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A Study on Comparison of Water Quality Index in Mylavaram Mandal, Krishna District, Andhra Pradesh

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Abstract: - In this work eleven water samples are collected from surface and ground water sources of three different villages Pondugala, Ananthavaram, and Chandrala in Krishna district of Andhra Pradesh. The water quality is analyzed for its suitability for drinking and construction purposes. Water quality index is developed based on two models viz., Parameter value based and standard value based and the index values obtained are compared. The water quality is high in hardness and TDS indicating water needs to be treated appropriately before consuming. The construction water quality indicates the water quality is high in acidity, alkalinity, organic and inorganic content. Two sources are identified as relatively better suitable among the 11 samples collected.

Keywords: - Water quality index, drinking water standards, construction water standards, water pollution.

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I. INTRODUCTION

The ground water quality is getting deteriorated due to several reasons [9] such as: (i) salt water intrusion (ii) organic, inorganic and heat pollution by sewage and industrial wastes (iii) leakages from waste sources. Ascertaining the ground water quality in and around Vijayawada is the need of the hour due to the formation of new capital of Andhra Pradesh after bifurcation. Several infrastructural ventures are being developed which along with increased drinking water demand for the population likely to migrate to the State capital is a serious concern. The quality of the water in the region, named as AP Capital Region Developmental Authority (APCRDA), is a major concern for the Administration. Few studies are available for the analysis of water quality in the region [7, 10, 13, 20, 22, 23, 24].

The ground water samples are collected in several locations, tested and results are compared with standard values for drinking purposes [1, 2, 10, 12, 15, 20, 24, 20]. It is observed that, all parameters tested for drinking purpose are within the desired limits [22], mixed results obtained from the study [2, 10, 20, 24] and the quality parameters are in excess of desired parameters [1, 12, 20]. Grab sampling is done in many studies but seasonal variations are also studied [12] for variation of water quality parameters with respect to season. The ground water quality is not suitable for drinking purposes at many of the studied locations. Poor ground water quality due to industrial wastes [7] is noticed.

Water Quality Index is developed [6, 13, 15, 17, 20, 21, 23] for the ground water samples collected. Spatial distribution of water quality index is plotted [23] and GIS mapping is performed [3, 4]. For water quality modeling, regression models [16, 20] and artificial Neural Networks are used [14, 19] are used. Majority of the studies are focusing mainly on studying the ground water quality for drinking purposes only. Very few studies are available for assessment of its use for construction purpose. Ground water quality is assessed for drinking, irrigation, and construction [13], drinking and irrigation [15] purposes.

II. STUDY REGION AND METHODOLOGY OF PRESENT STUDY

Three villages in Krishna district viz., Pondugala, Ananthavaram and Chandrala of Mylavaram mandal are selected for the present study purpose. Four samples each from Pondugala and Ananthavaram villages are collected while three samples are collected from Chandrala village. The sources of the samples are identified, viz., Bore well, Pond water, tap water, and drinking water from houses, such that they are mostly used in these villages.

The objectives of the present study are hence taken up with the following objectives:

- To assess the suitability of available water for its suitability for drinking and/or construction purpose.

- To develop water quality index for the drinking water quality in the study region.

Selected water quality parameters are identified separately for the present study for examination of water samples for drinking and construction purposes based on prevailing IS codes viz., IS 10500:2012 and IS 456:2000 respectively. The identified parameters and the permissible limits of these parameters as per the above IS codes are given in Table-1. Except for pH, two values are given in Table-1 for each parameter. These values indicate Acceptable limit and Permissible limit in the absence of alternate source as per IS 10500:2012.

Table-1: Permissible limits of selected water quality parameters as per prescribed IS codes

S No	Drinking water purpose as per IS 10500: 2012		Construction purpose as per IS 456:2000	
	Parameter	**Limits**	**Parameter**	**Limits**
1	pH	6.5-8.5	pH	>6.0
2	TDS	500-2000	Acidity	< 5 mL
3	Turbidity, NTU	1-5	Alkalinity	< 25 mL
4	Total Hardness (TH)	200-600	Inorganic matter	3000
5	Ca^{+2}	75-200	Organic matter	200
6	Mg^{+2}	30-100	Chlorides	2000 for PCC, 500 for RCC
7	Chlorides	250-1000	Sulphates	400
8	Sulphates	200-400		

All values in mg/L, except Acidity and Alkalinity which are expressed in terms of titrant and pH in terms of pH units.

