Qualitative Analysis of Water Quality through Index Method: A Case Study of Firozabad City (India)

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Abstract: ***The present study intended to calculate the Water Quality Index of Firozabad ground water in order to assess the qualitative aspect of drinking water supply of the city by comparing it with existing standards for important parameters. Water Quality Index is calculated from physico-chemical analysis of eight parameters taken together, which ranges from 235.56 to 576.59 indicating the heavy pollution load in water. The result of this study indicate that the drinking water supply of the city do not conform the recommendation standards, and hence it is suggested to take all necessary precautionary measures before it is sent to public consumption to avoid adverse health impacts and to prevent various intestinal epidemics. It is concluded that WQI is a useful tool and can be used in comparing the water quality of different sources.***

Keywords: physico-chemical analysis, water quality index, qualitative aspect, drinking water

1. Introduction

Water, the most essential supporting element for the survival of human life gives full support in the movement, circulation and cycling of nutrients. It is interesting to note that the requirement of water for various purposes is increasing at a rapid rate on the one hand, while sufficient potable quality of water is deteriorating and its pollution level is going up at a fast rate on the other. However, out of 1500 km^2 of water present in the hydrosphere, merely 1% is available for the fulfillment of the needs of human beings and it is obtainable from the such sources as groundwater, river, lakes, soil profile, atmosphere and biological system, though 99% comes from groundwater (Singh. L 2010). In general, the quality of water is equally important as the quantity. Therefore, water quality is considered as an important factor to judge environment changes which are strongly associated with social and economic development (Darapu, et al 2011). According to WHO organization, about 80% of all the diseases in human beings are caused by water. Once the groundwater is contaminated, its quality cannot be restored by stopping the pollutants from the source. It therefore becomes imperative to regularly monitor the quality of groundwater and to device ways and means to protect it. Contamination of groundwater by domestic, industrial effluents and agricultural activity is a serious problem faced by developing countries. The industrial waste water, sewage sludge and solid waste materials are currently being discharged into the environment indiscriminately. These materials enter subsurface aquifers resulting in the pollution of irrigation and drinking water (Girija, T.R. et al., 2007). Therefore, the assessment of water quality is very important for knowing its suitability for various purposes. Water quality index (WQI) indicates the quality of water in terms of index number for any intended use. It is defined as a rating reflecting the composite influence of different water quality parameters were taken for calculation of water quality index (Rao et al.,2010). The concept of indices to represent gradations in water quality was first proposed by Horton (1965) then it developed by several researchers like Brown et al (1970) and improved by Deininger (Scottish development department, 1975). The index results represents the level of water quality in a given water basin, such as ponds, lake, river or stream (srinivas, J. 2013). Many researchers in india have studied water quality for different purposes. Dakad, N.K. (2008) studied to know the ground water pollution and its suitability for drinking and domestic purposes in Jhabua town of Madhya Pradesh. Rao, C.S (2010) calculated water quality index in order to assess the suitability of water collected from different areas in Guntur district of Andhra Pradesh. Srinivas, J. (2013) determined water quality index in Kakinada industrial areas of Andhra Pradesh.

2. Material and Methods

Water samples were collected in pre cleaned plastic bottles of 2 liters and were analyzed for water quality parameters like pH, electrical conductivity, total dissolved solids, total hardness, total alkalinity, calcium magnesium and chlorides as per standard method 2002. Water samples of bore well were collected from three selected sites namely Agra Gate (S1), Suhag Nagar (S2) and Raja Ka Tal (S3). In this study, for the calculation of water quality index, eight important parameters were chosen. The WQI has been calculated by using the standards of drinking water quality recommended by the Indian Council of Medical Research (ICMR) and Bureau of Indian Standards (BIS). Further, quality rating or sub index (q_n) was calculated with weighted arithmetic index method using the following expression.

$$q_n = 100\,(V_n - V_{io}) / (S_n - V_{io})$$

(Let there be n water quality parameters and quality rating or sub index (q_n) corresponding to nth parameter is a number reflecting the relative value of this parameter in the polluted water with respect to its standard permissible value).

q_n = Quality rating for the nth Water quality parameter.
V_n = Estimated value of the nth parameter at a given sampling station.

Sn = Standard permissible value of the *nth* parameter.
Vio = Ideal value of nth parameter in pure water, (i.e., 0 for all other parameters except the parameter pH and Dissolved oxygen (7.0 and 14.6 mg/L respectively).

Unit weight was calculated by a value inversely proportional to the recommended standard value *Sn* of the corresponding parameter.

Wn =K / Sn
Wn = Unit weight for the *nth* parameters.
Sn= Standard value for *nth* parameters.
K= Constant for proportionality.
The overall Water Quality Index calculated by aggregating the quality rating with the unit weight linearly (Brown, et al 1970).

$$\mathbf{WQI} = \sum qn\, wn / \sum wn$$

In this study, the computed grads of WQI values were categorized into five types for human consumption according to (Ramakrishniah, C.R et al 2009), as they were revealed in (Table 1) WQI indicates the quality of water in terms of index number which represents overall quality of water for any intended use.

