IRJSE *Int. Res. J. of Science & Engineering,* 2020; Special Issue A7: 32-36 SJIF Impact Factor 6.68
ISSN: 2322-0015
RESEARCH ARTICLE **OPEN ACCESS**

Assessment of water quality for drinking purposes using correlation study and water quality index.

Umare Vikas D

Department of Chemistry, Janata Mahavidyalaya Chandrapur
Email: drvikasdumare@gmail.com

Manuscript Details
Available online on http://www.irjse.in
ISSN: 2322-0015

Cite this article as:
Umare Vikas D. Assessment of water quality for drinking purposes using correlation study and water quality index., *Int. Res. Journal of Science & Engineering,* February, 2020, Special Issue A7: 32-36.

ABSTRACT

The water from bore well, deep well and tap were collected from different locations of Chandrapur city and nearby villages of the city. They were analyzed for physicochemical parameters to ascertain water quality for drinking use. The analysis report showed that some water parameters comply with drinking water standards. The correlation study was carried out to find out closeness between water quality parameters. The correlation study indicated that most of pair of water parameters significantly inter correlated to one another. The few parameters showed poor or insignificant correlation. The water quality index was calculated using weighted arithmetic index method. The range of water quality index clearly signifies poor quality and requires treatment before use.

Keywords: Physicochemical analysis, correlation coefficient, water quality, water quality index.

INTRODUCTION

Water is most essential natural resource required for all kind of living being on the earth for their survival.[1] It is the used for industrial, agricultural, drinking and other domestic utility.[2] The quality of water is depends on presence of physical, chemical and biological constituents in water. The release of undesirable content into water reservoir due to natural process like weathering of rock, industrialization, urbanization and anthropogenic activities degrades water quality and consequently affects life.[3-5]

The supply of potable water to every citizen by water supplying agencies is big issue and requires continuous monitoring of water quality. In the present work, an attempt has been made to evaluate and improve water quality by physicochemical analysis, correlation study and water quality index.

Study area

The Chandrapur city is located at 19.57^0 N latitude and 70.18^0E longitudinal in the eastern Maharashtra and situated at 189.9 meter above from main sea level. The area of the city region is about 70.02 KM^2.

METHODOLOGY

We have collected five water samples from viz. Tukum, ST Wokshop, Major Gate, Nandori, Khairgaon and assigned as S_1, S_2, S_3, S_4 and S_5 site sample respectively in the month of March 2019. The water was sampled in well cleaned pre-dried polythene bottles with necessary precautions. The temperature was recorded immediately and air tight with lid and brought into laboratory for chemical analysis. They were analyzed for water parameters like color, odor, taste, turbidity, PH, EC, TDS, TH, alkalinity, chloride, fluoride, nitrate, calcium, magnesium and iron using standard methods and results were related with standards given by USPH, BIS, WHO and ICMR.[6-10]

Statistical analysis: The results of chemical analysis were subjected to statistical analysis and inter correlated using Microsoft Excel. The correlation coefficient (r) between dependent and independent parameter was determined and correlation matrix diagram is constructed. The literature study reveals that several researchers founds correlation between dependent and independent water parameters and subsequently estimates drinking water quality.[11-13] In correlation study, correlation range from 0.8 to1.0 and -0.8 to -1.0 is termed as strong, from 0.5-0.8 and -0.5 to -0.8 as a moderate and weak when correlation range is 0.0 to +0.5 and -0.0 to -0.5.[14] The positive and negative sign indicates significant and non-significant correlation respectively.

