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Seasonal dissimilarity of trace metals in Groundwater Quality of Sandur Taluk, Bellary District (India) by Descriptive Analysis and Similarity Index

D. M. Thotappaiah[1], T. Suresh[1], Manjappa S[2], and Suresh B[3]

[1]Department of Chemistry, Vijayanagara Sri Krishnadevaraya University, Bellary-583104, Karnataka, India
[2]Department of Chemistry, University BDT College of Engineering, Davangere-577005, Karnataka, India
[3]Department of Civil Engineering, Bapuji Institute of Engineering & Technology, Davangere-577 005, Karnataka, India

Abstract: *Currently, human beings are depend upon the ground water for their daily needs and it is main source for all the living organisms. Most of the villagers in Sandur Taluka are depending upon the ground water for drinking purposes. In the present study 25 sampling locations were identified. The work was carried out during different months of the summer, winter and rainy seasons in March 2015 to April 2016 for the period of one year. A comprehensive study was conducted with respect to trace metals like Iron, Zinc, Copper, Nickel, Chromium, Cadmium and Lead contamination of ground water quality in Sandur Taluka, Bellary District. The trace metals were estimated by using Atomic Absorption Spectrometer, Shimadzu AA7000 model. Descriptive statistics and Similarity index have been employed to find out the dissimilarity of the trace metals in the study area. Standard methods have been employed in the estimation of the ground water samples. Nickel (Ni), Cadmium (Cd) and Lead (Pb) were also estimated but were below detectable level (BDL) in all ground water samples. Chromium, Zinc and cadmium content of the ground water samples was found to be within the guideline value of WHO and BIS. Fe showed the high concentrations in the three seasons. Descriptive statistics and similarity index were employed and analyses of the data reveal that the except iron distribution of other trace metals in the study area is widely off normal. The metal concentration of groundwater in the district follows the trend Fe>Cu>Zn>Cr>Pb>Cd during the study period.*

Keywords: *Dissimilarity, trace metals, ground water, similarity index and Sandur taluk.*

1. INTRODUCTION

Over the lost decades, the ground water quality were focused on the dissolved mineral salts. However recently, trace metals, organics and pesticides have become a focus of concern. Groundwater is main natural resources and it is used as a source of drinking water in most of the rural and urban families in India [4]. Trace metals are percolating into the ground water due to agricultural activity, industrial effluent through soil filter and from a variety of natural and anthropogenic sources. Once trace metals mixed with the groundwater, trace metal forms a complex geochemical and biological activity [9].

Abu-Rukh [2] worked on the trace metals ions migration in landfill location due to dumping of solid waste and finally author concluded that there is trace metals contamination in deep layers. Gharaibeh and Riad, [6] investigated and indicated, there is a possibility of surface water, ground water including soil pollution due to dumping of waste in Akidar waste dumping yard in north of the Akider waste dumping location.

As per the literature survey, [12] in developing world due to microbiological and chemical contaminations about 780 million people are not accessing potable water for drinking purposes.

In the present investigation, distribution of trace metals in groundwater samples collected from ground water in the selected villages of the Sandur Taluka are discussed. The data collected from the ground water could be regarded as the background trace element concentrations in the natural environment of this area. These data are employed to evaluate the extent of trace metals element contamination in groundwater in the Sandur taluk Bellary district. As per the literature survey, this is the first comprehensive study of trace metals in groundwater in Sandur Taluk. The results may be instructional for other mining locations with similar levels of urban development to understand the potential threats to their groundwater resources.

1.1 Study Area

The present study is carried out at Sandur area of Bellary district, Karnataka which is geographically

bounded by 15° 10' and 15°50' north latitude and 76° 55' and 76° 61' east longitude covering an area of above 565 meters (Figure 1). Sandur and its surrounding village's places of natural beauty with lush green mountains, valleys, deep gorges and most of the villages are depending upon the ground water for their daily needs. The Sandur town located to the south of Hosapete. It located on the southern edge of the original Vijayanagara metropolitan area. Sanduru Taluka has deposits of manganese ore and hematite (iron ore), and is home to several mines and steel plants in and around the taluka. Study area receives 750mm of elevation but has seen more than 1000mm of rainfall. As per 2011 census the population of the study area is 37,431.

2. MATERIALS AND METHODS

A total number of 25 groundwater samples were collected in 1 L colored polythene cans from different bore wells and hand pumps from the selected location in Sandur taluk for the period of one year from March 2015 to April 2016. The trace metals have been determined with Shimadzu make Atomic Absorption Spectrophotometer (AA-7000). For the determination of trace metals, the collected ground water samples were immediately acidified with HNO_3 to bring the pH below 2 to avoid the precipitation of the trace metals. The samples were concentrated and subjected to nitric acid digestion. Selected trace elements such as Iron, Zinc, Copper, Nickel, Chromium, Cadmium and Lead were estimated as per standard method [3].

