RESEARCH FRONT

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ASSESSMENT OF GROUNDWATER QUALITY IN UPPER KARHA RIVER BASIN

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ABSTRACT

Water from beneath the ground has been exploited for domestic use, livestock and irrigation since the earliest times. Although the precise nature of its occurrence was not necessarily understood, successful methods of bringing the water to the surface have been developed and groundwater use has grown consistently ever since.

In previous few years, the increasing threat to groundwater quality due to human activities has become a matter of great concern. A vast majority of groundwater quality problems present today are caused by contamination and by overexploitation, or by combination of both. Rapid urbanization in the Study Area resulted in steep increase of generation of wastes. Due to lack of adequate infrastructure and resources the waste is not properly collected, treated and disposed; leading to accumulation and infiltration causing groundwater contamination. In the Study area groundwater is only source of drinking water, thus a large population is exposed to risk of consuming contaminated water.

The Study Area is located at Purandhar Tahasil in Pune District Maharashtra State; actually it's a source region of Karha River. Now a days due to fast increasing Urbanisation, the people of this area has to face Groundwater Scarcity and Whatever the Groundwater is available it is not in good condition. That's why the attempt has been made hear is great concern with Groundwater Contamination. In present study, total 30 Groundwater samples has been analysed in the laboratory and on the basis of that data Various thematic maps has been generated, from those maps we can understand and can delineate the ground water contamination areas which are not suitable for the Agriculture purpose.

Key Words: Groundwater Contamination, Groundwater Scarcity.

INTRODUCTION

Groundwater resources are dynamic in nature and are affected by such factors as the expansion of irrigation activities, industrialization and urbanization. Hence monitoring and conserving this important resource is essential. The quality of water is defined in terms of its physical, chemical and biological parameters. Ascertaining the quality of groundwater is crucial before its use for various purposes such as drinking, agricultural, recreational and industrial uses (Sargaonkar and Deshpande 2003, Khan et al, 2003). Till recently, groundwater assessment has been based on laboratory investigation, but the advent of Satellite Technology and Geographical Information System (GIS) has made it very easy to integrate various databases (Mouna Ketata et al, 2011).

Understanding the groundwater quality is important seeing that it is the main factor determining its suitability for drinking use (Sivasankar and Gomathi 2009, Schulz and Howe, 1999).

