Water Quality Index For Assessment Of Water Samples Of Different Zones In Chandrapur City

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Abstract

The paper aims at determining the suitability of ground water of different zones in Chandrapur city with reference to index also termed as Water Quality Index (WQI). The objective of the index is to convert complex data pertaining to water quality into the most comprehensible and simple data that can be understood by general public and policy makers as a whole. The present work deals with monitoring of variation of seasonal WQI of selected locations of the city which is one of the most polluted city in the country as far as water and air pollutions are concerned. In the present study, groundwater sample of rainy and winter seasons of the selected different zones of the city were taken for investigation and analysed for various parameters with regard to drinking water standards and assessed for their suitability for human consumption.. After analysis it has been observed that ground water quality of most of the zones are not suitable for drinking water and deteriorates from rainy to winter season due to increase in microbial activity thereby highlighting the major issue of drinking water availability and measures to be adopted due to growing industrialization and unhealthy human activities.

Keywords: Ground water, Physico- Chemical characteristics, Pollution, Water Quality Index

1.0 INTRODUCTION:

Ground water is one of the major resources of the drinking water in Chandrapur city which is one of the industrialized city of Maharashtra The most potent threat to the quality of groundwater that has emerged in our country is pollution. The main source of pollution beneath the agricultural fields in India is excessive use of fertilisers and pesticides, which not only creep into plants and subsoil but in groundwater as well. Another source is rapid industrialization in and around the city which is the index of modernization thereby leading to alteration in the physical, chemical and biological properties of ground water. The third source is due to increased human activities (growing population) giving rise to various water borne diseases causing serious health problems.

In order to summarize water quality data in understandable format , number of measures (indices) have been devised. One such index is Water Quality Index(WQI) which was first mathematically developed by Horton as a means of deriving a single value from numerous test results .Similar to Ultra violet index or an air quality index , it can inform us about the potential threat to overall quality of water bodies. This index also helps to compare the data between various locations.

The different statistical methods were followed for studying water quality data depending on rank order of observations and factor analysis. (Shoji et al; 1966, Harkin, 1974). In the past, WQI method was adopted for evaluation of water quality (Gupta et al, 2003 ;Avvannavar & Shrihari, 2007 A.Kumar & A.Dua,2009; V.S.Shrivastava et al; 2010).

2.0 PHYSIOGRAPHY:

Chandrapur is a mineral rich district with a dense forest spread over 41.5 % of total land.. Physiographically, the district is situated in the Wainganga and Wardha river basin. The city is located in the eastern part of Maharashtra.It's geographical coordinates lies between 19.30' N to 20.45'N Latitude and 78.46'E longitude.

3.0 GROUND WATER MONITORING LOCATIONS (SAMPLING SITES) AND THEIR SELECTION :

The sampling points are chosen to cover the entire radius of 10 km of Chandrapur after preliminary survey of the area, in order to get a exact evaluation of water quality assessment in and around Chandrapur city. The selection of sampling sites are based on following criteria

Market area(S1) is the region where all activities related to storage and selling of vegetables, groceries, food products etc are carried out on daily basis. It is the oldest part of the city and local people consumes ground water as the drinking water through hand pumps. Moreover due to open drain system in this area, has led to the ground water contamination and some parameters beyond acceptable norms.

Residential area(S2) The Drinking water quality of the Tukum area was analyzed for physico-chemical parameters. As per IS –10500 sample exceeds limit for chlorides concentration. Chlorination also needs to be done prior to usage for drinking. The Bacteriological analysis of groundwater samples reveals that the water is not contaminated and can be used for drinking purpose with proper treatment.

MIDC area (S3) is one of the area where there is large concentration of various industries viz chemical, sponge iron unit, Automobile workshops,tiles industries etc. Based on available minerals and abundant water, various industries have been set up within and in the surrounding of Chandrapur City. Some are within the municipal limits and some in the various industrial zones in MIDC areas.

Commercial area(S4) is the area where private hospitals, restaurants, hotels, commercial complex schools are set up which has open drainage system and also lac improper sanitation.

Coal mines /Agri zone (S5) lies in the vicinity of the town where mining activities are carried out and this area also encompasses agricultural zone .The ground water contamination is due to heavily discharged mine water and Agricultural runoff and improper agricultural practices.

