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ESTIMATION OF WATER QUALITY INDEX BY WEIGHTED ARITHMETIC WATER QUALITY INDEX METHOD: A MODEL STUDY

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ABSTRACT

The current study is about water quality parameters of Vijayawada, Krishna district of Andhra Pradesh. This study is intended to estimate water quality Index (WQI) of study area using Weighted Arithmetic water quality index method. In this study the quality of water of study area is determined using the various physico - chemical parameters such as p^H , Total Dissolved Solids (TDS), Cl , SO_4 , Na, K, Ca, Mg, and Total Hardness (TH). Physico - Chemical analysis of water samples was carried out at one hundred and ninety different stations of study area for pre monsoon and post monsoon seasons of 2014 which is collected and analyzed out of which nineteen samples were selected and water quality index estimated. Out of one hundred and ninety samples nineteen prime locations (wherein physiochemical property values were maximum) were selected and the quality index was analysed and explained in this paper. This study is to investigate the suitability of water for drinking purpose based on Water quality Index (WQI) estimated. Keywords : Water quality index (WQI) , sulphate (SO_4), Sodium(Na),Potassium(K),Calcium(Ca), Magnesium(Mg), and Total Hardness (TH). Physico - Chemical parameters.

Key words: Crystalline silica, filler, rheology, fine aggregate.

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1. INTRODUCTION

"Water" the term is more important and one of the needs of human being to survive on this global village. Most part of this global village is covered by water ,that is 2/3rd's of area. Quality of ground water present in the current study area that is vijayawada, Krishna District , Andhra Pradesh is estimated. The quality of such water is estimated using four different methods present till now in this globe are National Sanitation Foundation Water Quality Index (NSFWQI), Canadian Council of Ministries of the Environment Water Quality Index(CCMEWQI), Oregon Water Quality Index(OWQI) and Weighted Arithmetic Water Quality Index Method(WAWQI).The present study is estimation of water quality index using weighted arithmetic water quality index method. In this study the reason for choosing the WAWQI method since it has edge over other methods such as in this method multiple water quality parameters are incorporated in to a mathematical equation that rates health of water body through a number called water quality index as well as it describes the suitability of surface and ground water sources for human consumption.

1.1. Study Area

Vijayawada, the second largest city in the state of Andhra Pradesh after Visakhapatnam, also it is one of the important commercial and transport centres of the state. The city happened to be the headquarters of the taluk for a long time and acted as a point of centrality to many of the districts of the state. The city is situated at the foot of a low range hills on the northern bank of the river Krishna with its cardinal points as 16° 31’ North latitude and 80° 37’ East longitude, around 70 km away from the coast. Over years the city has grown as a major economic, cultural and administrative nerve centre of coastal Andhra due to its nodal location as an important railway junction of and, also because of National Highway-5 and National Highway-9 traversing the city.

2. DATA COLLECTION

Water samples are collected randomly from different locations of vijayawada. Nearly one hundred and ninety samples were collected for pre-monsoon and one hundred and ninety samples were collected for post- monsoon for the year 2014. For all those three hundred and eighty samples the physio chemical properties of that collected water samples were analyzed and reported. Out of those three hundred and eighty samples only thirty eight that is nineteen samples for pre monsoon and nineteen samples for post monsoon for the year 2014 were considered for the water quality index for those areas or locations. The locations preferred among those thirty eight samples were having high physio chemical properties.

