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Seasonal Dissimilarity in Trace Metals Characteristics in Groundwater Quality of Hospate Taluk, Bellary District “New City Also Called Nagalapura" Karnataka, India

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Abstract
Assessment of trace metals in ground water used for drinking purposes in Riyadh region in the kingdom of Saudi Arabia was carried out. Samples were collected from 25 wells supplying drinking water to the inhabitants in the region. All samples were analyzed for 8 trace and macro elements (Al, Cd, Cr, Cu, Fe, Ni, Pb and Zn) using Atomic Absorption spectrophotometer. The minimum and maximum trace metals concentrations in different areas for Cr, Cu, Fe and Zn ranged between BDL to 0.561 ppm, 0.089 to 0.989 ppm, 0.041 to 1.700 ppm respectively Ni, Al, Pb and Cd were also measured but were found below detectable level (BDL) in the entire study period. The results were compared with the World Health Organization (WHO) and Bureau Indian standard (BIS) values. It reveals revealed the presence of some heavy metals in few ground water samples and hence refers heavy metal contamination of ground water sources. The result shows that most of the groundwater is deteriorated less than the permissible limit of WHO. It is recommended that an adequate and suitable treatment must be applied to the wells having elevated concentrations of the metals and supplying drinking water to the consumers.

Keywords: Ground Water Quality, trace metals pollution, drinking water source, human activities.

Introduction
Water, one of the most essential natural resources, is essential to sustain life. Based on the fundamental quality, water is used in different sectors viz. domestic, agriculture, power and industry. Therefore, one should have some basic information on quantity and quality of water resources for its proper usage and management. Continuous increase in water demands due to increasing population and developmental activities has resulted in more use of groundwater than the surface water resource which has led to groundwater reduction. Besides this, the groundwater quality is deteriorating due to dumping of massive industrial effluents and mining activities, as reported by various scholars in different parts of India (Lapworth, *et al.,* 2014 and K. G. Sekar and K. Suriyakala, 2016).

Materials and methods
Geology of Hospet
Geologically rocks of granodiorite and granite associated with iron and manganese ore bands. The rock formations are joined and are traversed by doleritic Dykes, Weathering in hard rocks is limited to 5 meters from ground level where as in schist and phyllite extends upto 20 meters.

Experimental Work
Present study comprises of interpretation and analysis of ground water samples collected from twenty five different locations at all over Hospet taluk. In our study, first we mark the sampling locations in five different zones of the city, then stations were established and groundwater samples were collected. The samples were analyzed for different trace metals

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and the results were carefully studied and analyzed. The present study provides a detailed description of the trace metals criteria of groundwater. Twenty five representative ground water samples were collected during post monsoon, 2017 and analyzed for Al, Cd, Cr, Cu, Fe, Ni, Pb and Zn

Collection of Samples

Ground water samples were collected in one-liter plastic bottles, which were previously thoroughly washed with tap water and rinsed with double distilled water. These were immediately acidified to pH 2 with HNO_3 in order to keep metals in solution and prevent them from stick on to the walls of the bottles. All samples were transported to the laboratory in iceboxes and refrigerated at 4°C until analyzed (APHA, 1992).

Sample Analysis

Samples were analyzed for trace metals (Al, Cd, Cr, Cu, Fe, Ni, Pb and Zn) using a Atomic Absorption Spectrophotometer (AAS). Statistical Analysis was also applied on the results and tabulated in the Tables.

Results and discussion

The location details of the ground water samples are displayed in Table 1. Experimental results were expressed in ppm and given in Table 2. In the presented study, the seasonal variations and distribution patterns of the metal contents in groundwater, data were exposed to several statistical treatments. Descriptive statistics based on normal distribution has been summarized for three seasons in Table 3.

Chromium (Cr): The minimum and maximum Cr concentrations were found to be BDL in all the seasons and 0.561 ppm in summer seasons. Out of total twenty five ground water samples only (24%) had measurable concentrations of Cr metal. However, none of the sample exceeded the Cr maximum contaminant limits stipulated for drinking water (Table 3). In the present study chromium content in groundwater are found to be above the permissible limit of WHO with a mean value of 0.051 ppm, 0.058 ppm and 0.071 ppm respectively in monsoon, summer and winter seasons. It may be seen from Table 3 that some of the ground water samples contain chromium at toxic levels. The skewness and kurtosis values for chromium in study period indicate that its distribution in the study area is not uniform. The distributions for chromium in groundwater appear to be asymmetric with the common feature of third quartile being wider than the second.