Water quality Index (WQI): Determination of water quality index is effective mathematical tools to ascertain water quality.[15-16] The weight arithmetic index method was used to evaluate suitability of water quality for drinking purpose in present work. The water parameters viz. turbidity, PH, EC, total dissolved solids, total hardness, alkalinity, chloride, fluoride, nitrate, calcium, magnesium and iron were selected to calculate water quality index. Determination of WQI was summarized as follows. Firstly unit weight (w_1) was assigned to water quality parameters on the basis of power of influencing water quality **Table 1**. In second step, relative weight (W_i) of each parameters **Table 1** was calculated by following expression.

$$Wi = wi / \sum_{i=1}^{n=12} \text{wi}$$

Where=Wi is relative weight, wi is unit weight of each parameter and n is number of selected parameters. In next step, quality rating of each parameter was calculated by dividing its concentration by its permissible limit and result multiplied by 100 according to formula as shown below.

$$Qi = (Ci\text{-}Ii/Si\text{-}Ii)*100$$

Where=Qi is water quality rating, Ci is concentration corresponding to i^{th} parameter, Ii is ideal value of i^{th} parameter in mg/l (ideal value of PH is 7 and all other parameters was zero), Si is standard value for i^{th} parameter in mg/l.

The water quality sub-index (SIi) was calculated for each parameter by multiplying its relative weight (Wi) with its water quality rating (Qi) using expression SIi= Wi*Qi where SIi is sub-index value for i^{th} parameter. Finally water quality index was determined by adding sub-indices of all parameters using following expression.

$$WQI = \sum_{i=1}^{n=12} \text{SIi}$$

The computed WQI were categorized into five classes for drinking.[17-18] The range for WQI for drinking use is given in **Table 2**

.RESULTS AND DISCUSSION

The sixteen water quality parameters were determined for water samples in present study and results were assembled in **Table 3**. All the water samples were colorless and acceptable odor and taste. Their temperature was fairly constant. The turbidity of all water samples are lies in the desirable limit. The PH of water is important parameter to know extent of hydrogen ion concentration in water. The PH of water samples under study lies in acceptable range given by BIS. The electrical conductivity of water determines soluble ionic concentration in water. In the present work EC lies in safer desirable range except S_4 site. The TDS of water samples lies in permissible limit except S_4 water. The alkalinity of S_4 and S_5 site sample lies above prescribed standard limit. The chloride, fluoride, nitrate, TH, Ca, Fe and Mg of all water samples lie in the desirable limit.

Table 1: Unit weight and relative weight determination

W/P	STD	Unit Weight (wi)	Relative weight (Wi)
Turb.	5	2	0.054
PH	7	4	0.108
EC	800	4	0.108
TDS	500	4	0.108
Alk.	200	2	0.054
Cl	250	2	0.054
F	1	4	0.108
NO3	45	5	0.135
TH	300	2	0.054
Ca	75	2	0.054
Mg	30	2	0.054
Fe	0.3	4	0.108
		Sum of wi=37	Sum of Wi= 0.999

Table 3: Physicochemical and statistical analysis of water samples

Sample	S_1	S_2	S_3	S_4	S_5	Mean	Range	WHO	USPH	BIS
Source	BW	TW	BW	BW	DW	--	--	--	--	--
Temp.	22.5	22.5	22.5	22.5	22.5	--	--	--	--	--
Color	CL	CL	CL	CL	CL	--	--	--	--	--
Odor	AG	AG	AG	AG	AG	--	--	--	--	--
Taste	AG	AG	AG	AG	AG	--	--	--	--	--
Turb.	0.50	0.30	0.17	0.40	0.80	0.349	0.7	--	--	5-10
PH	8.4	7.3	8.3	8.5	8.2	8.21	1.5	6.5-9.2	6-8.5	6.5-8.5
EC	722	715	949	3512	938	1654	2797	300	300	800
TDS	469	465	617	2283	610	1075	1818	500-1500	500	500-2000
Alk.	192	76	286	370	180	270.6	428	--	--	200
Cl	22	75	25	380	59	131.5	358	200-600	250	250-1000
F	0.33	0.02	0.66	0.21	0.19	0.291	0.78	1-1.5	--	1-1.5
NO_3	23.14	42.97	8.75	46.55	28.62	28.85	45.56	40-50		45
TH	216	142	400	456	32	359.7	510	100-500	500	300-600
Ca	24	34	29	128	73	62.77	105	75-200	100	75-200
Mg	47	26	90	80	38	70.11	104	30-150	30	30-100
Fe	0.13	0.11	0.02	0.13	0.03	0.081	0.11	0.3	1.0	0.3-1
All water parameters were expressed in mg/l except Turbidity and EC which were expressed in NTU and S/cm respectively. Abbreviations: BW, TW, and DW indicates Bore Well, Tap water and Dip well Water, CL=colorless, AG=Agreeable, Turb.=Turbidity										

