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RESEARCH ARTICLE

A STUDY ON THE HYDROGEOCHEMISTRY OF TATTIHALLA WATERSHED, KHANAPUR TALUK, BELGAUM DISTRICT, KARNATAKA

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ABSTRACT

Hydrogeochemistry of Tattihalla watershed was carried out to evaluate and assess its quality for domestic, agricultural and industrial suitability. Major ion chemistry such as Ca, Mg, Na, K, CO_3, HCO_3, Cl and SO_4 were analysed. Physical parameters such as pH, electrical conductivity (EC), total dissolved solids (TDS) and hardness (H) were analysed. Piper's diagram plot revealed the hydrochemical facies to be of type- Mixed CaMgCl and Mixed $CaNaHCO_3$. Physico-chemical analyses were carried out following standard guidelines (APHA, 1995) and its quality for different parameters were compared with Indian (BIS, 2003) and International (WHO, 2005) standards. EC value ranges from 34 to 235µS/cm and falls in excellent category. Sodium absorption ratio (SAR) classification for irrigation suitability indicates the water samples are in excellent category, suggesting that the low salinity and alkalinity. Wilcox diagram (1954) indicates the water samples falling in excellent to permissible category. Residual sodium carbonate (RSC) classifications were revealed that the water samples falling in good category and free from bicarbonate hazard.

INTRODUCTION

The quality of water plays very important role in its suitability for domestic, agriculture and industrial purposes. Because human health and agricultural production depends on quality of water. Many factors accounts for contamination of water quality from geological formations to anthropogenic activities. But with time these factors very badly deteriorate the quality of water, making it unsuitable for any purpose. With agricultural practices now becoming tech-savvy and with demand and production for better yielding crops, water is the primary and essential requirement. The limited and restricted surface resources of groundwater are the only other source. In due course of this over-exploitation and contamination of groundwater resources took place becomes important to manage and use sustainably the available water resources. Many researchers have studied and assessed the water quality for different purposes in different areas (Srinivasa 1996, Saleh 1999, Subbarao 2006, Sreedevi 2002)

Thus the present study no such detailed investigations has been carried out, so an attempt has been made to study the water quality of Tattihalla watershed for its suitability for domestic, irrigational purposes and suggest conjunctive and sustainable use of water resources

Study Area

The Tattihalla watershed, Khanapur taluk, Belgaum district, Karnataka is a tributary of perennial flowing river of Malaprabha. Geographically it lies at coordinates 75°32' and 76°45' E longitudes and 15°30' and 15°43' N latitudes, in the Survey of India topo sheet numbered 48I/10. Aerially spreaded over an area of 212 km2. The highest elevation is 694 meters. April and May months are hottest while December and January are coolest.

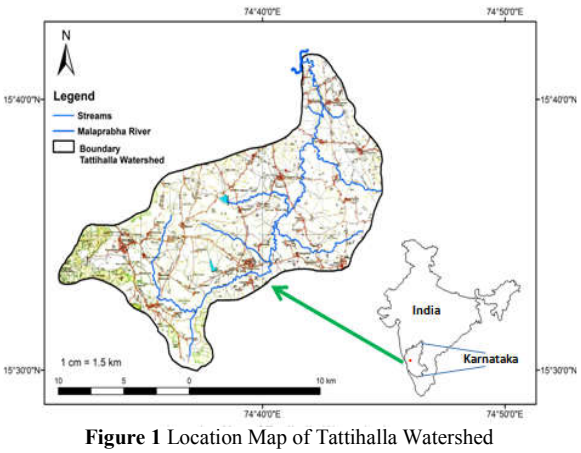

Figure 1 Location Map of Tattihalla Watershed

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Geology

Geologically, rocks of Precambrian age are exposed in the study area. Schistose rocks and banded iron formations (BIF) are the major litho-units. Schistose rocks are exposed all over the lower elevations while BIFs can be seen in small hillocks at higher elevations. Numerous quartz veins and some basic dykes intruded the schistose rocks.

MATERIALS AND METHODS

26 no. of water samples were collected in the post monsoon season. Analysis of physical and chemical parameters was carried out following standard guidelines (APHA, 1995). Table 1 shows the parameters analysed and standard methodology followed. The results obtained of physical and chemical analysis is shown in the Table 2.

