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Hydrogeochemistry of Sukhana River subbasin of Aurangabad district, INDIA

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Research Article

Abstract: Water quality has significant role in human health and sustenance of human, animals and plants. The quality of groundwater within a region is governed by both natural processes such as precipitation rate, weathering processes and soil erosion and anthropogenic effects such as urban, industrial and agricultural activities and the human exploitation of water resources. This paper deals with the drinking water quality of the Sukhana river sub-basin of Aurangabad districts. Twenty groundwater samples collected and were analyzed for major physicochemical parameter such as pH, Electrical Conductivity (EC), Total Disolve Soilids (TDS),Calcium (Ca^{2+}),Magnesium(Mg^{2+}),Total Hardness (TH), Sodium (Na^{+}),Potassium (K^{+}), Bicarbonate alkalinity (HCO_3^{-}),Sulphate (SO_4^{-}),Chloride (Cl^{-}) and Nitrate (NO_3^{-}) in order to understand the different geochemical processes affecting the groundwater quality. The analytical data were interpreted with World Health Organization and Indian Standard Institution drinking water standards. The analytical results indicate the majority groundwater samples are suitable for drinking purposes except few which indicates signs of deterioration in the study area. The aquifers of Sukhana river subbasin are subject to contamination at same places due to sewage effluents, industrial discharge and excessive use of fertilizers and pesticides in agriculture.

Keywords: Hydrogeochemistry, physicochemical parameter, water quality, Aurangabad.

Introduction:

Water is a vital natural resource, which is essential for multiplicity purposes. It is an essential constituent of all animal and vegetable matters. It is also an essential ingredient of animal and plant life. Its uses may include drinking and other domestic uses, industrial cooling, power generation, agriculture, transportation and waste disposal. It is due to the rapid Urban-industrial technology revolution and speedy, exploitation of natural resources by man, population explosion. Groundwater is one of the important sources of water used for domestic and industrial purpose, water-borne pathogens; toxic and nontoxic pollutants are the major water quality degradation parameters which are transported from recharge area to discharge area through aquifers by groundwater motion. Undesirable and soluble constituents in the water cannot be controlled after entering the ground (Johnson 1979; Krishna Kumar S, et al,2009). Groundwater plays a fundamental role in human life and development. The Safe portable water is absolutely essential for healthy living. 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). The overexploitation of groundwater for domestic, industrial activities and anthropogenic pollution-induced factors reduced the groundwater quality. The aim of the present study is to identify the hydrogeochemical characteristics and quality factors of the Sukhana river subbasin of Aurangabad.

Materials and methods:

The current study was designed to investigate the conditions of groundwater contamination in the study areas. The hydro geochemistry study was undertaken by randomly collected 20 groundwater samples from dug wells. Samples were drawn with a precleaned plastic polyethylene bottle. Prior to sampling, all the sampling containers were washed and rinsed thoroughly with the groundwater. The physical parameters such as pH and electrical conductivity were determined in the field at the time of sample collection. The chemical characteristics were determined immediately in the lab as per the standard methods for examination of water and wastewater (APHA,2002) and Trivedi and Goel (1984).all results are compared with standard limit recommended by the Bureau of Indian Standards (BIS,1991), and World Health Organization (WHO,1993).

Hydrogeochemistry:

Understanding the quality of groundwater is important as its quality because it is the main factor determining its suitability for domestic, drinking, agricultural and industrial purposes. The results of the physicochemical analysis are presented in table 1.

pH

The pH of a water sample measures its hydrogen ion concentration and indicates whether the sample is acidic, neutral or basic. The pH values of groundwater ranged from 7.2 to 8.5 with an average value 7.8. This shows that the groundwater of the study area is mainly alkaline in nature (Table.1).

Electrical Conductivity (EC)

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). The value of EC varied from 672 µmhos/cm to 1890 µmhos /cm with an average value of 1166 µmhos/cm. The maximum limit of EC in drinking water is prescribed as 1500 µmhos /cm as per WHO (1993) standard; all samples are within the permissible limit (Table.1).

Total Dissolves soilids (TDS)

The total dissolves solids (TDS) indicate the general nature of salinity of water. 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 (Deshpande and Aher, 2012). The TDS value ranged from 437 to 1229 mg/L with a mean of 758 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).

Calcium (Ca^{2+})

This element is essential for the life of plants and animals, for it are present in the animal's skeleton, in tooth, in the egg's shell, in the coral and in many soils. 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 141 mg/L with an average value of 60 mg/L, the desirable limit of calcium for 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).

Magnesium (Mg^{2+})

The principal sources of magnesium in the natural waters are various kinds of rocks, sewage and industrial wastes are also important contributors of magnesium. Magnesium (Mg^{2+}) concentration varies from 19 to 148 mg/L with mean values of 53 mg/L. According to BIS (1991) the desirable values of Mg is 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, 2011) (Table.1).

Total Hardness:

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. Hardness is defined as the concentrations of calcium and magnesium ions. A total hardness value varies from 220 to 752 mg/L with a mean values 367 mg/L. The desirable limit of total hardness (TH) for drinking water is specified by BIS (1991) as 300 mg/L and a maximum permissible limit of 600 mg/L. It is observed that except one samples, all samples are within maximum permissible limit (Table.1). The high concentration of hardness may be due to the disposal of improperly treated sewage and industrial wastes.