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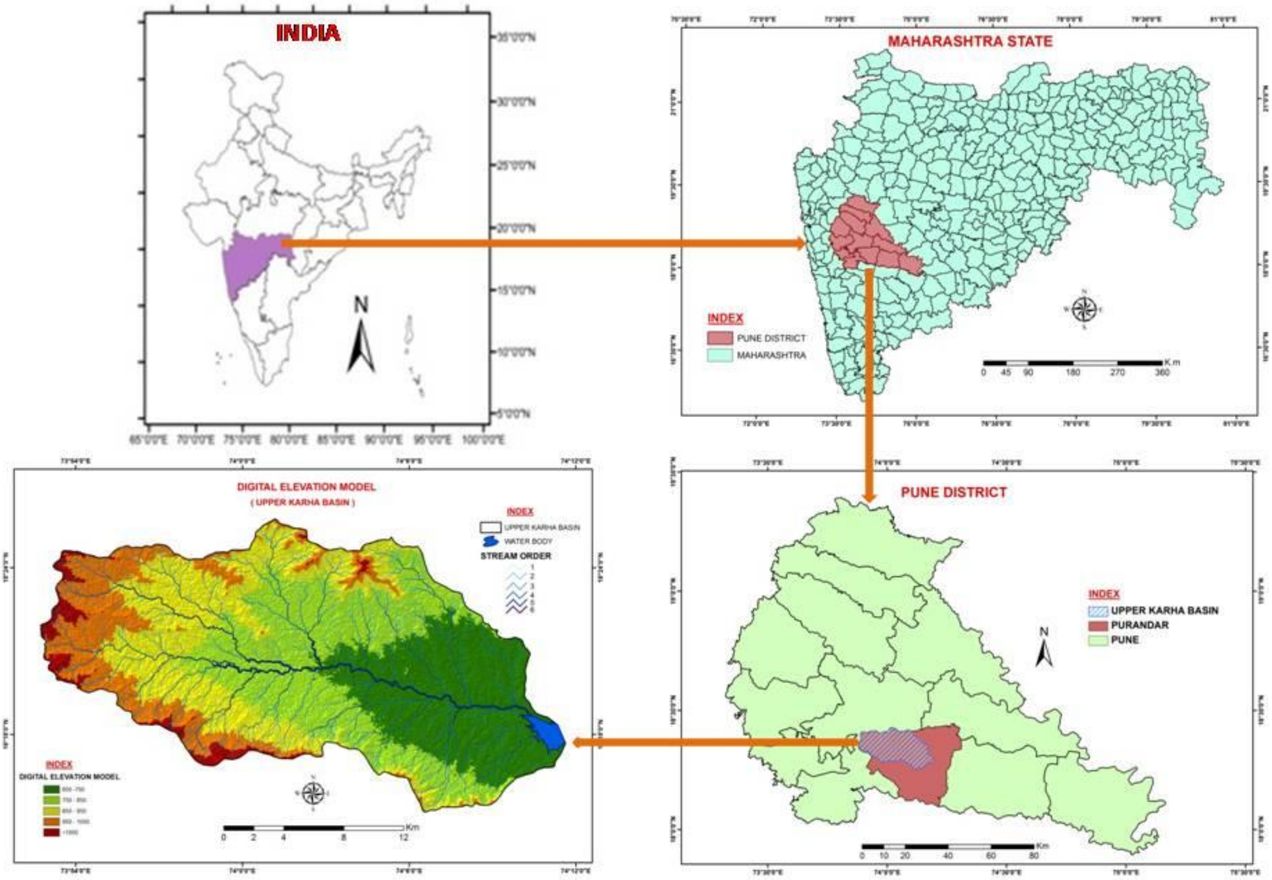
The present study has been carried out to assess the groundwater quality of Upper Karha River Basin which is situated in Purandar taluka, Pune district in knowing the impact of urbanization and developmental activities of rapid growth, industrial impact and use of chemical fertilizers and pesticides in the agricultural fields on the quality of groundwater.

STUDY AREA

Upper Karha river basin is situated in the Purandar Tehasil of Pune district in Maharashtra State and is located at 18° 15’ 00’’ to 18° 25’ 00” N latitude and 73° 52’ 40” to 74° 15’ 00’’ E longitudes. It is included in toposheet no. 47F/15 and 47 J/3 of Survey of India. The total area of Upper Karha River Basin is 396.2 Sq.Km.

LOCATION MAP OF THE STUDY AREA



METHODOLOGY

For present study Groundwater sample has been collected randomly during fieldwork within Study Area. Then those samples has been Analysed in laboratory and attributes has been attached to the spatial reference points which is taken by GPS. After that various thematic maps has been generated using Arc GIS software, from those maps conclusions has been drawn.

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TABLE-1: Water quality analysis data with spatial reference