Copper (Cu): The minimum and maximum copper concentrations were found to be 0.089 ppm in summer season and 0.989 ppm in the same season. From the present study it indicates all most all the ground water samples were had measurable concentrations of Cu metal, though none of the sample exceeded the Cu maximum contaminant limits stipulated for drinking water (Table 3). In the ground waters, copper levels are low with the majority of samples being below detection limits. Where the metal concentrations are above detection limits, they still fall below the WHO guidelines value of 2 ppm. Copper is an essential micronutrient, but in high concentration causes physiological effects in human. Water containing 3 mg copper/L was associated with gastrointestinal disturbance in adults, whereas water.

Iron (Fe): The minimum and maximum iron concentrations varied between 0.029 ppm in summer season and 0.721 ppm in winter season. Measurable concentrations of the metal were found in all most all the selected locations. However, 8 of the samples (32%) exceeded the relevant prescribed limits for drinking water (Table 3). The Iron concentration in ranges between 0.88 % and 6.33 % are somewhat higher than that reported from other Indian estuaries. During their study period higher concentrations of iron are observed throughout the estuary.

All the values are less than the permissible limit of 1.0 ppm. The content of Fe is within the permissible limit of BIS standards for drinking water. It can be attributed to the dissolution of ir on bearing rock and/or soils. The iron concentration obtained in the irrigation water used along the ground water were found to be higher than the value obtained for the control irrigation water which exhibits a concentration of 1.0 ppm.

Zinc (Zn): The minimum and maximum zinc concentrations varied between 1.324 ppm and 1.700 ppm. Measurable concentrations of the zinc metal were found in all the selected ground water samples. However, none of the samples exceeded the relevant prescribed limits for drinking water for zinc (Table 3). The concentration of zinc in groundwater is usually below 10 to 40 µg/litre (Elinder, *et al.*, 1986). Zinc is a nutritionally essential element. It is necessary for growth and is involved in several physiological functions. In all the samples under investigation, the zinc contents are much below the guideline value of 5 ppm (Krishan, et al., 2016). Negative kurtosis and Positive skewness values obtained for zinc in three seasons indicates flat distribution pattern with a long left tail. Asymmetric nature of zinc distribution is also apparent from the width of the third quartile which is much greater than the first and second quartile in both the seasons. During the study, seasonal variations in selected ground water observed for eight different trace metals under investigation. By comparing the average values of all selected trace metals, it is observed that the metal content of groundwater in the district follows the trend during the study period is Zn>Fe>Cr>C, in all the seasons. It has been noticed that average Zinc concentrations in all the seasons fall in high alert category (. Although, Zinc contents beyond the guideline value (10 ppb) of WHO and USEPA have been found in a large number of samples, no report of Arsenocosis from the areas has been known till date.

Conclusions and recommendations

Ground water samples were collected from 25 different locations the north side of the Hospet taluk, Bellary region. The maximum and minimum concentration of trace metals in different locations Cr, Cu, Fe and Zn ranged between BDL to 0.561 ppm, 0.089 to 0.989 ppm, 0.029 to 0.721 ppm and 0.041 to 1.700 ppm respectively Ni, Al, Pb and Cd were also measured but were found below detectable level (BDL) in the entire study period. Overall study, except iron all the other trace metals are not exceeded the maximum limits for drinking water in several sampled wells in the Hospet taluk of Bellary region. It is recommended to adopt some kind of inexpensive treatment to reduce the levels of iron content in selected areas supplying water directly to consumers without any type of treatment.