Table 1: Water Quality Index Grades (WQI) and status of water quality (Ramakrishniah, Sadashivaiah and Ranganna 2009)

Water Quality Index Levels	*Description*
<50	Excellent
50-100	Good water
100-200	Poor water
200-300	Very poor (bad) water
>300	Unsuitable and Unfit for drinking

Table 2: Drinking Water Standards recommending Aggencies and unit weights

Parameters	*Standard values (Sn)*	*Recommended agency*	*Units*	*Unit Weight (wn)*
Ph	6.5-8.5	ICMR/BIS	-	0.219
EC	300	ICMR	Micromhos/cm	0.371
TDS	500	ICMR/BIS	mg/lit	0.0037
TH	300	ICMR/BIS	mg/lit	0.0062
AL	120	ICMR	mg/lit	0.0155
Ca	75	ICMR/BIS	mg/lit	0.025
Mg	30	ICMR/BIS	mg/lit	0.061
Cl	250	ICMR	mg/lit	0.0074

Note: all values except pH and Electrical Conductivity are in mg/l.

3. Result and Discussions

According to the standards recommended by various agencies (Table 2), the results of the physico-chemical parameters water at various points shows that pH values at all stations are acceptable and varies from 7.46 (S2, Table 4) to 7.82 (S1, Table 3). pH is an important parameter which determines the suitability of water for various purposes (Sengupta and Dalwani 2008). Though, pH has no direct effect on human health, all biochemical reactions are sensitive to the variations of pH. If it is less, algae die, fish cannot reproduce and it causes acidity, corrosion, irritation of mucous membranes, tuberculosis and other health problems in humans (Srinivas, et al. 2013).

Electrical conductivity and total dissolved solids were also found to be very high. Electrical conductivity determines the water quality for drinking and agricultural purpose. The values of EC is from 968 (S3, Table 5) to 2483 (S1, Table 3) micromhos/cm. while its ideal value is <2.4 millimhos (Chatterjee 1992). The total dissolved solids ranges between 653.60-1766.40 mg/l (Table 3 and 5). Higher TDS at Agra Gate is due to the intensive industrial activity. TDS affects palatability of food cooked and also causes gastro intestinal irritation (Chaterjee and Raziuddin 2002).

Table 3: water quality index of Agra gate (s1)

Parameters	*Values S1*	*Standard values (Sn)*	*Unit Weight (wn)*	*Quality Rating (Qn)*	*wn*Qn*
Ph	7.82	6.5-8.5	0.219	54.53	11.94
EC	2483.20	300	0.371	827.73	307.09
TDS	1766.40	500	0.0037	353.28	1.31
TH	1286.40	300	0.0062	428.8	2.66
AL	193.60	120	0.0155	161.33	2.5
Ca	1066.40	75	0.025	1421.87	35.55
Mg	220.00	30	0.061	733.33	44.73
Cl	982.60	250	0.0074	393.04	2.91
			0.7088	4373.91	408.69
Water Quality Index $\sum qn\, wn/\sum wn$				**576.59**	

Table 4: water quality index of suhag nagar (s2)

Parameters	*Values S2*	*Standard values (Sn)*	*Unit Weight (wn)*	*Quality Rating (Qn)*	*wn*Qn*
Ph	7.464	6.5-8.5	0.219	30.93	6.77
EC	1319.8	300	0.371	439.93	163.22
TDS	909.4	500	0.0037	181.88	0.67
TH	358.4	300	0.0062	119.47	0.74
AL	213.2	120	0.0155	177.67	2.75
Ca	268	75	0.025	357.33	8.93
Mg	90.4	30	0.061	301.33	18.38
Cl	130.4	250	0.0074	52.16	0.39
			0.7088	1660.7	201.85
Water Quality Index $\sum qn\, wn/\sum wn$				**284.78**	

Table 5: water quality index of raja ka tal (s3)

Parameters	*Values S3*	*Standard values (Sn)*	*Unit Weight (wn)*	*Quality Rating (Qn)*	*wn*Qn*
Ph	7.80	6.5-8.5	0.219	53.07	11.62
EC	968.00	300	0.371	322.67	119.71
TDS	653.60	500	0.0037	130.72	0.48
TH	264.60	300	0.0062	88.2	0.55
AL	208.00	120	0.0155	173.33	2.69
Ca	118.20	75	0.025	157.6	3.94
Mg	136.80	30	0.061	456	27.82
Cl	53.80	250	0.0074	21.52	0.16
			0.7088	1403.11	166.96
Water Quality Index $\sum qn\, wn/\sum wn$				**235.56**	

Alkalinity value less than 100 mg/l is desirable for domestic use. However in large quantities it imparts bitter taste to water (Hariharan et al. 2010). In the present investigation the total alkalinity at all sampling stations is high and varied from 193.60-213.2 mg/l (Table 3 and 4). Total hardness of water is characterized by contents of calcium and magnesium salts (Srinivas, et al. 2013).The total hardness in the study area were found to range between 264.60-1286.40 mg/l (Table 5 and 3).