III. RESULTS AND DISCUSSIONS

Grab sampling is done in these villages. Samples are given identification codes such as P1-P4 and A1-A4 for the four samples from Pondugala and Ananthavaram villages respectively while C1-C3 represent three samples from Chandrala village. All the samples are tested in the laboratory as per the standard methods for examination of water quality parameters. The samples are selected such that P1, P4 and A3 represent bore water, P2, A1, A4 and C2 correspond to pond water, P3 and C1 represent drinking water, and A2 and C3 correspond to tap water. The results are given in Table-2.

Table-2: Drinking Water Quality Parameters of study region

Parameter	P1	P2	P3	P4	A1	A2	A3	A4	C1	C2	C3	Limits#
pH	6.8	8.02	8.16	7.2	7.21	7.6	7.98	8.3	7.16	8.79	7.54	6.5-8.5
Turbidity (NTU)	5	0	2.26	1.2	21	0	0	28	3.1	14	4	1-5
TDS	1584	2750	1860	1640	342	1210	395	252	690	506	512	500-2000
Ca^{+2}	60	56	82	60	40	64	56	32	32	15	21	75-200
Chloride	178	134	623	243	56	291	111	349	102	114	116	250-1000
Mg^{+2}	72	12	38	72	19	98	26	16	24	12	21	30-100
Total Hardness	724	216	480	760	180	568	248	148	364	180	280	200-600
Sulphates	341	71	221	186	64	122	96	67	110	102	104	200-400

All units are in mg/L except pH.
Limits are as per IS 10500: 2012

3.1 Water Quality Index based on parameter weight basis (WQIPVB)

Standard procedure mentioned in the literature [15, 17, 20] is followed in the present study to develop water quality index based on parameter weight basis (WQIPVB). The weights are assigned to each parameter such that, the most significant parameters have a weight of 5 and the least significant a weight of 1. The relative weight (Wi) of each parameter is calculated as a ratio of weight of individual parameter and total weights of all parameters. The computations are carried out as per the following procedure:

Relative weight of each parameter, $Wi = \sum (Wi/W)$
Where, W = total weights of all parameters
Quality index of each parameter, $Ci = [(Va-Vi)/(Vs-Vi)] \times 100$

Where, Va = Average value of the parameter
Vi = Ideal value of the parameter = 7 for pH and zero for other parameters
Vs = Standard value of the parameter
The product of (Ci)(Wi) is calculated and is summed up for all the parameters under the study.

The WQIPVB of the water for drinking purpose is assessed based on the following rating scale [13]:

WQIPVB Rating scale:
WQIPVB: < 50: Excellent
WQIPVB: 50-100: Good
WQIPVB: 100-200: Poor
WQIPVB: 200-300: Very poor water
WQIPVB: >300: Unsuitable

The assumptions considered in computation of WQIPVB for sample P1 are given in Table-3. The summation of the values of *CiWi* is found to be 155. Similarly the computations for all the other samples are completed. The standard value of pH and turbidity are considered as 7.5 and 5 respectively in the present study.

Table-3: Assumptions used in computation for WQI values for WQIPVB model for P1 location

S No	Parameter	Standard value (Vs)	Weight	Relative weight, Wi	Quality index, Ci	CiWi
1	pH	7.5	4	0.17	-40	-6.80
2	Turbidity (NTU)	5	3	0.13	100	13
3	TDS	500	3	0.13	316.8	41.18
4	Ca^{+2}	75	2	0.09	80	7.20
5	Chloride	250	3	0.13	71.2	9.26
6	Mg^{+2}	30	2	0.09	241.33	21.72
7	Total Hardness	200	3	0.13	362	47.06
8	Sulphates	200	3	0.13	170.50	22.16
	Total			1.00		154.79

3.2 Water Quality Index based on standard value basis (WQISVB)
This is a second approach followed and is also widely used in literature [6, 11, 18, 23]. For calculating WQISVB, the following equations were used.