Table 2: Classification of water quality

Water quality index	Rating of water quality
0-25	Excellent
26-50	Good
51-75	Poor
76-100	Very poor
Above 100	Unfit for drinking

Table 4: Correlation coefficient among water quality parameters

	Turb.	PH	EC	Alk.	TDS	Cl	F	NO_3	TH	Ca	Mg	Fe
Turb	1.000											
PH	0.211	1.000										
EC	-0.065	0.456	1.000									
Alk.	-0.185	0.815	0.786	1.000								
TDS	-0.065	0.456	1.000	0.786	1.000							
Cl	-0.045	0.298	0.982	0.656	0.982	1.000						
F	-0.408	0.568	-0.116	0.508	-0.116	-0.290	1.000					
NO_3	0.161	-0.344	0.554	-0.079	0.554	0.699	-0.876	1.000				
TH	-0.324	0.699	0.750	0.976	0.750	0.624	0.555	-0.113	1.000			
Ca	0.281	0.387	0.915	0.632	0.915	0.920	-0.304	0.622	0.585	1.000		
Mg	-0.493	0.674	0.530	0.904	0.530	0.380	0.769	-0.371	0.949	0.300	1.000	
Fe	-0.094	-0.065	0.388	-0.008	0.388	0.474	-0.521	0.662	-0.122	0.217	-0.215	1.0
Light red fill indicates strong correlation Light green fill indicates moderate correlation												

Table 5: Determination of water quality rating (Qi) of different parameters at respective sites

Sample	Turb.	PH	EC	Alk.	TDS	Cl	F	NO_3	TH	Ca	Mg	Fe
S_1	10	93.3	90.2	96	93.8	8.8	33	51.4	72	32	156.7	43.3
S_2	6	20	89.37	38	93	30	2	95.48	47.33	45.33	86.77	36.66
S_3	3.4	86.6	118.6	143	123.4	10	66	19.44	133.3	38.66	300	6.66
S_4	8	100	439	185	456.5	152	21	103.4	152	170.7	266.7	43.3
S_5	16	80	117.2	90	122	23.6	19	63.6	10.66	97.3	126.6	10

In the present study, the substantial relationship between two parameters had been derived with the help of correlation coefficient. The correlation coefficient (r) among different physicochemical parameters of water were calculated and presented in matrix **Table 4**. From matrix table, it is observed that EC had strong significant correlation with TDS (1.000), Cl (0.982), and Ca (0.915), moderate correlation with Alk. (0.786), NO_3 (0.554), TH (0.750) and Mg (0.530). This showed that with increase and decrease of EC value; TDS, Cl, Ca, Alk., NO_3, TH and Mg also exhibits decrease or increase in their value. The turbidity showed non-significant correlation with EC, Alk, TDS, chloride, fluoride, total hardness, magnesium and iron indicated that turbidity is independent on EC, Alk, TDS, chloride, fluoride, total hardness, magnesium and iron. The PH is strongly correlated alkalinity (0.815) and moderately correlated with fluoride (0.568), TH (0.699), and Mg (0.674). The alkalinity showed strong correlation with TH (0.976) and Mg (0.904) whereas moderate correlation with TDS (0.786), Cl (0.656), F (0.508), and Ca (0.632). The TDS showed significant correlation with Cl (0.982) and Ca (0.915), moderate correlation with NO_3 (0.554), TH (0.750) and Mg (0.530). The Cl founds strong correlation with Ca (0.920) and moderate correlation with NO3 (0.699) and TH (0.624). It reveals that Cl is present in water n the form of $CaCl_2$ and $CaNO_3$. The F showed moderate relation with TH (0.555) and Mg (0.769). The NO_3 showed moderate correlation with Ca (0.622) and Fe (0.662). The TH showed strong relation with Mg (0.949) and moderate relation with Ca (0.585). It suggested that TH of water samples s mainly due to presence of Mg and Ca ions. Other pair of parameters was either insignificant or poorly correlated presented in table 2.