Table. 1: Location of the bore wells in the North East of the Hospet Taluk, Bellary region

Sl No.	Locations	Sampling Point Code
1	Bukkadagara (SC-ST Keri)	HW-1
2	Bukkasagara (76 Venkartapura)	HW-2
3	Bukkasagara (76 Venkartapura) Near Anjaneya Temple	HW-3
4	Bylavaddigeri (Opp Hospital)	HW-4
5	Devalapura (Nallapur)	HW-5
6	Devalapura (Opp Mahadevana House)	HW-6
7	Devasamudra (Harejayagnuru)	HW-7
8	Devasamudra (Krishna Nagara Camp)	HW-8
9	Devasamudra (Near Health Centre)	HW-9
10	Gadiganuru (Opp Hospital)	HW-10
11	Gadiganuru (Opp Mallikarjuna House)	HW-11
12	Hampadevanahalli (Chikka Jayaganuru)	HW-12
13	Hampadevanahalli (Near Dugulamma Temple)	HW-13
14	Hossur (Kichadi Net)	HW-14
15	Hossur (Near Railway Gate)	HW-15
16	Kamalapaura (opp SriKari College)	HW-16
17	Nagenahalli	HW-17
18	Nagenahalli (Basavadurga)	HW-18
19	Ramasagara (Near Sugandi Renukamma House)	HW-19
20	Ramasagara (Near Sugandi Shivamurthy House)	HW-20
21	Sanaapura (near Kurugosu Basavarajappa House)	HW-21
22	Sanaapura (near Narasimha House)	HW-22
23	Seetharam Tanda (Mustafa Darga)	HW-23
24	Seetharam Tanda (N R Camp)	HW-24
25	Seetharam Tanda Cross	HW-25

