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HEAVY METAL TOXICITY IN GROUND WATER AROUND RAISER AREA LOCATED IN BIKANER DIVISION OF WESTERN RAJASTHAN

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ABSTRACT

Water quality is one of the most important concerns. The heavy metals in drinking water may cause severe health problems in human beings and also effect the growth and metabolic activities of plants. In this study heavy metals evaluated along with Na and K in the ground water of Raisar and its surrounding villages in district Bikaner of Rajasthan state. For this study 20 ground water samples were collected in year 2012. These samples were subjected to analysis for heavy metal like Fe, Mn, Cu and Zn by AAS method and Na and K by Flame Photometry method. The analysis of samples shows that following metals ranged from: Fe (0.02 to 0.1 ppm), Mn (0.005 to 0.079 ppm), Cu (0.02 to 0.25 ppm), Zn (1.8 tito 5.8 ppm), Na^+ (77 to 901 ppm) and K^+ (2 to 12 ppm). The results obtained were compared with BIS standards for drinking water and FAO standard for irrigation water. The presence of the heavy metals like Cu and Zn with Na^+ in ground water beyond the desirable limit warns for the disease in living beings. Our study suggested the preventive measures should be adopted to control the contamination of ground water of this region.

Key words: Heavy metals, Toxicity, Ground water, Bikaner, Rajasthan.

INTRODUCTION

Of all the natural resources, water is unarguably the most essential and precious. It is a universal solvent and as a solvent. It provides the ionic balance and nutrients that support all forms of life. In India, the major source of water used to meet the domestic, agricultural and industrial needs is the ground water[1]. In recent years, the growth of industry, technology, population, chemical fertilizers, uses of pesticides and some other problems like sewer leakage etc. degraded the ground water quality[2].

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In Bikaner district although the Indra Gandhi canal water is utilized for irrigation and drinking purpose, but ground water is the sole source of drinking irrigation water for local population of village's around Raisar[3]. The Bikaner district lies in arid zone of western Rajasthan and is a part of Thar Desert. It covers an area of about 27, 244 sq Km and lies between North Latitudes $27^{o}11'$ to $29^{o}03'$ and East Longitudes $71^{o}54'$ to $74^{o}12'$. The present research work covers an area around village Raisar and falls between North Latitude $27^{o}50'$ to $28^{o}05'$ and East Latitude $73^{o}30'$ to $73^{o}45'$.[4]

The present study has been carried out to evaluate the heavy metals like Fe, Mn, Cu, Zn along with Na and K ions in ground water of villages around Raiser, Bikaner District of Rajasthan state. Heavy metals contamination has been recognized as a major environmental concern due to their pervasiveness and persistence. These heavy metals are not biodegradable; hence, there is a need to develop such a remediation technique which should be efficient, economical and rapidly deployable in a wide range of physical setting[5]. If the heavy metals are present in large amount in water, also affect the quality of water and make water unfit for drinking, domestic, industrial and agricultural purpose.

EXPERIMENTAL

Material and methods

For heavy metals analysis twenty water samples were collected from Raiser and surrounding villages. The samples were collected during the month of May 2012 before monsoon. The samples were collected in polyethylene bottles (1 Liters capacity) which had been thoroughly washed with distilled water and rinses several times with the water to be collected. After collection of water samples add 5 mL concentrated HNO_3 in order preserve the metals and also avoid precipitation.

The collected samples were filtered by Whatman No. 42 filter paper. The samples were digested with concentrated nitric acid, to removal organic impurities from the samples and thus prevent interference in analysis. 10 mL of HNO_3 was adding to 100 mL of water in a 250 mL conical flask. The mixture was evaporated to half its volume on a hot plate after which it was allowed to cool and then filtered[6].

The analysis of heavy metal like iron, manganese, copper and zinc is done by using Atomic Absorption Spectrophotometer (AAS) and flame photometric method is used for sodium and potassium[7].

RESULTS AND DISCUSSION

The result of the AAS and flame photometric analysis of all the samples are shown in Tables 1.

