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Groundwater quality studies in Nanjangud Taluk, Mysore District, Karnataka, India

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ABSTRACT

An attempt has been made to classify the groundwater by various methods of Nanjangud taluk. The Nanjangud taluk having an area of 981.60 sq.km and it falls under Mysore district of Karnataka. Water quality parameters of the waters samples were analysed and the results of the analysis have been used to suggest models for predicting water quality. Quality of groundwater in a hard rock terrain is more controlled by the rock-water interaction and the residence time of water in aquifers. The residence time in turn depends on the groundwater systems within a larger hydrological unit. The hydrogeochemical facies of groundwater in the taluk of kabini river basin of Mysore district in Karnataka has been determined. Based on water samples collected and analysed from 50 locations, the hydrogeochemical facies in the area are found to be dominated by sodium-bicorbonate type.

Keywords: Groundwater, water quality, hard rock terrain, hydrological unit.

1. Introduction

Hydrogeochemical analysis of the groundwater of the taluk confluencing with the river Kabini in Nanjangud taluk of Mysore distract, Karnataka state has been now been attempted studying the controlling mechanism. Nanjangud taluk lies on South-Eastern parts of Mysore District and forms almost a plain boundary except for a few isolated hillocks to the south and west. These hills rise 600 to 700 feet above the general level of the boundary, which is at an elevation of 2400 feet above MSL. The highest peak lying on the South–Western corner of the taluk is 3108 AMSL.

1.1 Aim and Objectives

The present study has been adopted for the following objectives

- To Study of chemical composition of groundwater is a measure of its suitability as a source of water for human and animal consumption.
- To evaluate the suitability of water for domestic, industrial and irrigational purposes.
- To demarcate the various thematic maps and are prepared to illustrate the spatial distribution of groundwater in the taluk.

1.2 Study area

Its is bounded between North latitude 11^{o} 5′ 30” and12^{o}12’30’’ East longitude 76^{o} 22′30” to 76^{o} 56′30’’ Toposheets Numbers are 57 D/12, 57D/16,58A/5,58A/9,58A/13 Provides the physiographic coverage of the study area (Fg.1).Total extent of the study area is 981.60 sq. km covering parts or whole of 184 villages falling in Nanjangud taluk.

1.3 Geology and soil

The Nanjangud taluk covers crystalline rocks and high grade supracrustal rocks occurring as huge enclaves within gneisses of different ages, which include quartzite-pelite-carbonate association along with banded iron formations, manganiferous horizons and amphibolites (having dip 60^{0} & strike $N65^{0}E$). The components of ultramafic and basic rocks were emplaced in to the supracrustals and were invaded by large scale acid igneous rock. Nanjangud band is 8 km long, half km wide NE trending linear band extending from 3 km NNW of Nanjangud. Lithologically the belt consists of garnet pyribolites with lenses of calcyphire and crystalline limestone.

