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Assessment of ground water quality of Jagalur Taluk of Davangere Distric, Karnataka, India

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ABSTRACT

The current study deals with the analysis of ground water quality in Jagalur taluk of Davangere district, Karnataka. Twenty different sampling sites were selected for the analysis and parameters estimated include pH, alkalinity, total hardness, sulphate, chloride, total dissolved solids, carbonates, bicarbonates and electrical conductivity. The variations in the physico-chemical parameters in the water were observed and they were compared with BIS standards. Hence, the ground water samples are moderately polluted and can cause health hazards. In this study, the water samples of all the 20 sites of the studied area were quite good (fair) for irrigation purpose due to high salinity of ground water.

Key words : *Groundwater, Jagalur taluk, Brackish water, Very hard, Saline water.*

Introduction

Groundwater use in water system, enterprises and household utilization keeps on expanding where enduring surface water source are missing. The modernization, over abuse, quick industrialization and expanded populace has led to huge level of pollution in the ecosystems. To satisfy the rising need it is basic to perceive the new water assets and furthermore to discover healing techniques for development of water quality. Industrial waste and the metropolitan strong waste have developed as one of the main source of contamination of surface and ground water. In numerous pieces of the nation accessible water is rendered non-consumable due to the nearness of overwhelming metals in overabundance. The circumstance gets exacerbated throughout the summer season because of water shortage and rainr water release (Jai *et al.,* 2014; Thirumala and Kiran, 2017).

Groundwater is an unseen natural asset. It is underneath ground surface in dark pores and crevices of sands and rocks of the upper bit of the world's crust. The overall population is less acquainted with groundwater than with the more noticeable parts of the water cycle, for example, rain and surface water. Groundwater is utilized to meet 23% of all irrigation system requests, to take care of 53% of all public water supplies and to cover 97% of all rustic household water requests (Jayavel Raja *et al.,* 2010).

The sub surfacewater quality is degrading in Jagalur taluks due to increases human habitation and commercial practice. Therefore, the present study is undertaken to investigate some physico-chemical parameters of the ground water of Jagalur area of Karnataka.

Materials and Methods

Study Area

Jagalur taluk is positioned between $14^0$24'18.5"-$14^0$42'16.0" North latitude and East longitude of $76^0$06'34.7" and $76^0$32'02.2". Agriculture is the main occupation in this area. The main kharif crops are maize, ragi, tur and vegetables. Main crops of Rabi season are ragi, maize, horse gram, groundnut, and sunflower.

Jagalur taluk of Davangere district fall under Krishna river basin. The important rivers are Tungabhadra and its tributary, Chikka Hagari. The drainage network is influenced by South West monsoon. The soil of this area is covered by red sandy soil and black soil. The red sandy soil comprises of loams, sandy, sandy loams and medium black soils (Asokan, 2017).

Groundwater samples were collected from 20 different sampling sites (Table 1) of Jagalur taluk, Davangere district during. June 2014. The water samples were collected in black colored plastic carbouys of 2 liters capacity. The various physico-chemical parameters were analyzed in the laboratory as per standard methods (APHA, 2012; Trivedy and Goel, 1986).

pH was analyzed in the spot itself with the help of pH pen. Total alkalinity of the water samples were determined by titrating with N/50 H_2SO_4 using phenolphthalein and methyl orange as indicators. Chloride content was determined by titrating against standard solution of $AgNO_3$ using potassium chromate as an indicator. The electrical conductivity was measured by conductometric method. The total hardness was estimated by titrating with EDTA using Erichrome balck-T indicator. Sulphate was estimated by UV-visible spectrophotometer. TDS of water sample was measured by gravimetric method (Singh *et al.,* 2004; Manish *et al.,* 2016).

Results and Discussion

Table 2 and Figure 2 depict the minimum and maximum values of physic-chemical parameters of ground water in Jagalur taluk. Table 3 shows the BIS drinking water standards.

Classification based on total dissolved solids (TDS): There is a geological variability in chemical composition of underground water. Such variability is a function of geological substrate in which groundwater is found, the residence time of water in the groundwater interactions (Loaiciga, 2000). Groundwater chemistry alters when the water flows through the geological environment which increase the dissolved solids and ions (Suresha *et al.,* 2009).