$WQI=\Sigma (Wi \times Ci)$
Where $Wi= (K/Vsi)$
$K = \frac{1}{\sum(1/Vsi)}$, a constant value
$Ci = [(Va-Vi)/(Vsi-Vi)] \times 100$

Where, Wi is the weightage factor of each parameter
Si is the standard value for the ith parameter prescribed by the standards
Ci is the quality rating for ith parameter
Va is the measured concentration for ith parameter which is estimated value
Vi is the ideal concentration/value for ith parameter
Vsi is the standard concentration for ith parameter recommended by standards i.e., same as Si

WQISVB Rating scale:
WQISVB: < 50: Excellent and fit for human consumption
WQISVB: 50-80: Moderately contaminated
WQISVB: 80-100: Excessively contaminated
WQISVB: >100: Highly contaminated and not suitable

The assumptions considered in the development of WQISVB are given in Table-4. The calculations for all other locations are carried out in a similar manner. The results obtained from the two models considered are shown in Fig.1 while the ranking based on Index value computed is given in Table-5.

Table-4: Assumptions used in computation for WQI values for WQISVB model for P1 location

S No	Parameter	Standard value (Vsi)	1/Vsi	Weight, Wi	Quality index, Ci	WiCi
1	pH	7.5	0.13	0.34	-40	-13.6
2	Turbidity	5	0.20	0.51	100	51.0
3	TDS	500	0.002	0.01	317	3.17
4	Ca+2	75	0.01	0.03	80	2.4
5	Chlorides	250	0.004	0.01	71	0.71
6	Mg+2	30	0.03	0.08	241	19.28
7	Total Hardness (TH)	200	0.01	0.01	362	3.62
8	Sulphates	200	0.01	0.01	171	1.71
	Sum		**0.40**	1.00		**68.3**
	K = (1/Sum(1/Vsi))		2.53			

Table-5: Comparison of Rating of drinking water quality based on the models developed

S No	Location Code	Rating of drinking water quality as per the model	
		WQIPVB	WQISVB
1	P1	Poor	Moderately contaminated
2	P2	Poor	Moderately contaminated
3	P3	Poor	Highly contaminated
4	P4	Poor	Moderately contaminated
5	A1	Good	Highly contaminated
6	A2	Poor	Moderately contaminated
7	A3	Good	Moderately contaminated
8	A4	Poor	Highly contaminated
9	C1	Good	Moderately contaminated
10	C2	Poor	Highly contaminated
11	C3	Good	Excessively contaminated

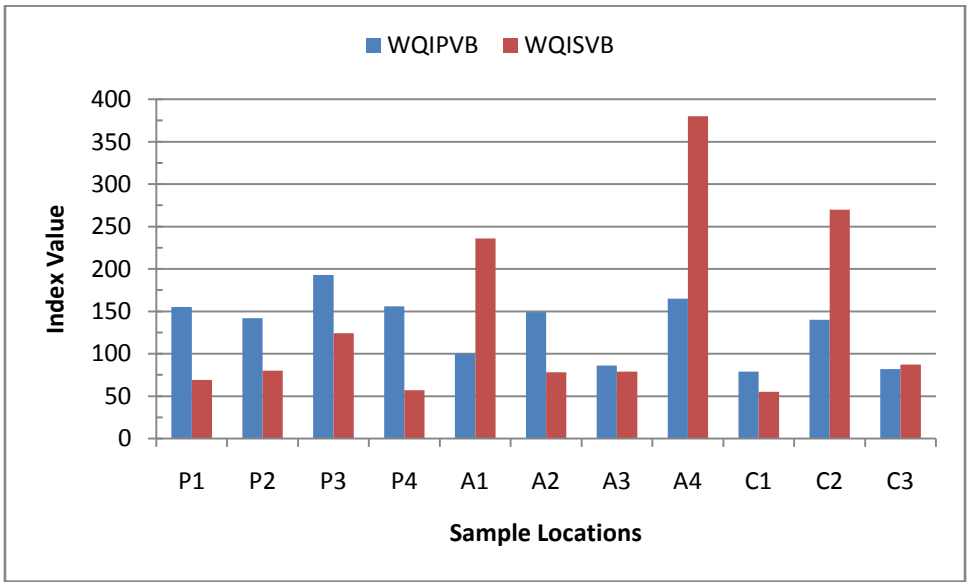

Fig.1 Comparison of Water Quality Index of two models considered in the study

It can be noted from the Table-5 that the drinking water quality is poor for P1-P4, A2, A4 and C2 based WQI PVB while the water quality is ranked as moderately contaminated for P1, P2, P4, A2, A3, and C1 based on WQISVB. For all samples of Pondugala the drinking water quality is ranked as Poor in both the models while it is a mixed ranking in other samples. To understand the variations in rankings, the parameters that are responsible for high values of WQI are identified for each of the two models and are summarized in Table-6.

