Water Quality Assessment of Groundwater Resources Based on WQI in Purna River Basin of Buldana Region

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Abstract- The water Quality Assessment has been performed for various groundwater sources such as dugwell, tubewell & borewell in Purna River Basin at Buldana region, Maharashtra (India). Five different villages were selected & Water Quality Index (WQI) was calculated by using National Sanitation Foundation (NSF) information system in post monsoon, summer & winter season. WQI for the region shows fair water quality in post monsoon season which further changes to medium in summer & winter season for dug well but medium quality is observed for borewell & handpumps in all season where quality slightly changes in summer & winter than post monsoon season so to investigate the reason for water quality change & its measure to be taken up for purna river basin in terms of groundwater management required. A total of 150 water samples were analysed for various physical and chemical parameters. The study showed that all water samples were within the standard permissible limit prescribed by WHO and ISI standards for drinking water except salinity, chloride, nitrate, phosphate and conductivity. On the basis of CCME Water Quality Index (WQI) derived from physicochemical studies, the drinking water was 73% safe and 27% unsafe for the drinking and domestic purposes in salinity-affected villages of Purna River Basin.

Keywords — Drinking Water, Purna River Basin, Salinity Affected Villages, Water Quality Assessment, Water Pollution, Water Quality Index.

I. INTRODUCTION

Today water pollution is the biggest crisis for whole human world which is characterized by deterioration of water quality by means of human activities which in turns make it unfit for drinking and domestic purpose. Chemical fertilizers and pesticides getting in untreated sewage and industrial influents are the main sources of water pollution. Natural sources are contaminated from various roots such as effluent from different industries, discharge of drainage systems, domestic as well as municipal waste etc. Ground water survey and development agency (GSDA). Government of Maharashtra identified 547 salinity affected villages from which 93 are situated in Buldana district. Buldana district covers Purna river valley of 4693sq.km. wherein ground water besides basin of Purna river is severely affected by salinity and poor quality. Water Quality Index is regarded as one of the most effective way to communicate water quality.

II. MATERIALS AND METHODS

Ground water samples collected from dug wells, tube wells and hand pumps from the salinity affected villages in Buldana district of Vidarbha region which accounts of total 150 water sample during the period of 2020-21. Ground water samples collected in sterilized bottles using standard procedure.

The analysis of various physicochemical parameters such as pH, turbidity, temperature, total dissolved solids, dissolved oxygen, chloride, salinity, phosphate, nitrate and conductivity were carried out by standard methods [2].

Calculation of CCME Water Quality Index (CCME WQI) was made by then following formula.

$$CCMEWQI = 100 - \left[\frac{\sqrt{F_1^2 + F_2^2 + F_3^2}}{1.732} \right]$$

The divisor 1.732 normalizes values in the range of 0 to 100; the 0 represents poor and 100 represents the excellent

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water quality. Where F1, F2 and F3 represent scope, frequency and amplitude as under;

$$F_1 = \left[\frac{Number\ of\ failed\ variables}{Total\ number\ of\ variable}\right] \times 100$$

F1 (scope) represents the percentage of variables that do not meet their objectives (failed objectives).

F_2 (frequency) represents the percentage of individuals test that do not meet their objectives(failed test).

$$F_2 = \left[\frac{Number\ of\ failed\ tests}{Total\ number\ of\ tests}\right] \times 100$$

F_3 (amplitude) represents the amount by which failed test values do not meet their objectives value. F_3 was calculated in three steps;

The number of times by which an individual concentration is greater than (or less than, when the objective is a minimum) the objective is termed an "excursion" and is expressed as follows, when the test value must not exceed the objective:

$$excursion = \left[\frac{Failed\ Test\ Value}{Objective\ Value}\right] - 1$$

For the cases in which the test value must not fall below the objectives:

$$excursion = \left[\frac{Objective\ Value}{Failed\ Test\ Value}\right] - 1$$

The collective amount by which individual tests were out of the compliance was calculated by summing the excursion of individual tests from their objectives and dividing by the total number of tests (both those meeting objectives and those not meeting objectives). This variable, referred to as the normalized sum of excursion, or nse, is calculated as:

$$nse = \frac{\sum excursion}{\text{Total Test}}$$

$$F_3 = \left[\frac{nse}{0.01nse + 0.01}\right]$$

F3 is then calculated by the asymptotic function that scales the normalized sum of the excursion from objectives (nse) to yield a range between 0 and 100. Depending on WQI, the quality of water was categorized into:

Excellent (CCME-WQI value 95-100): Water quality is protected with virtual absence of threat or impairment; condition very close to natural or pristine levels.