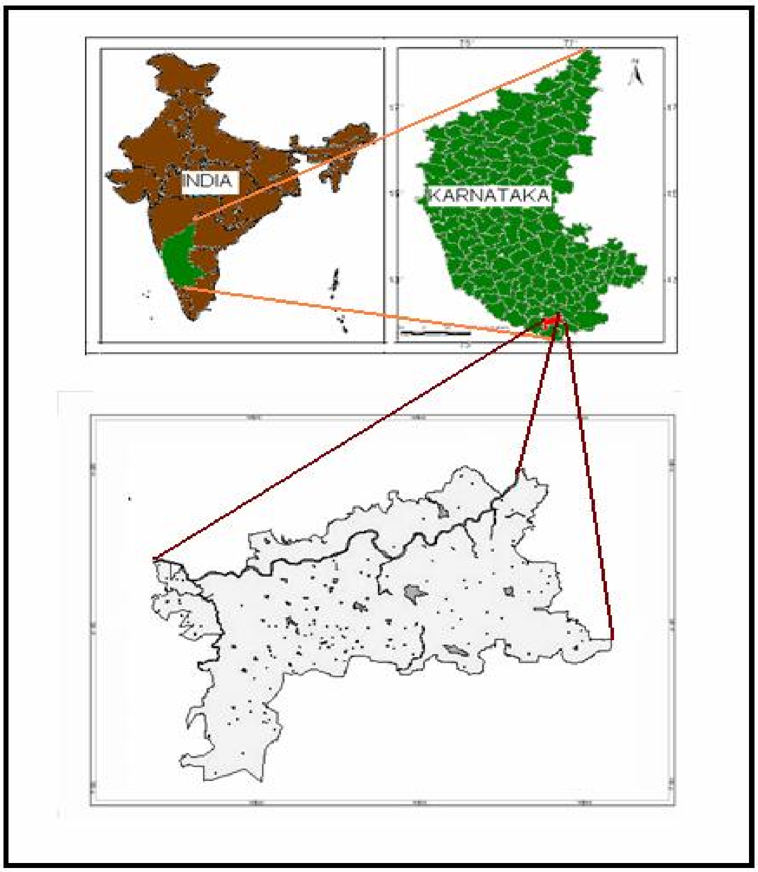

Figure 1: Location map of the study area

2. Methodology

Information on the quality of groundwater is an important aspect any hydrological investigation. The chemical composition of groundwater is a measure of its suitability as a source of water for human and animal consumption, irrigation and for industrial purpose. The prevailing geological environment provides characteristic groundwater composition. In Nanjangud area, the aquifers are mostly open geochemical systems, in which the chemical composition of groundwater is controlled by the rock water interaction during the time of residence. Groundwater samples were collected from 41 wells. The samples were pretreated and analyzed as per ISI standard methods. The EC, pH and TDS and major ions including Ca, Mg, Na, K, HCO_3, CO_3, CL, and NO_3 and SO_4 were determined.

The hydrogeochemical data have interpreted using the following methods in this study.

1. Classification of groundwater with respect to its hardness, salinity and sodium Hazard based on Handa' classification (1965).
2. Identification of water types based on Scholler's method (1967).
3. Determination of the hydrogeochemical facies by Piper'sTrilinear's plot(1944).
4. Ca CO_3 SATURATION INDICES OF groundwater using Ph method (Hem,1961; Handa, 1964) and equilibrium Ca method (Larsen and Boswell, 1942).
5. Identification of the mechanisms controlling chemistry of water using Gibb's Diagram (Gibb's1970). In addition to these, Corrosivity Ratio (Ryzner, 1944) and residual sodium carbonate were also determined.

The suitability of groundwater for different purposes is assessed based on the amount of Total Dissolved Solids (TDS). The dominant hydrochemical facies are correlated with the ion-evolution sequence of Chebatorev (1955). The spatial and time variant changes of groundwater quality are assessed through graphical representations.Ionic ratios computed from ionic concentration expressed in 'epm' or 'r' values are calculated for classifiying the water bodies. These hydrochemical parameters are useful for tracing the geochemical evolution of groundwater. Schoeller's (1956) concept of water type is related the evolution of that groundwater with respect to chemistry. The data shows that the groundwater in the area is of II, III, and IV types, Where r CO_3> rCL is considered as type II, r CO_3>r SO_4>rCL is considered as type III and r CL>r SO_4> rCO_3 and r Na >rMg >rCa are considered as type IV. The predominance of chloride ion in certain areas reflects greater residence time of groundwater.

3. Results and Discussion

Various thematic maps are prepared to illustrate the spatial distribution of groundwater in the taluk. The hydrochemical data plotted over the modified Hill Piper diagram of Handa (1965) is useful for characterizing the water types and to evaluate the suitability of water for domestic, industrial and irrigational purposes. In addition this diagram also provides the geochemical modifications and evolution of water quality during its mobility in the subsurface systems.

