International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Impact Factor (2012): 3.358

On Water Quality Standards and Water Quality Indices

Priyanka Chugh[1], Amarjit Kaur[2], Harpreet Kaur[3], Satish Kumar[4] and H.S. Sahota[*]

[1]Research Scholar of Punjab Technical University& Asst. Prof. Rama Devi S.D. Kanya Mahavidhyala Pathankot, Punjab, India
[2]Associate Professor Govt. College Hoshiarpur, Punjab, India
[3]Assistant Professor SBBSIET, Khiala, Distt. Jalandhar, Punjab, India
[4]Principal JSS Degree College, Kauli, Patiala, Punjab, India
*Dean Research and Development JSS Group of Institutes, Kauli, Patiala, Pb(India)

Abstract: ***The quality of water is expressed through a number called Water Quality Index. Physico-chemical and Biological parameters available in water under examination are used to arrive at this number. Measured content of the pollutant, ideal content and standard content for safe use determine this number. Whereas the ideal content and measured one are fixed for a sample, the standard content varies from country to country and from agency to agency. Thus, WQI arrived at by using different standards may vary, if the standard values differ. Presently measured results and standard values of different countries / agencies yield drastically varying WQI in some cases in present measurements. The Australian, Canadian, WHO, ICMR and BIS standards give very high values of WQI. The standards of EPA and EU respectively yield WQI, 67 and 64. They are in reasonably good agreement and yield fairly good quality of drinking water.***

Keywords: Water pollution, Water Quality Index, Standard values, Physico-chemical and Biological Parameters

1. Introduction

Water is essential for survival of life on earth. It is most precious natural resource. In our country ground water is the major source of drinking water. The quality of ground water degrades as the content of its chemical constituent's increases. Leachate from solid waste dumping sites adds to ground water pollution. Use of fertilizers, pesticides and weedicides also lead to water pollution of shallow aquifiers. Hence ground water becomes unfit for use. Health is also affected due to high concentration of fluorides, chlorides, sulphates, nitrates, ions and arsenic, chromium, manganese, mercury, cadmium, etc. cations.

Quality of water is a major factor in determining the welfare of society. Water quality management is thus fundamental for human welfare [1]. So it is very important to measure the level of contamination in water resources. The introduction of Water Quality Indices (WQI) is an effective tool for measurement of level of contamination. WQI is defined as, "a rating reflecting the composite influence of different water quality parameters on overall quality of water" [2], [3]. Extensive research has been carried out by different workers in assessing water quality profiles of rivers and lakes using different pollution stress parameters [4],[5]. Environmental departments and agencies of Australia [6], Bureau of Indian Standards [7], Canada [8], Environmental Protection Agency of USA [9], European Union [10], Indian Council of Medical Research [11] and World Health Organization [12] have given considerable attention to standardize reference values for various water quality parameters involved in calculation of WQI. Permissible limits of various cations and anions for drinking water quality differ in many cases. These values V_s and ideal value for best quality water V_i are used to determine this number WQI which reflects the quality of water immediately.
Even ranges, proposed for quality of water differ in case of different agencies. For example, according to National Foundation and Sanitation [13] range between 91-100 is excellent, 71-90 is good, 51-70 medium, 26-50 fair, 0-25 is poor but according to Canadian Council of Ministers of Environment, water quality index [8] WQI range between 95-100 is excellent, range 80-94 is good, 65-79 is fair, 45-59 is marginal, 0-44 is poor. Some workers [14] use WQI less than 50 as excellent and between 80-100 water is contaminated. Thus, there exists an ambiguity in expressing excellent or poor quality of water even through WQI. In order to prove that WQI calculated using standards proposed by different countries differ widely even through V_n values are same and method used to calculate WQI is same [14] we present the results of our recent measurements.

2. Methodology of Calculation of WQI

The method is based on finding the unit weight of a standard or reference value say V_s for a measured parameter. The sums of weights of all the measured parameters are normalized to one in order to find the constant of proportionality K. For calculation of WQI, a quality called Quality Rating Q_n is defined as:

$$Q_n = \frac{V_n - V_i}{V_s - V_i} \text{ X } 100 \quad (1)$$

where the symbols have the usual meanings[14]
$W_1 = \frac{K}{V1}$ considered here for five parameters

$$\sum_{n=1}^{5} Wn = 1 \quad (2)$$

Sub indices are given by
$(SI)_n = (Q_n)^{Wn}$. The over all WQI is calculated by taking geometric mean of these sub indices as given by:

$$\prod_{n=1}^{5} (SI)\, n = \prod_{n=1}^{5} (Q_n)^{Wn}$$

$$WQI = \text{Antilog}\left[\sum_{n=1}^{5} W_n = 1 \ \log Q_n\right] \quad (3)$$

The results of our present measured parameter values V_n and standards V_s for various countries are given in Table 1. The unit weights Wn, quality ratings Qn and WQI calculated using the method of Tiwari and Mishra [14] are listed in Table 2.

Table 1: Measured V_n , V_s of various agencies and K values. All values are in mg/l.

