Assessment of Ground Water Quality in Shrirampur Tehsil: A GIS-Integrated Approach

Dr. S. P. Cholke

Department of Geography, R. B. N. B. College Shrirampur

Abstract: In recent years, an increasing threat to ground water quality due the results of man's activity at ground surface; the industries are discharging their effluents consist varies chemicals and dissolved salts more than the permissible limits with overuse of fertilizers on agricultural land coupled with overuse of water for irrigation have resulted in causing salinization of ground water. The quality of ground water depends on physical, chemical and biological factors; however, determining the overall water quality condition is difficult due to the spatial variability of multiple contaminants and the wide range of indicators, therefore, a GIS-based ground water quality index (WGQI) is one of the most effective tools to determining its suitability for drinking and agricultural purposes. It is observed that in the village Bhokar, Matapur and Eklahare has very high GWQ Index (between 13-27) therefore, water is more polluted and unsuitable for drinking due to extensive use of fertilizers, overuse of water for irrigation and discharge of molasses into the open ground. Therefore it is the need of the hour that the system of agriculture should be revitalized, to make an environmentally stronger. For this, first and foremost step is to conserve the surface and ground water where the Ground water quality is declining.

Keywords: GWQI, GIS, agriculture, fertilizer, over irrigation

1. Introduction

In recent years, an increasing threat to ground water quality due to human activities has become of great importance. The adverse effects on ground water quality are the results of man's activity at ground surface; the industries are discharging their effluents consisting of dissolved salts more than the permissible limits along with overuse of fertilizers on agricultural land coupled with more usage of irrigation water have resulted in causing salinity in ground water. The quality of ground water depends on a large number of individual hydrological, physical, chemical and biological factors, therefore, the quality of ground water varies from place to place, with the depth of water table, and from season to season and is primarily governed by the extent and composition of dissolved solids present in it.

However, describing the overall water quality condition is difficult due to the spatial variability of multiple contaminants and the wide range of indicators (chemical, physical and biological). This contribution proposes a GISbased ground water quality index (WGQI) which synthesizes different available water quality data (e.g., CI^- , Na⁺, Ca²⁺) by indexing them numerically relative to the Indian standards and World Health Organization (WHO) standards. Ground Water quality index (GWQI) is one of the most effective tool to determining its suitability for drinking and agricultural purposes which is defined as a rating reflecting the composite influence of different water quality parameters and becomes an important parameter for the assessment and management of groundwater.

2. Study Area

Shrirampur Tahsil is located in the North part of Ahmednagar district of Maharashtra state and is extended between $19^{\circ} 45$ to $20^{\circ} 30$ N latitudes and $74^{\circ} 00$ to $74^{\circ} 30$ E longitudes. The total geographical area of the tahsil is 579.87sq.km which covers 54 villages. The net cultivated area in 2006–07 was 480 sq. km. About 70% of the area is

irrigated by canal and dug wells, putting high pressure on groundwater resources of the Tahsil. The total population of tahsil is 2, 56,441 (Census, 2001) and almost 80 % of the workforce is engage in the agriculture, horticulture, animal husbandry and Sugar Industries. The Tahsil has a subtropical monsoon climate. March, April, and May are the hottest months while December and January are the coldest. The maximum temperature recorded during summers is about 44°C and it is as low as 8°C in winters. The Tahsil receives an approximate average rainfall of 550 mm and more than 75% of which occurs during the monsoon period (July-September). The important rivers/streams traversing the tahsil are Pravara and Godavari. Last few decades, the use of chemicals and fertilizers has increased to enhance the yield of sugarcane crop. The pollutants of these pesticides leach through soil to reach the water table. There is a main environmental issue due to depleted quality of surface water resources in the river that has been polluted to a large extent. The groundwater resources are also being polluted because of surface water pollution through over irrigation, high consumption of chemical fertilizers and agro based industry.

3. Methodology

The present study has been carried out in following two stages

Stage 1 - Groundwater sample collection:

Fifty Two water samples were collected in 1000ml volume from different wells, tube wells and hand pumps from different villages in Shrirampur Tahsil in January 2010. The water level of dug-well was measured by simple measuring tape. Simultaneously, GPS readings were taken for latitude, longitude, and height above mean sea level (MSL). After sampling, collected samples were immediately brought to analytical laboratory and stored and further, analysis was started without delay. Stage 2 - Integrated GIS Analysis of Groundwater samples:

Each of the groundwater samples was analyzed for 13 parameters such as pH, Electrical Conductivity (EC), TDS, Total Hardness (TH), Sodium (Na+), Potassium (K), Calcium (Ca), Magnesium (Mg), Total Alkalinity (TA) as HCO3, Chloride (Cl), phosphate (PO₄), Sulphate(SO₄) and Iron(F) using standard procedures, details are presented in Table. The range of variation of water quality parameters for different sampling stations of the tahsil, were assigned subjective weights to evolve composite ground water quality index (CGQI) for different stations. The range of subjective weight varied from 1 to 5, a weight of 1 indicate good water quality and weight of 5 means highly polluted ground water quality. The total CGQI values where obtained by summing the water quality weights of individual water quality parameters to enable evaluation of extent of water pollution

and its spatial variation for the area corresponding to different villages

A Potential GWQI map generated in the ArcGIS 9.3 for the area using spatial interpolation techniques can give an assessment regarding the spatial variation of different water quality parameters associated with different water quality factors.