3.1 Groundwater Hardness

The region can be divided in to six zones as A_1, A_2 andA_3, (permanent hardness) and B_1, B_2, and B_3 (temporary hardness) (Handa,1965). The spatial variation of groundwater hardness is shown in Figure.2. The analysis has shown that the permanent hardness is majority of the area falls under the temporary hardness and B_1 category is dominated the area. Permanent hardness is noticed in about 65% of the area and is due to increase of rock water interaction mechanism.

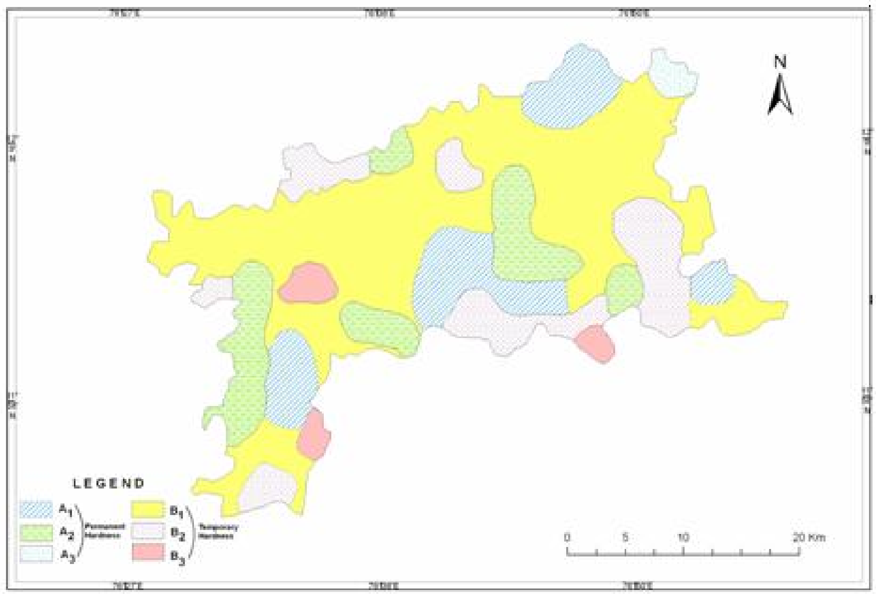

Figure 2: Ground water hardness of study area

3.2 Total Dissolved Solids

As groundwater moves and stays for a longer time along its flow path, increased in total dissolved concentrations and major ions normally occur (Norris et al. 1992).