Table 1: Concentration of metal ions in the groundwater samples collected during pre monsoon period-2012

S. No.	Name of Village	Fe	Mn	Cu	Zn	Na	K
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
1	Ranisar	0.08	0.04	0.1	1.8	230	12
2	Naurangdesar	0.02	0.01	0.12	5.5	609	4
3	Bamblu	0.02	0.005	0.1	2.2	402	4
4	Bichwal	0.1	0.079	0.25	2.1	550	7
5	Pemasar	0.04	0.012	0.14	2.4	901	4
6	Udasar	0.04	0.021	0.14	2.8	454	5
7	Raisar	0.03	0.013	0.1	3.3	867	5
8	Himtasar	0.04	0.016	0.12	3.4	459	4
9	Ridmalsar	0.05	0.031	0.08	2.5	570	7
10	Sheobari	0.1	0.078	0.2	5.8	395	4
11	Bhinasar	0.08	0.042	0.18	5.1	298	5
12	Udramsar	0.04	0.017	0.15	5.4	153	5
13	Kilchu	0.04	0.022	0.14	2.4	143	4
14	Gadwala	0.02	0.008	0.02	2.2	177	2
15	Napasar	0.05	0.032	0.05	4.5	249	6
16	Sinthal	0.02	0.009	0.02	2.2	103	4
17	Mundsar	0.03	0.007	0.23	4.3	77	3
18	Belasar	0.03	0.012	0.18	3.8	149	3
19	Tejrasar	0.03	0.019	0.14	4	276	6
20	Gusainsar	0.04	0.018	0.08	2.4	142	2

The Table 1 presents the distribution of heavy metal like Fe, Mn, Cu, Zn, and Na and K at different key wells of sturdy area. The effect of these metals on the nature of water can be visualized as follows -

Iron: Iron is most commonly available metal on the planet earth. Iron deficiency in human body causes anemia but its high amount affects target organs which are the liver, cardiovascular system and kidneys[8]. According to BIS drinking water standard the desirable limit of iron is 0.3 ppm, which may be extend up to 1 ppm. In study area the iron varies from 0.02 ppm to 0.1 ppm. This shows that iron content in water samples are less than the permissible limit.

For irrigation water FAO recommended maximum concentration of Fe is 5 mg/L. All samples are below the permissible limit. Iron plays an important role in respiration, photosynthesis and production of healthy green leaves. Plants suffer from chlorosis and stunted growth due to ion deficiency[9].

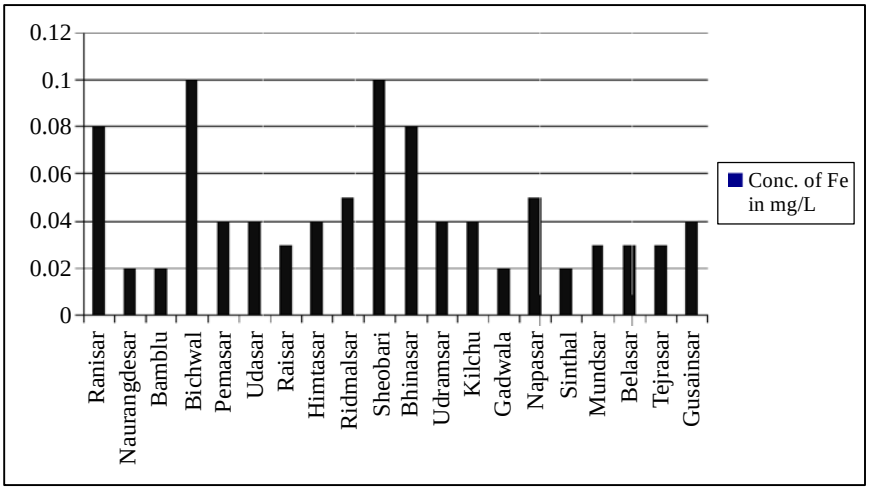

Fig. 1: Concentration of Fe metal in ground water samples

Manganese: It is lethal to humans in higher concentration. It is essential as a cofactor in enzyme systems and metabolism processes. Its chronic exposure leads to neurological disorders[10]. It imparts undesirable taste and stains plumbing fixtures and laundry. According to BIS drinking water standard the desirable limit of manganese is 0.1 ppm, which may extend up 0.5 ppm. In Table 1 the ground water samples show the range of Mn from 0.007 to .079 ppm, which is found in permissible limit.