Table 1 Details of Pre monsoon 2014 sampling Locations

S.No	Sample No	Area	Location
1	S1	Gollapudi	TTDC
2	S2	Vidhyadharapuram	4 Pillars centre (Hotel Diamond)
3	S3	Kothapeta	Ganganamma Temple (OPP. To KBN college)
4	S4	Winchipeta	Railway quarters
5	S5	Brahmana Street	New Temple
6	S6	Kedareswararao peta	Friut market kalyanamandapam
7	S7	K.Khandrikha	shirdi nagasai temple (OPP to vignesh towers)
8	S8	Payakapuram(old)	Ramalayam
9	S9	Machavaram	Dasa Anjaneya swamy temple
10	S10	Gunadala	CTO Office
11	S11	Executive club	5 no.route

12	S12	Vijayanagar colony	Funtime club
13	S13	Autonagar	Automobiles technician kalyanamandapam
14	S14	Kamaiah topu	Maruthi nilayam
15	S15	saibaba kalyanamandapam	Opp. To autonagar bus teriminal
16	S16	Benz Circle	Hanuman Temple
17	S17	Rythu bazar	Bundar Road
18	S18	Ajithsingh nagar	Vijayawada
19	S19	vijayawada (U)	Vijayawada

Table 2 Details of Post monsoon 2014 sampling Locations

S.No	Sample No	Area	Location
1	S1	Gollapudi	TTDC
2	S2	Vidhyadharapuram	4 Pillars centre (Hotel Diamond)
3	S3	Kothapeta	Ganganamma Temple (OPP. To KBN college)
4	S4	Winchipeta	Railway quarters
5	S5	Brahmana Street	New Temple
6	S6	Kedareswararao peta	Friut market kalyanamandapam
7	S7	K.Khandrikha	shirdi nagasai temple (OPP to vignesh towers)
8	S8	Payakapuram(old)	Ramalayam
9	S9	Machavaram	Dasa Anjaneya swamy temple
10	S10	Gunadala	CTO Office
11	S11	Executive club	5 no.route
12	S12	Vijayanagar colony	Funtime club
13	S13	Autonagar	Automobiles technician kalyanamandapam
14	S14	Kamaiah topu	Maruthi nilayam
15	S15	saibaba kalyanamandapam	Opp. To autonagar bus teriminal
16	S16	Benz Circle	Hanuman Temple
17	S17	Rythu bazar	Bundar road
18	S18	Ajithsingh nagar	Vijayawada
19	S19	vijayawada (U)	Vijayawada

3. CALCULATION OF WATER QUALITY INDEX (WQI)

3.1. Methodology in Calculating WQI Using WAWQI Method

Step 1: Collect data of various physico- chemical water quality parameters.

Step 2: Calculate Proportionality constant " K " value using formula $k = (1/(1/\sum_{i=1}^{n} si))$ where "si" is standard permissible for n^{th} parameter.

Step 3: calculate quality rating for nth parameter(q_n)where there are n parameters . This is calculated using formula

$q_n=100\ \{ (v_n-v_{io})/(s_n-v_{io})\}$. Where as v_n = Estimated value of the n^{th} parameter of the given sampling station. v_{io}= Ideal value of n^{th} parameter in pure water. And s_n=Standard permissible value of the n^{th} pareameter.

Step 4: Calculate unit weight for the n^{th} parameters. $W_n=(k/s_n)$.

Step 5: Calculate Water Quality Index (WQI) using formula , $WQI = ((\Sigma w_n * q_n)/\Sigma w_n)$.

Table 3 Water Quality Index (WQI) and Status of water quality (Chatterji and Raziuddin,2002)

Water Quality Index Level	Water Quality Status
0 -25	Excellent Water Quality
26-50	Good Water Quality
51-75	Poor Water Quality
76-100	Very Poor Water Quality
>100	Unsuitable for drinking

Table 4 Analysis of pre monsoon 2014 & **Table 5** Analysis of post monsoon 2014 Water quality Analysi