Parameter	*Measured V_n, Average values of 7 sites and six bimonthly measurements*	*Standard values V_s*						
		WHO [12]	EPA [9]	CCME [8]	ICMR [11]	BIS [7]	EU [10]	AUS [6]
Sulphate	278.18	500	250	250	400	400	250	500
pH	8.70	8.0	9.5	9.5	8.5	8.5	8.5	8.5
EC	1345.0	2500	1500	2500	300	300	2500	1500
Total Hardness	322.1	300	200	500	300	300	500	200
Chloride	20.46	250	250	250	1000	1000	250	250
Value of K	-	7.424	8.408	7.733	8.048	8.048	8.646	7.733

Table 2: Unit weights W_n , Quality rating Q_n and WQI using various standards.

	WHO [12]	EPA [9]	CCME [8]	AUS [6]	EU [10]	BIS [7]	ICMR [11]
W_n	0.029696	0.033634	0.030932	0.030932	0.034584	0.008048	0.008048
	0.014848	0.033634	0.015466	0.015466	0.034584	0.020121	0.020121
	0.927988	0.885011	0.909753	0.909753	0.910105	0.946859	0.946859
	0.002970	0.005606	0.005155	0.005155	0.003458	0.026828	0.026828
	0.02475	0.042043	0.038665	0.038665	0.017292	0.026828	0.026828
Q_n	8.18	8.18	8.18	8.18	8.18	2.05	2.05
	55.64	111.27	55.64	55.64	111.27	69.55	69.55
	170.30	68.12	113.53	113.53	68.12	113.53	113.53
	53.80	89.67	89.67	89.67	53.80	448.35	448.35
	107.36	161.05	161.05	161.05	64.42	107.37	107.37
WQI	151	67	105	105	64	129	129

A perusal of Table 2 reveals that WQI using Australian, Canadian and WHO standards are quite high, EU and EPA, WQI are quite close respectively 67 and 64 and reasonably acceptable, whereas BIS and ICMR, WQI are higher and identical.

3. Conclusions

The water quality index WQI, depends upon basically two factors W_n and Q_n besides the measured values of chosen parameters. W_n in itself is unit weight of a standard normalized through a constant K in which K times sum of unit weights is put = 1. Thus lower the limit of a parameter towards pollution, higher will be its contribution to WQI. The other factor Q_n is directly connected to $V_n - V_i$, and inversely to $V_s - V_i$. Both W_n and Q_n are important in the calculation of WQI. On, $V_n = V_i$, i.e. no parameter has any pollution and the content is only equal to ideal content V_i, the numerator for Q_n, becomes zero and WQI = 0, the water quality will be excellent. For $V_n = V_s$, the $Q_n = 1$ and the water quality will be just tolerable, beyond this water will not be fit for consumption. If now we look at our Table 1, we find that K value for different countries / agencies standards are not very different whereas the standards themselves differ widely thus giving rise to large variation in W_n. Similarly Q_n also differs widely. Thus WQI too differ widely, between 64 and 67 for EU and EPA respectively to 151 for WHO. For CAN, AUS, BIS and ICMR standards also the water quality is unfit for drinking. Thus we are left to conclude that some sort of uniformly of standard tolerable content fixation is utterly desirable.

4. Acknowledgements

Ms. Priyanka Chugh is indebted to Punjab Technical University Kapurtahala road, Jalandhar for registering her for Ph.D. The authors are grateful to the Chairman and Director of JSSGOI, Kauli, Patiala (Punjab) for encouragement and support.

References

[1] Gupta S.C., Chemical character of ground water in Magbur District Rajasthan Ind. J. Environment Health 33(3), 341-44, (1991).
[2] Deininger, R.A. and Macinans, J. J. A water quality of Environmental and Industrial Health. School of Public, University of Michigan, Amarbar, Michigan, (1971).
[3] Harkins, R.D. An objective water quality index. J. Water Pollution Cont. Fed. 3; 589-590, (1974).
[4] Chugh Priyanka, Parmar, K.S. Manhas Preeti and Sahota, H.S., Alarming Pollution Level in rivers of Punjab, Indian J. Environ. Protection Vol. 31, 482-86, (2009).
[5] Parmar, K.S., Chugh Priyanka, Manhas Preeti, Bhardwal Rasmi and Sahota, H.S., Seasonal Variation of Physico – Chemical parameters and Water Quality Indexing of Harike Lake, Ind. J. Environ. Protection vol.31, 482-86, (2011).
[6] Australian Drinking Water Guidelines (ADWG), 6(2004). Endorsed by NHMRC 10-11 , (April 2003), web address : http://www.hmrc.gov.au

[7] BIS-(1993) Bureau Indian Standard Specifications for drinking water, New Delhi.
[8] CCME (2005), Canadian Environmental Sustainability Indicators for fresh water quality: Data Sources and method catalogue no. 16-256XE.
[9] EPA – (2006); United States Environment Protection Agency, Washington DC, Water Quality Standard Review and Revision (2006).
[10] EU Water Quality Standards. Council Directive 98 / 83 / EC on the quality of water intended for human consumption, adopted by council, (Nov. 1998).
[11] ICMR, Manual of Standards of Quality for Drinking Water Supplies, Indian Council of Medical Research, Spl. Rep. No. 44: 27(1975)..
[12] WHO, Guidelines for Drinking Water Quality, (2004), Third Edition vol. 1; Recommendation, World Health Organisation, Geneva (2004) .
[13] Mitchell Mark and Stapp Williams, B; Field Manual for Quality Monitoring, 12th Edition,(2000).
[14] Tiwari, T.N. and Mishra, M. Weighted geometric mean quality index for river Jhelum in Kashmir. Journal of M.A.C.T. 19, 33-41(1986).