	108.9	384	265.83	182	51.4
TDS (ppm)	145.0	155.9	170.67	886	766.67	966	60
EC (µS/cm)	214.40	231.18	251	1314	1105	1390	90
Cal. Hardness (ppm)	18.11	18.5	23.46	58.4	83	116.8	9.42
Mag. Hardness (ppm)	8.37	7.71	8.024	35.7	29.39	18.53	3.11
Total Hardness (ppm)	80.00	78.53	90.3	292	325	368	37.14
D.O (ppm)	-	6.22	-	5.6	-	-	-
B.O.D (ppm)	-	3.04	-	3.24	-	-	-
C.O.D (ppm)	-	17.5	-	14.1	-	-	-
NH_3 (ppm)	0.02	0.009	0.005	0.006	0.05	0.01	0
NO_2 (ppm)	0.34	0.428	0.28	0.028	0.008	0.02	1.45
NO_3 (ppm)	8.44	6.95	4.52	8.45	7.76	9.88	2.16
K (ppm)	2.83	2.94	1.93	13.6	6	27.8	1.43
Na (ppm)	29.6	33	32.6	120	102.67	103.8	19.57
Cl (ppm)	31.93	31.7	41.6	184	269	313	24

Table 2: Averages of the Physico Chemical Analysis of Water Samples in Summer Season

PARAMETER	CANAL	S.W PRE TREATMENT	S.W POST TREATMENT	G.W PRE TREATMENT	G.W POST TREATMENT	G.W Direct drinking/ OHT	NTR/NGO
Turbidity (NTU)	-	7.52	2.71	3.7	2.8	4.2	1.44
pH	-	8.46	8.24	7.17	7.49	6.97	7.7
CO_3 (ppm)	-	1.87	2	0	6	0	0
HCO_3 (ppm)	-	114.25	111.33	222.5	245	193	39.14
Total Alk. (ppm)	-	115.5	113.33	222.5	245	193	39.14
TDS (ppm)	-	187.5	182	465	504	964	75.71
EC (µS/cm)	-	278.75	264.67	695	752	1390	114.3
Cal. Hardness (ppm)	-	26.5	24.26	42	56.4	105.6	7.71
Mag. Hardness (ppm)	-	11.3	11.76	18.24	19.7	20.22	3.14
Total Hardness (ppm)	-	110	109.33	180	222	347	32.14
D.O (ppm)	-	3.78	-	4.6	-	-	-
B.O.D (ppm)	-	5.33	-	5.4	-	-	-
C.O.D (ppm)	-	22	-	24	-	-	-
NH_3 (ppm)	-	0.05	0.02	0.03	0.02	0.03	0.15
NO_2 (ppm)	-	0.04	0.12	0.25	0	0.2	0
NO_3 (ppm)	-	4.3	2.97	13.55	12.11	49.52	2.76
K (ppm)	-	4	3.66	4.5	5.4	46	3.57
Na (ppm)	-	45	44.8	75	82.2	123.8	27
Cl (ppm)	-	33.5	32.13	85	94	271.52	18.36

Table 3: Averages of the Physico Chemical Analysis of Water Samples in Rainy Season

PARAMETER	CANAL	S.W PRE TREATMENT	S.W POST TREATMENT	G.W PRE TREATMENT	G.W POST TREATMENT	G.W Direct drinking/ OHT	NTR/NGO
Turbidity NTU	10.96	9.54	6.49	5.8	5.6	7.96	3.07
pH	8.11	8.59	8.24	7.28	7.17	7.07	7.58
CO_3 (ppm)	0	2.5	0	0	0	0	0
HCO_3 (ppm)	93.15	94.37	98.75	322	236	152	42.85
Total Alkalinity (ppm)	93.15	96.8	98.75	322	236	152	42.85
TDS (ppm)	174.74	170	187.5	850	756	996	112.9
EC (µS/cm)	250.52	241.25	268.13	1208	1100	1466	162.9
Cal. Hardness (ppm)	30.32	32.8	30.75	80.8	117.6	1264	12.57
Mag. Hardness (ppm)	8.58	6.39	7.45	17.52	14.16	1855	3.17