In all ground water samples Mn is below the maximum recommended limit 0.2 mg/L given by FAO for irrigation water. Less concentration of manganese causes disturbances in plant mechanisms[11].

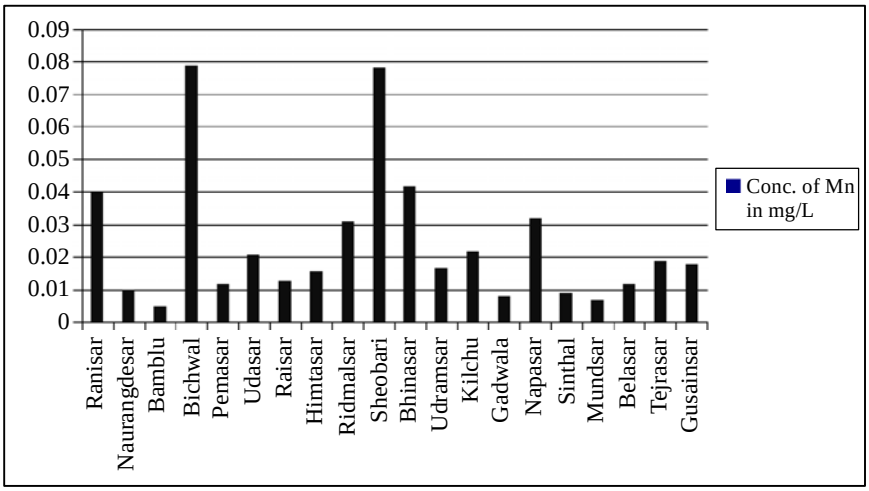

Fig. 2: Concentration of Mn metal in ground water samples

Copper: The Table 1 shows the copper in study area ranged from 0.02 ppm to 0.25 ppm. The desirable limit of coppers is 0.05 ppm according to BIS drinking water standard, which may be extend up to 1.5 ppm. The study shows that except villages Gadwala, Napasar & Sinthal in other 17 villages the copper concentration is more than desirable limit. Copper is essential components of key metalloenzyme that maintain the vascular and nervous system[12]. Ingestion of excessive copper can cause gastrointestinal distress with symptoms such as nausea, vomiting, and abdominal pain. Liver toxicity was seen in doses high enough that resulted in death[13].

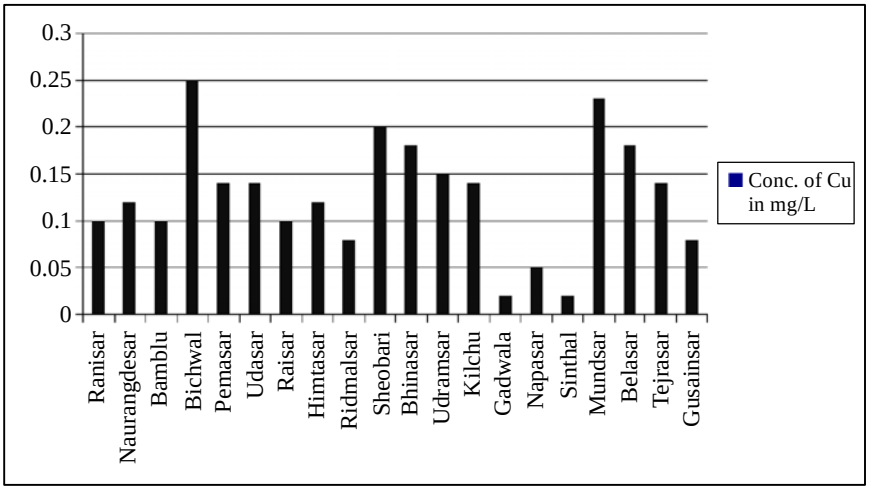

Fig. 3: Concentration of Cu metal in ground water samples

For irrigation water FAO recommended maximum concentration of Cu is 0.2 mg/L. In two sample sites Bichwal and Mundsar the copper concentration is high. Excess of Cu in soil plays a cytotoxic role, induces stress and causes injury to plants. This leads to plant growth retardation and leaf chlorosis[14].