4. Results and Discussions

The chemical analyses of the groundwater sample of 52 villages are summarized respectively in Table No.1 and GWQI scores are presented in Table 2. GWQ Index map is generated in the ArcGIS 9.3 with regarding the spatial variation of different water quality parameters associated with different water quality factors.

Table 1: The ground water quality data pertaining to the 50villages of Shrirampur tahsil

ID	pН	EC	TDS	TH	Na	K	Ca	Mg	HCO3	CI	SO4	NO3	F
1	8.1	3968	2070	295.2	113.8	6.8	12.1	59.2	782.8	464.5	32.8	50.8	1.7
2	7.5	949	1840	247.6	106.5	6.9	23.3	48.8	686.7	144.0	20.5	42.0	1.1
3	8.1	1214	1190	249.7	104.7	5.8	19.3	53.3	851.5	136.1	39.4	56.6	0.9
4	8.0	2101	2170	292.2	109.3	2.5	25.7	74.1	734.8	366.6	57.5	53.1	0.9
5	8.2	2764	1020	183.6	99.3	1.8	20.9	38.1	600.5	426.0	36.7	49.2	1.3
6	7.7	1336	2150	263.1	120.1	1.1	18.5	37.8	519.9	149.1	17.9	56.6	0.8
7	8.1	2448	830	199.5	157.5	2.8	14.5	41.0	573.0	346.0	362.0	20.7	1.2
8	7.8	1958	1030	228.0	115.6	1.0	17.7	45.3	597.4	262.7	46.3	54.9	1.1
9	7.9	1438	1330	354.5	111.1	2.6	17.7	69.9	391.4	222.5	80.6	34.1	1.2
10	7.7	1428	1290	243.2	102.9	0.4	61.8	46.4	652.4	229.1	57.3	43.1	0.8
11	7.9	2795	1170	186.1	98.4	1.3	25.7	26.1	563.1	179.9	40.3	49.2	1.2
12	7.6	1438	1080	235.6	236.5	1.1	15.3	43.9	666.1	203.6	62.0	23.1	1.1
13	7.9	2244	1190	295.3	243.7	4.0	29.7	54.2	609.2	40.8	67.1	53.1	1.3
14	7.6	1846	1110	234.2	252.8	5.3	12.1	46.5	701.0	101.3	52.4	54.9	1.3
15	8.3	1795	540	154.0	223.9	0.2	29.7	28.6	810.3	67.3	22.7	60.2	1.3
16	7.7	1724	1280	177.1	106.5	0.6	19.3	27.3	453.2	114.6	77.8	57.3	0.9
17	7.3	1071	1630	330.1	115.6	0.6	19.3	57.6	487.6	188.4	84.4	59.8	1.1
18	8.1	2336	1120	211.9	97.5	2.5	38.5	41.4	549.4	126.0	77.1	50.7	1.1
19	7.7	1836	1620	239.3	88.5	1.8	44.9	36.7	391.4	99.4	85.2	54.9	1.2
20	8.2	1673	2100	351.7	97.5	1.8	30.5	61.4	501.3	107.0	89.6	60.2	0.9
21	7.5	2356	660	188.7	115.6	1.6	24.9	34.5	377.6	116.5	35.7	50.7	0.9
22	8.0	1346	1770	379.4	74.1	0.4	55.4	72.5	535.6	148.7	85.9	13.1	1.1
23	7.4	1907	1770	398.8	92.1	1.3	16.9	80.0	515.0	78.6	126.0	54.9	0.8
24	7.7	1693	2020	391.2	120.1	7.0	24.9	69.9	528.8	102.3	93.0	69.2	1.2
25	7.9	2101	920	207.4	81.3	1.1	26.5	31.2	487.6	156.2	78.4	53.1	1.1
26	8.0	1907	1080	242.4	195.0	4.3	16.9	36.8	624.9	98.5	74.9	44.9	0.9
27	8.1	520	600	200.0	62.3	0.6	32.1	15.6	412.0	71.0	73.4	7.3	1.1
28	7.7	1214	800	350.0	82.1	1.1	60.1	26.8	257.5	149.1	71.4	56.6	1.1
29	7.7	673	400	205.0	67.7	0.6	60.1	12.7	360.5	56.8	73.0	26.9	1.1
30	8.0	1408	900	255.0	124.5	1.1	40.1	20.0	463.5	156.2	71.7	13.1	1.1
31	7.7	1173	1800	275.0	100.2	2.8	32.1	22.9	566.5	42.6	71.7	41.2	1.1
32	7.7	3111	3200	470.0	343.9	1.3	32.1	41.9	566.5	589.3	71.1	52.3	1.1
33	8.1	2173	1600	375.0	204.0	1.3	28.1	33.1	463.5	326.6	71.5	53.1	1.1
34	7.8	887	1600	110.0	110.1	0.8	28.1	7.3	309.0	106.5	72.0	56.2	1.1
35	7.8	632	400	185.0	79.4	1.1	52.1	11.7	360.5	42.6	72.6	21.3	1.1
36	7.7	2540	2000	715.0	232.9	1.1	100.2	57.5	412.0	177.5	70.6	39.9	1.1
37	7.8	785	400	235.0	82.1	0.6	32.1	19.0	257.5	85.2	71.7	30.1	1.1
38	7.5	3356	2400	815.0	232.9	1.7	112.2	65.8	463.5	85.2	70.7	68.1	1.1
39	7.9	969	700	265.0	102.0	0.8	32.1	21.9	257.5	142.0	70.9	12.0	1.1
40	7.6	1142	700	280.0	93.0	0.8	48.1	21.4	463.5	120.7	71.8	59.8	1.1
41	8.1	1785	1000	375.0	120.0	0.9	28.1	33.1	360.5	255.6	71.5	60.2	1.1
42	7.7	979	700	325.0	70.4	0.6	40.1	26.8	257.5	120.7	71.6	73.8	1.1
43	7.7	1071	700	315.0	89.4	0.6	16.0	28.8	360.5	106.5	71.9	56.1	1.1
44	77	10271	8600	1710.0	1236.5	49	124.2	151.5	463 5	11147	71.1	15.0	11