Total Hardness (ppm)	111.6	107.5	107.5	258	344	396	43.31
D.O (ppm)	-	4.63	-	5.5	-	-	-
B.O.D (ppm)	-	5.33	-	4.24	-	-	-
C.O.D (ppm)	-	17.8	-	13.4	-	-	-
NH_3 (ppm)	0.05	0.017	0.01	0.02	0.03	0.06	0.02
NO_2 (ppm)	0.02	0	0.03	0.004	0	0.01	0.006
NO_3 (ppm)	12	4.31	4.11	9.24	33.2	47.72	2.57
K (ppm)	0.16	0	0.5	4.4	0	4.4	1.71
Na (ppm)	49.7	49	51.62	313	87.2	94.8	51
Cl (ppm)	36.57	43.87	39.9	167.32	114.86	290.67	41.52

Table 4: Averages of the Physico chemical analysis of water samples in three seasons (summary)

PARAMETER	CANAL	S.W PRE TREATMENT	S.W POST TREATMENT	G.W PRE TREATMENT	G.W POST TREATMENT	G.W Direct drinking/ OHT	NTR/ NGO
Turbidity (NTU)	7.01	7.1	3.96	3.5	3.06	4.16	1.67
pH	8.35	8.6	8.12	7.4	7.43	7.08	7.84
CO_3 (ppm)	0	2.43	0.66	1.3	2	0	0
HCO_3 (ppm)	95.42	103.24	106.32	3.08	248.94	175.6	44.46
Total Alkalinity (ppm)	95.42	105.03	106.99	309.5	248.94	175.6	44.46
TDS (ppm)	159.87	171.1	10.05	733.6	675.5	975.3	82.87
EC (µS/cm)	232.46	250.3	261.26	1072.3	985.6	1415.3	122.4
Cal. Hardness (ppm)	24.21	25.9	26.25	60.4	85.6	116.26	9.9
Mag. Hardness (ppm)	8.47	8.4	9.07	23.82	21.08	19.1	3.14
Total Hardness (ppm)	95.8	98.67	102.37	243.3	297	370.3	37.53
D.O (ppm)	-	4.87	-	5.2	-	-	-
B.O.D (ppm)	-	4.56	-	4.2	-	-	-
C.O.D (ppm)	-	19.1	-	13.5	-	-	-
NH_3 (ppm)	0.03	0.02	0.01	0.03	0.03	0.03	0.05
NO_2 (ppm)	0.18	0.15	0.14	0.01	0.0004	0.07	0.48
NO_3 (ppm)	10.22	3.18	3.86	10.14	17.67	35.7	2.49
K (ppm)	1.49	2.31	2.03	7.5	3.8	26.06	2.23
Na (ppm)	39.65	42.33	43	169.3	90.69	107.4	32.52
Cl (ppm)	34.25	37.02	37.87	145.4	139.28	291.73	27.96

The physico chemical analysis of Eluru canal area drinking water shows that PH values at Nandamuru (9.24), Arrula (8.80), Krishnayyapalem (8.73) and Badampudi (8.69) are higher than the permissible limit of 8.50 in winter season. Similarly at Kovvali (9.30) and Krisnayyapalem (8.65) in summer season and Nandamuru (8.90), Krishnayyapalem (8.65) and Navabpalem (8.58) have crossed the limit. Similarly TDS, EC, TH, TA, Na and Chloride values are high in ground water samples of Nandamuru, Narayanapuram, Chebrolu and Kaikaram and crossed the standard values prescribed by BIS. Nitrates are high in ground water samples of Badampudi, Chebrolu, Kaikaram and Pulla.

Table 5: Microbiological Analysis of Drinking Water Surface Water of Eluru Canal Area:

S.No	NAME OF THE VILLAGE	WINTER	SUMMER	RAINY
1.	Nidadavolu	0	0	0
2.	Nandamuru	≥2400	210	1600
3.	Arrula	1100	1600	460
4.	Navabpalem	460	93	460
5.	Krishnayapalem	≥2400	0	≥2400
6.	Prathipadu	0	15	0
7.	T.P.Gudem	0	0	0
8.	Pentapadu	460	240	1100
9.	Unguturu	0	43	43
10.	Bhimadolu	240	0	460
11.	Gundugolanu	0	0	1600
12.	Pothunuru	≥2400	0	≥2400
13.	Kovvali	93	43	43
14.	Eluru	0	0	0

MPN values of Surface water shows that only in Nidadavolu, Tadepalligudem Gudem and Eluru Municipalities have Zero values in all the three seasons. In Gundugolanu it was zero in winter and summer seasons. In Prathipadu it is zero in winter and rainy seasons. In no other villages it is zero for any two seasons. It is a clear indication of the efficiency of technology variation between rural and urban areas. In case of Municipalities the treated water is 100% potable (9 out of nine) in all the three seasons where as in case of rural areas it is only 24.24% potable (8 out of 33).