LOCATIONAL INFORMATION			PH	EC	SAR	RSC	Na %	TDS
ZENDE WADI	74.0137068038	18.4045095335	7	499.8	0.94	-2.75	32.92	324.9
TATHE WADI	74.0480308753	18.3231729675	7.1	1332.8	3.04	-4.92	67.31	866.3
KHALAD	74.0795319904	18.3261505368	8.2	1607.2	1.81	-6.78	40.02	1044.7
KHANAVDI	74.1064077834	18.3319663060	7.2	1705.2	1.22	-8.16	23.54	1108.4
PARGAON	74.1331971964	18.3576843167	7.5	911.4	1.72	-4.19	45.42	592.4
GURHULI	74.0974344262	18.4059946888	7.2	921.2	1.8	-3.92	47.3	598.8
VANPURI	74.0723566437	18.3760505912	7.9	1999.2	1.78	-7.6	35.43	1299.5
SAKURDE	74.1217111546	18.2714960432	8.8	1156.4	0.88	-2.94	34.98	751.7
PIMPLE	74.0321272170	18.3006957794	7.5	2871.4	2.65	-8.07	62.03	1866.4
NARAYANPUR	73.9802140490	18.2994279050	8.4	1999.2	1.95	-7.36	48.15	1299.5
KODIT.BK	73.9783088498	18.3397051794	7.5	372.4	1.27	-1.24	68.75	242.1
GARADE	73.9275277778	18.3490277778	7.2	372.4	1.04	-1.63	50.83	242.1
BHIVRI	73.9265672320	18.3891951103	7.1	2459.8	3.38	-6.58	72.13	1598.9
CHAMBHLI	73.9734897171	18.3714821298	7.1	1881.6	3.07	-5.7	73.62	1223.0
THAPE WADI	73.8993541480	18.3375996860	7.3	1146.6	2	-5.02	46.95	745.3
PATHAR WASTI	73.8995305631	18.3760450978	8.3	2763.6	2.18	-10.06	43.2	1796.3
VARAVADI	73.8886211439	18.3540302427	8.3	1127	2.2	-4.4	61.72	732.6
SOMARDI	73.9347299926	18.3194651450	8.2	784	2.2	-2.91	79.62	509.6
ASKARWADI	73.8955146706	18.4009427600	7.1	1813	1.71	-10.16	32.42	1178.5
KHOPOR WADI	73.9662788830	18.3946685916	7.7	754.6	1.57	-3.72	45.6	490.5
SUPE.KH	74.0141445316	18.3203619215	7.4	714	1.31	-2.48	42.14	502.0
SONORI	74.0506902148	18.3863248134	7.9	812	1.48	-2.53	48.17	414.0
AMBODI	74.0451200731	18.3519271467	8.2	1960	1.89	-6.69	41.4	1274.0
PAWAR WADI	74.0122023326	18.3695158355	7.3	1127	1.99	-5.18	47.66	732.6
SHIVRI	74.0836585929	18.2858804032	7.4	921.2	1.95	-4.39	50.86	598.8
DUNE WASTI	74.1548428800	18.2843890427	7.3	872.2	2.25	-1.82	85.07	566.9
KOTHALE	74.1567899794	18.3227625818	7.1	1930.6	2.63	-10.01	55.77	1254.9
NARALICHA MALA	74.1193630377	18.3037073068	6.9	1639	1.65	-7.55	39.55	1039.0
BHAGWAT WASTI	74.1035493892	18.3691817903	6.8	1296	1.55	-7.65	37.12	789.0
JEJURI	74.1789798884	18.2842738829	8.2	2303	2.5	-3.23	83.98	1497.0
Maximum			8.8	2871.4	3.4	-1.2	85.1	1866.4
Minimum			6.8	372.4	0.9	-10.2	23.5	242.1
Average			7.6	1401.8	1.9	-5.3	51.5	906.0
Standard deviation			0.5	686.6	0.6	2.6	16.2	449.0
BIS Standards			6.5-8.5	1400	-	-	-	500

WATER QUALITY ASSESSMENT FOR AGRICULTURAL PRACTICES

Assessment of the suitability of ground water for agricultural purpose is mainly based upon the estimation of parameters like Salinity hazards, SAR, RSC and Na percentage. In addition to that pH, Ec, and TDS is also delineated to assess the groundwater suitability for Agricultural purpose.

SODIUM ABSORPTION RATIO (SAR)

SAR is express as,

$$\text{S.A.R.} = \frac{Na^+}{\sqrt{\frac{1}{2}(Ca^{2+} + Mg^{2+})}}$$

All values expressed in meq/L.

As per the classification of SAR ratio suggested by Raghunath (1987) if ratio less than 10 it is very good quality for irrigation purposes. On the basis of SAR values all water samples from the study area belongs to very good quality.