Irai River(Datala Bridge) (S6)- The Irai river flowing through the heart of the city is one of the major source of water used for drinking mostly for cattle , irrigation,agriculture and industrial purpose. The water contamination is due to effluent discharge from industries, fly ash disposal from power plant, religious activities such as Idol immersion and other rituals, bathing of cattles etc.

4.0 MATERIALS AND METHODS

4.1Sample Collection

Water samples were collected in pre-cleaned sterilized polypropylene bottles with necessary precaution from different sites. Samples were collected in monsoon as well as winter seasons. Various physico-chemical parameters are analysed as given in standard manual of water and waste water analysis .

The main aim of the study is to investigate the physico-chemical characteristics of water samples in Chandrapur city , because most of these samples are located in the vicinity of the city. Sample sites are described in **Table 1.**

Table1. Description of water sampling sites

Sampling Code	Source	Location
S1	Bore well	Market area
S2	Bore well	Residential area
S3	Bore well	MIDC
S4	Bore well	Commercial area
S5	Bore well	Coal mines/Agri zone
S6	Irai River	Datala Bridge

4.2 Laboratory Analysis

The collected water samples analysed for ten parameters in the lab as per standard procedures.

The pH was measured with pH meter. Analysis of DO, alkalinity, chlorides, total hardness, Dissolved Oxygen, B.O.D, turbidity, MPN, fluoride, Iron were carried out in our laboratory.

Reagents used for the present investigation as per standards and double distilled water used for preparing various solutions. All the reagents and calorimetric solution were prepared and purified according to standard method for the examination of water .

5.0 PHYSICO-CHEMICAL ANALYSIS OF WATER SAMPLES :

Table 2 shows the values of various physico-chemical parameters for different locations.

Samples / Parameters	WHO/ BIS	S1		S2		S3		S4		S5		S6	
		R	W	R	W	R	W	R	W	R	W	R	W
PH	6.5-8.5	7.0	7.5	6.95		6.96		7.04		7.01			
Total Hardness(mg/l)	500	268	540	144	292	160	576	284	224	240	300		212
Chlorides (mg/l)	200	40	275.91	25	55.98	28	93.97	65	155.95	66	50		97.66
Alkalinity (mg/l)	200	300	170	220	204	440	212	450	250	280	200		78
D.O. (mg/l)	4-6	4.2	8	6.0	6.5	8.0	8.2	6.8	8.2	7.0	7.8		9.0
B.O.D. (mg/l)	6	60	80	87	110	80	100	98	100	100	90		110
M.P.N.(per 100 ml)	10	900	920	7.2	16	20	17	180	210	430	920		540
Turbidity(NTU)	5-10	3.8	0.5	2.0	0.4	4.2	0.4	3.0	0.6	2.0	3.0		3.7
Fluoride(mg/l)	1.5	1.1	0.7	1.0	0.3	0.6	0.8	0.9	0.6	0.18	0.4		1.4
Iron (mg/l)	0.3	0.1	0.1	0.12	0.12	0.1	0.18	0.16	0.2	0.18	0.2		0.16

6.0 Determination of Water Quality Index(WQI)

The Water Quality Index was calculated using Weighted Arithmetic Index Method. Essentially a WQI is a compilation of number of parameters that can be used to determine the overall quality of a water.

The mathematical relation used to calculate WQI is given as-

- WQI= Σ Q i Wi / ΣWi
- Where Q i – Quality rating scale
- Wi - Relative weight , Wi = 1/Si
- Si- Std. permissible value
- Q i = 100 [(Vn-Vi) /(Vs- Vi)]
- Vn- actual or test value of the parameter
- Vi- ideal value of the parameter
- Vs- recommended WHO std of the parameter

In this study, the WQI for human consumption is considered and permissible WQI for drinking water is taken as 100.

Sample Calculation for S1(Rainy Season) Table 3

S.No.	Parameter	Test value	Si	Qi	Wi=1/Si	QiWi
1	pH	7.0	7.0	0	0.143	0
2	Total Hardness	268	500	53.6	0.002	0.1072
3	Chlorides	40	200	20	0.005	0.1
4	Alkalinity	300	200	150	0.005	0.75
5	D.O.	4.2	6.0	121	0.17	20.6
6	B.O.D	60	6.0	1000	0.17	170
7	MPN	900	10	9000	0.1	900
8	Turbidity	3.8	10	38	0.1	3.8
9	Fluoride	1.1	1.5	73.33	0.7	51.33
10	Iron	0.1	0.3	33.33	3.33	111
					ΣWi= 4.55	ΣQ iW i = 1257.68
				WQI =	276.41	