Table-6: Parameters identified for high index values in the models

S No	Location Code	Water Source	Reason of poor water quality as per the model	
			WQIPVB	WQISVB
1	P1	Bore water	High values of Turbidity, TDS, TH, Sulphates, Mg+2	High values of Turbidity
2	P2	Pond water	High values of pH, TDS, TH	High values of pH
3	P3	Drinking water	High values of pH, TDS, Chlorides, TH	High values of pH, Turbidity, Mg+2
4	P4	Bore water	High values of TDS and Mg+2	High values of pH, Turbidity, Mg+2
5	A1	Pond water	Good	High values of pH, Turbidity
6	A2	Tap water	High values of pH, TDS, Mg+2, TH	High values of pH, Mg+2
7	A3	Bore water	Good	High values of pH
8	A4	Pond water	High values of pH, Turbidity	High values of pH, Turbidity
9	C1	Drinking water	Good	High values of pH, Turbidity
10	C2	Pond water	High values of pH, Turbidity	High values of pH, Turbidity
11	C3	Tap water	Good	High values of pH, Turbidity

The following observations are drawn from Table-6:

- Few common parameters are found in both the models along with few extra parameters.
- Bore water in Pondugala is Poor quality, while the quality is Good for the sample from Ananthavaram (A3). The ranking as per WQISVB indicates only the higher pH value otherwise the other parameters are comfortable.
- Pond water is usually high in turbidity and is reflected in A1, A4, and C2. However, due to the limits defined for ranking the water quality, the water quality is ranked as Good in A1 as per WQIPVB while Highly contaminated as per WQISVB. Same parameters of high values are noticed in A4 and C2.
- Tap water in Ananthavaram (A2) is having high values of Magnesium, TDS and TH and pH. But in WQISVB the high values of TDS and TH are found of less importance.
- The major parameters that are inducing high index values in all the three villages are pH, Turbidity, TDS, TH and Magnesium. It shows that the water samples are either hard (TH) are having high TDS.
- The high values of pH are limited to P2, P3, P4, A1-A4, C1-C4. It should be noted from Table-2 that, the pH values are ranging from 6.8-8.16 in Pondugala, 7.21-8.3 in Ananthavaram, 7.16-8.79 in Chandrala. The standard value considered for pH is 7.5 (range 6.5-8.5) and hence high values are noticed at few locations leading to high index values.
- The high values of Turbidity are limited to specific locations (P1, A4, C1, C2, and C3). The range of values recorded in Pondugala is 2.2-5, in Ananthavaram it is 0-28, and in Chandrala it is 3.1-14. The standard value considered is 5 NTU and hence high index values are obtained at few locations.
- Further, it is noted from the two models considered that WQIPVB is giving weightage based on relative importance of parameters, which is perception based and hence occasionally variable. But the WQISVB model is based on standardizing the weights based on a standard value that is considered in the study for a specific parameter (1/Si). Hence the ambiguity is less. It can be thus concluded from the present study that results of WQISVB are more reliable than that of WQIPVB.

3.3 Construction water quality comparison

The results of the water samples for ascertaining their quality for construction purpose is given in Table-7. The following are the observations from Table-7:

- Organic Matter (OM) content is high in Pondugala, parts of Ananthavaram (A1, A4) and Chandrala (C3). Inorganic Matter (IM) content is high in Pondugala (P1, P4), parts of Ananthavaram (A2, A3, A4) and Chandrala (C2, C3). The Inorganic solids are more in Bore water and tap water.
- The IM and OM usually do not interfere in concrete work except for the presence of few inorganic salts which reduces the strength of concrete [8].
- pH, Sulphates, Chlorides, and TSS are within the limits in all the villages. The water can be used for either PCC or RCC purpose without any difficulty of corrosion.

- Alkalinity and acidity are high in many of the samples. This may lead to long term corrosion of steel in concrete and reduced compressive strength of concrete due to acidic waters [8] while the compressive strength is slightly increased due to high alkaline conditions [5].
- From the results obtained, A3 and C2 are relatively better sources of water for construction purpose though they have slightly excess values of IM content.