The quantities of calcium in natural water depend up on the type of rocks. Small concentration of calcium is beneficial in reducing the corrosion in water pipes. Magnesium hardness particularly associated with sulphate ion has laxative effect on persons unaccustomed to it (Hariharan et al 2010). In the present study calcium and magnesium ions are found in the range of 118.20-1066.40 mg/lit (Table 3 and 5) and 90.4-220.00 mg/l (Table 3and 4) respectively.

Chloride is one of the most important parameter in assessing the water quality. Munawar (1970) is of the opinion that higher concentrations of chlorides indicate higher degree of organic pollution. In this study chloride concentration lies between 53.80-982.60 mg/lit.

4. Conclusion

The water samples taken from various locations of the Firozabad city for physico-chemical analysis, reveals that all the parameters of Agra Gate (S1) except pH is beyond the permissible limits ICMR and BIS. While Suhag Nagar (S2) and Raja ka Tal (S3) lies within the maximum prescribed limit. The analysis of experimental investigation on quality of groundwater using physico-chemical parameters of the study area indicates that the quality of water in terms of index number is very poor to unsuitable or unfit for drinking purpose. Those index values reveal that the status of water at Agra gate (576.59) is unfit according to WHO guideline standards (Ramakrishniah et al 2009). Contrary to this, the WQI values for the sampling sites S2 (Suhag Nagar) and S3 (Raja ka Tal) is 284.78 and 235.56 respectively, indicating very bad water (200-300). The high WQI values is due to increase in pollution due to the discharge of various domestic and industries wastewater and also other anthropogenic hazardous waste. Thus, it can be inferred from the results of the present study that water of Firozabad city is severely contaminated. Therefore, it is recommended that the municipal board of the city should take into account this serious issue of water quality degradation. Moreover, there should be a regular monitoring for the quality of water, because this could increase the risk of direct threats to human health and environment.

References

[1] Ahmad, I.K., Salih, N.M. and Nazar, Y.H. **2012**. Determination of water quality index (WQI) for Qalyasan stream in Sulaimani city, Kurdistan Region of Iraq. *International Journal of Plant, Animal and Environmental Sciences.* Vol. **2**. Issue.**4**. pp.148-156.

[2] Brown, R. M. , McClelland, N. I. Deininger, R. A. , and Tozer, R. G. **1970**. "A water quality Index- Do we dare?", *Water & Sewage Works*. Vol. **117 (10)**:339-343.

[3] Chatterjee, A.A. **1992**. Water quality of Nandankanan lake, India. *J. Environ. Hlth*. Vol. **34. No. 4**, pp. 329-333.

[4] Chatterjee, C. and Raziuddin, M. **2002**. Determination of water quality index (WQI) of a degraded river in Asanol Industrial area, Raniganj, Burdawan, West Bengal, Nature. *Environment and pollution Technology*. Vol. **1. No. 2**, pp. 181-189.

[5] Darapu, Er. S.S. K., Sudhakar, Er. B., Krishna, K.S.R., Rao, P. V., and Shekhar M. C. **2011**. Determining Water Quality Index for the Evaluation of water Quality of River. *International Journal of Engineering Research and applications (IJERA)*. Vol. **1, issue 2**, pp. 174-182.

[6] Dhakad, N.K., Shinde, D. and Choudhary, P. **2008**. Water Quality Index of ground water (GWQI) of Jhabua Town, M.P. India. J. *Environmental Res. Dev.* Vol. **2. No. 3**, pp. 443-446.

[7] Girija, T.R., Mahanta. C. and Chandramouli, V. **2007**. Water Quality Assessment of an untreated effluent impacted urban stream: the Bharalu Tributary of the Brahamaputra River , India. *Environmental Monitoring and Assessment*, pp. 221-236.

[8] Horton, R. K. (**1965**). " An index number system for rating water quality". Journal Water Pollution Control Federation, **N(37)**, PP.(300-305).

[9] Munawar,M. **1970**. Limnological studies on fresh water ponds of Hydrabad, India-II. *J. Hydrobiologia*. **Vol. 35**. Pp. 127-162.

[10] Ramakrishniah, C.R., Sadashivaiah, C. and Ranganna, G. **2009**. Assessment of Water Quality Index for the Groundwater in Tumkur Taluk. *E-Journal of Chemistry*. **6(2)**, 523-530.

[11] Rao, C.S., Rao, B. S., Hariharan, A.V.L.N.S.H. and Bharathi, N.M. (**2010**). Determination of water quality index of some areas in Guntur district Andhra Pradesh. *International Journal of Applied Biology and Pharmaceutical Technology*, 1: **Issue-1**, 79-86.

[12] Sengupta, M. and Dalwani, R. (Ed.). **2008**. Determination of water quality index and suitability of an urban waterbody in Shimoga Town, Karnataka. *Proc of Taal **2007**: The 12th World Lake Conference*. Pp 342-346.

[13] Singh, L. **2010**. Environmental Geography. APH Publlishing Corporation. New Delhi, pp. 250-251.

[14] Srinivas, J., Purushotham, A.V. and Murali Krishna, K.V.S.G. **2013**. Determination of water quality index in industrial areas of Kakinada, Andhra Pradesh, India. *Int. Res. J. Environment Sci.* **Vol.2 (5)**, pp. 37-45.