Sample No	Area	Location (TABLE 4)	p^H	T.D.S	Cl	SO_4	Na	K	Ca	Mg	TH
S1	Gollapudi	TTDC	8.68	432	80	63	86	3.6	24	24	160
S2	Vidhyadharapuram	4 Pillars centre (Hotel Diamond)	8.2	582	110	75	95	6.9	40	34	240
S3	Kothapeta	Ganganamma Temple (OPP. To KBN college)	7.98	659	110	67	110	17	32	44	260
S4	Winchipeta	Railway quarters	7.79	581	90	81	101	8	40	34	240
S5	Brahmana Street	New Temple	8.85	877	140	74	123	100	56	39	300
S6	Kedareswararao peta	Friut market kalyanamandapam	8.52	819	220	76	188	1.8	24	44	240
S7	K.Khandrikha	shirdi nagasai temple (OPP to vignesh towers)	7.99	2515	940	265	654	96	16	107	480
S8	Payakapuram(old)	Ramalayam	8.43	439	100	62	95	3.6	24	24	160
S9	Machavaram	Dasa Anjaneya swamy temple	8.44	730	120	79	145	7	24	29	180
S10	Gunadala	CTO Office	8.87	947	170	95	270	54	8	34	160
S11	Executive club	5 no.route	8.41	774	200	79	176	9	32	49	280
S12	Vijayanagar colony	Funtime club	8.51	691	200	100	122	4.3	32	49	280
S13	Autonagar	Automobiles technician kalyanamandapam	8.37	774	200	167	145	3.1	40	58	340
S14	Kamaiah topu	Maruthi nilayam	8.13	479	90	23	88.1	4	32	24	180
S15	saibaba kalyanamandapam	Opp. To autonagar bus teriminal	8.42	992	320	131	210	7.8	24	68	340
S16	Benz Circle	Hanuman Temple	8.71	471	80	66	85.3	3.3	16	34	180
S17	Rythu bazar	Bundar Road	8.68	464	80	56	84	9.4	24	29	180
S18	Ajithsingh nagar	Vijayawada	8.36	422	80	60	66	3.6	24	24	160
S19	vijayawada (U)	Vijayawada	8.35	427	80	67	79	6	24	24	160
Sample No	**Area**	**Location (TABLE 5)**	**pH**	**T.D.S**	**Cl**	**SO4**	**Na**	**K**	**Ca**	**Mg**	**TH**
S1	Gollapudi	TTDC	8.44	399	60	41	67.6	3.36	41	20	180
S2	Vidhyadharapuram	4 Pillars centre (Hotel Diamond)	8.29	573	120	80	97.3	29	41	25	200
S3	Kothapeta	Ganganamma Temple (OPP. To KBN college)	8.56	556	110	78	102	17.2	24	34	200
S4	Winchipeta	Railway quarters	8.3	487	11	86	97.	21	16	25	14

			3		0		8				0
S5	Brahmana Street	New Temple	7.97	717	130	83	111	45	57	29	260
S6	Kedareswararao peta	Friut market kalyanamandapam	8.36	774	180	95	152	42	24	39	220
S7	K.Khandrikha	shirdi nagasai temple (OPP to vignesh towers)	8.6	2509	940	350	696	3.9	8	108	460
S8	Payakapuram(old)	Ramalayam	8.18	2509	980	415	628	15	773	98	580
S9	Machavaram	Dasa Anjaneya swamy temple	8.52	691	120	95	125	69.8	16	34	180
S10	Gunadala	CTO Office	8.61	634	150	58	171	44.6	8	20	100
S11	Executive club	5 no.route	8.58	781	200	88	141	35	32	44	260
S12	Vijayanagar colony	Funtime club	7.86	794	210	136	114	41	577	49	340
S13	Autonagar	Automobiles technician kalyanamandapam	8.12	819	200	231	101	80.2	57	49	340
S14	Kamaiah topu	Maruthi nilayam	8.49	477	100	65	95.3	4.26	16	34	180
S15	saibaba kalyanamandapam	Opp. To autonagar bus teriminal	7.32	1203	320	161	186	9.1	89	74	520
S16	Benz Circle	Hanuman Temple	8.63	568	110	93	102	4.84	8	49	220
S17	Rythu bazar	Bundar road	8.67	579	100	112	125	30.9	16	34	180
S18	Ajithsingh nagar	Vijayawada	8.59	413	100	61	61	4	41	25	200
S19	vijayawada (U)	Vijayawada	8.22	596	100	88	98	18	24	44	240