RESIDUAL SODIUM CARBONATE (RSC)

The values for RSC is calculated as per Eaton, (1950)

RSC= (CO_3 + HCO_3) - (Ca+ Mg)

All values expressed in meq/L.

Accordingly, Lloyd and Heathcote (1985) have classified irrigation water based on RSC as Suitable (< 1.25), marginal (1.25 to 2.5) and not suitable (> 2.5). According to RSC values of water samples from study area range from -10.2 to -1.2 suggesting that the all of the samples suitable to irrigation.

SODIUM PERCENTAGE (SSP)

The sodium percentage calculated by using following formula, where the concentration is expressed in meq/l.

SSP = (Na × 100) / (Ca + Mg)

Na % is defined as the ratio of sodium to the total cations in meq/L (Li et al., 2010). Water with % Na greater than 60% may result in sodium accumulations that will cause a breakdown in the soil's physical properties. It is observed that, the Na % values in 21 water samples is lower than 60 and higher in 9 water samples from the study area.

HYDROGEN ION ACTIVITY (PH)

The pH refers to the activity or effective concentration of hydrogen (H^+) ions in the water. It is expressed as negative logarithm to the base 10 of H^+ ion concentration or activity in moles/ liter (Bouwer 1978). The pH of natural water is controlled by carbon dioxide, carbonate and bicarbonate system. Natural waters commonly contain dissolved carbon dioxide gas and bicarbonate ions, which form a buffering system with carbonic acid. Hence, pH of natural water varies in a specified and limited range (Davis and De Wiest 1967).

The pH was measured with the help of portable pH meter. Prior to reading, pH meter was calibrated by buffer solutions of 4.0, 7.0 and 9.2. After, each reading electrode was washed with distilled water to increase the accuracy.

ELECTRICAL CONDUCTIVITY (EC)

Electrical conductivity is an ability of water to conduct or to carry an electrical current (Davis and De Wiest 1967). The specific conductance of water is a function of water temperature, hence a standard temperature usually 25^0C, is specified in reporting the values (Todd 2006). The E.C. values are expressed in S.I. unit as micro Siemens per cm (µS/cm), which is numerically equivalent to micro-mhos per cm (µm/cm). Electrical conductivity gives an idea about the total dissolved solids present in the water. The classification of water based on EC values, as given by Water quality classification (US Salinity Lab. 1994), is presented in Table 2.

TABLE NO-2: EC based classification of water samples (After US salinity Lab. 1994)

Class	EC range
Very Low Conductive	100 - 250µS/cm
Low Conductive	250 - 750µS/cm
Medium Conductive	750 - 2250µS/cm
High Conductive	>2250µS/cm

Electrical Conductivity was measured with the help of conductivity meter. Prior to recording the instruments was calibrated by 0.01M KCl solution.

TOTAL DISSOLVED SOLIDS (TDS)

Total dissolved solids were determined as the amount of residue left after evaporation of the filtered water sample.

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An evaporating dish made up of silica (100 ml capacity) was ignited at 550± 50^{0}C in a muffle furnace for about one hour. Then it was cooled in desicator and weighed. An aliquot of 100ml filtered water sample was evaporated in the same evaporating dish on a hot plate, maintaining temperature below 98^{0}C. The residue was heated at 103-105^{0}C in an oven for one hour and weighed after cooling the evaporating dish in a desicator.

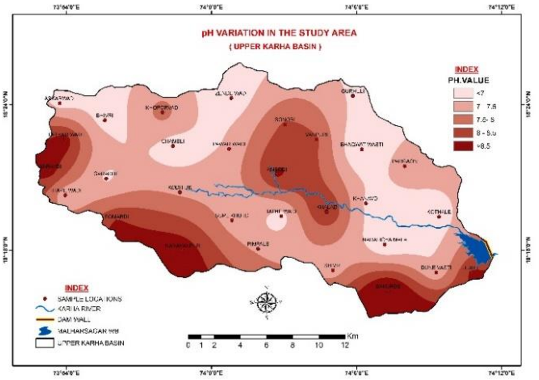
Total Dissolved Solids (mg/L) = {(A - B) X 1000 X 1000} / V