Table-7: Comparison of Construction Water Quality Parameters:

Parameter	P1	P2	P3	P4	A1	A2	A3	A4	C1	C2	C3	Limits
Organic Matter	300	1000	1200	500	600	200	200	800	200	100	1200	200
Inorganic matter	500	300	300	1500	200	500	500	700	300	600	800	300
Sulphates	341	71	220	185	64	122	96	67	110	102	104	500
Chlorides	178	134	623	243	55	291	112	34	102	114	116	a)1000-RCC b)2000-PCC
TSS	700	1000	950	1400	950	150	350	850	900	600	450	2000
Alkalinity	55	65	100	61	32	76	24	22	52	23	36	20
Acidity	4	6	8	7.5	6	4.5	3	4.5	5	3.2	3	<=5
pH	6.8	8.02	8.16	7.2	7.21	7.6	7.98	8.3	7.16	8.79	7.54	> 6

All units are in mg/L except Alkalinity and Acidity expressed in terms volume of titrant, pH in terms of pH units

IV. CONCLUSIONS

The water quality in and around Vijayawada is of major concern due to formation of new capital of Andhra Pradesh as several developmental activities are being taken up. The water quality for drinking and construction purposes in three villages of Krishna district is examined by collecting eleven samples. The water quality is mainly hard and having high TDS in most of the sampling locations that requires treatment for removal of hardness and TDS before used for direct drinking purposes. The water quality for construction purpose is not bad but high in Inorganic matter, organic matter and alkalinity at a few locations. The water can be used for construction purposes with limitations and in absence of any other source.

REFERENCES

[1]. M. Adekunle, M. T. Adetunji, A. M. Gbadebo and O. B. Banjoko. "Assessment of Groundwater Quality in a Typical Rural Settlement in Southwest Nigeria", International Journal of Environment Research Public Health, 4(4), 2007, 307-318, ISSN 1661-7827.

[2]. A.A. Adesuyi, Nnodu Valerie Chinedu, Akinola Modupe Olatunde, Njoku Kelechi Longinus, Jolaoso Anuoluwapo Omosileola. "Groundwater Quality Assessment In Eliozu Community, Port Harcourt, Niger Delta, Nigeria", International Journal of Scientific & Technology Research, 4 (12), 2015, 149-155, ISSN 2277-8616.

[3]. K. Ambiga. "Assessment of Groundwater Quality Index Using GIS at Tirupathi, India", International Research Journal of Engineering and Technology, 3 (2), 2016, 552-564, e-ISSN: 2395 -0056, p-ISSN: 2395-0072.

[4]. R. Basawaraja and K B Chari. "Metrics and Dynamics of Urban Sprawl of Raichur City, India", International Journal of Advanced Remote Sensing and GIS, 7 (1), 2018, 2580-2588.

[5]. Himanshu Sharma, Hemant Sood, and Deepanshu. (2015). "Effect of Concentration of alkaline water on strength of Concrete", International Journal of Civil Engineering, 2 (1), 2015, 4-6, e-ISSN: 1694-2280.

[6]. R. Kavidha. "Ground Water Analysis in Erode District", Journal of Environmental Engineering and Studies, MAT Journals, 3 (1), 2018, 1-5.

[7]. G. Krishnaveni, T. Bhagyakumar and O. Sailaja, "Physico Chemical Properties and Heavy Metal Content of Water Collected from Ibrahimpatnam nearby VTPS Vijayawada", International Journal of Pharmacy and Biological Sciences, 6 (3), 2015, 42 – 49.

[8]. K.J. Kucche, S. S. Jamkar and P. A. Sadgir. "Quality of Water for Making Concrete : A Review of Literature" International Journal of Scientific and Research Publications, 5 (1), 2015, 1-10.

[9]. D.P. Kuity "Groundwater Quality: Indian Scenario", Vistas in Geological Research, ISBN: 81-900907-0-4, Special Publication in Geology, 13 (January 2015), 2015, 91-100.