Zinc: In the present study, the zinc concentration has been found to be 1.8 ppm to 5.8 ppm. The maximum desirable limit of Zn is 5.0 ppm according to BIS drinking water standard, which may be extended up to 10 ppm. The analysis of Table 1 shows that some sample sites like Naurangdesar, Sheobari, Bhinasar, Udramsar have value of Zn more than 5 ppm. The higher concentration of Zn causes gastrointestinal effects such as abdominal pain, vomiting and diarrhea, anaemia and renal damage. Very high levels of zinc can damage the pancreas and disturb the protein metabolism[15].

The maximum recommended limit of irrigation water for Zn is 2.0 mg/L given by FAO. Except village Ranisar all 19 ground water samples have Zn concentration more than 2.0 mg/L. High levels of Zn in soil inhibit many plant metabolic functions; result in retarded growth. Zinc toxicity in plants limited the growth of both root and shoots. Zinc toxicity also causes chlorosis in the younger leaves, which can extend to older leaves after prolonged exposure of zinc[16].

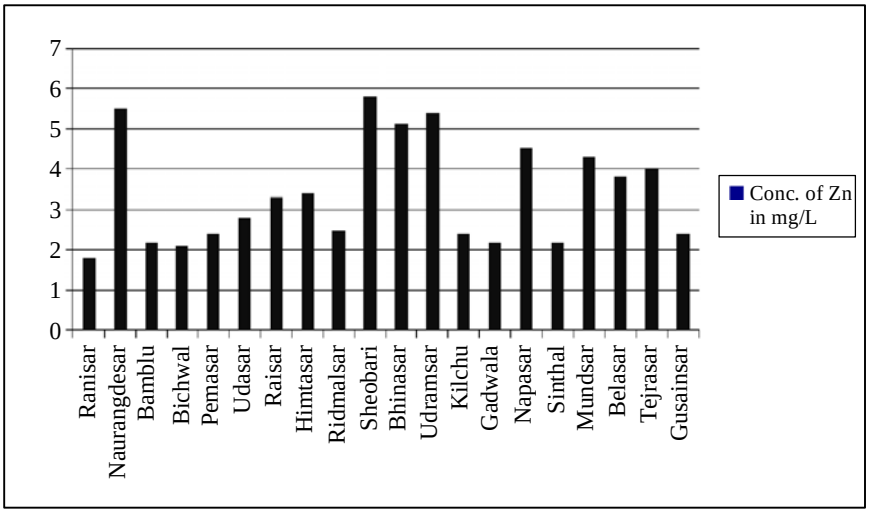

Fig. 4: Concentration of Zn metal in ground water samples

Sodium: Sodium (Na) occurs as a major cation in the water samples. The primary

source of sodium in natural water is from the release of the soluble products during the weathering of igneous rocks. The concentration of sodium in the study area varies from 77 to 901 mg/L. the maximum permissible limit of sodium is 200 ppm as prescribed by WHO and other organization. Except the villages Udramsar, Kilchu, Gadwala, Sinthal, Mundsar, Belasar and Gusiansar the ground water of other villages comes under the non safe zone for drinking with reference to the concentration of sodium. The high concentration of sodium causes severe health problems like hypertension, heart disease and kidney problem[17].

In plants the sodium toxicity symptoms are leaf burn and dead tissue along the outside edges of leaves. High sodium (Na) in irrigation sources may lead to the deterioration of soil structure[18].