3. RESULTS AND DISCUSSION

To look into the seasonal variations and dissimilarity outlines of the metal concentrations in groundwater, data were exposed to descriptive statistics based on normal distribution has been summarized for three seasons in Table 3. Locations details are depicted in the Table 1. A comparison of the trace metals in groundwater samples have been made with WHO (1988), and BIS (1991) drinking water standards (Table 2). Similarity index were performed by Pearson's product moment correlation and are presented in Table 4.

Seasonal distributions of various metals in groundwater are graphically presented in Figure 2. Standard methods have been employed in the estimation of the ground water samples. Nickel (Ni), Cadmium (Cd) and Lead (Pb) were also estimated but were below detectable level (BDL) in all ground water samples.

Iron is the most important element and it is essential for human body [13], most common health problem due to Iron deficiency is hydrochormic macrobiotic anemia. Iron found in groundwater all over the world, maximum concentration of iron content in may cause the water bad taste, discoloration, turbidity and treatment systems [14] and [1]. In overall investigation, the iron varied from 0.399 to 2.042 mg/L. The permissible limit for iron is 0.3 mg/L. The concentration of iron in all the 25 ground water samples are showing high and above the permissible limit in the selected villages. Seasonal observations also indicates that about 96% of iron content in all the ground water samples excessively greater than the permissible limit (Figure 2).

The concentration of zinc in ground water samples in selected villages of the Sandur taluka varied from 0.012 to 0.121 mg/L (Table 2). As per the WHO the maximum permissible limit of zinc is 5 mg/L [5]. Measurable concentrations of the zinc metal were found in 9 samples (36.0% samples). Currently, the investigated results are indicates the concentration Zinc in ground water samples are well below the permissible limit for drinking water for zinc (Figure 2).

The copper and chromium ranged from 0.042 - 0.362 mg/L and 0.006 - 0.062 mg/L. As per the WHO and BIS, the maximum permissible limit for copper and chromium is 1.50 mg/L and 0.05 mg/L [7]. The results indicated that all the samples of the study area are within the permissible limit. Twelve and eleven ground water samples (48% and 44%) had measurable concentrations of Cu and Cr metal respectively, though none of the ground water sample shown the Cu and Cr maximum contaminant limits stipulated for drinking water (Table 2).

Similarity index and descriptive statistics were estimated between the occurrence of trace metals (only four metals like Fe, Cu, Zn and Cr) in selected villages of the Sandur taluka has been depicted in Table 3 and Table 4 respectively. The SPSS software was used to measure the similarity index [9].

Both positive and negative correlations were observed during all the seasons. A strong positive correlation (0.8) was observed between all trace metal and Fe concentrations and other trace metals were shown a weak positive correlation (0.5) was found for zinc and copper. However, the most of the other metals Cu and Cr showed a weak negative correlation was observed

which means that the Cu metal concentrations decreased as the well Cr concentration increased [10].

Table 1: *Location of the sampled bore well and open wells in the Sandur Taluk, Bellary District*

Sl No	Village	location	Latitude and Longitude
1	Laxmipura	Outside village	15.10 Lati, 76.48 Longi
2	Nandihalli	near school	15.11 Lati, 76.48 Longi
3	Tumati	Down the village	15.10 Lati, 76.48 Longi
4	Bujanganagara	Near bus stop	15.11 Lati, 76.48 Longi
5	Narasingapura	bus stop circle	15.10 Lati, 76.48 Longi
6	Ranajithpura	near school	15.12 Lati, 76.48 Longi
7	Susheelanagara	Hospet road side	15.10 Lati, 76.47 Longi
8	Siddapura	near devi temple	15.12 Lati, 76.48 Longi
9	Jaisingpura	outside	15.12 Lati, 76.48 Longi
10	Venkatagiri	near Anjaiani temple	15.12 Lati, 76.48 Longi
11	Dowlatpura	near masjid	15.10 Lati, 76.50 Longi
12	D.Thimmalapura	Outside village	15.04 Lati, 76.49 Longi
13	Taranagara	near halla	15.12 Lati, 76.50 Longi
14	Muraripura	Near doni	15.11 Lati, 76.50 Longi
15	V-Nagalpura	Behind the govt. school	15.11 Lati, 76.50 Longi
16	Taluru	Govt. school	15.11 Lati, 76.51 Longi
17	Chikkantapura	road side Agriculture land	15.12 Lati, 76.53 Longi
18	S-Basapura	near bus stand	15.11 Lati, 76.52 Longi
19	Kurekuppa	Road side	15.11 Lati, 76.52 Longi
20	Dharmapura	Ashryaya colony	15.11 Lati, 76.52 Longi
21	Yashavantanagara	Kudligi road side	15.04 Lati, 76.49 Longi
22	Nidagurthi	beside the pond	15.03 Lati, 76.48 Longi
23	Mallapura	near govt. school	15.03 Lati, 76.48 Longi
24	Katinakamba	near bus stand	15.02 Lati, 76.47 Longi
25	Bandri	inside vasavi temple	15.02 Lati, 76.47 Longi