Table 6 Calculations of WQI for Pre Monsoon 2014 Data

Property	**pH**	**TDS**	**Cl**	**SO4**	**Na**	**K**	**Ca**	**Mg**	**TH**	**Σwi**	**Σqi**	**WQI**
S1	8.44	399	60	41	67.6	3.36	41	20	180		477.70	57.07
S2	8.29	573	120	80	97.3	29	41	25	200		843.92	110.09
S3	8.56	556	110	78	102	17.2	24	34	200		745.18	97.31
S4	8.33	487	110	86	97.8	21	16	25	140		697.87	91.76
S5	7.97	717	130	83	111	45	57	29	260		1076.29	142.85
S6	8.36	774	180	95	152	42	24	39	220		1107.15	149
S7	8.6	2509	940	350	696	3.9	8	108	460		2092.27	232.65
S8	8.18	2509	980	415	628	15	773	98	580		3227.27	290.82
S9	8.52	691	120	95	125	69.8	16	34	180		1302.56	187.55
S10	8.61	634	150	58	171	44.6	8	20	100		972.53	135.12
S11	8.58	781	200	88	141	35	32	44	260		1091.59	145.44
S12	7.86	794	210	136	114	41	577	49	340		1898.45	187.33
S13	8.12	819	200	231	101	80.2	57	49	340		1671.83	227.69
S14	8.49	477	100	65	95.3	4.26	16	34	180		563.40	71.25
S15	7.32	1203	320	161	186	9.1	89	74	520		1207.15	138.14
S16	8.63	568	110	93	102	4.84	8	49	220		673.76	87.39
S17	8.67	579	100	112	125	30.9	16	34	180		906.53	122.38
S18	8.59	413	100	61	61	4	41	25	200		546.02	65.6
S19	8.22	596	100	88	98	18	24	44	240		785.12	103.46
K	0.44	34.62	7.12	4.78	6.11	0.56	1.11	1.86	11.49			
Wi	0.05	0.03	0.03	0.02	0.03	0.06	0.01	0.06	0.04	0.33		
Si	8.5	1000	250	250	200	10	75	30	300			

Table 7 Calculations of WQI for Post Monsoon 2014 Data

Property	pH	TDS	Cl	SO4	Na	K	Ca	Mg	TH	Σwi	Σqi	WQI
S1	8.44	399	60	41	67.6	3.36	41	20	180		477.70	57.07
S2	8.29	573	120	80	97.3	29	41	25	200		843.92	110.09
S3	8.56	556	110	78	102	17.2	24	34	200		745.18	97.31
S4	8.33	487	110	86	97.8	21	16	25	140		697.87	91.76
S5	7.97	717	130	83	111	45	57	29	260		1076.29	142.85
S6	8.36	774	180	95	152	42	24	39	220		1107.15	149
S7	8.6	2509	940	350	696	3.9	8	108	460		2092.27	232.65
S8	8.18	2509	980	415	628	15	773	98	580		3227.27	290.82
S9	8.52	691	120	95	125	69.8	16	34	180		1302.56	187.55
S10	8.61	634	150	58	171	44.6	8	20	100		972.53	135.12
S11	8.58	781	200	88	141	35	32	44	260		1091.59	145.44
S12	7.86	794	210	136	114	41	577	49	340		1898.45	187.33
S13	8.12	819	200	231	101	80.2	57	49	340		1671.83	227.69
S14	8.49	477	100	65	95.3	4.26	16	34	180		563.40	71.25
S15	7.32	1203	320	161	186	9.1	89	74	520		1207.15	138.14
S16	8.63	568	110	93	102	4.84	8	49	220		673.76	87.39
S17	8.67	579	100	112	125	30.9	16	34	180		906.53	122.38
S18	8.59	413	100	61	61	4	41	25	200		546.02	65.6
S19	8.22	596	100	88	98	18	24	44	240		785.12	103.46
K	0.44	34.62	7.12	4.78	6.11	0.56	1.11	1.86	11.49			
Wi	0.05	0.03	0.03	0.02	0.03	0.06	0.01	0.06	0.04	0.33		
Si	8.5	1000	250	250	200	10	75	30	300			

