Hydrochemical Characteristics and Groundwater Quality Assessment in Shendra Area, Aurangabad District, Maharashtra, India

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Research Article

Abstract: Hydrochemical characteristics and groundwater quality assessment study was carried out in and around Shendra area of Aurangabad, Maharashtra, India. Twenty five groundwater samples collected randomly to investigate physicochemical parameter such as pH, Electrical Conductivity (EC), Total Dissolve Solids (TDS),Calcium (Ca^{2+}), Magnesium(Mg^{2+}),Total Hardness (TH), Sodium (Na^{+}), Potassium (K^{+}), Bicarbonate alkalinity (HCO_3^{-}),Sulphate (SO_4^{-}) and Chloride (Cl^{-}) in order to understand the different geochemical processes. The chemical characteristics were determined as per the standard methods for examination of water and wastewater (APHA, 2002), Trivedi and Goel (1984), and all results are compared with standard limit recommended by the Bureau of Indian Standards (BIS,1991), and World Health Organization (WHO,1993). Comparison of geochemical data indicates the majority groundwater samples are within the limit prescribed by Bureau of Indian Standards and World Health Organization.

Keywords: Groundwater, Hardness, water quality, Shendra, Aurangabad, Maharashtra, India

Introduction

Groundwater plays a fundamental role in human life and development. The Safe portable water is absolutely essential for healthy living. About 80% of the diseases of the world population and more than one-third of the deaths in the developing countries are due to contamination of water (WHO 1984; Earth Summit, 1992). Man can control the some undesirable chemical constituents in water before it enters the ground. But, once the water enters the ground, man's control over the chemical quality of water of percolating water is very limited (Johnson, 1979). Groundwater is ultimate and most suitable fresh water resource for human consumption in both urban as well as rural areas. The importance of groundwater for existence of human society cannot be overemphasized (Rizwan, *et al,* 2009). During the last decade rapid urbanization has taken place in and around Aurangabad city. The industrial establishments in and Aurangabad and the industrial township of Chikalthana as well as Waluj and Shendra are responsible for disposing treated and untreated effluents in the natural drainage system. This has lead to widespread groundwater contamination. Thus, it is very essential to check levels of pollution and protect this valuable resource so considering this aspect twenty five groundwater sampling from in and around Shendra industrial area are carried out and analyze for various physico chemical parameters.

Details of the study area

Aurangabad is the tourist capital of Maharashtra and is also an important industrial and I.T. hub in Marathawada region. Aurangabad city is situated at the southern slopes of Ellora Ranges. Aurangabad sits in a strategic position on the Deccan Plateau. The city stands in the Dudhana valley between Lakenvara range on the north and Satara hills on the south. The industrial area of Shendra is covered in part of the Survey of India Toposheet No. 46 M/5. Shendra industrial area is five star industrial estates located 17 km from Aurangabad on Jalna road towards the east of the city and is one of the newly developing areas having SEZ unit (Fig.1). Shendra industrial area houses number of industries which includes Audi India, Skoda Auto,Volkswagen, Wockhardt, Siemens and allied industries.

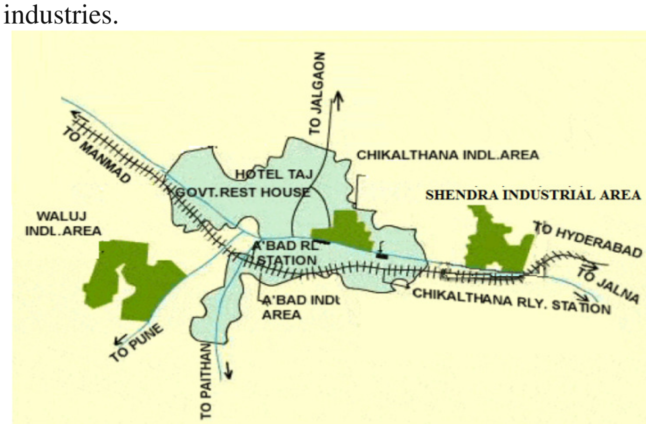

FIG.1 MAP SHOWING THE SHENDRA INDUSTRIAL AREA OF AURANGABAD

Geology and hydrogeology

The entire Shendra industrial area of Aurangabad is underlain and surrounded mainly by basaltic lava flows belonging to the Deccan volcanic province that flooded during upper cretaceous to eocene age in the Deccan plateau. The Deccan traps sequence consists of multiple layers of solidified lava flows. The prominent geological units observed in study area are the horizontally disposed basaltic lava of dark grey in color. The lava flows are horizontal and each flow has distinct two units. The upper layers consist of vesicular and amygdule zeolitic basalt whiles the bottom layer consists of massive basalt. The lava flows are individually different in their ability to receive as well as hold water in storage and to transmit it. The difference in the productivity of groundwater in various flows arises as a result of their inherent physical properties such as porosity and permeability. The groundwater occurs under water table conditions and is mainly controlled by the extent of its secondary porosity i.e. thickness of weathered rocks and spacing of joints and fractures. The highly weathered vesicular trap and underlying weathered jointed and fractured massive trap constitutes the main water yielding zones. The soil is mostly formed from igneous rocks and are black, medium black, shallow and calcareous types having different depths and profiles (CGWB, 2001; Deshpande and Aher, 2012). Adverse quality conditions increase the investment in irrigation and health, as well as decrease agricultural production. This in turn, reduces agrarian economy and retard improvement in the living conditions of rural people (Deshpande and Aher, 2011a; Aher and Deshpande,2014).