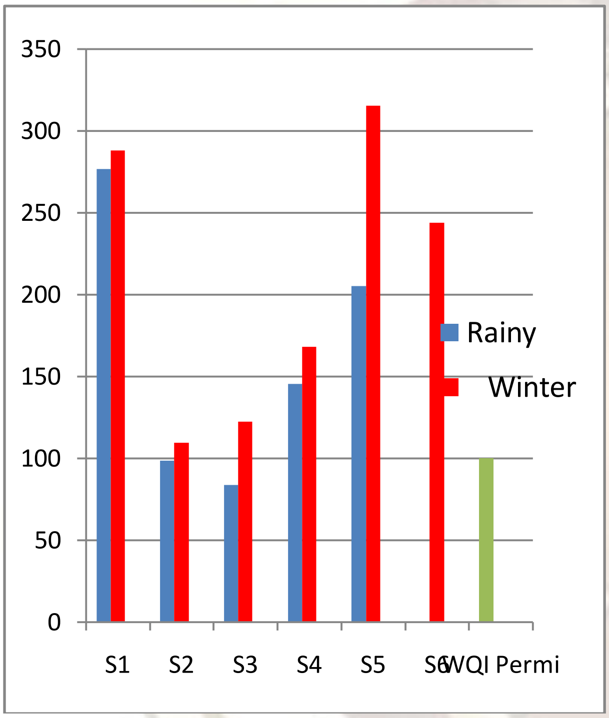
Water Quality Classification (Table 4)

WQI Value	Water Quality
Less than 50	Excellent
50 – 100	Good Water
100 – 200	Poor Water
200 – 300	Very Poor Water
Above 300	Water unsuitable for drinking

7.0 Results for WQI (Table 5)

Location	Rainy Season		Winter Season	
	WQI	Water Quality	WQI	Water Quality
S1	276.41	Very poor	287.91	Very poor
S2	98.57	Good	109.2	Poor
S3	83.61	Good	122.25	Poor
S4	145.38	Poor	167.78	Poor
S5	204.92	Very poor	315.33	Unsuitable for drinking
S6			243.93	Very poor

Graphical Representation of WQI (fig1)



8.0 DISCUSSION:

Water Quality Index for various locations are calculated for rainy as well as winter season. The water quality indices that were found in two different seasons have been tabulated in Table 5. Table3 represents calculation of Water Quality Index (WQI) of location S1(Market area) in rainy season which is 276.41.

For better understanding of the variation, the result was also represented graphically in Figure 1. Also, Table 4 explains water quality classification based on WQI criteria for different ranges of WQI values.

From the comparative analysis of WQI values for all sampling location in both rainy and winter season, it was observed that WQI values for location S1 varied from **276.41** in rainy to **287.91** in winter season. In location S2, it varied by **98.57** in rainy to **109.2** in winter season. At location S3, WQI varied from **83.61** to **122.25**. For S4 , it varied from **145.38 to167.78 and for S5 from 204.92 to 315.33 in rainy a**nd winter season respectively.

Hence, it can be seen that water quality of different locations in the city deteriorates slightly from rainy season to winter season. This could be due to the fact that the microbial activity get reduced due to low temperature, thereby keeping DO level at a very satisfactory range during entire rainy season. Also during winter , the water quality deteriorates on account of the increase in microbial activity as well as increase in pollutants concentration due water evaporation as the temperature is normally higher in the city.

The permissible WQI for human consumption is upto 100. Samples S2 and S3 (Rainy seasons)shows quality good for drinking purpose but at the same time poor quality in winter season. In majority of the cases water contamination has been remarkebaly increased .

9.0 CONCLUSION :

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It is very clear from the graph that WQI for coal mines region (S5)is totally unsuitable for drinking purpose while for market area (S1) is of very poor quality.

Application of Water Quality Index (WQI) in this study has been found useful in assessing the overall quality of water and to get rid of judgment on quality of the water. This method appears to be more systematic and gives comparative evaluation of the water quality of sampling stations.

There are some limitations of WQI. For instance, WQI may not carry enough information about the real quality situation of the water. Also many uses of water quality data cannot be met with an index. But there are more advantages of WQI than disadvantages. An index is a useful tool for "communicating water quality information to the public and to legislative decision makers;" it is not "a complex predictive model for technical and scientific application" (McClelland, 1974).

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