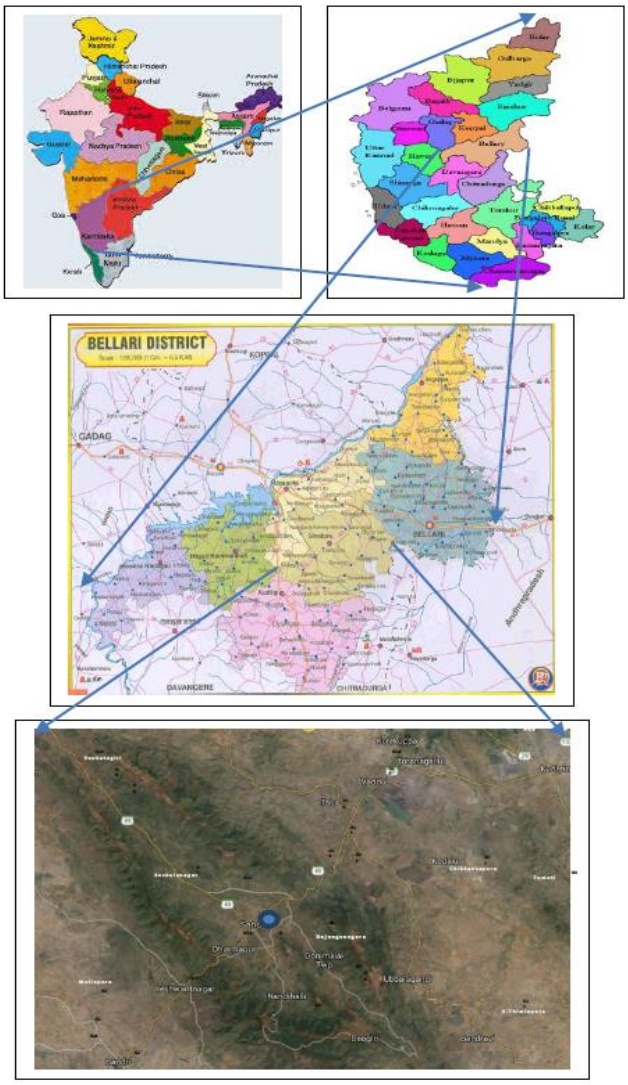

Figure 1: *Location Map of the Study Area Showing Ground Water Sampling locations*

Table 2: *Comparison of the trace metals of groundwater of the study area with WHO and ISI for drinking purpose*

Sl No.	Trace metals	WHO (1993)		BIS (1991)		Average Concentration in the study area, ppm
		Max desirable	Max permissible	Max desirable	Max permissible	
1.	Lead	-	0.05	0.05	No relaxation	Below detectable level
2.	Iron	0.3	1.0	0.3	1.0	0.399 - 2.042
3.	Copper	0.05	1.0	0.05	1.5	0.042 - 0.362
4.	Nickel	-	0.02	-	0.02	Below detectable level
5.	Cadmium	-	0.005	0.01	No relaxation	Below detectable level
6.	Zinc		5.0			0.012 - 0.121
7.	Chromium		0.05			0.006 - 0.062

Note: *All the trace metals are expressed in ppm*

During the investigation, seasonal dissimilarity are also estimated for all the trace metals. Except for Iron, lower values for all the trace metals are obtained in the summer season than in the rainy and winter season [8]. By comparing the average values of all the trace metals, it is observed that the metal content of groundwater in the selected villages of Sandur taluka follows the trend Fe>Cu>Zn>Cr>Pb>Cd in all the three seasons. The iron is generally elevated in most areas, originating from laterite bearing geologic formation [11]. The same trends were also observed in the study area, this may be due to geological strata of the study area.