Materials and Methods

In order to assess the physico-chemical parameters, a total of 25 ground water samples from study area were collected in good quality polyethylene bottles of one-liter capacity and prior to sampling all the sampling containers were washed and rinsed with the groundwater. The chemical parameters viz. pH and electrical conductivity (EC) were measured, using digital instruments immediately after sampling. The groundwater sampled bottles were labeled, tightly packed, the collected groundwater samples were analyzed for total hardness (TH), Total dissolved solids (TDS) calcium (Ca^{++}), magnesium (Mg^{++}), sodium (Na^{+}), potassium (K^{+}), carbonate (Co_3^{-}), bicarbonate (HCO_3^{-}), chloride (Cl^{-}), and sulphate (SO_4^{-}). The chemical characteristics were determined as per the standard methods for examination of water and wastewater (APHA, 1992), Trivedi and Goel (1984), and all results are compared with standard limit recommended by the Bureau of Indian Standards (BIS,1991), and World Health Organization (WHO,1993).

Groundwater Quality Assessment

Groundwater quality assessment was carried to determine its suitability in terms of drinking purposes, the hydro chemical analysis of groundwater samples is presented in (Table.1) and comparing the Hydrochemical parameters of groundwater in the study area with the prescribed Bureau of Indian Standards (BIS,1991), and World Health Organization (WHO,1993). The pH of a water sample measures its hydrogen ion concentration and indicates whether the sample is acidic, neutral or basic. The pH value of absolute pure water is 7. If the pH value is less than 7, the water is said to be acidic in nature and if it is more than 7 the water is called as alkaline. The pH values of groundwater ranged from 6.7 to 8.5 with an average value 7.6. This shows that the groundwater of the study area is mostly alkaline in nature (Table.1). Electrical current is the ability of an object to conduct electric current. It depends upon the presence of various ionic species in the water. The measurement of electrical conductivity is directly related to the concentration of ionized substance in water and may also be related to problems of excessive hardness and other mineral contamination (Jain *et. al,*2009; Aher,2012). The value of EC varied from 640 µmhos/cm to 2840 µmhos /cm with an average value of 1236 µmhos/cm. The total dissolves solids (TDS) indicate the general nature of salinity of water. TDS are a direct measurement of the interaction between ground water and subsurface minerals. The total dissolved solids (TDS) are the concentrations of all dissolved minerals in water indicate the general nature of salinity of water. Concentration of dissolved solids is important parameter in drinking water (Aher, 2012). The TDS value ranged from 416 to 1846 mg/L with a mean of 803 mg/L. The BIS specifies a desirable total dissolved solids limit of 500 mg/L and a maximum permissible limit of 2000 mg/L, and in study area all samples are within the permissible limit as prescribed by BIS (1991). High values of TDS could be due to intensive irrigation. Sources for TDS include agricultural run-off, urban run-off, industrial wastewater, sewage, and natural sources such as leaves, silt, plankton, and rocks. Piping or plumbing may also release metals into the water. Calcium is naturally present in water this element is essential for the life of plants and animals. The presence of calcium in drinking water is natural geological source, industrial waste, mining by products and agricultural wastes. Calcium (Ca^{2+}) values ranged from 34 to 275 mg/L with an average value of 87 mg/L, the desirable limit of calcium for

Table 1: Result of physico chemical analysis of groundwater samples in study area