If the TDS values (mg/l) is <500 classed as fresh water; Brackish water 500-30000; Saline water 30000-50000 and brine water >50000 mg/l. Hence, ground water of Jagalur taluk included under brackish water category.

Classification based on total hardness (TH): Sawyer and McCarty (1967) have classified water into four categories based on total hardness as Soft 0-75

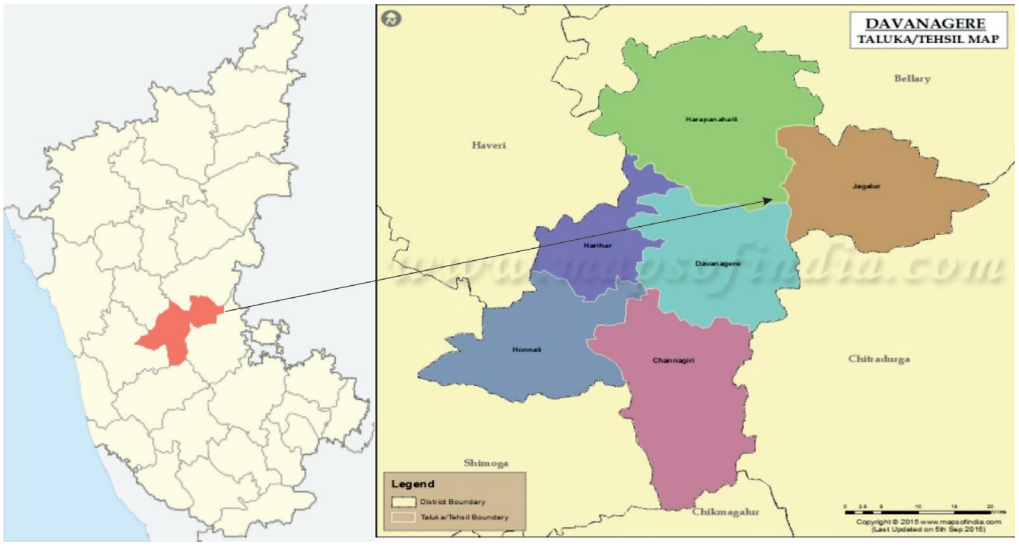

Fig. 1. Locality of Jagalur taluk, Davanagere district (Source: en.wikipedia.org; mapsofindia.com)

mg/l; Moderately Hard 75-150 mg/l; Hard 150-300 mg/l and very hard > 300 mg/l respectively. Total hardness is due to the dissolution of mineral salts present in the geological strata consisting of hard granite rocks, gneissic formation, chlorite schist and mica schist belt. The observation made in the present study reveals that 100% of water belongs to very hard category.

Electrical conductivity (EC): Groundwater can be classified into 05 categories on the basis of electrical conductivity (µmohs/cm) as Excellent 0-333; Good 333-500; Permissible 500-1000; Brackish 1,000-1,500; Saline 1,500-10,000.

In the present study, the data revealed that 60% belong to permissible category and 40% belong to saline category.

Classification of water quality for irrigation purpose

Classification of water quality of Jagalur taluk for irrigation purpose (According to the classification made by United state salinity Laboratory; Shah *et al.*, 2008).

Electrical conductivity µmhos/cm	Category of water	% sites of Jagalur taluk
< 250	Low salinity (Excellent)	0
250-750	Medium salinity (Good)	0
750-2250	High salinity (Fair)	90%
> 2250	Very high salinity (Poor)	10%

The classification of water quality of Jagalur taluk for irrigation purpose is presented in the above Table. It suggests that water samples of all the 90% of the sites were quite good (fair) and 10% were poor for irrigation purpose due to high salinity of ground water.

Classification based on chloride concentration

Based on chloride content in water it is classified as (mg/l)-Oligohaline < 5; Fresh 30-150; Fresh-Brackish 150-300 ; Brakish >300. Ground water in Jagalur area included under Fresh-Brackish (70%) to Brakish (30%) category.