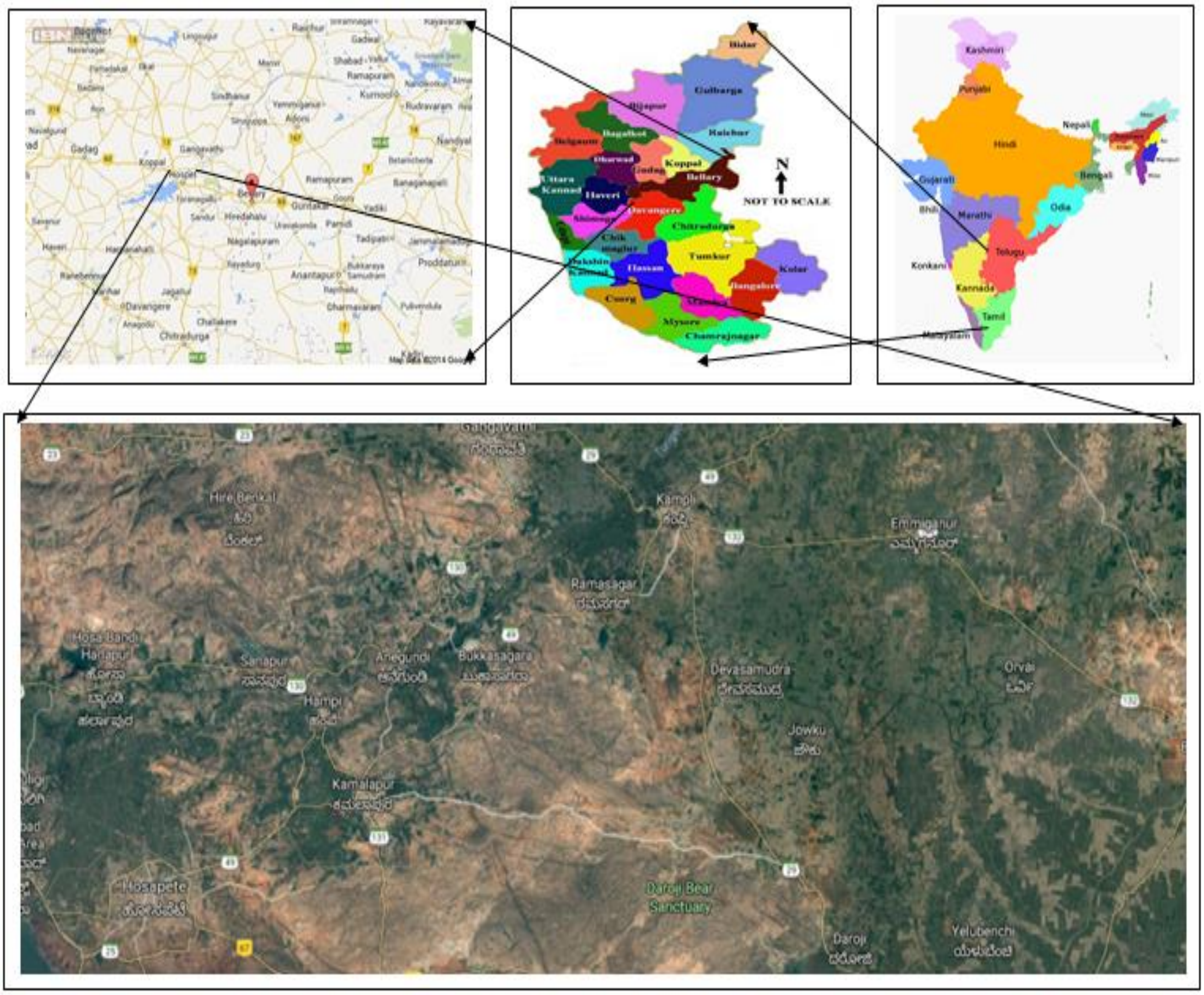

Fig. 1: Showing Location map of the North East of the Hospet Taluk, Bellary region