4. RESULTS AND DISCUSSIONS

The ground water quality of present study area that is vijayawada, krishna district , Andhra Pradesh is calculated or estimated using different physico and chemical parameters such as p^H**,** Total Dissolved Solids (TDS), Cl , SO_4 , Na, K, Ca, Mg, and Total Hardness (TH) at nineteen different stations of study area. The data collected regarding physicochemical parameters is during pre-monsoon 2014 and post - monsoon of 2014. Water quality index values depicted through the Weighted arithmetic water quality index method were shown in table number 6 & 11. Table no: 6 indicates the water quality index values of pre-monsoon 2014 and table no :11 indicates the water quality index values for post - monsoon 2014.Fig 2 the pictorial depiction clearly explains that the pre monsoon 2014 values are much suitable for drinking purpose in most of the stations where samples are collected. Whereas in post monsoon 2014 data shows that most of the stations are not suitable for drinking according to the table no: 7 .The pollution after monsoon is more than that of pre monsoon in current study area during the year 2014.

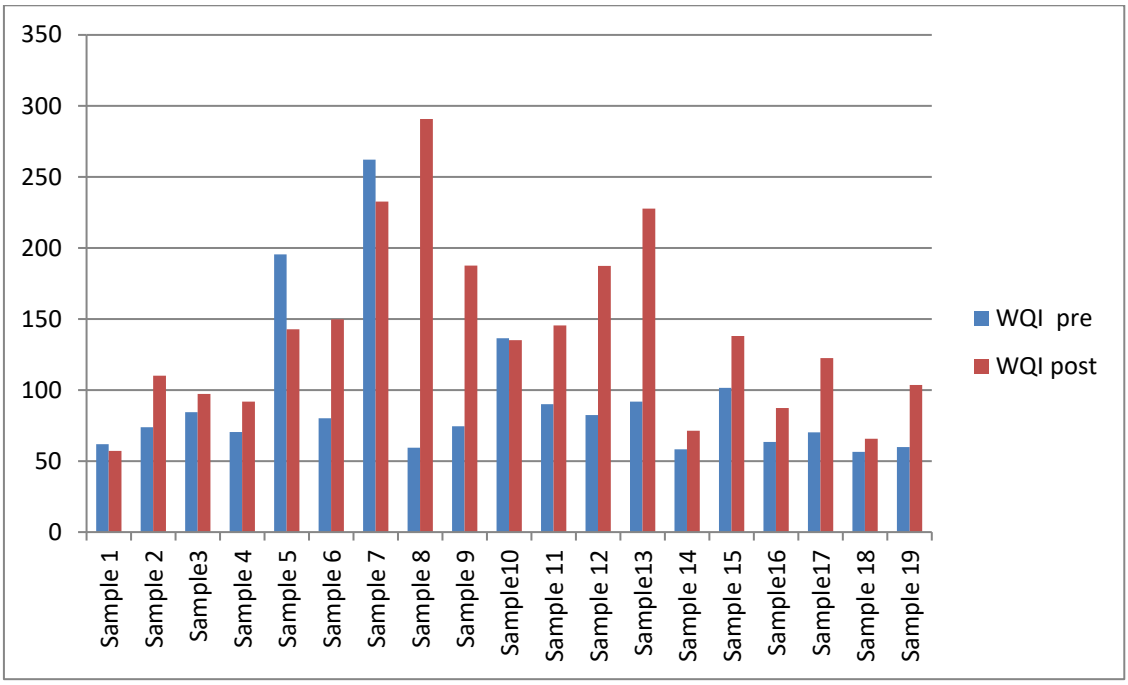

Figure 1 Pictorial Depiction

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