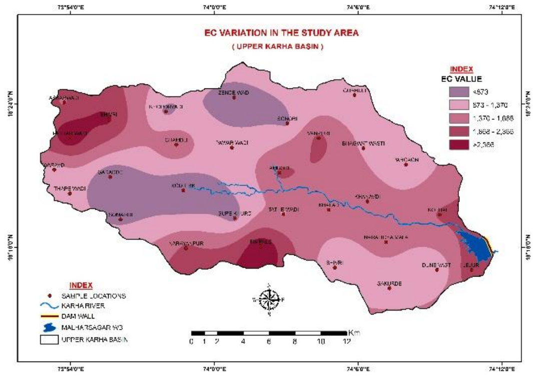
Where: A: Final weight of the dish in g,

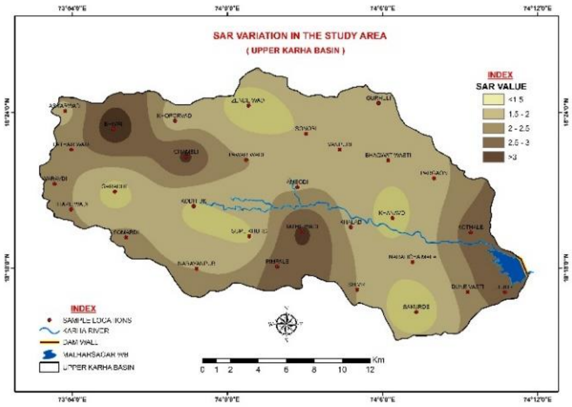
B: Initial weight of the dish in g,

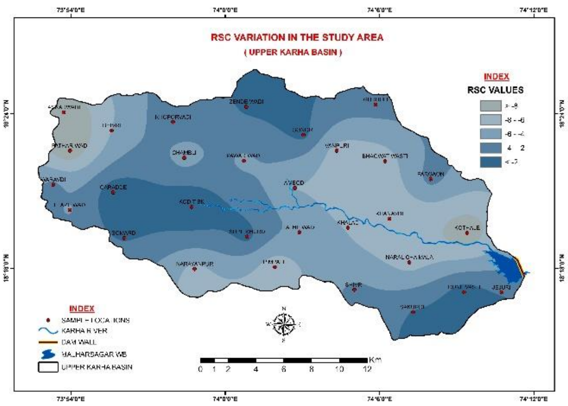
C: Volume of sample taken in ml

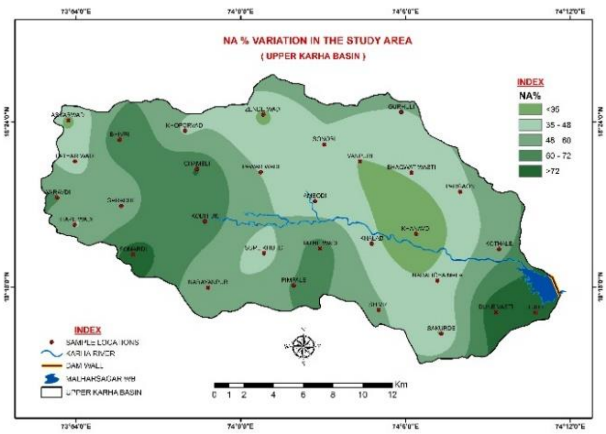
GROUNDWATER QUALITY MAPS











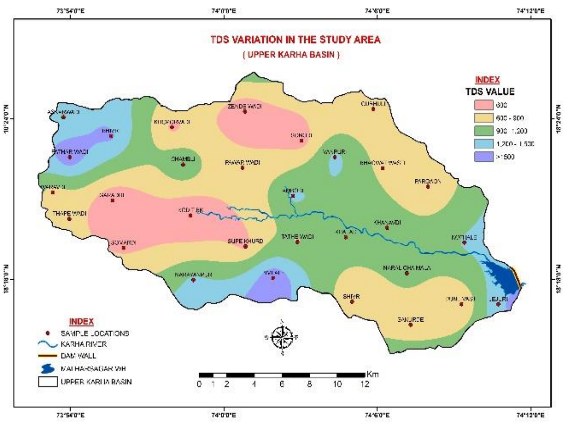


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Table no-3 pH Area Measurement