Table. 2: Concentrations of heavy metal ions in groundwater samples

Sl No.	Monsoon (Rainy Season)								Summer (Pre monsoon)								Winter Season							
	Fe	Zn	Cu	Ni	Cr	Al	Pb	Cd	Fe	Zn	Cu	Ni	Cr	Al	Pb	Cd	Fe	Zn	Cu	Ni	Cr	Al	Pb	Cd
HW-1	0.682	0.624	0.183	BDL	0.014	BDL	BDL	BDL	0.424	0.524	0.104	BDL	0.018	BDL	BDL	BDL	0.721	0.598	0.214	BDL	0.021	BDL	BDL	BDL
HW-2	0.241	1.245	0.312	BDL	0.023	BDL	BDL	BDL	0.124	1.105	0.248	BDL	0.026	BDL	BDL	BDL	0.324	1.324	0.421	BDL	0.019	BDL	BDL	BDL
HW-3	0.102	0.270	0.102	BDL	0.014	BDL	BDL	BDL	0.098	0.214	0.101	BDL	0.012	BDL	BDL	BDL	0.108	0.124	0.254	BDL	0.018	BDL	BDL	BDL
HW-4	0.124	0.624	0.091	BDL	0.012	BDL	BDL	BDL	0.094	0.528	0.089	BDL	0.018	BDL	BDL	BDL	0.241	0.164	0.120	BDL	0.022	BDL	BDL	BDL
HW-5	0.214	1.241	0.102	BDL	0.013	BDL	BDL	BDL	0.184	1.124	0.101	BDL	0.016	BDL	BDL	BDL	0.265	0.321	0.264	BDL	0.021	BDL	BDL	BDL
HW-6	0.169	1.700	0.124	BDL	BDL	BDL	BDL	BDL	0.116	1.624	0.142	BDL	0.014	BDL	BDL	BDL	0.198	0.189	0.214	BDL	BDL	BDL	BDL	BDL
HW-7	0.125	1.390	0.145	BDL	0.142	BDL	BDL	BDL	0.112	1.312	0.162	BDL	0.154	BDL	BDL	BDL	0.165	0.214	0.231	BDL	0.212	BDL	BDL	BDL
HW-8	0.214	1.211	0.112	BDL	BDL	BDL	BDL	BDL	0.189	1.101	0.104	BDL	BDL	BDL	BDL	BDL	0.278	0.345	0.224	BDL	BDL	BDL	BDL	BDL
HW-9	0.261	1.152	0.106	BDL	BDL	BDL	BDL	BDL	0.172	1.084	0.989	BDL	BDL	BDL	BDL	BDL	0.321	0.278	0.206	BDL	BDL	BDL	BDL	BDL
HW-10	0.039	0.989	0.145	BDL	0.021	BDL	BDL	BDL	0.029	0.896	0.162	BDL	0.032	BDL	BDL	BDL	0.079	0.042	0.214	BDL	0.042	BDL	BDL	BDL
HW-11	0.195	1.294	0.132	BDL	BDL	BDL	BDL	BDL	0.099	1.045	0.124	BDL	BDL	BDL	BDL	BDL	0.214	0.214	0.198	BDL	BDL	BDL	BDL	BDL
HW-12	0.241	0.892	0.243	BDL	0.142	BDL	BDL	BDL	0.124	0.8975	0.248	BDL	0.124	BDL	BDL	BDL	0.265	0.324	0.264	BDL	0.231	BDL	BDL	BDL
HW-13	0.125	1.150	0.412	BDL	0.121	BDL	BDL	BDL	0.105	1.056	0.389	BDL	0.108	BDL	BDL	BDL	0.186	0.189	0.423	BDL	0.181	BDL	BDL	BDL
HW-14	0.342	0.986	0.234	BDL	BDL	BDL	BDL	BDL	0.292	0.957	0.248	BDL	BDL	BDL	BDL	BDL	0.345	0.421	0.412	BDL	BDL	BDL	BDL	BDL
HW-15	0.162	0.920	0.124	BDL	BDL	BDL	BDL	BDL	0.121	0.829	0.120	BDL	BDL	BDL	BDL	BDL	0.241	0.178	0.189	BDL	BDL	BDL	BDL	BDL
HW-16	0.214	0.933	0.145	BDL	0.062	BDL	BDL	BDL	0.189	0.954	0.421	BDL	0.078	BDL	BDL	BDL	0.219	0.321	0.165	BDL	0.079	BDL	BDL	BDL
HW-17	0.129	0.998	0.124	BDL	0.043	BDL	BDL	BDL	0.108	0.986	0.145	BDL	0.054	BDL	BDL	BDL	0.265	0.178	0.214	BDL	0.058	BDL	BDL	BDL
HW-18	0.321	1.050	0.324	BDL	0.062	BDL	BDL	BDL	0.289	1.045	0.389	BDL	0.059	BDL	BDL	BDL	0.341	0.345	0.486	BDL	0.076	BDL	BDL	BDL
HW-19	0.145	0.825	0.192	BDL	0.014	BDL	BDL	BDL	0.112	0.865	0.189	BDL	0.021	BDL	BDL	BDL	0.245	0.241	0.278	BDL	0.081	BDL	BDL	BDL
HW-20	0.195	0.689	0.172	BDL	0.023	BDL	BDL	BDL	0.145	0.546	0.241	BDL	0.026	BDL	BDL	BDL	0.192	0.189	0.241	BDL	0.038	BDL	BDL	BDL
HW-21	0.241	0.802	0.203	BDL	BDL	BDL	BDL	BDL	0.201	0.879	0.201	BDL	BDL	BDL	BDL	BDL	0.248	0.345	0.231	BDL	BDL	BDL	BDL	BDL
HW-22	0.378	0.789	0.154	BDL	0.412	BDL	BDL	BDL	0.298	0.865	0.168	BDL	0.561	BDL	BDL	BDL	0.421	0.421	0.214	BDL	0.521	BDL	BDL	BDL
HW-23	0.125	1.020	0.241	BDL	BDL	BDL	BDL	BDL	0.112	0.984	0.246	BDL	BDL	BDL	BDL	BDL	0.165	0.165	0.321	BDL	BDL	BDL	BDL	BDL
HW-24	0.241	0.789	0.164	BDL	0.145	BDL	BDL	BDL	0.201	0.792	0.198	BDL	0.124	BDL	BDL	BDL	0.248	0.321	0.245	BDL	0.159	BDL	BDL	BDL
HW-25	0.169	0.628	0.145	BDL	BDL	BDL	BDL	BDL	0.125	0.568	0.241	BDL	BDL	BDL	BDL	BDL	0.198	0.214	0.189	BDL	BDL	BDL	BDL	BDL

Note: All parameters are expressed in ppm

Table. 3: Comparison of statistical data of different metals during the study period

Seasons	Monsoon (Rainy Season)				Summer (Pre monsoon)				Winter Season			
Parameters	**Fe**	**Zn**	**Cu**	**Cr**	**Fe**	**Zn**	**Cu**	**Cr**	**Fe**	**Zn**	**Cu**	**Cr**
Mean	0.216	0.216	0.177	0.051	0.163	0.911	0.231	0.058	0.260	0.307	0.257	0.071
Standard Error	0.025	0.025	0.016	0.018	0.017	0.057	0.037	0.023	0.024	0.048	0.018	0.023