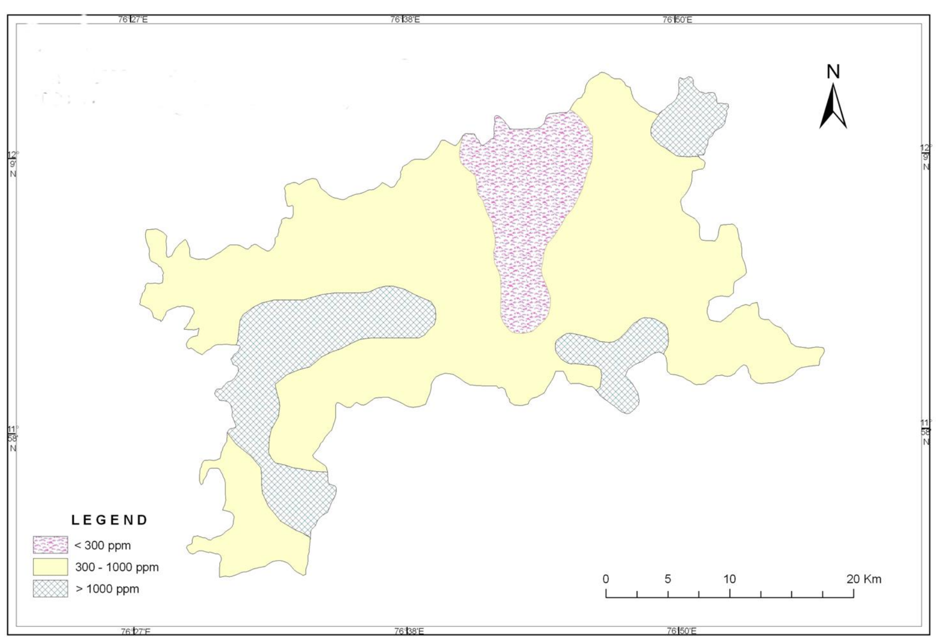

Figure 3: Total dissolved solids of study area

Higher TDS shows longer residence period of water (Davis and De Viest, 1966). TDS content is usually the main factor, which limits or determines the use of groundwater for any purpose (Nordstrom, 1987). The analysis of samples for the seasons has shown that there is a general tendency of increase of TDS, based on TDS, for various uses like general household, drinking, irrigation and understanding and it could be seen from the Figure.3 that a majority of the portion is occupied by 300 to 1000 ppm TDS followed by >1000 ppm concentration and finally <350ppm. During the stay or movement of the groundwater in the subsurface the TDS concentration slowly gets enriched and shown in figure 3 .

3.3 Salinity- Sodium Hazard

The groundwater for irrigational needs could be gauged by the salinity-Sodium hazards (Balasubramanian, 1986; Sastri and Lawrence, (1988). Based on this, the aquifers of the study area can be divided into seven zones (Figure.4.). They are C_2S_1, C_3S_1, C_3S_3, and $C_4S_2$and C_4S_3. The samples have shown that salinity and sodium hazard are low in the area. C3and C4 types seen in the region is not suitable for irrigation. S_2type is suitable for permeable coarse-grained soils and S3is suitable for good drained soils. Water types seen in class are C_3S_3 and C_4S_2, where permeability is poor.

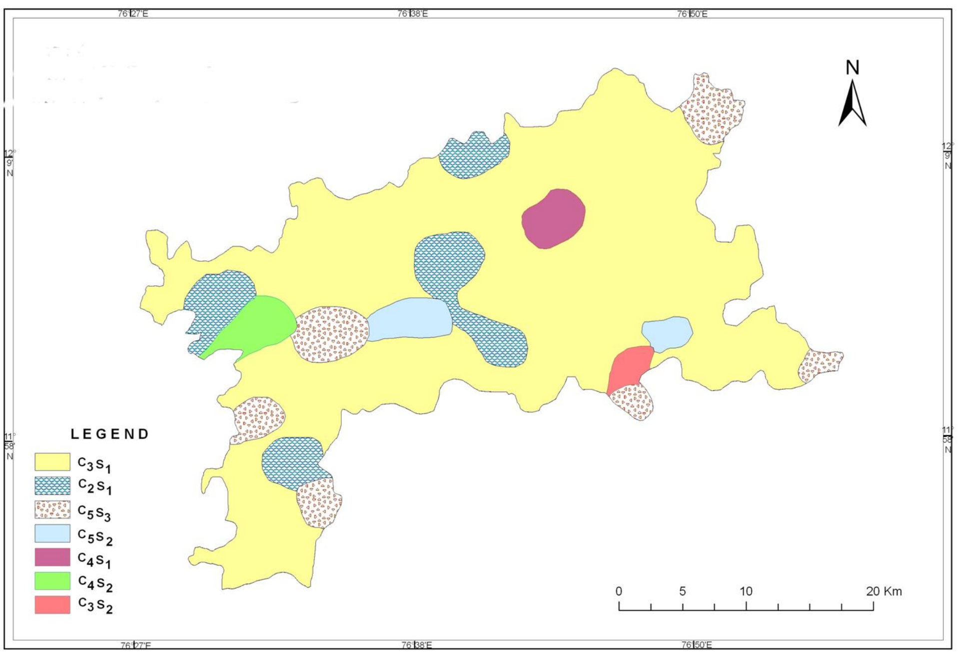

Figure 4: Salinity- Sodium hazard in study area

3.4 Indices of Base Exchange

Indices of Base Exchange data are calculated (Schoeller, 1956).Sharma, (1982) attributed that based on exchange capacity of ions between groundwater and weathered materials, a basin can be divided into recharge and discharge zones. In the area the indices have not shown any kind of relationship with recharge-dischargesand shows in Figure.5.