SR.NO	pH VALUE	AREA Sq.Km	AREA in %
1	<7	92.6	23.4
	7 - 7.5	148.6	37.5
3	7.5 - 8	70.6	17.8
4	8 - 8.5	50.0	12.6
5	>8.5	29.4	7.4
6	WB	4.9	1.2
7	**TOTAL**	**396.2**	**100**

Table no-4 EC Area Measurement

SR.NO	EC VALUE	AREA Sq.Km	AREA in %
1	<873	52.9	13.4
2	873 - 1370	153.7	38.8
3	1370 - 1868	134.3	33.9
4	1868 - 2366	39.9	10.1
5	>2366	10.5	2.6
6	WB	4.9	1.2
7	**TOTAL**	**396.2**	**10**

Table no-5 SAR Area Measurement

SR.NO	SAR VALUE	AREA Sq.Km	AREA in %
1	<1.5	40.5	10.2
2	1.5-2	198.9	50.2
3	2-2.5	87.9	22.2
4	2.5-3	58	14.7
5	>3	5.9	1.5
6	WB	4.9	1.2
7	**TOTAL**	**396.2**	**100**

Table no-6 RSC Area Measurement

SR.NO	RSC VALUE	AREA Sq.Km	AREA in %
1	> -8	14.1	3.6
2	(-8) to (-6)	84.5	21.3
3	(-6) to (-4)	101.0	25.5
4	(-4) to (-2)	128.8	32.5
5	< -2	62.8	15.9
6	WB	4.9	1.2
7	**TOTAL**	**396.2**	**100**

Table no-7 Na% Area Measurement

SR.NO	Na% VALUE	AREA Sq.Km	AREA in %
1	<35	27.0	6.8
2	35 - 48	138.1	34.9
3	48 - 60	136.3	34.4
4	60 - 72	74.0	18.7
5	>72	15.9	4.0
6	WB	4.9	1.2
7	**TOTAL**	**396.2**	**100**

Table no-8 TDS Area Measurement

SR.NO	TDS VALUE	AREA Sq.Km	AREA in %
1	<600	53.2	13.4
2	600 - 900	155.4	39.2
3	900 - 1200	131.5	33.2
4	1200 - 1500	40.0	10.1
5	>1500	11.1	2.8
6	WB	4.9	1.2
7	**TOTAL**	**396.2**	**100**

US SALINITY HAZARD WILCOX (1955) DIAGRAM

SAR (Sodium Adsorption Ratio) is an important parameter for determining suitability of groundwater to irrigation because it is a measure of alkali / sodium hazards to crops (Richard, 1954). Kumaresan and Riyazuddin (2006); Golekar et al., 2014 discussed their results using Wilcox diagram (Wilcox, 1955) and illustrate that all water samples falls in S1 category which is indicating low sodium alkali hazards but according to salinity 23 groundwater samples fall in C field of C3 indicating high salinity hazards; 3 samples fall in the field C2 indicating medium salinity hazards (Zende wadi,Garade, Chambhli) and remaining 4 samples falls in salinity hazards C4 which is indicating very high salinity hazards (Pimple, Bhivri, Pathar Vasti, Jejuri). The Wilcox plots suggest that the area under study be converted into salinity prone.