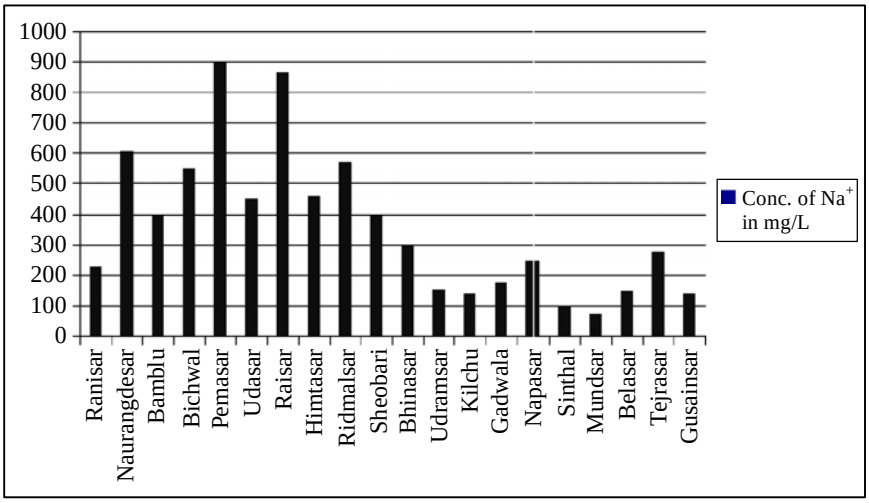

Fig. 5: Concentration of Na^+ in ground water samples

Potassium: The most common minerals for potassium source are the feldspar, microcline leucite, biotite present in the granite of the area[19]. The behavior of potassium (K) is generally similar to the sodium content in water but its concentration as much as low in compare to sodium in ground water. It maintains fluid in balance stage in the human body. The excess amount of potassium present in the water sample may lead nervous and digestive disorder[20]. It is one of the essential macro minerals for plant survival. Its presence is of great importance for soil health, plant growth and animal nutrition. In present investigation potassium concentration was ranged from 2 to 12 mg/L. All the samples have potassium concentration in permissible limit.

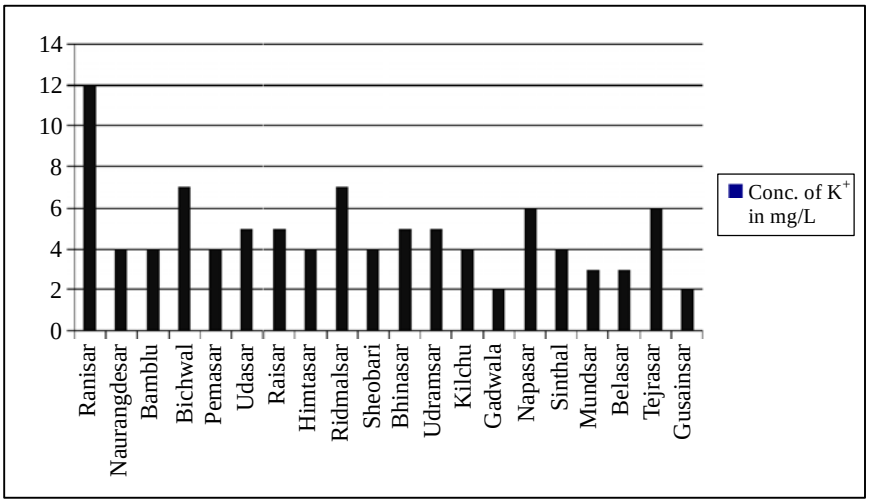

Fig. 6: Concentration of K^+ metal in ground water samples

CONCLUSION

The ground water quality assessment on the heavy metal helps to getting better information result. It is evident that in the present study the highest concentration of Fe and Mn is 0.1 mg/L and 0.079 mg/L, respectively. The concentration of these metals is below the recommended limit for drinking and irrigation purposes. However the highest concentration of Cu is 0.25 mg/L. The result shows that 85% of samples are above the maximum desirable limit (0.05 mg/L) for drinking & 8.33% samples were far above the maximum recommended limit (0.2 mg/L) for irrigation purposes. The highest concentration of Zn in samples is 5.8 mg/L. The result shows that 20% samples are above the maximum desirable limit (5.0 mg/L) for drinking and 95% samples are above the maximum recommended limit (2 mg/L) for irrigation purpose. In many sample sites Na concentration is also very high for drinking and irrigation. The result shows that K concentration is in the range for drinking and irrigation purpose. Even though, the condition is not very bad at present, there may be problems if the same continues in future and the ground water sources will be completely polluted and become unfit for drinking and other purpose. Hence this is high time to preserve and protect these precious resources.

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