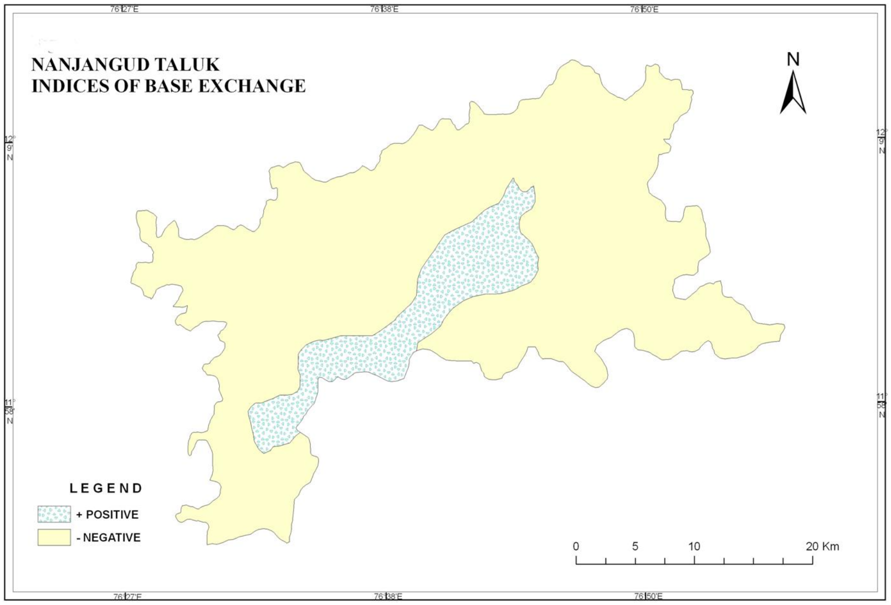

Figure 5: Study areas indices of Base Exchange

3.5 Corrosivity Ratio

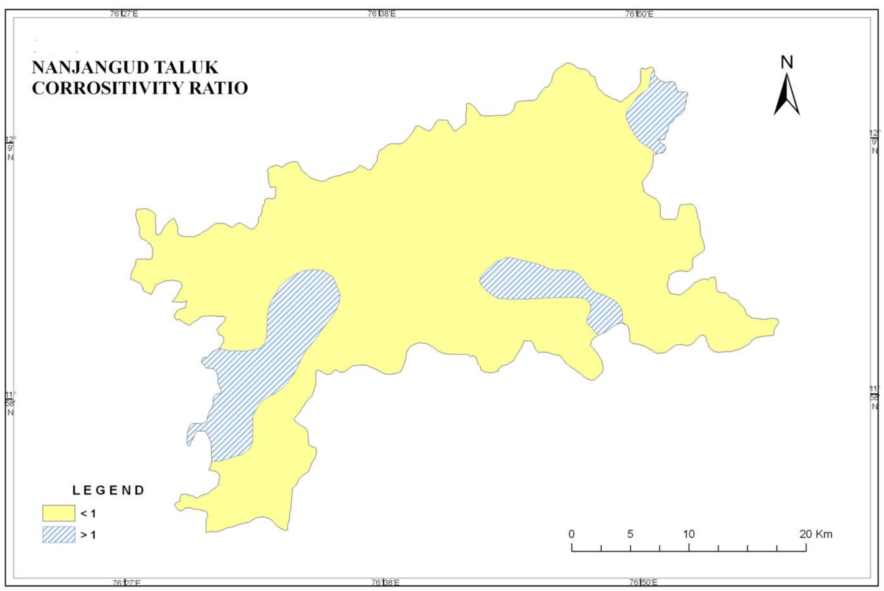

Figure 6: Corrosivity ratio of study area

The corrosivity ratio is important to know whether the water can be transported in metallic pipes or not. The groundwater with corrosivity ratio less than one is considered to be safe for transport of water in any pipe (Balasumbramanian, 1986).If the corrosivity ratio is greater than one, only non-corrosive pipes have to be used for transporting water. The intensity of corrosion depends upon certain physical factors like temperature, pressure and velocity of flow of water (Ayer and Westcot, 1985). Higher concentration of CL and SO_4 also increase