Table 1 List of physico-chemical parameters and analytical methods adopted

Sl.No	Parameter	Analytical Method/Instrument
1	pH	Elico LI120
2	Electrical Conductivity (EC)	Elico CM180
3	Total Dissolved Solids (TDS)	EC*0.65 (Todd, 1980)
4	Hardness (H)	Trimetric
5	Calcium (Ca)	Trimetric
6	Magnesium (Mg)	Calculation
7	Sodium (Na)	Flamephotometer
8	Potassium (K)	Flamephotometer
9	Carbonate (CO_3)	Trimetric
10	Bicarbonate (HCO_3)	Trimetric
11	Chloride (Cl)	Trimetric
12	Sulphate (SO_4)	Colorimeter

Table 2 Physico-chemical analysis results

S.No	Location	Source	pH	EC	TDS	Hardness	Ca	Mg	Na	K	CO_3	HCO_3	Cl	SO_4
1	Basarkhod	BW	7.3	174	112	760	79	137	136	0.23	0	425	638	250
2	Deglolli	BW	7.2	88	57	350	51	54	83	0.56	0	26	243	84
3	Bailur	BW	7.5	39	25	132	36	10	63	0.24	0	140	50	13
4	Gundanhatti	BW	7.5	51	33	202	12	42	69	0.15	0	225	80	13
5	Bidi	BW	7.4	52	53	254	26	46	82	0.31	0	170	205	84
6	Sagari	BW	7.8	56	36	54	19	1	71	0.2	0	100	36	5
7	Halga	BW	7.7	127	82	366	45	62	96	0.4	0	255	308	250
8	Gundpi	BW	7.3	56	36	70	16	7	87	0.34	0	100	47	10
9	Halsi	BW	7.4	65	42	180	38	21	103	0.2	0	205	146	13
10	Chennevadi	OW	7.7	54	35	220	10	48	113	3.03	0	245	95	50
11	Nandgad	OW	7.2	93	60	220	14	45	136	4.28	0	220	261	45
12	Garbenhatti	BW	6.8	130	84	92	24	8	104	0.62	0	110	121	10
13	Hadalgi	BW	7.3	84	54	188	42	20	116	4.29	0	285	151	50
14	Banki	BW	7.2	79	51	280	57	34	106	1.06	0	190	206	26
15	Bekvad	BW	7.4	53	34	182	39	20	111	0.53	0	145	152	10
16	Kadtan bagevadi	BW	6.9	34	22	150	67	4	311	0.15	0	185	78	5
17	Muglihal	BW	7	178	115	106	79	22	150	0.47	0	365	702	150
18	Mugalihal cross	OW	7.4	236	152	850	45	180	110	0.17	0	135	53	10
19	Gandigvad	BW	7.5	74	47	140	18	23	113	0.24	0	180	64	5
20	Tolgi	BW	7.6	65	48	230	23	42	113	0.95	0	240	89	5
21	Itgi cross	BW	7.4	48	31	220	44	27	113	0.36	0	245	55	19
22	Devar sighalli	BW	7.5	68	44	240	25	43	109	0.39	0	235	81	10
23	Bogur	BW	7.4	152	98	270	59	30	111	0.32	0	180	179	30
24	Ambadgatti	BW	6.9	251	162	970	218	104	155	0.41	0	395	795	300
25	Tigdoli	BW	7.3	153	99	320	52	44	121	0.88	0	230	321	10
26	Degaon	BW	7.4	53	34	140	68	7	118	0.26	0	180	98	26

RESULTS AND DISCUSSION

Water Quality

Piper's Diagram

Hydrochemical facies of the groundwater of study area were identified by plotting cations and anions in Piper's trilinear diagram. The diagram showed that most of the samples are concentrating in field area 3 and 4 and categorizes class type as- mixed CaMgCl and mixed CaNaHCO3. This indicates strong acids (Cl, SO4) exceed weak acids (HCO3, CO3).