Sample No.	pH	EC (µS cm^{-1})	TDS (mg/L)	TH (mg/L)	Ca^{2+} (mg/L)	Mg^{2+} (mg/L)	Na^{+} (mg/L)	K^{+} (mg/L)	HCO_3^- (mg/L)	SO_4^{2-} mg/L)	Cl^- (mg/L)
1	7.0	1230	800	408	99	39	71	3	268	88	122
2	7.5	680	443	250	65	24	12	1	198	23	26
3	7.6	980	630	334	89	27	49	3	179	53	36
4	7.7	1021	671	382	46	67	28	1	246	23	52
5	7.8	672	432	223	53	23	19	1	197	29	29
6	7.8	724	471	287	54	38	14	2	272	21	27
7	7.7	1892	1231	749	59	132	213	4	383	137	427
8	7.4	1374	893	380	66	52	87	1	268	82	160
9	8.5	1569	1020	368	34	69	164	1	180	66	230
10	8.0	1217	791	412	45	73	48	1	316	42	86
11	6.7	1360	884	544	96	74	108	1	272	162	208
12	7.2	1260	819	584	128	64	38	1	272	107	192
13	7.5	640	416	240	78	11	32	0	200	29	46
14	7.1	1220	793	324	64	40	74	0	224	92	106
15	7.9	1038	675	288	38	47	44	1	240	31	78
16	7.4	3960	2574	900	181	109	239	4	488	89	600
17	7.4	4280	2782	1360	200	209	151	6	460	227	660
18	7.9	1600	1040	452	48	81	78	1	380	85	136
19	7.9	1583	1029	508	69	82	112	1	308	63	214
20	7.5	640	416	240	78	11	32	0	200	29	46
21	7.1	1220	793	324	64	40	74	0	224	92	106
22	7.4	2840	1846	628	275	21	200	58	312	76	384
23	7.6	2890	1879	852	208	81	296	1	500	168	526
24	7.4	3960	2574	900	181	109	239	4	488	89	600
25	7.8	668	431	227	59	31	24	0	167	42	38
Min.	6.7	640	416	223	34	11	12	0	167	21	26
Max.	8.5	4280	2782	1360	275	209	296	58	500	227	660
Avg.	7.6	1683	1094	509	99	66	102	6	293	81	216

drinking water is specified by BIS (1991) as 75 mg/L and a maximum permissible limit of 200 mg/L. It is observed that all the samples were within the maximum permissible limit. (Table.1). In natural water magnesium occurs with calcium, but it concentration generally lower than the calcium. Magnesium (Mg^{2+}) concentration varies from 11 to 132 mg/L with mean values of 52 mg/L. According to BIS (1991) the desirable values of Mg^{2+} are 30 mg/L and a maximum permissible limit of 100 mg/L, where only one samples were exceeding maximum permissible limit. Excess of magnesium shows the hardness in water (Deshpande and Aher, 2011b). (Table.1). Hardness of water is related to presence of Ca^{2+} and Mg^{2+} in water basically depending on soil type of that area. The hardness of natural waters depends mainly on the presence of dissolved calcium and magnesium salts. Total Hardness is considered as a major character of drinking water. A total hardness value varies from 223 to 749 mg/L with a mean values 411 mg/L. The maximum permissible limit of total hardness (TH) for drinking water is specified by BIS (1991) as 600 mg/L. It is observed that except two samples, all samples are within maximum permissible limit (Table.1). The high concentration of hardness may occur locally in groundwater from chemical and industry effluent as well as excessive application of lime to the soil in agricultural areas. Chloride ions are generally present in natural waters and its presence can be attributed to dissolution of salts. Soil porosity and permeability can build up chloride ions in water. The chloride (Cl^-) ion concentration varied between 26 to 427 mg/L with a mean values 141 mg/L. The desirable limit of chloride for drinking water is specified by BIS (1991) as 250 mg/L and a maximum permissible limit of 1000 mg/L. It is observed that all the samples were within the maximum permissible limit prescribed by BIS (1991) (Table.1). The primary source of carbonate and bicarbonate ions in groundwater is the dissolves carbon dioxide in rain and snow which, as it enters the soil, dissolves more carbon dioxide. The bicarbonate alkalinity varies from 167 to 383 mg/L with an average value of 254 mg/L (Table.1). Sodium values ranged from 11 to 213 mg/L (Table.1). The permissible limit of sodium for drinking water is specified by BIS (1991) as 200 mg/L and only one sample is crosses the permissible limit (Table.1). The European Economic Community (EEC,1980) has prescribed the guideline level of potassium at 10 mg/L in drinking water. Potassium values ranged from 1 to 58 mg/L and as per European Economic Community (EEC,1980) criteria, only one sample is crosses the permissible limit and remaining samples of the study area fall within the guideline level of 10 mg/L (Table.1). Sulphate can be found in almost all natural water. Sulphate (SO_4^-) content in groundwater is made possible through oxidation, precipitation, solution and concentration, as the water traverses through rocks (Karanth,1987). The Sulphate values of groundwater ranged from 21 to 162 mg/L with an average value 71 mg/L, this show that the all the sample were within the maximum permissible limit prescribed by BIS (1991) (Table.1).

Conclusions

The groundwater samples from the various places of study area were analyzed and the analysis report shows that the majority groundwater samples are within limit except few which indicates signs of deterioration in the study area. The high consumption of fertilizer chemicals and dramatic development of urbanization are main factors for groundwater quality degradation at few places. To meet the ever increasing need of potable groundwater, the best way is to control the groundwater by protecting it from contamination and increase the groundwater resources by recharging it through rainwater harvesting, excess rain water stored should be directed to recharging wells and also encourage the framers to use biofertilizers and biopesticides to avoid the surface water and groundwater contamination before it becomes unmanageable.

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