Table 1: Chemical analysis data of Nanjangud taluk

Sl no	EC (Ohm)	pH	TDS (ppm)	SAR	RSC
1	1566	7.30	922	3.950	2.582
2	1231	7.80	862	3.276	1.801
3	1347	7.50	678	.1052	5.533
4	590	7.15	364	3.489	3.181
5	73	7.70	454	1.585	-.6369
6	3316	7.36	2100	10.460	2.094
7	795	6.99	444	.3633	1.544
8	877	7.57	500	1.152	1.368
9	1084	7.19	645	3.734	.1988
10	2520	7.45	1506	4.402	-6.287
11	680	7.85	395	1.612	-.1022
12	2730	7.79	1628	4.989	.4891
13	1330	7.65	733	2.382	1.479
14	675	7.70	359	.2540	-.9427
15	1398	7.52	456	1.561	-4.683
16	500	8.30	370	2.525	2.422
17	930	8.87	80	2.777	-3.935
18	720	0.00	562	3.994	3.684
19	600	7.65	500	1.868	.8908
20	720	7.25	490	5.274	3.755
21	930	8.10	670	3.979	3.008
22	390	7.65	294	1.596	.4554
23	5000	7.52	2480	5.848	-7.435
24	1560	7.47	920	2.610	-2.210
25	790	8.20	350	2.004	1.654
26	3000	5.00	1710	15.324	1.943
27	740	8.20	410	2.001	.8639
28	780	9.20	620	3.400	1.717
29	950	4.80	590	5.837	15.550
30	935	8.26	620	2.639	-3.768
31	130	7.58	890	4.686	4.655
32	1900	8.87	930	2.916	-5.007
33	960	7.40	625	3.396	3.290
34	1300	7.00	500	1.591	-4.121
35	1400	8.21	956	4.806	4.412
36	910	7.40	400	2.492	1.738
37	1650	6.90	860	.5264	-7.243
38	1300	3.10	726	3.359	-2.99
39	930	7.38	670	2.264	1.584
40	3100	8.35	1850	15.297	8.396
41	860	7.90	620	5.102	8.403

the corrosion rate (Raman,1983). The corrosivity ratios were calculated using the methods proposed by Ryzner (1944). About 73% of groundwater in the study area is found to be safe for transportation in any kind of pipes since the corrosivity ratio is less than 1 and remaining

27% of the area has corrosivity more than1 and needs non-corrosive pipes for lifting groundwater (Figure. 6).

3.6 $CaCO_3$ Saturation index

$CaCO_3$ saturation index was calculated using equilibrium pH Method. And equilibrium Ca method. The saturation index of the study area is found to be positive. Water with positive saturation index has a tendency of incrustation and negative saturation index has the tendency of corrosion (Tamtha,1993). Hence the groundwater of this region is capable of forming scales in the water supply systems (Figure 7).