Good (CCME-WQI value 80-94): Water quality is protected with only a minor degree of threat or impairment; condition rarely deport from natural desirable levels.

Fair (CCME, WQI value 65-79): Water quality usually protected, but occasionally threatened or impaired; conditions sometimes depart from natural or desirable levels.

Marginal (CCME, WQI value 45-64): Water quality is frequently threatened or impaired; conditions often depart from natural or desirable levels.

Poor (CCME, WQI value 0-44): Water quality is almost always threatened or impaired; conditions usually depart from natural or desirable levels [3].

III. RESULT AND DISCUSSION

A total of 150 water samples from various sources from salinity-affected villages of Buldhana district of Vidharbha were analyzed for physicochemical quality and Water Quality Index (WQI) was calculated for each village and district. On the basis of various physiochemical parameters each water sample was classified into within permissible limit (WPL), below permissible limit (BPL) and above permissible limit (APL) as prescribed by WHO [6].

(Table 1). The maximum pH of 10 was recorded at Palsoda village, and minimum pH of 6.5 at Rigaon. All other water samples from rest of the villages showed pH within permissible limit. High pH of water might be responsible for fish kills as it controls the physiological reactions [5]. Seasonal variations were observed in atmospheric temperature,maximum temperature was noticed during summer due to dry weather condition. The minimum temperature was recorded during the rainy season. The temperature is an important factor for various chemical and biochemical reactions in water; and solubility of most substances is also largely depends of temperature [1]. Maximum conductivity of 2510 μmhos/cm was recorded in Waghola and minimum (103μmhos/cm) in water in Khedgaon. Maximum TDS (1225 mg/L) were recorded in DGW at Palsoda, and minimum (90mg/L) in Pimpri Koli. Gastro-intestinal irritation is caused due to higher TDS [1].

Turbidity was determined by visual method with nearly all the samples within permissible limits except the surface water samples. Presence of DO in water may be due to direct diffusion from air and photosynthetic activity of autotrophs. Permissible limit for chloride and salinity is 200-600 mg/L, but maximum of 1355 mg/L and 2447 mg/L were recorded in Waghola.

Table 1: Permissible limit and physiochemical quality of drinking water available in salinity-affected villages of Buldhana districts of Purna river basin.

Paramaeters	Permissible Limit(PL)	Number of Water Samples		
	-	BPL	WPL	APL
pH	6.5-9.5	0	140	10
Turbidity	5 NTU	0	145	5
TDS	500-1000	20	120	10
Conductivity	300μmhos/cm	60	0	60
D. O.	6.0-9.5	15	135	0
Chloride	200-600	0	120	30
Salinity	200-600	0	15	135
Phosphate	25 (μg/L)	142	0	8
Nitrate	45	148	0	2

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Note: All the values are given in mg/L otherwise as stated. BPL: Below permissible limit, WPL: within permissible limit, APL: Above permissible limit

Table 2: Source-wise quality of drinking water in salinity-affected villages based on WQI.

Source	Marginal	Fair	Good	Excellent
Surface Water (SW)	5	4	0	0
Shallow Groundwater (SGW)	2	26	26	3
Deep Groundwater (DGW	0	15	51	9
Public Water Supply (PWS)	0	0	8	1
Total	7 (4.3%)	45 (30%)	85 (57%)	13 (8.7%)

The permissible limit for phosphate in water is 25µg/L, and 8 water samples were above the permissible limit. The maximum phosphate was 48 µg/L in SW at Rigaon, and minimum (5 µg/ L) in PW at Pimpri Koli, Phosphate is a nutrient and its concentration above normal limit indicates eutrophication [4]. The maximum nitrate was 63mg/L in the SW at Rigaon, and minimum (9 mg/L) in SGW at Pimpri koli.

On the basis of WQI, out of 150 water samples, 7 (4.3%) were marginal, 45 (30%) fair, 85 (57%) good, and 13 (8.7%) excellent.

IV. CONCLUSION

The CCME water quality index indicated that drinking water quality in Purna river basin of Buldhana districts of Vidarbha region was marginal (4.3%), fair (30%), good (57%) and excellent(8.7%) in the year 2020-2021, but high content of chloride, salinity and conductivity in some places made it unsafe for drinking purposes. On the basis of these physicochemical qualities and CCME water quality index (WQI), 73% water was safe and 27% unsafe for drinking purposes Buldana districts of the Vidharbha region in Maharashtra.

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