Statistical; Analysis

One-way ANOVA with post-hoc Tukey HSD test data

One-way ANOVA of k=4 independent treatments:

Conclusion from ANOVA

The Tukey HSD test, Scheffé, Bonferroni and Holm multiple comparison tests follow. These post-hoc tests would likely identify which of the pairs of treatments are significantly different from each other.

Tukey HSD test data

Scheffé multiple comparison

Treatments pair	Tukey HSD Q statistic	Tukey HSD p-value	Tukey HSD inference
A vs B	6.3296	0.0019501	** p<0.01
A vs C	4.9025	0.0151379	* p<0.05
A vs D	2.7287	0.2552473	insignificant
B vs C	1.4271	0.7266732	insignificant
B vs D	3.6009	0.0901283	insignificant
C vs D	2.1737	0.4412269	insignificant

Treatment →	pH (A)	EC (B)	TDS (C)	TH (D)	Pooled Total
Observations N	5	5	5	5	20
Sum ΣxiΣxi	42.8000	6,740.0000	5,230.0000	2,930.0000	14,942.8000
Mean ¯xx¯	8.5600	1,348.0000	1,046.0000	586.0000	747.1400
Sum of squares Σx2iΣxi2	368.3400	11,136,600.0000	6,814,300.0000	1,904,700.0000	19,855,968.3400
Sample variance s2s2	0.4930	512,770.0000	335,930.0000	46,930.0000	457,452.8815
Sample std. dev. ss	0.7021	716.0796	579.5947	216.6333	676.3526
Std. dev. of mean SE¯xSEx¯	0.3140	320.2405	259.2026	96.8814	151.2370

Source	Sum of Squares SS	Degrees of freedom *v v*	Mean square MS	F statistic	p-value
Treatment	5,109,082.7760	3	1,703,027.5920	7.6059	0.0022
Error	3,582,521.9720	16	223,907.6232		
Total	8,691,604.7480	19			

Treatments Pair	Scheffé TT-statistic	Scheffé p-value	Scheffé inference
A vs B	4.4757	0.0039240	** p<0.01
A vs C	3.4666	0.0264608	* p<0.05
A vs D	1.9295	0.3276711	insignificant
B vs C	1.0091	0.7971041	insignificant
B vs D	2.5462	0.1325618	insignificant
C vs D	1.5371	0.5183009	insignificant

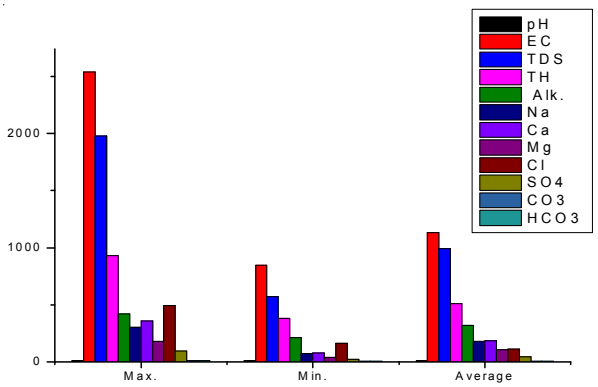

Fig. 2. Maximum and minimum values of ground water quality of Jagalur taluk, Davangere district, Karnataka

Discussion

As indicated by BIS the permissible limit off pH esteem for drinking water is 6.5 to 8.5. Abnormal values of pH in water causes harsh taste, influences mucous layer, causes erosion in pipelines and furthermore influences oceanic life. The standard allur-

Table 1. Sampling sites of Jagalur taluk, Davangere district

Site	Place
S1	Sagalaghatta
S2	Kartigere
S3	Narenahalli
S4	Kallenahalli
S5	Thubinakatte
S6	Magadi
S7	Gopalapura
S8	Lakkampura
S9	Jammapura
S10	Arasinagundi
S11	Lingalli
S12	D Bommanahalli
S13	Anabur
S14	Reddihalli
S15	Siddihalli
S16	Yerehalli
S17	Dundahalli
S18	Near KEB
S19	Jagalur School
S20	Venkatapura

ing constraint of alkalinity in consumable water is 200 mg/l according to BIS standards. Abundance alkalinity in water is likewise hurtful for water system which prompts soil harm by modifying the dirt pH which upgrade soil pH to an incredible apply and diminish crop yields. A high substance of broke up solids raises the thickness of water, impacts osmoregulation of new water life form, decreases solvency of gases (like oxygen) and lessens utility of