Chloride (Cl^-)

Chloride originates from sodium chloride which gets dissolved in water from rocks and soil. It is good indicator of groundwater quality and its concentration in groundwater will increase if it mixed with sewage. The chloride (Cl^-) ion concentration varied between 24 to 424 mg/L with a mean values 108 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

Bicarbonate Alkalinity (HCO_3^-)

Alkalinity is the measure of the capacity of the water to neutralize a strong acid. The Alkalinity in the water is generally imparted by the salts of carbonates, silicates, etc. together with the hydroxyl ions in free state

(Trivedi and Goyal, 1986).The bicarbonate alkalinity varies from 176 to 380 mg/L with an average value of 250 mg/L (Table.1).

Sodium (Na^+)

Sodium (Na^+) is present in a number of minerals. All groundwater contains some sodium because most rocks and soils contain sodium compounds from which sodium is easily dissolved. The increasing pollution of groundwater has resulted in a substantial increase in the sodium content of drinking water. Sodium values ranged from 16 to 221mg/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).

Potassium (K^+)

The main sources of potassium in ground water include rain water, weathering of potash silicate minerals, use of potash fertilizers and use of surface water for irrigation. The European Economic Community (EEC) has prescribed the guideline level of potassium at 10 mg/L in drinking water. Potassium values ranged from 1 to 9 mg/L and as per European Economic Community (EEC) criteria, all samples of the study area fall within the guideline level of 10 mg/L (Table.1).

Sulphate (SO_4^-)

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 18 to 165 mg/L with an average value 55 mg/L, this show that the all the sample were within the maximum permissible limit prescribed by BIS (1991) (Table.1).

Nitrate (NO_3^-)

The Nitrate (NO_3^-) content of the samples water ranged from 19 to 182 mg/L with an average value 65 mg/L (Table.1). According to BIS (1991) the desirable values of Nitrate (NO_3^-) is 45 mg/L and a maximum permissible limit of 100 mg/L, where 12 samples below desirable limit, 3 samples are above desirable limit but within maximum permissible limit and 5 samples were exceeding maximum permissible limit prescribed by BIS (1991) (Table.1). NO_3^- is mainly derived from various agricultural and anthropogenic activities.

Conclusions:

The groundwater samples from the various places of Sukhana river sub basin of Aurangabad district were analyzed and the analysis reports shows that the majority groundwater samples are suitable for drinking purposes except few which indicates signs of deterioration in the study area. The aquifers of Sukhana river subbasin are subject to contamination at same places due to sewage effluents, industrial discharge and excessive use of fertilizers and pesticides in agriculture. The weathering process of rock formations, water dissolved natural organic, inorganic compounds, high consumption of fertilizer chemicals and dramatic development of urbanization are main factors for groundwater quality degradation. 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 conventional recharge measures like construction of cement nalla bandh, recharge trench, recharge shaft etc. in the catchment area to arrest rainwater. It is also recommended to undertake roof top rainwater harvesting on large scale.

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Table 1: Result of Physico chemical analysis of groundwater samples

Sample No.	pH	EC ($\mu S\ cm^{-1}$)	TDS (mg/L)	Na^+ (mg/L)	K^+ (mg/L)	Mg^{2+} (mg/L)	Ca^{2+} (mg/L)	TH (mg/L)	HCO_3^- (mg/L)	SO_4^{2-} mg/L)	Cl^- (mg/L)	NO_3^- (mg/L)
1	7.8	706	459	18	1	40	51	292	228	29	24	71
2	7.6	695	452	16	1	19	67	248	200	21	24	62
3	7.7	960	624	56	2	23	90	320	176	49	84	134
4	7.7	1030	670	33	1	63	48	380	256	24	54	173
5	7.7	672	437	20	1	20	54	220	192	25	28	42
6	7.9	727	473	17	1	35	56	284	276	18	26	25
7	7.8	1890	1229	221	3	148	58	752	380	135	424	118
8	8.0	1450	943	91	1	60	35	336	200	80	174	40
9	8.5	1569	1020	164	1	69	34	368	180	66	230	44
10	8.0	1217	791	48	1	73	45	412	316	42	86	74
11	7.9	1536	998	67	1	58	70	416	220	165	116	40
12	8.4	1380	897	60	3	79	51	452	192	51	100	19
13	8.0	1163	756	37	1	55	42	332	260	67	68	43
14	7.2	819	532	25	3	40	53	296	288	25	36	19
15	7.9	1038	675	44	1	47	38	288	240	31	78	22
16	7.7	998	649	60	9	21	74	272	212	45	100	33
17	7.3	940	611	39	1	22	70	268	232	40	64	25
18	7.9	1600	1040	78	1	81	48	452	380	85	136	29
19	7.9	1583	1029	112	1	82	69	508	308	63	214	103
20	7.7	1344	874	59	1	24	141	452	272	46	102	182
Min.	7.2	672	437	16	1	19	34	220	176	18	24	19
Max.	8.5	1890	1229	221	9	148	141	752	380	165	424	182
Avg.	7.8	1166	758	63	2	53	60	367	250	55	108	65