Median	0.195	0.195	0.145	0.014	0.124	0.954	0.189	0.018	0.245	0.241	0.231	0.021
Mode	0.241	0.241	0.145	0.000	0.112	1.045	0.248	0.000	0.265	0.321	0.214	0.000
Standard Deviation	0.125	0.125	0.079	0.090	0.086	0.285	0.183	0.114	0.122	0.242	0.089	0.117
Sample Variance	0.016	0.016	0.006	0.008	0.007	0.081	0.034	0.013	0.015	0.058	0.008	0.014
Kurtosis	7.613	7.613	2.102	10.848	2.429	1.475	12.544	16.725	8.166	13.669	1.109	8.725
Skewness	2.278	2.278	1.496	3.024	1.452	-0.158	3.206	3.845	2.284	3.337	1.286	2.715
Range	0.643	0.643	0.321	0.412	0.395	1.410	0.900	0.561	0.642	1.282	0.366	0.521
Minimum	0.039	0.041	0.091	0.000	0.029	0.214	0.089	0.000	0.079	0.042	0.120	0.000
Maximum	0.682	1.700	0.412	0.412	0.424	1.624	0.989	0.561	0.721	1.324	0.486	0.521
Sum	5.394	5.394	4.431	1.263	4.063	22.781	5.770	1.445	6.493	7.665	6.432	1.779