Bonferroni and Holm results: all pairs simultaneously compared

Treatments Pair	Bonferroni and Holm TT-statistic	Bonferroni p-value	Bonferroni inference	Holm p-value	Holm inference
A vs B	4.4757	0.0022938	** p<0.01	0.0022938	** p<0.01
A vs C	3.4666	0.0190825	* p<0.05	0.0159020	* p<0.05
A vs D	1.9295	0.4295891	insignificant	0.2147945	insignificant
B vs C	1.0091	1.9676140	insignificant	0.3279357	insignificant
B vs D	2.5462	0.1294128	insignificant	0.0862752	insignificant
C vs D	1.5371	0.8628919	insignificant	0.2876306	insignificant

Bonferroni and Holm results: only pairs relative to A simultaneously compared

Treatments Pair	Bonferroni and HolmTT-statistic	Bonferroni p-value	Bonferroni inference	Holm p-value	Holm inference
A vs B	4.4757	0.0011469	** p<0.01	0.0011469	** p<0.01
A vs C	3.4666	0.0095412	** p<0.01	0.0063608	** p<0.01
A vs D	1.9295	0.2147945	insignificant	0.0715982	insignificant

Table 2. Minimum and maximum values of ground water quality of Jagalur taluk during June 2014

	pH	EC	TDS	TH	Alk.	Na	Ca	Mg	Cl	SO_4	CO_3	HCO_3
Max.	9.5	2540	1980	930	420	300	360	180	495	95	8	11
Min.	7.8	850	570	380	210	70	75	40	165	22	1	1
Average	8.6	1130	990	510	320	178.5	185	105	110	45	3.2	4.4

Table 3. Drinking water standards of BIS (IS:10500:1991) (Source:www.wqaa.gov.in)

Sl. No.	Parameters	Desirable Limit mg/L	Permissible Limit mg/L
1.	pH	6.5-8.5	No relaxation
2.	Colour	5	25
3.	Nitrate	45	100
4.	Total Hardness	300	600
5.	Turbidity	5	10
6.	Sulphate	200	400
7.	Chloride	250	1000
8.	Fluoride	1.0	1.5
9.	Calcium	75	200
10.	Magnesium	30	100
11.	Iron	0.3	1.0

water for drinking, water system and mechanical purposes (Kumar Swamy, 1999). According to Indian details for Drinking water IS:10500 the attractive furthest reaches of TDS is 500 mg/L and as far as possible is 2000 mg/L. Surpassing the reasonable furthest reaches of hardness causes poor washed with cleanser, decay of the nature of garments, scale development and skin disturbance (Shashank Saurabh *et al.*, 2014; Priyanaka Khanna and Rai, 2016).

According to Indian standards for drinking water, attractive constraint of chloride is 250 mg/l, and as far as possible is 1000 mg/l. Sulphate occurs normally in water because of filtering from gypsum and other regular minerals. Sulphate content in drinking water surpassing the 400 mg/l grant harsh taste and may cause gastro-digestive tract disturbance and cantharsis (Priyanaka Khanna and Rai,2016; Manivasakam, 2005). Conductivity of ground water tests changed somewhere in the range of 850 and 2540 µmhos/cm.

Conclusion

Groundwater is significant for the future economy and development of our country. On the off chance that the asset is to stay accessible as top notch water for group of people yet to come it is essential to shield from conceivable contamination. Consequently, it is suggested that appropriate water quality administration is fundamental to keep away from any further contamination. Nearby geographical settings may bolster the expanding centralization of physico-chemical attributes in groundwater. Porosity of the soil and rock likewise adjusts the qualities of the groundwater. The investigation region shows the degrees of all out disintegrated solids and hardness in tests. Ground water boundaries in examining locales have fluctuated because of anthropogenic activities, yet this worth doesn't have any destructive effect for the water to use for water system reason. Consequently, the ground water in Jagalur taluk is reasonable for drinking, industrial, domestic and irrigation purposes .after certain level of treatment before utilization, and it additionally should be protected from the potential sources of contamination.

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