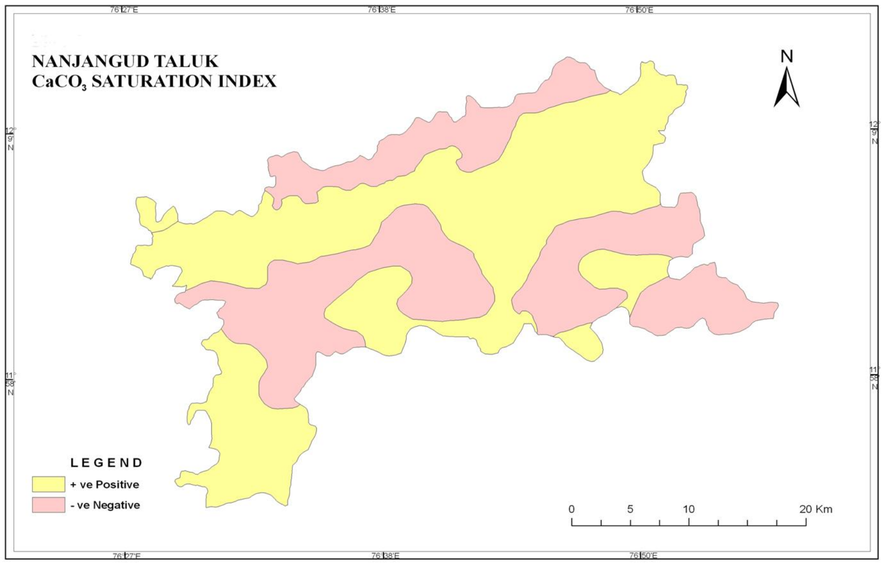

Figure 7: $CaCO_3$ saturation index of study area

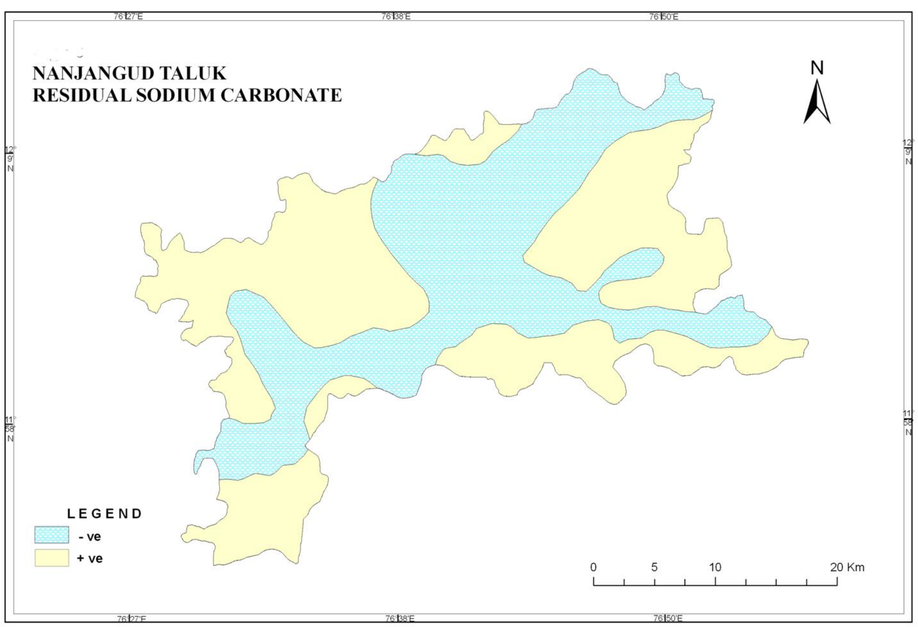

Figure 8: Residual sodium carbonate content of study area

3.7 Residual Sodium Carbonate (RSC)

Residual Sodium was calculated using the formula

$$RSC= (CO_3+HCO_3)-(Ca+Mg) \text{ (as given in Table 1)} \quad \text{---------} \ 1$$

With reference to the computation of RSC, the water quality of the area is found to be safe in almost 78% the samples and rest of the water is found to be having higher RSC values and it is not fit for irrigational purposes (Figure 8).

4. Conclusion

The chemistry of groundwater existing in hardrock trrain is mainly controlled by the rock-water interaction mechanisms. The total dissolved solids are expected to increase along the length of the flowpath and also the time of residence. The present investigation has confirmed that even in small an area the residence time and length of flow paths control the groundwater chemistry.

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