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Geochemical Evolution of Groundwater in the Purna Alluvial Basin, Maharashtra

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ABSTRACT

Groundwater qualities of Purna basin saline area have been extensively monitored in pre- and post-monsoon periods of the year 2006 to evaluate its groundwater chemistry. The interpretations on the based on a total of 94 samples each were collected in pre- and post-monsoon periods out of which, 24 belongs to dug wells and rest 70 to bore wells. Most of the samples are collected from the saline area and analyzed various physic-chemical parameters like pH, electrical conductivity (EC), total dissolved solid (TDS), alkalinity, sodium (Na), potassium (K), calcium (Ca), magnesium (Mg), hardness (TH), chloride (Cl), sulphate (SO4) and nitret (NO3). On the basis of physical and chemical parameters of groundwater of both borewells and dugwell in general, high to very high then the permissible limits of various constituents/parameters, as per the standard set by WHO (1984) and Indian Slandered (1991). In the study area the concentration pH, TDS, Na, NO_3 and total hardness show an increasing trend from pre-monsoon to post-monsoon period, in both shallow and deep aquifers. On the basis of mean value electrical conductivity and TDS are high recorded in deep aquifer.

I. INTRODUCTION

The continuation of groundwater salinity in the study area is already been reported about five decade back (Wynne, 1869) but the problem could get initial attention after a gap of five decades (Crookshank, 1926; Kailasam, 1949; Chatterjee, 1959) etc. Adyalkar (1963), for the first time, reported geology, hydrogeology, palaeogeography, pattern of sedimentation and probable cause of salinity. It is noticed that the salinity problem of the area remains the same, despite of the fact, that general groundwater problem including peripheral sweet water zone has become more acute due to lowering of groundwater table, mainly because of unwise and excessive pumping, low rain fall, poor management etc.

A close review of the salinity problem shows that systematic approach to interpret the cause, extend and present status of salinity is still lacking. As such, one-time geochemical data on the saline groundwater is not available (Adyalkar, 1996), which is probably true even today. Considering the severeness of the problem, the work has been initiated by collecting the groundwater samples from entire saline area in order to interpret the present status of the salinity.

STUDY AREA

The study region, located between longitudes 75°56'25" to 77°56'46"E and latitudes 20°08'31" to

21˚40'30"N. the present study cover an area of 6,090 km2 mostly covered by the basalt of Deccan Trap while the alluvial tract occupy mostly the central part, of which, 2,726 km2 central part is marked by saline groundwater. The area experiences salinity problem, covering major parts of districts Amravati, Akola and Buldhana. It is covered by the Survey of India toposheet nos. 55G/9-12, 18; 55H/1,5; 55D/1, 9 & 13. The groundwater samples are collected from the saline track including marginal sweet water area.

II. METHODS AND MATERIAL

Ninety-four water samples each were collected in pre- and post-monsoon periods form dugwell and borewell. In case of bore wells, samples have been taken after pumping of the stagnant water, whereas, sampling from the dug wells have been carried out by the wells which were in continuous use. The analysis has been carried out as per the procedure laid down by APHA (1992). The pH and EC were measured immediately at sampling site using portable meters. Alkalinity (Al), calcium (Ca), chloride (Cl) and total hardness (TH) were determined by respective volumetric titration methods. Magnesium (Mg) is measured by subtracting calcium value from the total hardness. Bicarbonate (HCO3) was calculated by the numerical calculation of pH and phenolphthalein alkalinity values. Sodium (Na) and potassium (K) were determined by using flame photometer, whereas, SO4 and NO3 by UVVIS spectrophotometer. Total dissolved solids (TDS) concentration was calculated from EC adhering to the procedure of Hem, (1991).

III. RESULTS AND DISCUSSION

Hydrogeochemistry

The physical and chemical parameters (average value, minimum and maximum value) including pH, EC, TDS and Major cation and anion were analyzed are given in Table 1. The dugwell show values of pH, Mg, Na, NO_3 and total hardness show higher concentration in the post-monsoon, where as, the decreasing trend for TDS, Ca, Cl and SO_4 in pre-monsoon period. Also the borewell of the groundwater in the study area recorded increasing trend in post-monsoon period for pH, Ca, Na, and NO_3 and decreasing trend is record for TDS, Mg, Cl, SO_4 and TH.

Physical parameters

The pH of shallow aquifer varies from 6.9-9.6 (mean 7.5) in pre-monsoon period to 07-9.4 (mean 7.8) in post-monsoon period, where as, in deep aquifer the pre-monsoon value range from 6.8-8.6 (mean 7.23) and 6.9-9.3 (mean 7.6) in post-monsoon period (Table 1). The exceptionally high value of pH, more then 9, is also recorded at a few places, which may be due to the localized phenomena i.e., nature and influence of alluvial constituents, decomposition of salts and anthropogenic causes etc. Electrical conductivity, which measures total dissolved solids concentration, ranges from 300 -18,300:mhos/cm and 210-15,800:mhos/cm in shallow aquifer during pre- and post-monsoon periods; and, 200-18,200:mhos/cm and 300-18,800:mhos/cm respectively in deep aquifer. Most of the values fall in high (750-2,250:mhos/cm) and very high (2,250-5,000:mhos/cm) categories of irrigation water as proposed by Richard (1954). The higest EC value indicates the presence of salinity in groundwater Jain and Vaid (2018). The total dissolved solids are comparatively high in shallow aquifer, with an average value of 2,993mg/l in pre-monsoon and 2,726mg/l in post-monsoon period, as compared to 2,028mg/l and 1,853mg/l respectively, for deeper aquifer. The higher value of TDS of shallow aquifer is quite obvious as evaporation due to high temperature in pre-monsoon, and addition of salts through meteoric water in post-monsoon periods are the common phenomena Naik et al. (2009).