Table 6: Microbiological analysis of drinking water (Ground water) of Eluru Canal area

S.No	Name of the Village	WINTER	SUMMER	RAINY
1	Nidadavolu	460	0	0
2	Nidamaru	0	15	64
3	Kaikaram	1100	0	460
4	Pulla	≥2400	23	--
5	Badampudi	0	0	0
6	Narayanapuram	43	0	1600
7	Chebrolu	240	0	≥2400

The MPN values of drinking ground water samples shows that it is zero in Badampudi village in all the three seasons. Whereas it is zero in Nidadavolu town during summer and rainy seasons. Only in summer season it is zero in Narayanapuram and Chebrolu. But altogether ground water samples are better than surface water samples.

Table 7: Microbiological Analysis of Drinking Water (NTR/NGO/ Private companies) of Eluru Canal area:

S.No	Name of the Village	WINTER	SUMMER	RAINY
1	Nandamuru	43	7	460
2	Kovvali	9	0	0
3	Krishnayapalem	43	0	0
4	Gundugolanu	≥2400	0	0
5	Pentapadu	460	0	0

The drinking water samples supplied by NTR srujala sravanthi, NGO organizations and other private companies are analyzed for its potability and the results show that no sample in winter season have zero MPN value. Whereas in other two seasons except Nandamuru it is zero in other villages (Kovvali, Krishnayyapalem, Gundugolanu and Pentapadu) where the samples are collected.

Table 8: Percentage Potability of various sources of drinking water (Both rural and municipalities in Eluru canal area)

S.No	Surface water	Ground water	NGO/NTR/ Private
1	40.47%	45.45%	53.33%

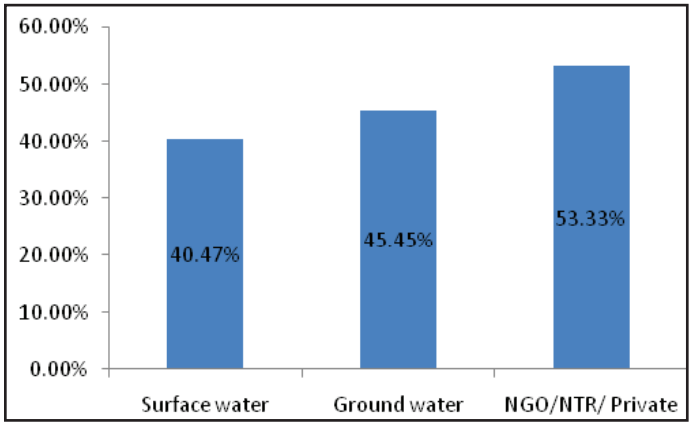

Fig.1: Percentage potability of drinking water samples of various sources in Eluru canal area:

IV. Conclusion

The objective of every nation is to provide safe drinking water for all. Panchayat involvement, community participation, Private public partnership, intersectorial coordination are very important to achieve the mission of distributing safe drinking water to the rural areas of India. In India, investments in community water supply and sanitation projects have increased steadily from first plan to the tenth plan. However health benefits in terms of reduction in water borne diseases have not been commensurate with the investment mode. Though health sector is being the burden of water and sanitation related infectious diseases, presently it does not have adequate institution or expertise for monitoring and surveillance of community water supply programmes in the country. India has witnessed significant improvement in rural water supply with increasing coverage of areas and a large volume of financial sources made available. A series of schemes are aimed at improving the supply of drinking water for rural habitations and now for maintaining and ensuring quality. One of the greatest challenges has been the convergence of various departments associated with water. Water and sanitation programmes have generated largely in isolation from programmes in health and education. A wide approach is needed where water and sanitation issues looked at with the aim of reducing disease, improving hygiene, improving educational levels and reducing poverty.

There could be little doubt that water is a basic necessity for the survival of humans. There is interplay of various factors that govern access and utilization of water resources and in the light of the increasing demand for water it becomes important to look for holistic and people centered approach for water management. Clearly drinking water is too fundamental and serious issue to left to one institution alone. It needs the combined initiative and action of all, if at all we are serious in socio economic development. Safe drinking water can be assured, provided we set our mind to address it. While on the one hand the pressure of development

are changing the distribution of water in the country , access to adequate water has been cited as the primary factor responsible for limiting development. The average availability of water remains constant according to the natural hydrological cycle but the per capita availability reduces steadily due to an increasing population.

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