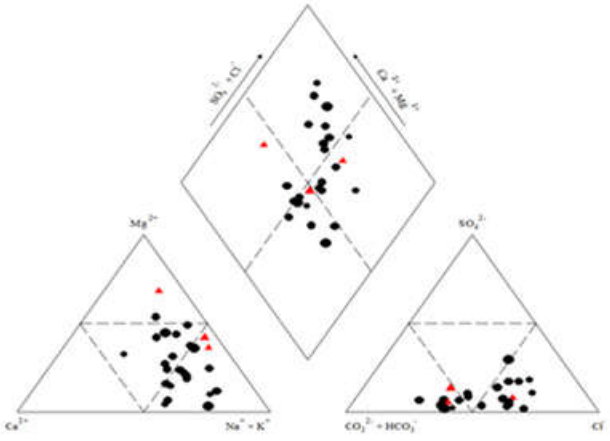

Figure 2 Piper's Diagram for the waters of Tattihalla watershed

Drinking Quality

Analytical results of the study area were compared with Indian and International standards viz- Bureau of Indian Standards (BIS 2003) and World Health Organisation (WHO 2005). Table 3 shows the permissible and allowable limits of different parameters. Comparisons of both standards indicates all parameters in the study area are in allowable limit except pH, where 69.23 % of water samples falling in saline category and one sample of magnesium is exceeding allowable limit.

Table 3 Drinking water standards of BIS (2003) and WHO (2005)

Parameter	Drinking Water Standards				> Allowable limit	%
	BIS (2003)		WHO (2005)			
	Permissible	Allowable	Permissible	Allowable		
pH	7.0-8.5	6.5-9.2	7-8.5	6.5-9.2	1-11, 13-15, 18-23	69
TDS	NS	NS	500	1000	NIL	-
TH	300	600	-	1000	NIL	-
Ca	75	200	75	200	NIL	-
Mg	50	150	50	150	18	1.00
Cl	250	1000	200	600	NIL	-
SO_4	200	400	200	400	NIL	-

Electrical conductivity (EC)

EC value ranges from 34 to 235µS/cm and water samples was classified based on Sarma (1982), which indicated all the water samples from the study area falls in the class excellent (Table 4).

Table 4 EC classification based on Sarma (1982)

Class	EC range in µS/cm	No. of samples	Percentage
Excellent	0-333	26	100
Good	333-500	Nil	-
Permissible	500-1000	Nil	-
Brackish	1000-1500	Nil	-
Saline	1500-10,000	Nil	-

Irrigational water quality

Sodium Absorption Ratio (SAR)

SAR is considered a better measure of sodium/alkali hazard in irrigation, is directly related to the adsorption of sodium by soil and is an important criterion to determining the suitability of

water for irrigation. SAR measures the relative proportion of sodium ions in water sample to that of calcium and magnesium. Excess of sodium compared to calcium and magnesium may affect soil characteristics considerably, thus reduces soil permeability and restricting supply of water needed for crops. The SAR is classified as shown in Table 5 and is calculated using:

$$SAR = \frac{Na^+}{(\sqrt{Ca^{2+} + Mg^{2+}})/2}$$

all values are in epm. According to classification (Table 5), it shows that all water samples in the study area falls in excellent category. Similar studies were also done by comparing with USSL diagram (Richard 1954), in which plot of SAR vs EC were plotted and classified, which revealed that 15 water samples fall in field of C2S1, indicating medium salinity and low sodium, 8 water samples fall in field of C3S1, indicating high salinity and low sodium and 2 samples falling in field of C4S1, indicating very high salinity and low sodium.

Table 5 Classification based on SAR

Class	SAR range	No. of samples	Percentage
Excellent	<10	26	100
Good	10-18	Nil	-
Fair	18-26	Nil	-
Poor	>26	Nil	-

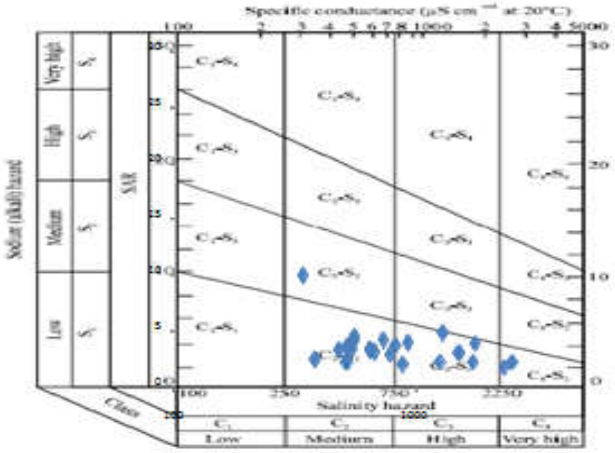

Figure 3 USSL classification of irrigation waters based on Richard 1954

Sodium percent (Na %)