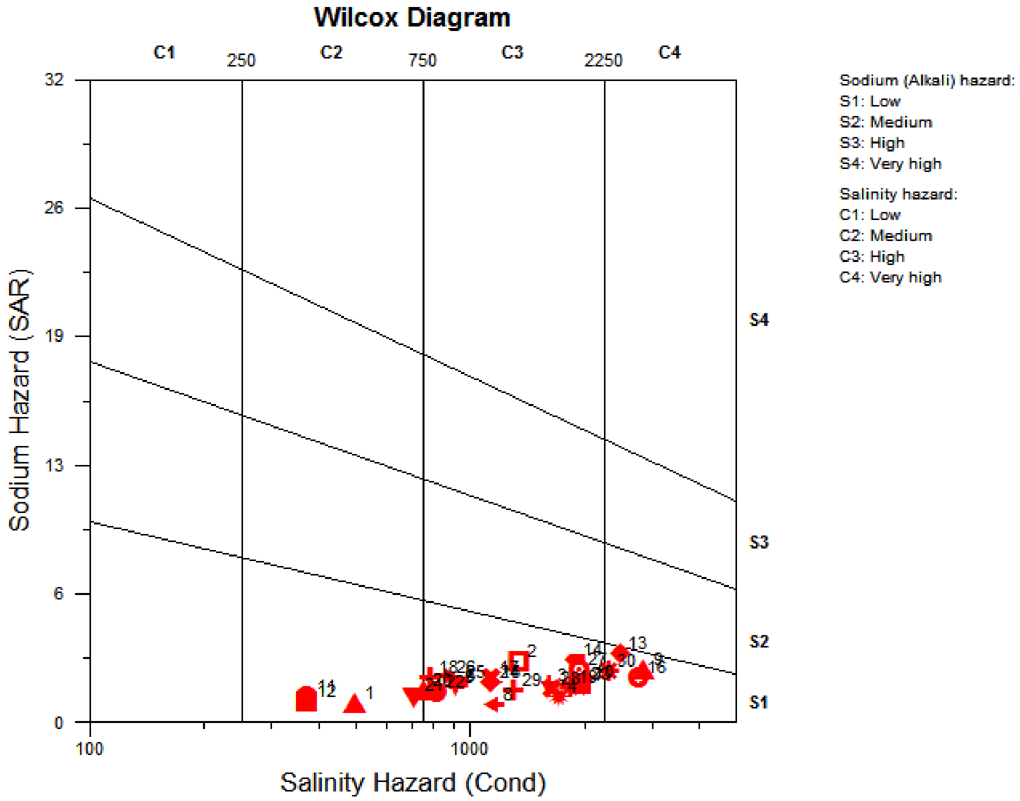

Figure 3 Salinity and sodium hazard diagram

DISCUSSION OF RESULTS

Table 1 shows the chemical compositions of dissolved constituents in the study area. Hydrogen exponent, pH, measured at the sampling site, ranges from 6.8 to 8.8, average pH = 7.6. Table 1 shows that all sampled water is either weakly acidic or neutral. Electrical Conductivity (EC) is an indirect measurement of ionic strength and mineralization of natural water (Umapathy, 2011). EC ranges from 372.4 to 1871.4 µs /cm as an average value 1401.8 µs /cm was observed in the water samples from study area. It observed that 23 water sample having high saline nature and 4 samples shows very high saline nature (Pimple, Bhivri, Pathar Vasti, and Jejuri). 3 Samples show medium saline nature in the Study area (Zende wadi,Garade, Chambhli).

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. The principle component of TDS is calcium, Magnesium, Sodium, Potassium, cations and Carbonates chloride, sulphate and Nitrate inions. The BIS specifies a desirable total dissolved solids limit of 500 mg/L. Total Dissolved Solids, according to table 1, range in from 242.1 to 1866.4 mg/l on average 906 mg/l. Thus, Total Dissolved Solids are highly above the desirable of BIS drinking water standards (500 mg/L). The TDS results suggest that all water samples are not fit for Agricultural purpose except sample number 1, 11, 12 and 22 (Zende Wadi, Kodit

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Budruk, Garade, Sonori). It is possible that shallower parts of the aquifer are more affected by residential pollution than deeper parts.

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