Chemical parameters

The mean values of magnesium and sodium shows that both are the dominant constituents of the groundwater of both shallow and deep aquifers, however, there is a marked change in their trends

during pre- and post-monsoon periods. Magnesium in shallow aquifer ranges from 36.9-1,978mg/l (mean 253mg/l), which shoot up to the mean value of 402.8mg/l in post-monsoon period, in a ranges of 32.9 to 205mg/l, where as, in case of deep aquifer, the pre-monsoon concentration ranges from 13.1 to 4,681mg/l (mean 332.4mg/l) and show a little decreasing trend i.e., 3,043mg/l. The concentration of sodium is exceptionally high in the shallow aquifer with a mean value of 296.6mg/l in pre-monsoon to 621mg/l in post-monsoon. Similar increasing trend of sodium has also been noticed in deep aquifer with a mean of 288.7 and 363.7mg/l, respectively. The significant increase in sodium concentration of shallow aquifer during post-monsoon period is noticeable. The concentration of calcium also shows an irregular trend in shallow and deep aquifers. In shallow aquifer, the pre-monsoon mean value is 167.6mg/l, which decreases to 129.1mg/l in post-monsoon period, where as, a reverse trend is exhibited by deep aquifer i.e., 97.9mg/l in pre-monsoon, which rise up to 111.8mg/l in post-monsoon. Potassium shows a remarkable change of concentration in shallow and deep aquifers. The mean values of potassium from shallow aquifer in pre- and post-monsoon periods are 25.16mg/l and 30.28mg/l respectively, which are quite high as compared to deeper aquifer having 5.825mg/l and 2.699mg/l, respectively.

Chloride is also a significant constituent in the shallow as well as deep aquifer, and shows a decreasing trend from pre- to post-monsoon period. However, the concentration is in general high in shallow aquifer. Similar decreasing trend is also exhibited by sulphate. Nitrate, though constituting a very less quantity, experiences a higher value in post-monsoon period in both the aquifers.

Sr. No	Para-meters	monsoon / period	Dug well		Bore well		WHO Standard		Indian Standard	
			Concentration in Mg/l*	Mean	Concentration in Mg/l*	Mean	Highest Desirable	Highest Permissible	Highest Desirable	Highest Permissible
1.	pH	Pre- Post-	6.9-9.6 7-9.4	7.51 7.78	6.8-8.6 6.9-9.3	7.23 7.62	6.5-8.5	7.0-8.5	6.5-8.5	-
2	EC	Pre- Post-	300-18300 210-15800	-	200-18200 300-18200	-	-	-	-	-
3.	TDS	Pre- Post-	186-11346 130-9796	2993 2726	124-11284 186-11656	2028 1853	500	1000	500	2000
4.	Ca	Pre- Post-	28.8-901.8 20-665.3	167.6 129.1	14.4-681.3 12-877.7	97.9 111.8	75	200	75	200
5.	Mg	Pre- Post-	36.9-1978 32.9-2050	253 402.8	13.1-4681 26.3-2670	332.4 304.3	-	150	30	100
6.	Na	Pre- Post-	4.5-565 30.4-2545	296.6 621	5-676 10-2008	288.7 363.7	-	200	-	-
7.	Cl	Pre- Post-	25.3-3990 35.5-1491	749.7 463.4	28.4-5424 20.5-1697	497.8 332.5	200	600	250	1000
8.	SO_4	Pre- Post-	3.01-296 15-350	129.5 113.8	5-296 3-275	107.2 90.3	200	400	200	400**
9.	NO_3	Pre- Post-	0.2-22 0.1-27	14.9 16.3	0.8-26 0.1-25.2	14.8 18.4	45	-	45	100
10	TH	Pre- Post-	140-5250 100-4770	792.5 934.4	140-8550 70-5370	765.3 733.5	100	500	300	600

Table 1. Range in concentration and mean values of physical and chemical parameters of the samples and their comparison with WHO (1984) and Indian Standards (1991) for drinking water.

IV.CONCLUSION

The comparison of analytical data of both the aquifers have been made with the specifications set by WHO (1984) and Indian Standard (1991) for human consumption. The mean values of TDS of shallow aquifer in pre- and post-monsoon periods i.e., 2,993mg/l and 2,726mg/l, clearly indicates that the water is not potable even as per the specifications of Indian Standard (1991), which has the maximum permissible limit of 2,000mg/l as compared to 1,000mg/l in case of WHO (1984) Standards. Similarly, in deep aquifer, the mean values in pre- and post-monsoon periods are 2,028mg/l and 1,853mg/l respectively, which are also very close to the highest permissible limit of Indian Standard (1991). The mean sodium concentration is also high in both shallow and deep aquifers; however, in shallow aquifer the value is exceptionally high, i.e., 621mg/l during post-monsoon period.

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