Table 5 and **6** showed water quality rating (Qi), WiQi, Water quality index and quality of water at respective sampling sites. The WQI at site S4 showed heavy pollution may be due to anthropogenic activities and found to be unfit for drinking use. The WQI at site S_1, S_2 and S_5 was 65.28, 52.48 and 65.74 respectively indicated poor quality for drinking use whereas WQI of S_3 indicated very poor water quality for drinking use.

CONCLUSION

The quality of water in the Chandrapur city and nearby areas has been analyzed. On the basis of analytical finding most of water parameter at all sites lies beyond desirable limit. The correlation study reveals significant inter correlation between several dependant and independent parameters. The WQI of water at respective site showed poor quality of water. It can be concluded that **w**ater quality was not too good and require pre-treatment before use.

Acknowledgements: The author is thankful to M. Subhas, Principal, Janata Mahavidyalaya, Chandrapur (M. S.) for providing necessary facility during work.

Conflicts of interest: The authors stated that no conflicts of interest.

REFERENCES

1. Smita P. G. and Byrappa K, Physico-chemical characteristics of water samples of Bantwal Taluk, South-Western Karnataka. India. J Environ Biol, 2007, 28: 591-595.
2. Singh S. and Janardhan R., Evaluation of ground water quality and its suitability for domestic and irrigation use in part of the Chanduli-Varanasi region Uttarpradesh, India. Journal of water resource and protection, 2015,7, 572-587
3. Khatri N. and Tyagi S. Influences of natural and anthropogenic factors on surface and ground water quality in rural and urban areas, Journal of Frontier in Life science, 2015; 8, (1) 23-29
4. Diersing and Nancy, Water Quality: Frequently ask questions, Florida Brooks National Marine Sanctuary, Key West, FL, 2009
5. Sharma, S. and Bhattacharya, Drinking Water Contamination and Treatment Techniques. Appl. Water Sci. 2017, 7 (3) : 1043-1067.
6. APHA Standard method of examination of water and waste water 20th edition (Washington) (1995) 148
7. BIS Manual for specification for drinking water, Bureau of Indian Standards, BIS, India, (1983) pp 23-56.
8. WHO Guideline for drinking water quality, 3rd edition, World Health Organization, Switzerland (2004) pp 1-515.
9. ICMR, Guidelines for drinking water quality, Indian Council of Medical Research New Delhi, India (1996) pp 456-463.
10. USPHS Drinking water Standard, United States Public Health Service, Washington (1962), pp 956-978
11. Jothivenkatachalam K and et al Correlation analysis of drinking water quality in and around Perur Block of Coimbtore District, Taminadu India. Rasayan Journal of Chemistry 2010, 3, (4) 649-654
12. Heyderi, M. M and et al Correlation study and regression analysis of drinking water quality in Kashan City, Iran, Middle East J. of Scientific Research, 2013, 13, (9), 1238-1244.
13. Kumar, N. and Sinha, D. K. Drinking water quality management through correlation study among various physicochemical parameters: A case study. Int. J. of Environ. Sci. 2010, 1, (2), 253-259.
14. Nair G. A and et al Physicochemical parameters and correlation coefficients of ground water of North east Libya. Poll. Res 2005, 4, 1-6
15. B. Hulya, Utilization of water quality index method as a classified tool, Environmental monitoring and assessment. 2009, 167, 300-306.
16. P. B. Jagadeeswari and K. Ramesh Water quality index for Assessment of water quality in South Chennai Coaster Aquifer, Tamilnadu, India, International J. of Chem. Tech Research. 2012, 4, (4), 1582-1588
17. Brown R. M. and et al, Water Quality Index-Crashing, The Psychological Barrier, Proc. 6th Annual Conference, Advances in Water Pollution Research. 1972, 787-794
18. C. Chatteree and M. Rizuiddin, Determination of Water Quality Index of a Degraded River In Asanol Industrial Area, Ranianz, Burdwan, West Benal, Nature, Environment and Pollution Technology. 2002, 1, (2),181-189.