[10]. Ch. Leelavathi, U. Krishna Sainath, and Abdul Khadar Rabbani. "Physicochemical Characterization of ground water of Autonagar, Vijayawada, Krishna district," International Journal of Education, Development and Research, , 4 (2), 2016, 1324-1328, ISSN: 2321- 9939.
[11]. Priti Singh and I.A. Khan. (2011). "Ground water quality assessment of Dhankawadi ward of Pune by using GIS", International Journal of Geomatics and Geosciences, 2 (2), 2011, 688-703.
[12]. Priyanka, Surendra Prasad and Anand Mohan Jhaa. (2014). "Quality Assessment of Drinking Water: A Case Study of Mohanpur Village of District Samastipur, Bihar, India", International Journal of Plant, Animal and Environmental Sciences, 4 (2), 2014, 75-79, ISSN 2231- 4490.
[13]. V. Ramakrishna, M. Charitha, G.V.S.N. Sai, S.N.D. Manikanta, and B. Rani, . "A Study on Ground Water Quality in AP CRDA Region", Asia Pacific Journal of Research, I (LII), 2017, 71-80, ISSN (Online): 2347-4793.
[14]. V. Ramakrishna (2011). "Modeling For Water Quality Prediction Using Regression and Artificial Neural Networks", Proceedings of National Seminar on Environment and Sustainable Development, Acharya Nagarjuna University, Guntur Dt., Oct 28-29, 2011, 37.
[15]. V. Ramakrishna (2017). "A Study on Water Quality Ranking in Rajam", International Journal of Engineering, Research and Technology, 6 (6), 2017, 344-349.
[16]. V. Ramakrishna, P.N.V. Sainath, N. Varun Krishna, Ch. Eshwar, B. Swathi, V. Keerthi, and G. Krishna Ashish (2017b). "Water Quality Modeling Using Regression Technique", National Conference on Recent Trends in Civil Engineering organized by Civil Engineering Department, SRK Institute of Technology, Vijayawada, 17-18 February, 2017.
[17]. Sanjib Das., Pankaj Kumar Roy and Asish Mazumdar. "Development of Water Quality Index for Groundwater in Kolkata City, West Bengal, India", ARPN Journal of Engineering and Applied Sciences, 8 (12), 2013, 1054-1058, ISSN 1819-6608.
[18]. J. Sirajudeen and Abdul Vahith R. **"**Applications of Water Quality Index for Groundwater Quality Assessment on Tamil Nadu and Pondicherry, India", Journal of Environmental Research and Development, 8 (3), 2014, 443-450.
[19]. P. Sirisha, K.N. Sravanthi and V. Ramakrishna. "Application of Artificial Neural Networks for Water Quality Prediction", International Journal of Systems and Technology, 1 (2), 2008, 115-123, ISSN 0974-2107.
[20]. G. Sudhakar, G. Swarnalatha, P.Brahmaji Rao, and V. Venkataratnamma. "Water Quality Analysis in Acharya Nagarjuna University Region, Guntur, Andhra Pradesh, India", IOSR Journal of Environmental Science, Toxicology and Food Technology, 8 (9: II), 2014, 37-40, ISSN: 2319- 2399.
[21]. G. Sudhakar, G. Swarnalatha, G. Vijayakumar, P. Brahmaji Rao, and V.Venkatarathnamma."Application of Nemerow's Pollution Index (NPI) for groundwater quality assessment of Bapatla mandal west region, coastal Andhra Pradesh, India", International Journal of Applied Sciences and Engineering Research, 4 (4), 2015, 500-506, ISSN 2277 – 9442.
[22]. M. Sujatha, A. Gopalakrishnayya, and T.Satyanarayana. "Assessment of Groundwater Quality in Rural Areas of Vijayawada, A.P.", International Journal of Engineering Research and Applications, , 2 (4), 2012, 645-648, ISSN: 2248-9622.
[23]. K. Sundara Kumar, Ch. Satish Kumar, K. Hari Prasad, B. Rajesh, R. Sivaram Prasad, and T. Venkatesh. "Assessment of Ground water Quality using Water Quality Index", International Journal of Innovative Research in Advanced Engineering, , 3 (2), 2015, ISSN: 2349- 2163.
[24]. B. Venkateswararao (2011), "Physicochemical analysis of selected ground water samples of Vijayawada rural and urban in Krishna district, Andhra Pradesh, India", International Journal of Environmental Sciences, , 2 (2: 2011), 2011, 722-726, ISSN 0976 – 4402.

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