Table 3: *Descriptive Statistics of trace metal dissimilarity in groundwater of Sandur Taluk Bellary district at 25 different locations*

Seasons	Descriptive stats	Mean	Median	Mode	Standard Deviation	Range	Minimum	Maximum
Summer	Fe	1.029	0.972	0.981	0.3	1.401	0.641	2.042
	Zn	1.029	0.972	0.981	0.3	1.401	0.641	2.042
	Cu	0.012	0	0	0.019	0.062	0	0.062
	Cr	0.03	0	0	0.04	0.121	0	0.121
Winter	Fe	0.64	0.605	0.611	0.191	0.878	0.399	1.2706
	Zn	0.015	0	0	0.024	0.101	0	0.101
	Cu	0.072	0	0	0.095	0.3	0	0.3
	Cr	0.007	0	0	0.009	0.024	0	0.024
Rainy	Fe	0.835	0.789	0.796	0.244	1.137	0.520	1.6563
	Zn	0.018	0	0	0.029	0.108	0	0.108
	Cu	0.098	0	0	0.112	0.362	0	0.362
	Cr	0.012	0	0	0.019	0.062	0	0.062

Seasons	Descriptive stats	Standard Error	Sample Variance	Kurtosis	Skewness	Sum	Count
Summer	Fe	0.06	0.09	7.924	2.796	25.714	25
	Zn	0.06	0.09	7.924	2.796	25.714	25
	Cu	0.0037	0.0003	2.7007	1.8127	0.301	25
	Cr	0.008	0.002	-0.736	0.865	0.74	25
Winter	Fe	0.0373	0.0348	7.9236	2.7957	15.9998	25
	Zn	0.0047	0.0006	6.4618	2.2508	0.367	25
	Cu	0.019	0.009	0.7834	1.2657	1.788	25
	Cr	0.0017	0.0001	-0.8469	0.8531	0.165	25
Rainy	Fe	0.0487	0.0592	7.9236	2.7957	20.8569	25
	Zn	0.0054	0.0007	4.3079	1.9182	0.432	25
	Cu	0.0222	0.0124	-0.0076	0.9745	2.245	25
	Cr	0.0037	0.0003	2.7007	1.8127	0.301	25

4. CONCLUSIONS

Ground water samples collected from 25 villages in Sandur taluka, Bellary district. The minimum and maximum concentration of the Fe, Cu, Zn, Pb, Cr, Ni and Cd trace metals for selected ground water samples were analyzed but Nickel and lead were found below the detachable level. Fe exceeded the maximum limits for drinking water in all the selected locations of ground water samples. A strong positive similarity index was observed between the Fe and other three trace metals like Zn, Cu and Cr. Based on the above investigation, it is recommended to adopt some kind of inexpensive treatment to reduce the level of Fe in ground water samples in the selected villages of the Sandur taluka since this water is not suitable for direct consumption for drinking purposes.

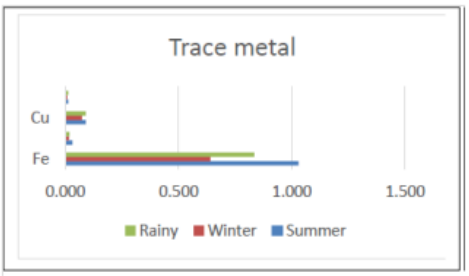

Figure 2: *Sesonal variation in the trace metals during the study period*

Table 4: *Similarity Index between the trace metals in Ground water during the study period*

Seasons	Summer			
Trace metals	Fe	Zn	Cu	Cr
Fe	1			
Zn	0.842	1		
Cu	0.947	0.468	1	
Cr	0.78	0.04	-0.315	1
Seasons	**Winter**			
Trace metals	**Fe**	**Zn**	**Cu**	**Cr**
Fe	1			
Zn	0.786	1		
Cu	0.898	0.561	1	
Cr	0.64	0.102	-0.354	1
Seasons	**Rainy**			
Trace metals	**Fe**	**Zn**	**Cu**	**Cr**
Fe	1			
Zn	0.7479	1		
Cu	0.8471	0.4188	1	
Cr	0.6797	0.0563	-0.3148	1

Table 5: *Samples having measurable concentrations of the trace metals and percentage of locations exceeding the maximum contaminant limits in groundwater of Study Area*

Samples having concentration of the trace metals			Samples having concentrations of trace metals exceeding the maximum contaminant levels		
Trace metals	**No. of Locations**	**%**	**Maximum Concentration level /µg/L**	**No. of Locations**	**%**
Lead	-	-	50	-	-
Iron	-	-	300	25	100
Copper	13	52	50	11	44
Nickel	-	-	70	-	-
Cadmium	-	-	10	-	-
Zinc	25	100	5000	-	-
Chromium	14	56	50	2	8

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