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45	7.7	2509	1800	575.0	211.2	0.8	32.1	52.1	515.0	355.0	70.8	50.7	1.1
46	7.7	2836	2400	655.0	227.4	1.1	40.1	59.0	669.5	426.0	70.7	49.2	1.1
47	7.5	5773	5000	945.0	1056.0	1.9	184.4	69.7	206.0	908.8	70.5	44.5	1.1
48	8.0	408	400	275.0	57.8	0.6	28.1	23.4	257.5	71.0	71.5	39.8	1.1
49	7.5	3733	2800	875.0	338.4	1.3	88.2	74.6	257.5	461.5	70.7	50.8	1.1
50	7.7	806	400	270.0	71.3	0.6	32.1	22.4	206.0	177.5	71.9	44.4	1.1

(Source: Computed by the Author)

GWQ Score	Water quality	Name of Villages
0 to 2.9	Excellent	Kadit BK, Khokar, Karegaon, Matul Than, Khandala, Khanapur Takalibhan
2.9 to 4.3	Good water	Nimgaon Khairi, Mankal Wadgaon, Bhamathan, Undirgaon, Mal Wadgaon, Barhmangaon, Dighi, Shrirampur, Belapur, Mandve, Gondhavani, Kadit
4.3 to 7.2	Poor water	Gujarwadi, Bheradapur, Pedegaon, Fatyabad, Ainatpur, Nipani Wadgaon, Kanhegaon, Wangi Kh. Haregaon, Gumandeo, Malewadi,
7.2 to 13	Very poor water	Naur, Rampur, Kamalpur, Wadala Mahadeo, Khridi, Malunje Bk, Ladgaon, Uambargaon, Wadatgaon, Kurranpur, Gondegaon, Galnimb, Ukkhalgaon, Nursari
13 to 27	Unsuitable for Drinking	Bhokar, Matapur, Eklahare,



Figure 1: Ground Water Quality of Shrirampur Tehsil

The GWQ Index indicated that the electrical conductivity (EC) of the water is high due to presence of more dissolved salts in it. The water is alkaline in the area with concentration of Na+, K+. Ca+, Cl- , Mg+, SO4, carbonates etc., generally exceeding the CPCB standards. It is observed that in the village Bhokar, Matapur and Eklahare has very high GWQ Index (between 13-27) therefore, water is more polluted and unsuitable for drinking due to extensive use of fertilizers and over irrigation in agriculture and discharge of molasses into the open ground. In the villages Naur, Rampur, Kamalpur, Wadala Mahadeo, Khridi, Malunje Bk, Ladgaon, Uambargaon, Wadatgaon, Kurranpur, Gondegaon, Galnimb, Ukkhalgaon and Nursari was recorded high GWQ Index (between 7.2-.13) due to the water quality is very poor. Takalibhan , Kadit BK, Khokar, Karegaon, Matul Than, Khandala and Khanapur villages has been observed very low GWQ Index (between 0-2.9) with excellent water which is more suitable for drinking and agricultural purposes.

Therefore it is the need of the hour that the system of agriculture should be revitalized, to make an environmentally stronger. For this, first and foremost step is to conserve the surface and ground water where the Ground water quality is declining.

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