The suitability of the groundwater for irrigation depends on the minerals and its interaction present in water and its effect on plants and soil. When the concentration of sodium is high in irrigation water, sodium ions tend to be absorbed by clay particles which reduce soil permeability. Thus, air and water circulation is restricted during wet conditions and it becomes very hard in dry (Saleh 1999). This can be computed using:

$$\%Na = \frac{(Na^+ + K^+) \times 100}{(Ca^{2+} + Mg^{2+} + Na^+ + K^+)}$$

all values are in epm.The classification for irrigation suitability based on sodium percent is presented in Table 6 and it was found that 69.23% of water samples fall in excellent, 19.23 water samples fall in good and 11.53% of water samples fall in permissible category. The plot of sodium percent vs EC i.e., Wilcox diagram (1954) indicate 53.84% of the water samples falling in range excellent to good, 26.92% of water samples falling in good to permissible, 11.53% of water samples falling in permissible to doubtful and 7.69% of water samples fall in doubtful to unsuitable category.

Table 6 Sodium percent classification for irrigation water

Class	Na%	No. of samples	Percentage
Excellent	< 20%	18	69.23
Good	20-40	5	19.23
Permissible	40-60	3	11.53
Doubtful	60-80	Nil	-
Unsuitable	>80	Nil	-

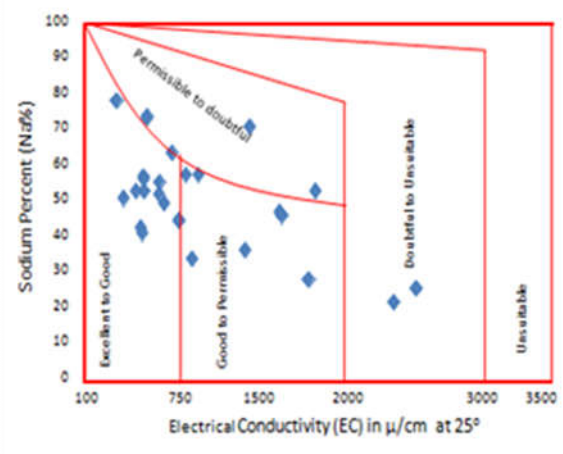

Figure 4 Classification of irrigated waters based on Wilcox, 1955

Residual Sodium Carbonate (RSC)

The excessive of carbonate and bicarbonate over calcium and magnesium in the groundwater describes its suitability for irrigation. With water samples having higher concentrations of bicarbonate, there is a tendency for calcium and magnesium to precipitate due to increase in water in the soil (Eaton 1950; Ragunath 1987). RSC can be calculated as:

RSC = (CO_3 + HCO_3) – (Ca + Mg)

all values are in epm.

According to the classification (Table 7), 88.46% of water samples fall in good category and 11.53% fall in medium category of suitability for irrigation.

Table 7 RSC classification for irrigation water

Class	RSC	No. of samples	Percenatage
Good	>1.25	23	88.46
Medium	1.25-2.5	3	11.53
Bad	<2.5	Nil	-

CONCLUSION

The groundwater quality of the Tattihalla watershed, Khanapur taluk, Belgaum district, Karnataka is categorized as fresh waters based on TDS values. The hydrochemical facies revealed that the groundwater belong to type – mixed CaMgCl and mixed CaNaHCO3. Based on pH values 69.23% of the water samples in the study area is under saline conditions. Schistose rocks of Precambrian age are highly weathered and fractured, resulting unconfined aquifer conditions. USSL (1954) and Wilcox (1954) diagrams suggest that the water

samples to in excellent to permissible range of suitability for irrigation. SAR, Na% and RSC parameters to determine suitability of irrigation suggest that the water samples in the study area are fit for irrigation practices. While comparison with BIS (2003) and WHO (2005) standards suggest its suitability for domestic purpose. Furthermore, it is advised to authorities to carry out conjunctive and sustainable development of surface and groundwater resources and check its quality seasonally.

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