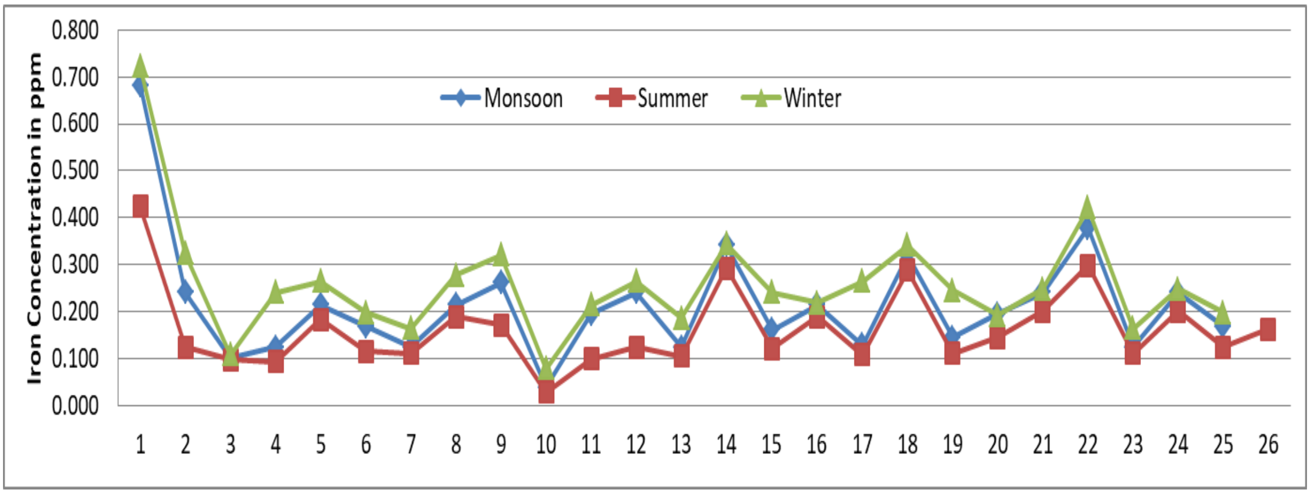

Fig. 2: Seasonal variations of Iron (ppm) during the study period

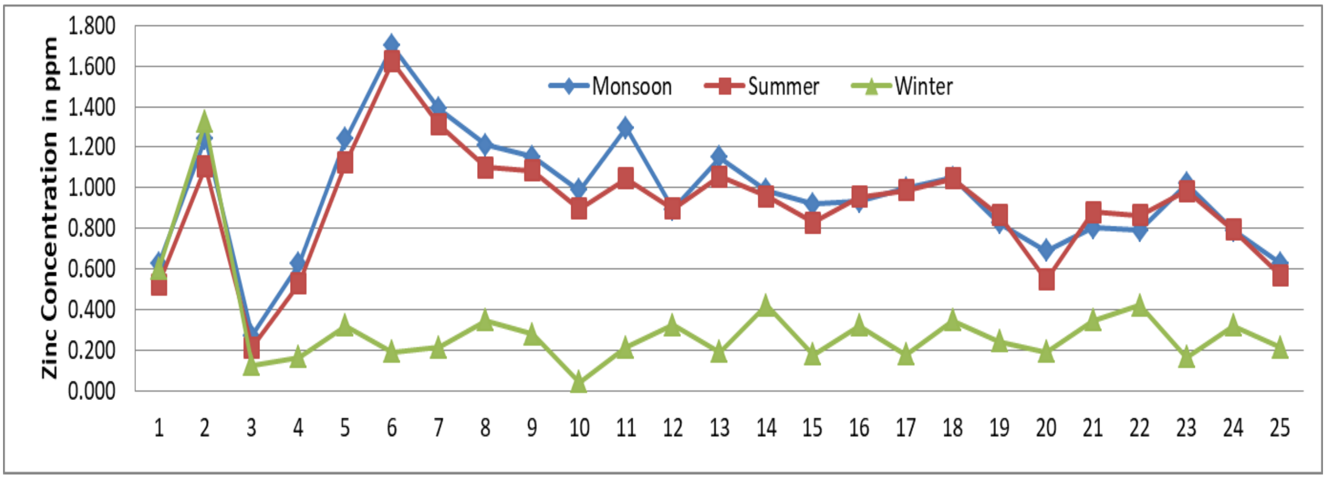

Fig. 2: Seasonal variations of Copper (ppm) during the study period

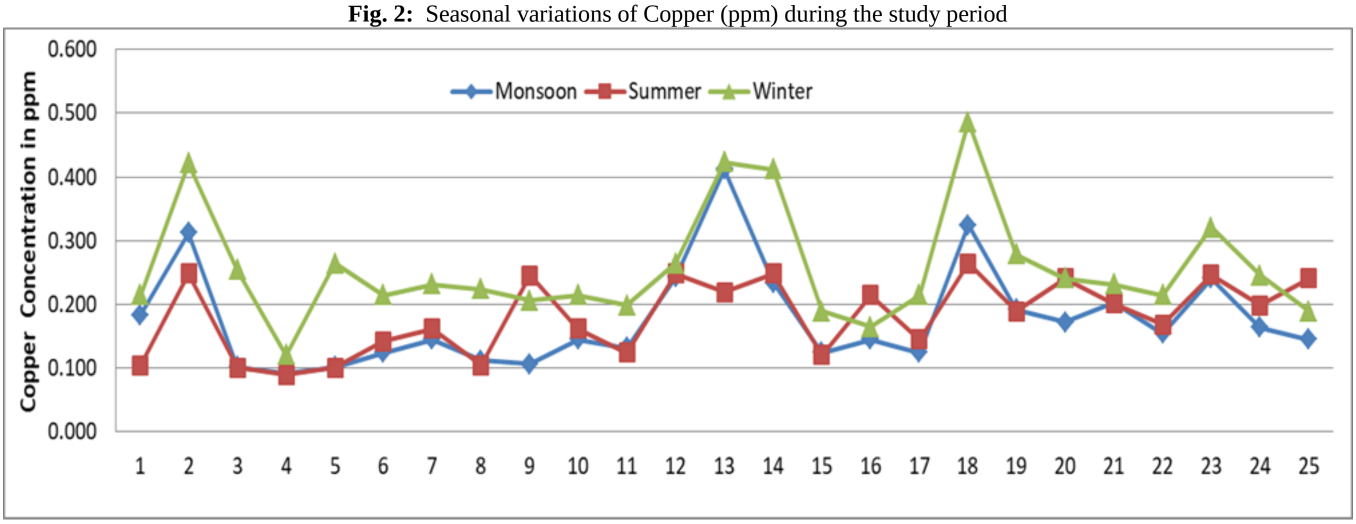

Fig. 2: Seasonal variations of Zinc (ppm) during the study period

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